

2021

**PURDUE FALL
UNDERGRADUATE
RESEARCH
EXPOSITION**

NOVEMBER 15-22, 2021

West Lafayette, Indiana

THANK YOU TO THE FALL EXPO SUPPORTERS

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College of Education	College of Pharmacy	Purdue Polytechnic Institute
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	Krannert School of Management	

SEE YOU IN THE SPRING!

Spring Undergraduate Research Roundtable

Date to be determined (late January/early February) | Virtual using Discord

Undergraduate Research Pitch Competition

Date to be determined (mid-March) | In-person presentations with YouTube Livestream

More information and submission site coming January 2022.

Spring Undergraduate Research Conference

April 11-15, 2022 | Anticipated hybrid format

More information and submission site coming January 2022.

Celebrate Thinkers, Creators, & Experimenters

April 21, 2022 | In-person

More information and submission site coming January 2022.

Spring 2022 Undergraduate Research Seminars

Semester-long | In-person

Topics and dates announced January 2022. Submit topics to ugresearch@purdue.edu.

SPECIAL APPRECIATION TO THE CONFERENCE PLANNING COMMITTEE'S UNIT DELEGATES FOR SUPPORT IN ORGANIZING THIS EVENT

PRESENTER KEY

Last Name	First Name	Presentation
Agarwal	Ishika	1
Agrawal	Aditya	53
Akert	Karl	96
Akinleye	Olukunle	13
Al Salmi	Salim	173
Alangari	Abdulrahman	5
Aldawood	Mohamad	5
Alkishi	Faisal	5
Allington	Carley	2
Alminauskas	Gabriel	3
Almorohen	Yasmeen	21
Alsinan	Nasser	5
Alturkait	Deemah	4
Alwakeel	Mohammed	5
Amin	Arpit	6
Anderson	Lauren	102
Arellano	Paloma	7
Arend	Grace	8
Arinze	Brianna	103
Arndt	Mitchell	9
Aroumougam	Hemanth	96
Arowolo	Muyiwa	55, 83
Ashok	Rahul	78
Attardo	Joseph	56
Ayhan	Doruk	10, 11
Ayub	Jinan	104
Babuisis	Nicholas	12
Ballabh	Sagnik	122
Banna	Vishnu	105
Bastian	Joanna	106
Bateriwala	Viranch	107
Beckman	Jennifer	108
Behl	Ranjan	6
Bellad	Gouri	13
Bernicke	Daniel	7
Bernstein	Zach	130
Berry	Nathan	14
Bhatia	Arsh	109
Bicim	Umut	15, 34
Binti Khairul Hisham	Aliah Adriana	16
Booker	Harrison	19
Boyd	Ryan	56
Buchanan	Jonathan	70

Last Name	First Name	Presentation
Budde	Jessica	148
Buellesbach	Ava	61
Bullock	John	105
Burgess	Mason	17
Camarillo	Javier	110
Campbell	Collin	148
Castilho	Miguel	7
Castillo	Jahsiah	151
Castro	Raul	111
Chadha	Harsabreen	112
Chambers	Evan	113
Chan	Pou Hei	18
Chanchani	Shaan	79
Chang	Younggil	19
Chen	Caroline	157
Chen	Eric	19
Chen	Guhao	20
Chen	Ken	138
Chen	Ting-Han	105
Cheng	Erica	138
Chie	Chongyi	21
Choi	Heera	46
Chokkhanchitchai	Tanon	17
Chopra	Tasveen	22
Christie	Niamh	23
Chun	Daniel	47
Collins	Tyler	24
Coltin	Eli	64
Cooke	MaryClaire	25
Craven	Mitchel	122
Cuevas-Quiñones	Sara	26
Damge	Rachel	106
Daudi	Hasnain	27
Davin	Connor	28
Davis	Ben	30
Davis	Chyna	29
Davis	Kameryn	142
Davis	Kevin	54
Davis	Zachariah	31
Davis	Zachary	38
Degener	Martin	11
Desai	Tirth	24
Dickerson	Charles	142

Last Name	First Name	Presentation
Diemer	Tim	172
Dimitri	Brandon	114
Dinh	Alice	133
Dragnea	Alice	115
Dube	Amikosh	19
Duncan	Claudia	116
Eliopoulos	Nick	148
Elkin	Sam	90
Emenim	Chinonso	117
Fang	Scott	53
Farino	Dominick	117
Fauber	Daphne	146
Fedrizzi	Tyler	19, 32
Feinberg	Rachael	118
Feng	Xinyi	119
Fink	Alexander	3
Fisher	Aidan	121
Fisher	Claire	120
Flanary	Sean	122
Flaningam	Eric	64
Fotedar	Gautam	33
Freck	Joseph	176
Frederick	Jeremy	114
Friedman	Samantha	106
Fulford	Hanna	15, 34
Gan	Yiting	148
Garg	Aaryan	148
Garg	Avika	35
Garg	Avika	38
Gatewood	Aubrey	147
Giacchetti	Mason	122
Gibbs	Kai	24
Gildenhuys	Nicholas	162
Gilley	Bryson	7
Godhani	Akshay	123
Goli	Preethi	78
Graber	Matthew	124
Grafford	Emma	61
Green	Lily	125
Griffin	Colton	36
Grynheim	Nira	126
Guada	Santiago	78
Guard	Daksh	122

Last Name	First Name	Presentation
Guardado	Ethan	37
Gunapati	Neha	127
Guo	Xiangyu	53
Gupta	Apoorva	172
Gupta	Krish	38
Han	Jiaxuan	47
Hanna	Lydia	147
Hasan	Haris	39
Hastidt	Robert	40
Haydock	Josephine	128
Heinowitz	Caitlin	115
Hernandez	Brandon	41
Hershberger	Drake	129
Hesting	Lauren	42
Heying	Robert	58
Hiner	Austin	130
Hochbaum	Jasper	123
Hodges	Madison	131
Hoerner	Owen	30
Holder	Kal	43
Holesha	Samantha	132
Hu	Dainong	45, 148
Hu	Yiliu	44
Huang	Joseph	133
Huang	Laula	133
Huang	Po-Ying	68, 95
Huang	Yule	10
Huntoon	Dylan	52
Hwang	Jongkyu	50
Ibrahim	Mohamed	134
Iwu	Stephen	158
Jennewein	Aidan	60
Jensen	Ryan	24
Jeon	Brad	105
Jeong	Byeongchan	46
Jin	Yeonseung	47
Jordana	Gladys	79
Jung	Leonard	6
Kallam	Saket	79
Kalra	Adhiksit	135
Kang	Connie	45
Kawiecki	Joe	11
Kayrouz	Colby	136

Last Name	First Name	Presentation
Keeven	Weston	51
Keller	Lael	79
Kenning	Scott	48
Kim	Han Soo	50
Kim	Jaeeun	49
Kim	Juhyung	46
Kim	Tyler	130
Kimera	Lynnet Francesca	137
King	Audrey	125
Klokkevold	Katherine	51
Kneeland	Katherine	52
Kocher	Ayden	138
Kolar	Tomas	86
Koshy	Joshua	173
Kosmerl	Mark	12
Kovalan	Ethan	58
Kraynik	Matt	86
Krefta	Oliver	121
Krishnan	Arshee	106
Krishnasamy	Jagan	139
Krutsch	Jackie	140
Kulali	Sharon	141
Kumar	Deepthi	54
Kummarapurugu	Sanjeev	101
Kupka	Abigail	161
LaCoursiere	Chase	86
Lagpacan	Zach	7
Lam	Jamie	3
Lan	Yunhao	24
Lantz	Max	10
Larrea	Ariana	133
Le	Victor	139
Leatherman	Johanna	61
Lee	Chun	53
Lee	Eugene	54
Lee	Max	123
Lee	Ming-chin	176
Lee	Seoyoung	53
Li	Bohou	17
Lin	Yu-Hsuan	147
Liu	Jingyuan	133
Liu	Mingyuan	159
Liu	Shuihan	17, 92

Last Name	First Name	Presentation
Llerena	Mateo	142
Lo	Lawrence	28
Lo	Wang Ning	92
Loesch	Olivia	143
Loney	Alexander	55, 83
Loshe	Benjamin	56
Lovell	Heath	53
Macatangay	Jalen	57
Mahajan	Riya	58
Manglore	Nikhil	147
Marks	Alexander	59
Marupeddi	Vinitha	138
Masaeng	Aleena	12
Maxey	Christopher	7
Mayo	Christine	60
McKenzie	Nick	58
McNealey	Amaya	144
Mendez	Brianna	61
Mishra	Suyash	145
Mohammed M	Mahdi	70
Mondal	Ankit	10
Moon	Youngjoo	46
Morrison	Chris	86
Mueller	Kathryn	146
Mui	Marvin	19
Mulchandani	Elan	58
Murday	Matthew	114
Murthy	Sanjana	62
Naidu	Siddhesh	11
Narasimha	Rohan	63
Narra	Niharika	147
Neville	Alec	12
Newell	Jace	64
Ngo	Raymond	86
Nguyen	Long	138
Nord	Tyler	10
Oberley	Will	75
Pachalla	Vaibhav	138
Pachin	Tikhon	147
Padmanabhan	Nimal	92
Pai	Aaditya	101
Pal	Neha	12
Panzade	Aarini	75

Last Name	First Name	Presentation
Park	Erin	10
Park	Jason	32
Patel	Ansh	22
Patel	Avi	138
Patel	Dev	65
Patel	Seejay	114
Patil	Rohan	79
Pattaswamy	Kartik	66
Pilaszewicz	Artur	7
Pirrello	Julia	67
Prabhu	Annapoorna	147
Praharaj	Ayush	68
Prakash	Raghul	158
Prakash	Tejas	19
Prall	Anna	69
Pramanik	Sohan	148
Prasannakumar	Akshaj	28
Priebe	Christopher	86
Prince	Owen	162
Priyadarshini	Neha	47
Pu	Congyu	100, 149
Putziger	John	150
Quan	Ian	123
Rabindran	Sudarmadhi	61
Rajiv Gadre	Rishikesh	27
Rajpal	Angel	53
Ram	Naren	79
Ramirez	Sabine	151
Ramkumar	Adhitya	68
Ramsey	Patrick	152
Ranawat	Harsh	17
Ranka	Rushabh	133
Rao	Ishaan	12
Rastogi	Shreya	153
Raviprakash	Rthvik	70
Rayan	Sahana	154
Rebeiro	Aloysius	87
Reed	Alison	155
Regier	Nicholas	71
Reinecke	Becca	22
Rittner	Evan	11
Roach	Mallory	156
Robinson	Melchizedek	58

Last Name	First Name	Presentation
Rodriguez	Julianne	151
Roffers	Megan	157
Rogers	Alex	138
Romans	Daniel	158
Rondon Cordero	Hannah	72
Rothschild	Molly	159
Roy	Abigail	115
Rubin	Lian	22
Rubino	Ben	73
Russell III	Carl	74
Saeed	Ibrahim	75
Sahin	Burkay	78
Salisbury	Peter	160
Santos	Diane	76
Saridena	Abhiram	148
Schmittenberg	Elliott	161
Scirocco	Michael	68
Scott	Anthony	77
Sebal	Nick	24
See	Jing Yin	162
Sego	Robert	78
Seidita	Dominic	163
Seo	Leo	30
Sethi	Yashoheet	12
Sharma	Shreya	22
Shashidhar	Pranav	79
Shatkowski	Benjamin	164
Shen	Kaiwen	56
Simons	Sitara	106
Singh	Pranav	24
Singh	Siddharth	17
Singhal	Saurabh	66
Sinha	Prateek	173
Sinha	Shantanu	165
Sinpanyalert	Poonyapat	80
Sipes	Abigail	81
Sirit	Isabella	82
Skiba	Lisette	166
Skoumal	Griffen	58
Smith	Kylie	178
Smith	Samuel	12
Sodunke	Olan	55, 83
Sommer-Kohrt	Kylie	61

Last Name	First Name	Presentation
Song	Harim	47
Sonnenberg	Madelyn	8
Sridhar	Shashank	19
Srigiri	Vedha	60
St. Pere	Thomas	167
Stanczykiewicz	Elena	84
Sturt	Shannon	85
Sun	Jennifer	168
Suppiah	Alexander	10
Thai	Meghan	96
Thalos	Andrew	130
Thapar	Hersh	13
Thomas	Elizabeth	172
Thompson	Jackson	130
Tokala	Rohit	148
Tonissen	Sara	169
Tran	Hoang	148
Tran	Huy-Minh	86
Truppner	Casey	130
Tsai	Darin	87
Tsai	YaLing	90
Tuchinda	Pume	105
Unger	Samantha	22
Upatising	Vichapat	79
Urmanov	Aleksey	22
Valdez	Jacob	11
Van	Duncan	45
vanVeldhuisen	Aletea	170
Vargas	Christian	142
Velleca	Aidan	24
Venkatachalam	Ilakkiya	88
Verastegui	Nicholas	86
Vinodh Sangeetha	Sundhararajan	6
Voss	Lauren	89
Wadlington	Sam	12
Waldren	Matthew	90
Walter	Ryan	38
Wang	Christopher	173
Wang	Hang	91
Wang	Henry	30
Wang	Jerry	101
Wang	Sharron	38
Wang	Shiqi	56

Last Name	First Name	Presentation
Wang	Sirou	171
Wang	Tong	172
Wang	Xingjian	133
Washer	Emilie	174
Wen	Zongdao	92
White	Marissa	175
Williams	Taylor	93
Woerner	Sean	94
Wondaferahu	Essey Wondaferahu	151
Wong	Elliot	52
Wongsonegoro	Harrison	32
Woo	Joseph	19
Wu	Bo-Yang	68, 95
Wu	Songhao	96
Wu	Yuxuan	100
Xie	Wencong	98
Xie	Zhengxiang	97
Yang	Wenhui	17
Young	Victoria	179
Young	William	7
Yu	Tiffany	78
Yu	Yue	176
Zabalegui Lopez	Erik	27
Zabit	Marc	30
Zeng	Hui	100
Zhang	Alan	87
Zhang	Kaiqi	101
Zhang	Katherine	92
Zhao	Yueting	177
Zhilinskaya	Irina	178
Zhou	Timothy	56
Zurek	Adam	121

RESEARCH TALKS

A Hierarchical Framework for Safe Reinforcement Learning

Author(s):

Ishika Agarwal, College of Science

Abstract:

We proposed a two-level hierarchical framework for safe reinforcement learning. The high-level part is a search-based planner with a Lyapunov heuristic generated in the lower-level part. The planner aims at generating safe and efficient paths for complex tasks. The lower-level part contains a learning-based controller and its corresponding Lyapunov function, which characterizes the controller's stability property. We train the learning-based controller with goal-conditioned reward in an open-space environment, where the learning agent is safe to operate. We collect data to characterize its stability property with the trained neural network controller and learn a Lyapunov function from the collected data. The generated Lyapunov function serves two purposes. First, it will be part of the high-level heuristic for our planning algorithm. Second, it acts as a part of runtime shield to guard the safety of the whole system. Our framework can operate safely in complex environments with both static and dynamic obstacles. We demonstrated the effectiveness of a range of navigation tasks with various robot dynamics.

Mentor(s):

Zikang Xiong, College of Science, Computer Science

Suresh Jagannathan, Purdue University

Forward Genetic Screening for Suppression of spirrig distorted double mutants in Arabidopsis thaliana trichomes

Author(s):

Carley Allington, College of Agriculture

Abstract:

The actin cytoskeleton is necessary to transport and deliver raw materials for cell wall assembly during growth. Leaf hairs or trichomes serve as microscopic chemical and physical protection to plants, and those of *Arabidopsis thaliana* leaves have revealed the Actin-related protein (ARP) 2/3 pathway of actin polymerization. ARP2/3 is a protein complex known to be necessary polymerize actin meshworks that align actin bundles roadways needed for transport within the cell. SPIRRIG is a protein also involved in the actin-dependent growth pathway in plants that recent research has suggested negatively regulates ARP 2/3. A mutation in the ARP2 subunit-encoding gene of produces trichomes with bloated stalks and short branches (arp2/wrm), while mutations in SPIRRIG are known to cause a weak distortion including elongation and moderate twisting of the trichome branches (spirrig). The arp2;spirrig double mutants have a partially rescued arp2/wrm phenotype, indicating that SPIRRIG negatively regulates a cellular activity or protein that is involved in ARP2/3-dependent growth. Therefore, using a forward genetic approach an investigation on the suppression of this negative interaction was conducted. Initial observations of this study yielded that a mutation in an unknown gene(s) activity causes the partially rescued arp2;spirrig to revert to the strong arp 2/wrm loss of function phenotype. The suppressor of suppressor screen identified many arp2;spirrig double mutants that had been converted back to the strong arp 2/wrm phenotype. For the recessive suppressor of arp 2/wrm -1 (sas1) statistically significant reduction in trichome branch length was observed in sas1 compared to the control arp2;spirrig. We predict that sas1 will identify a new pathway that promotes branch elongation either in parallel or in series after ARP2 functions. DNA isolation and next generation genome sequencing of bulked segregants in a mapping population is being utilized to clone SAS1 and the other suppressors. We expect to uncover unknown components of the actin dependent morphogenesis pathway in *Arabidopsis thaliana* trichomes.

Mentor(s):

Daniel Szymanski, College of Agriculture, Agronomy

Quantum Integrated Photonics: Photonic Integrated Circuits

Author(s):

Gabriel Alminauskas, College of Engineering

Jamie Lam, College of Engineering

Alexander Fink, College of Engineering

Abstract:

To supplement and replace traditional electronics, many common electrical applications- from communications and sensors, to even integrated circuits and processors- can be replaced with counterparts using light. Integrated photonics focuses on this field, and the development of photonic integrated circuits aims to integrate multiple light-using components on one circuit, similar to its electronic counterpart. To design these circuits, their components are currently simulated and tested using Lumerical's Finite-Difference Eigenmode (FDE) simulator, which tests their reaction to different conditions. Then, these components are combined and integrated into the overall circuit, which will then be fabricated for real-world testing. One essential component in the development of these circuits is the testing of the simulation environment itself, ensuring that it's results accurately represent reality: one method of this is known as convergence testing. To do this testing, a common photonic element- e.g., a rectangular silicon waveguide- is tested to find it's simulated Effective refractive index (n_{eff}) over a commonly used range of wavelengths of light. Then, to determine its accuracy, testing conditions mostly unrelated to this n_{eff} index (such as simulation area and coarseness of sampling) are varied to determine if this n_{eff} value converges around an expected value, determining that slightly varying simulations of the same component produce approximately the same result. Confirming that the simulated environment produces consistent results, the component can be tested with more intensive simulated environments (such as the application of heat) in preparation for developing higher-level components.

Mentor(s):

Lucas Cohen, College of Engineering, Electrical & Computer Engineering

Research Talk Presentation: 4 :: Social Sciences/Humanities/Education

Exploring the interaction between provocation, grandiose narcissism, and intimate partner violence

Author(s):

Deemah Alturkait, College of Health & Human Science

Abstract:

Narcissism is seen to be related to general aggression, as people with grandiose narcissism (GN) tend to behave aggressively in order to regain respect from people who may have undermined their abilities. One model to help explain this relationship is the Threatened Egotism Model, which asserts that the threat of disturbances to one's self-esteem may lead to grandiosity and aggression. Additional research indicates that aggression in people with GN is only directed towards people who have disrespected or demeaned an individual high in GN's self-worth. Despite the intimate nature of romantic relationships, where individuals high in GN are likely to have their ego threatened by an intimate partner, few studies have examined GN as a predictor of intimate partner violence (IPV) perpetration, where the existing evidence is contradictory and inconclusive. Therefore, in the present research, we aim to address these discrepant findings by examining whether individuals high in GN report feeling more instigated by certain types of provocation. Additionally, the present study explores if this provocation predicts the frequency of past-year IPV perpetration. 538 participants were recruited from the introductory psychology course of a midwestern university, as well as from Amazon's Mechanical Turk. Participants completed measures of narcissism and IPV perpetration. Results will inform GN's association with IPV perpetration and clinical and research implications will be reviewed. Results will also be discussed in terms of further developing theoretical, conceptual, and etiological models of GN's relationship to IPV.

Mentor(s):

Molly Maloney, College of Health & Human Science, Psychological Sciences

Daniel Oesterle, Purdue University

Christopher Eckhardt, Purdue University

PCB & Wiring Design Utilization in Autonomous Vehicles

Author(s):

Mohammed Alwakeel, College of Engineering

Mohamad Aldawood, College of Engineering

Nasser Alsinan, College of Engineering

Faisal Alkishi, College of Engineering

Abdulrahman Alangari, College of Engineering

Abstract:

Autonomous vehicles (AV) are the new global trend of modern transportation systems. Many advanced cities are considering utilizing the technology of AVs due to their safety, efficiency, and accessibility. As such, the objective of the Autonomous Motorsports Purdue (AMP) wiring team is to enhance the capabilities of self-driving vehicles by establishing an organized labeled wiring harness for the currently developed AV. In addition, the team is creating a preliminary printed circuit board (PCB) schematic that fulfills the vehicle's electrical capabilities. The current design of the PCB involves a microcontroller circuit that is responsible for the communication between the Jetson, the brain of the vehicle, and the vehicle subsystems. The second circuit contains the MOSFET devices which level shift the received signals. Finally, the third circuit amplifies the range of the received PWM signal to be from 0 to 12 volts, the range required to operate the motor controller. The current progress on the wiring harness between the PCB and the rest of the subsystems has consisted of labeling the wires to document the wiring subsystems, creating new wire connectors that will be connected to the vehicle's PCB, and reorganizing the wiring to avoid loose connections. The intended test field of this research is the Indy Autonomous Challenge (IAC), where the final form of the vehicle can reach its highest performance, which will provide important insight regarding future research opportunities to improve the AVs' electrical abilities.

Mentor(s):

Aly El Gamal, College of Engineering, Electrical & Computer Engineering

Shreya Ghosh, Purdue University

2022 IEEE Autonomous Unmanned Aerial Vehicles (UAV) Competition

Author(s):

Arpit Amin, College of Engineering

Ranjan Behl, College of Engineering

Leonard Jung, College of Engineering

Sundhararajan Vinodh Sangeetha, College of Engineering

Abstract:

A student university team sponsored by Purdue University UAV Research and Test Facility (PURT) is competing in the 2022 IEEE UAV Competition. The competition consists of tracking and following a mobile ground target using an unmanned aerial platform with a variety of sensors in a simulation and physical testing stage. The simulation portion of the competition consists of a simulated quadrotor and rover in a Gazebo-ROS environment. The hardware portion consists of physical testing in the PURT Hangar 6. The team has approached the problem with two main research thrusts. The first research thrust is utilizing the OpenPifPaf Pose Estimation model and optimizing it for NVIDIA edge computing platforms like the NVIDIA NX using Tensor RT. The main research contribution is an open source Robot Operating System (ROS) wrapper allowing for extension into robotics hardware utilizing the pose information. The second research thrust is integrating the open source Fast-Tracker algorithm with MAVROS and PX4 flight controller systems. The end result is a physical quadrotor platform with highly optimized Pose Estimation models running on the NVIDIA NX in real-time and active control using the Pose information.

Mentor(s):

James Goppert, College of Engineering, Aeronautics & Astronautics

Riley Franklin, College of Engineering, Aeronautics & Astronautics

Electric Roadway Feasibility

Author(s):

Paloma Arellano, College of Engineering

Daniel Bernicke, College of Engineering

Miguel Castilho, College of Engineering

Bryson Gilley, College of Engineering

Zach Lagpacan, College of Engineering

Christopher Maxey, College of Engineering

Artur Pilaszewicz, College of Engineering

William Young, College of Engineering

Abstract:

The development of electric roadways (ERs) with dynamic wireless power transfer (DWPT) technology has great potential for decarbonizing our transportation sector. However, the initial capital cost of developing an ER is high. To assist stakeholders (e.g., investors, utilities, or transportation authorities) in assessing the financial feasibility of an ER, including the financial risk of undertaking such a project, a website was developed that facilitates the decision making process by serving as an easy-to-use graphical user interface. This website allows the user to input various parameters related to the development of an ER project, such as financial parameters, component capital and operating/maintenance costs, and anticipated traffic flow values. The website uses Python in the back-end to perform electric power flow and financial analysis calculations, and displays information about the ER electrical distribution system design, the levelized cost of the ER, and other financial feasibility indicators. As an illustrative case study, a feasibility analysis of all major interstates in the state of Indiana has been performed. This was based on traffic data collected from the Indiana Department of Transportation. The results indicate that ERs can be financially feasible under certain conditions. A key variable is the adoption rate of heavy-duty vehicles with DWPT technology.

Mentor(s):

Dionysios Aliprantis, College of Engineering, Electrical & Computer Engineering

Diala Haddad, Purdue University

Sleep in Duplication 15q11.2-q13.1 Syndrome: A literature review

Author(s):

Grace Arend, College of Science

Madelyn Sonnenberg, College of Health & Human Science

Abstract:

Duplication 15q11.2-q13.1 Syndrome (Dup15q) is a rare genetic disorder diagnosed in early childhood characterized by low motor skills, language development difficulties, and reduced cognitive function (DiStefano et al., 2016). Multiple studies report varying sleep problems within these individuals using electroencephalography (EEG) recordings and the Children's Sleep Habits Questionnaire (CSHQ; Owens et al., 2000). This literature review summarizes and evaluates the sleep profiles reported for Dup15q samples and case studies. The eleven articles used within this review were retrieved from the Web of Science database. In sum, the Dup15q studies report sleep profiles with atypical poly-spike patterns, atypical sleep spindles, and poor sleep stage transitions from EEG recordings. Additionally, CSHQ scores were consistently in the clinical range. Given that Dup15q is rare, studies with large samples that evaluate sleep do not exist, but this review serves to inform researchers, clinicians, and caregivers on replicated and consistently reported sleep profiles.

Mentor(s):

AJ Schwichtenberg, College of Health & Human Science, Human Development & Family Studies

High Speed Strain Data Capture for Football Collisions

Author(s):

Mitchell Arndt, College of Engineering & Honors College

Abstract:

The purpose of this project is to collect data from 60 strain gauges with a frequency of 2kHz per channel to measure the forces occurring during an impact to the head. American football is one of the most popular sports in the United States with players of all ages and skill levels clashing on the field with continual impacts to the head. Before understanding the effects these collisions have on a player's brain it is first necessary to acquire data. Our team is using 20 strain gauge rosettes attached to a football helmet to measure the normal strains in three axial directions, providing a 3D understanding of the forces at 20 different locations on the helmet. Two almost identical microcontroller collection circuits are used; the difference being one main board sends the other a sync signal to ensure the separately clocked systems maintain tight timing synchronization. Each board takes 30 individual strain gauge inputs and multiplexes them down to 10 before they are amplified to reach the full-scale voltage of the microcontroller. The embedded software is responsible for switching the selected input channels and writing the analog data to an SD card for later post-processing and data analysis. This project has finished the data collection prototyping stage and is currently in the analysis stage. In the future, the team plans to use information learned in the analysis stage to reduce the number of rosettes and fabricate a miniature version of the device that can fit into a football helmet.

Mentor(s):

Tom Talavage, College of Engineering, Electrical & Computer Engineering

Eric Nauman, Purdue University

FEMTA Suborbital Flight Experiment: Component Redesign

Author(s):

Doruk Ayhan, College of Engineering

Yule Huang, College of Engineering

Max Lantz, College of Engineering

Ankit Mondal, College of Engineering

Tyler Nord, College of Engineering

Erin Park, College of Engineering

Alexander Suppiah, College of Engineering

Abstract:

FEMTA (Film Evaporation MEMS Tunable Array) is a water-based micropropulsion system being developed at Purdue University for small satellite attitude control. The FEMTA Suborbital Flight Experiment aims to test the propellant management system developed for the FEMTA microthruster, which uses an expanding hydrofluoroether diaphragm to provide steady water flow through the system. Before production of final flight hardware, components of the existing unit required iteration to ensure successful operation. The propellant flow for the experiment terminates in a vented collection chamber, which initially failed to release vapor at a sufficient rate. Thus, vent size was increased to prevent excessive pressurization. The test unit's wiring system, originally disorganized, now splits existing cables into independent harnesses to minimize clutter and protect against flight vibration. In conjunction, electronics were overhauled to remove unnecessary connectors and add more robust controls for solenoids and thermistors. Adding a software-defined radio system allows these electronics to operate without exceeding the New Shepard launch vehicle's electromagnetic interference limits. To reduce the critical flight electronics' exposure to environmental hazards, an aluminum housing was developed that incorporates electronics interfaces and a removable cover for accessibility. This series of component redesigns allows for a high degree of confidence in the successful operation of the FEMTA Suborbital Flight Experiment.

Mentor(s):

Katherine Gasaway, College of Engineering, Aeronautics & Astronautics

Steven Pugia, Purdue University

Martin Denenger, Purdue University

Alina Alexeenko, Purdue University

Engineering Test Unit Testing for the Zero-Gravity FEMTA Suborbital Experiment

Author(s):

Doruk Ayhan, College of Engineering

Martin Degener, College of Engineering

Joe Kawiecki, College of Engineering

Siddhesh Naidu, College of Engineering

Evan Rittner, College of Engineering

Jacob Valdez, College of Engineering & Honors College

Abstract:

The Film-Evaporation MEMS Tunable Array (FEMTA) is a device that exploits the capillary forces of an ultra-pure deionized water propellant to provide a controllable 150 μN of thrust at a low 0.65 W of electrical power. FEMTA's novel propulsion capabilities require an equally novel approach to supply deionized water for its micro-thrusters. The FEMTA Suborbital Propellant Management Experiment aims to develop and test a vapor-pressure driven propellant pump that provides steady back pressure and propellant flow to the FEMTA micro-thrusters. The Engineering Testing Unit (ETU) is a full-scale prototype of the propellant management system designed for verification and validation before the 2022 Blue Origin New Shepard launch. The first stage of evaluation for the ETU was a series of dry tests performed without the water propellant in a vacuum chamber. These dry tests were executed to verify the behavior of the propellant management system components at stages of the Blue Origin New Shepard launch. The propellant management system components were evaluated by characterizing and logging important data metrics such as pressure and temperature. Data evaluation aided in identifying and resolving several issues about the initial ETU design, including significant pressure leaking and invalid pressure sensor calibrations. The ETU is undergoing preparation for its second stage of evaluation: a series of wet tests involving deionized water propellant pumped through the components of the unit. The wet tests will provide the opportunity to discover issues of the ETU design as it functions in a vacuum.

Mentor(s):

Katherine Gasaway, College of Engineering, Aeronautics & Astronautics

Steven Pugia, Purdue University

Alina Alexeenko, Purdue University

NASA Solar Cruiser Sail Simulated View

Author(s):

Nicholas Babusis, College of Engineering

Mark Kosmerl, College of Engineering

Aleena Masaeng, College of Engineering

Alec Neville, School of Management

Neha Pal, College of Engineering

Ishaan Rao, College of Engineering

Yashoheet Sethi, College of Engineering

Samuel Smith, College of Engineering

Sam Wadlington, School of Management

Abstract:

Solar sails are thin, reflective foil sheets that allow spacecraft to perform low-thrust maneuvers without expending propellant. This allows deep space missions to go farther with less propellant, lowering cost and enabling previously infeasible missions. The Purdue Solar Sail project is developing a camera system to monitor the deployment and performance of the sail on NASA's 2025 Solar Cruiser mission, which will test the largest solar sail ever launched. Testing the camera system requires a space environment analog with similar lighting conditions and background.

A model solar sail and black background are being designed based on NASA-provided dimensions and expected light levels. The model includes a section of highly reflective foil to simulate the sail, a dark backdrop to imitate the darkness of space, and a strong point source light to simulate sunlight. Different versions of backdrop will be tested to imitate light absorption levels as seen in space. A 16'X12' wall will be used to further absorb light that may be reflected by the simulated light source. The light needs to be reflected by the foil and absorbed by the wall to provide the high-contrast environment for space photogrammetry. A 3D-printed camera mount was created to hold the camera in place at varying angles for replicability of images.

This model aims to achieve the lighting conditions the satellite would encounter once deployed. This is vital for ensuring the camera functions properly so that photogrammetry can be performed on the sail.

Mentor(s):

Katherine Gasaway, College of Engineering, Aeronautics & Astronautics

Alina Alexeenco, Purdue University

Freeze Dryer Testing for the Zero-Gravity FEMTA Suborbital Experiment

Author(s):

Gouri Bellad, College of Engineering

Olukunle Akinleye, College of Engineering

Hersh Thapar, College of Engineering

Abstract:

Film-Evaporation MEMS Tunable Array (FEMTA) is a water-based micropropulsion system designed for SmallSat applications, in conjunction with a propellant management system. The FEMTA Suborbital Flight Experiment is a payload experiment designed to test the propellant management system that will be exposed to varying temperatures and pressures throughout the launch. It will be tested on Blue Origin's New Shepard vehicle in 2022. A REVO freeze dryer (RV85) will be utilized to test the experiment by imitating expected suborbital flight conditions. It operates through lyophilization. The REVO allows materials to cool below their respective triple points, ensuring sublimation and avoiding melting.

The team designed and fabricated a test plate modeling the FEMTA baseplate and outlined two freeze dryer tests. The first is to record experiment behavior and data during outgassing, assessing the loss of material when in a vacuum (space environment), using the Residual Gas Analyzer (RGA) of the REVO.

For the second test, the team determined minimum and maximum temperature and pressure value constraints while extracting temperature and pressure values for the flight using the Standard Atmosphere Model. These values, coupled with the constraints served as a basis for designing the test points. The team will collect experimental data on the flight simulation through lyophilization.

The next steps are to perform the freeze dryer outgassing test, freeze dryer flight simulation test, analyze the data collected from the REVO cross-examining the expected data and the data collected, and contribute to reviews of the FEMTA systems.

Mentor(s):

Katherine Gasaway, College of Engineering, Aeronautics & Astronautics

Steven Pugia, Purdue University

Alina Alexeenko, Purdue University

Feasibility Analysis of Unmanned Aerial Firefighting Systems

Author(s):

Nathan Berry, College of Engineering & Honors College

Abstract:

The purpose of this investigation is to limit unrestrained wildfires through designing and exploring the feasibility of a system of autonomous, unmanned vehicles to monitor, detect, and extinguish wildfires. The project focused on designing an optimal system of systems consisting of fire-detecting satellites, fire-locating fixed-wing airborne drones, and firefighting multirotor drones to limit the destruction of fires in remote locations. The satellite design required analysis of orbital mechanics to optimize the fire detection time, the resolution required for a sensor on a satellite, and the clarity of the signal downlink to a ground system. The second major system researched and developed was a fixed wing, autonomous drone. This system was optimized to precisely locate a fire within the area that the satellite detected. In order to minimize the time to locate the fire, the optimal flight path was determined. Finally, the multirotor drones were fully designed to carry fire extinguishing payload to deposit on the fire. In order to optimize the multirotor design, Monte Carlo simulations were formed to test the effect of different components on the range, flight time, and speed of the drones. Finally, a full dynamical system was developed to complement the physical CAD design of the systems to analyze and validate that the concept was feasible.

Mentor(s):

Redacted Redacted, Redacted, Redacted

Characterization of microbial populations in landfill leachate for metal bioleaching

Author(s):

Umut Bicim, College of Science & Honors College

Hanna Fulford, College of Engineering & Honors College

Abstract:

In the United States, municipal solid waste (MSW) landfills remain a potential mining source of recoverable materials, including but not limited to critical, precious, and rare earth metals found in electronic waste. This is possible due to collectible leachate that filters through MSW landfills, carrying metals, nutrients of value, and microbes—some of which may hold key metal bioleaching properties—within. The purpose of this study is to begin analyzing leachate from MSW landfills in the American Midwest to understand the composition of microbial communities within these landfills. Landfill leachate samples sourced in northern Indiana, representing the landfill process during unique times of operation, were used in this study. Culture-independent studies, utilizing both DNA extraction and PCR for communities of archaea, bacteria, and fungi, were performed on leachate samples. Preliminary results indicate suitable concentrations of DNA ranging between 0.8 ng/mL and 10.7 ng/mL that permit PCR and other microbial characterization techniques. Follow-up research will involve analyzing other Midwestern leachate samples, identifying landfill microbes with metal bioleaching properties, and developing a way to integrate these microbes with membrane filtration and other physico-chemical processes to improve recovery of important metals from leachate.

Mentor(s):

Lori Hoagland, College of Agriculture, Horticulture & Landscape Architecture

Amisha Shah, Purdue University

Inez Hua, Purdue University

Alejandro Sanchez, Purdue University

Wind-Powered Continuous Reverse Osmosis Water Desalination

Author(s):

Aliah Adriana Binti Khairul Hisham, College of Engineering

Abstract:

Water scarcity is a grave issue that is faced by lots of people worldwide. This phenomenon is further exacerbated by climate change, overpopulation, and water-intense industrial activities. To combat this issue, reverse osmosis (RO) water desalination system is broadly introduced in order to produce freshwater while maintaining the desired thermodynamic efficiency and economic feasibility. RO water desalination is a process of separating freshwater from salt water using a semi-permeable membrane. In status quo, there are various forms of energy present in RO system (e.g: hydraulic, mechanical, electrical energy, etc.) to power the hydraulic components. The conversion from one form of energy to the other results in a significant amount of energy loss due to entropy. Not only that, the RO system also operates on fossil fuels that are harmful to the environment. To address these issues, this research project focuses on harnessing wind energy from hydraulic wind turbine as a prime source of energy to power a continuous RO system. Wind energy is a clean form of energy which is sustainable for long-term use. Upon the completion of this research project, the continuous RO system is able to successfully operate using the simulated wind energy from the wind turbine's cyber physical system (CPS). Additionally, using a hydrostatic transmitted-wind turbine, the mechanical to electrical energy conversion from the wind turbine to the pump in the RO system is successfully eliminated.

Mentor(s):

David Warsinger, College of Engineering, Mechanical Engineering

Helber Antonio Esquivel-Puentes, Purdue University

Akshay Rao, Purdue University

Automated Business Card Reader

Author(s):

Mason Burgess, College of Engineering

Tanon Chokkhanchitchai, College of Engineering

Shuihan Liu, College of Engineering

Harsh Ranawat, College of Engineering

Bohou Li, College of Engineering

Siddharth Singh, College of Science

Wenhui Yang, College of Engineering

Abstract:

Purdue University hosts several career fairs each year, with all of them resulting in several thousands of business cards being printed. The goal of the Business Card team for this semester is to develop a mobile application which has the ability to take a picture of a business card by camera or fetch business card images from one's smartphone storage, extract useful information from it, and store it into the contact list of the user's phone. This reduces the overall need for paper usage at career fairs and other business related events. The project team is structured into two sub-teams. While one sub-team is working on application development, the other works on image processing algorithms.

For the interface sub-team, the primary project is to develop a mobile application in android studio that communicates with an external server to run the algorithm team's image processing algorithm. The application is developed in the Java language and the server communication is developed in Node Javascript.

On the other hand, the algorithm team is working on developing an algorithm to extract characters from images of business cards. The methods implemented include traditional signal processing techniques such as 2-dimensional convolution as well as more recent algorithms such as Machine Learning

Mentor(s):

Aly El Gamel, College of Engineering, Electrical & Computer Engineering

Carla Zoltowski, Purdue University

Unmanned Sediment Sampling System for Surface Water Sediment Collection

Author(s):

Pou Hei Chan, College of Engineering

Abstract:

We propose an unmanned core sediment sampling system that consists of an Unmanned Surface Vehicle (USV) and a sediment sampler (USS) to collect sediment in surface water environments such as rivers, streams, lakes, ponds, and reservoirs. The coring system of the USS is monitored by sensors measuring its positions and the forces it exerts, allows for the sample to be extracted with minimal disruption to the integrity of the sample core. We present the physical specification of the USV and USS and evaluate the system by conducting a field experiment.

Mentor(s):

Byung-Cheol Min, Polytechnic Institute, Computer Information

Jun han Bae, Purdue University

SWARMS Simulation Algorithmic Development

Author(s):

Younggil Chang, College of Engineering

Harrison Booker, College of Engineering

Amikosh Dube, College of Engineering

Shashank Sridhar, College of Engineering

Marvin Mui, College of Engineering

Joseph Woo, College of Engineering

Tejas Prakash, College of Engineering

Eric Chen, College of Engineering

Tyler Fedrizzi, College of Engineering

Harrison Wongsonegoro, College of Science

Jason Park, College of Engineering

Abstract:

There is a high demand for drone systems in various research, agricultural, and search and rescue applications. The purpose of our research is to design and develop an automated drone flight system, on our web-based platform SWARMS, that is capable of path planning and avoiding dynamic obstacles on the way. We assess the various methods of mapping, path planning, and obstacles avoidance based on the environment and the state of the drone. We implemented Dijkstra's algorithm and A* for path planning with a given environment map. For obstacles that are not present on the map, we consider two main categories based on the shape of the obstacle: sloped terrains and large obstacles, based on which the system decides the most efficient behavior of the drone to avoid the obstacles. We use the depth data collected from the LiDar sensor on the drone to calculate the slope of the terrain and detect the edges of the obstacles in the path of the drone. We created various virtual environments through Unreal Engine and the AirSim library. We obtain the voxel grid, a representation of the occupancy of a given environment, and dynamically convert and provide it for efficient path planning. We test and simulate drone flights with path finding and obstacle avoidance algorithms. Our future objectives are implementing machine learning algorithms to find the optimal flight routes, developing a computer vision object recognition system to improve the accuracy of obstacle avoidance, and implementing map streaming to reduce memory footprint.

Mentor(s):

Shreyas Sundaram, College of Engineering, Electrical & Computer Engineering

Tong Yao, Purdue University

Identifying Solutions to the Ethical and Social Implications of Location-based Data Collection

Author(s):

Guhao Chen, School of Management & Honors College

Abstract:

With mobile devices dominating the digital landscape, location-based data collection is a common occurrence. The paper analyzes the social and ethical implications of this phenomenon and presents a viable solution to curtailing invasive US state and corporate data collection measures. A key focus will examine the interactions of data between businesses, consumers, and the government. The research is structured into four sections, with the first two examining how and why the data is collected. The paper considers examples of data optimizing business practices to maximize profit. The latter half consists of an assessment of possible ethical and social implications of data collection for various stakeholders such as consumers and corporations. Drawing from case studies of companies with recent data scandals, it examines the imbalance of benefits between consumers and corporations. Many possible solutions to addressing the increasingly invasive techniques of data collection are proposed and evaluated, including legislation, data activism, industry competition, and individual action. The paper concludes that a multi-pronged approach best addresses this complex issue, drawing on interdisciplinary perspectives of engineers, policy makers, business analysts, and scholars.

Mentor(s):

Lindsay Weinberg, Honors College

World Food Program Operations in South Sudan: Supply Chain Optimization

Author(s):

Chongyi Chie, School of Management & Honors College

Yasmeen Almorohen, School of Management

Abstract:

Due to the impact left by the COVID-19 pandemic, economic crisis, political conflicts, and civil wars, South Sudan is vulnerable to a famine emergency. According to the World Food Program (WFP), South Sudan has reached historic levels in hunger and malnutrition, where 70% of the population needs humanitarian assistance and over 100,000 people are in IPC Phase 5 Catastrophe. We developed a linear model that assists WFP in optimizing its monthly supply chain between distribution centers and warehouses to respond to the demand of South Sudan's 1.7 million internally displaced persons (IDP). Our model first assumes that demand equals the capacity of warehouses and considers the operational costs, capacity availability, lead time, risk factors, and route inaccessibility corresponding to the three transportation methods: trucks, river barges, and airplanes. The results showed varied usage of the transportation methods between the distribution centers and warehouses arcs. However, insufficient warehouse capacity is revealed when considering the actual demand of IDPs in the model. This outcome suggests the need for WFP to establish more storage and transportation fleet capacity to satisfy the monthly requirement of famine-struck South Sudan.

Mentor(s):

Olga Senicheva, School of Management, Operations Management

NASA Solar Cruiser Sail Camera Engineering Unit Testing

Author(s):

Tasveen Chopra, College of Engineering

Ansh Patel, College of Engineering

Becca Reinecke, College of Engineering

Lian Rubin, College of Engineering & Honors College

Shreya Sharma, College of Engineering

Samantha Unger, College of Engineering

Aleksey Urmanov, College of Engineering

Abstract:

The advent of long-distance space travel has led to increased urgency in the development of new propulsion technologies. Solar sails use the sun as a renewable source of energy to propel a vehicle through space. In 2025, NASA will launch its Solar Cruiser mission that will further test the capabilities of solar sails. Purdue University was selected for a student collaboration to develop a camera system for photogrammetry of the sail during the mission to properly analyze the state and efficiency of the solar sail.

The first step in the research process was compiling camera terms and settings in order to create a base understanding of cameras. The camera selected by NASA needs to withstand the harsh environments of takeoff and space, with limits defined by NASA and the launch vehicle. Necessary analysis for space mission systems include thermal, radiation, shock, vibration, and potentially acoustic testing. A GigE Area Scan camera was used as an initial sample camera to start developing testing procedures.

Further research will be performed on the environmental tests, and testing procedure documentation will be written. Once NASA selects a camera for the Solar Cruiser mission, which is scheduled to launch in 2025, the subteam will perform tests available at Purdue, such as thermal vacuum, vibration, and potentially radiation testing. All research and results from testing performed will be analyzed in order to determine that the camera will endure the harsh environment of launch and space travel.

Mentor(s):

Katherine Gasaway, College of Engineering, Aeronautics & Astronautics

Alina Alexeenko, AAE

Relational Aggression among Couples: An I³ Model Analysis of the Effects of Stress and Alcohol Use Patterns

Author(s):

Niamh Christie, College of Health & Human Science & Honors College

Abstract:

Intimate partner violence (IPV) is a significant public health concern experienced by millions of men and women in their lifetime. Although the etiology of IPV is multifactorial, individual risk factors contributing to IPV are well-established. Heavy alcohol use and problematic alcohol consumption patterns among couples are associated with IPV and other negative relationship outcomes. Concordant and discordant drinking, which refer to the degree to which frequency and volume of partner alcohol consumption overlap, have been found to be both risk and protective factors for relationship health. Specifically, heavy discordant and concordant use are associated with higher likelihood of relationship conflict, whereas light concordant use is linked to increased intimacy. Prior research has also documented that stress is a significant risk factor for IPV. With anecdotal reports and research findings suggesting an increase in IPV during the COVID-19 pandemic, it is timely to consider fluctuations in stress during the pandemic and their association with relationship outcomes. The present study uses Ecological Momentary Assessment (EMA), to evaluate the relationship between alcohol use patterns in couples, stress, and risk for relational aggression. Using the I³ Model of Aggression—a multifactorial metatheoretical framework organizing dynamic risk factors for IPV—the present study examines COVID 19-related stress as an impelling variable and couple's concordant and discordant alcohol use as inhibiting/disinhibiting variables for relational aggression. Results will inform our understanding of the complex interactions among these dynamic risk factors, and empirical and clinical implications of these findings will be considered.

Mentor(s):

Molly Maloney, College of Health & Human Science, Psychological Sciences

Dan Oesterle, Purdue University

Christopher Eckhardt, Purdue University

Development of a Semi-Autonomous Vertical Take-off and Landing Drone

Author(s):

Tyler Collins, College of Engineering

Tirth Desai, College of Engineering & Honors College

Kai Gibbs, College of Engineering

Ryan Jensen, College of Engineering

Yunhao Lan, College of Engineering

Nick Sebal, School of Management

Pranav Singh, College of Engineering & Honors College

Aidan Velleca, College of Engineering

Abstract:

This research project was completed in our VIP Team, Robotic Exploration. The team was tasked with designing a semi-autonomous vertical take-off and landing (VTOL) drone that is able to gather data from its surroundings and relay that data back to another semi-autonomous vehicle acting as our “base”. The drone is able to collect data utilizing a camera, altitude sensor, and proximity sensor. Testing of the drone will be done by placing it in an environment unknown to the engineering team, and determining how accurately the drone can map out and navigate its environment.

The programming and electronics subgroup utilized Raspberry Pi's and a flight controller Crazyflie. Meanwhile, the mechanical design and aerodynamics team learned how to design a drone on a 3D modeling software that fit predetermined constraints. All subgroups had to make reasonable estimations and draw conclusions with the information given to us in order to select parts and design the drone.

Mentor(s):

Preet Dhir, College of Engineering, Aeronautics & Astronautics

Eric Nauman, Professor of Mechanical Engineering, Purdue University

Methylation-based Regulation of the Small GTPase, Ras, via Isoprenylcysteine carboxyl methyltransferase (ICMT)

Author(s):

MaryClaire Cooke, College of Science

Abstract:

Isoprenylcysteine carboxyl methyltransferase (ICMT) and its methylating activity on the small GTPase Ras is understood to be an important regulator of the localization and functioning of Ras. Ras is highly involved in various cellular pathways, including the mitogen-activated protein kinase (MAPK) signaling cascade, stimulating cell growth and migration. It is hypothesized that the GTPase activity of Ras on its substrates is contingent upon the localization of Ras to the plasma membrane, facilitated by its methylation. When a Ras mutation occurs, cancerous Ras isoforms can be found in a continual state of activation leading to unregulated cell proliferation. Ras mutations contribute highly to the development of cancers, specifically 30% of pancreatic cancer. Our research aims at better understanding the mechanisms in which Ras is methylated by ICMT, and to demonstrate the role that this post-translational modification plays on the functioning of Ras and other downstream kinases. This understanding is integral in order to identify mechanisms of Ras that could be targeted therapeutically.

Mentor(s):

Shal Low-Nam, College of Science, Chemistry

Ariana Cardillo, Purdue University

Evaluating a potential volcano on the rim of Jezero crater, Mars

Author(s):

Sara Cuevas-Quiñones, College of Science

Abstract:

On the southeast rim of Jezero crater is a feature that stands up to ~2 km high above the surrounding area, with an irregularly shaped crater on its summit and the lowest thermal inertia of the Jezero region. While several studies and recently NASA's Perseverance rover have focused on understanding the likely volcanic origin of the Jezero crater floor unit, little has been done to characterize this largest and closest seemingly volcanic feature. Using multiple data sets such as CRISM, HiRISE, CTX, THEMIS and MOLA, we study the possibility of this mountain having a volcanic origin, which could have important implications when interpreting Perseverance's findings.

Even with limited CRISM coverage of the mountain and despite its prior interpretation as dust-covered, we observed diverse mineralogy. Some regions were spectrally dominated by olivine or pyroxene, and localized Mg/Fe-smectite clay exposures were also detected. To investigate how this mountain compares to other Martian volcanoes, we used MOLA data to create topographic profiles and to measure geomorphic properties (3) for comparison with eight other Martian volcanoes. Additionally, we measured the average thermal inertia of each of these volcanoes for which THEMIS images with an image rating higher than four were available.

While inferring a definite origin may not be possible from orbit, several lines of evidence are consistent with a volcanic interpretation. The near centralized summit crater, the slopes consistent with stratovolcanoes, the lack of distinguishable lava flows, the relatively smooth caldera interior and lower thermal inertia are all consistent with explosive volcanism. Igneous minerals olivine and pyroxene are present, and clay minerals could imply ancient formation of easily alterable (fine-grained, glassy) material, as recently reported on other ancient Martian stratovolcanoes.

Mentor(s):

James Wray, Georgia Institute of Technology

Frances Rivera-Hernández, Georgia Institute of Technology

Jacob Adler, Georgia Institute of Technology

VISORS: Virtual Super-Resolution Optics Using Reconfigurable Swarms

Author(s):

Hasnain Daudi, College of Engineering

Erik Zabalegui Lopez, College of Engineering

Rishikesh Rajiv Gadre, College of Engineering

Abstract:

VISORS is a space mission that will deploy two CubeSats to obtain high resolution images of the Sun's corona to determine why the corona exhibits exceedingly high temperatures. The project is a collaborative effort between ten Universities, a NASA facility and a laboratory. Purdue VISORS focuses on the thermal modeling and analysis of the two satellites.

The thermal analysis includes developing an accurate thermal model of both satellites using Thermal Desktop. The team simulates various test cases with variations in beta-angle and orientation of the satellites to identify the hot and the cold cases. Analyzing the results helps the team identify which components will not survive the space environment.

The team has progressed from having a simplified 7-node model, to a more detailed model, which incorporates the different components of the satellite. The components include the propulsion system and the propellant, an avionics system etc. The detailed model gives us temperature ranges of the components, which are compared against their operational and survivable temperature ranges.

The satellite models are being updated with new components periodically, and a design has not been finalized. The team is seeing promising results as most of the components are within their operational temperatures. For components outside their survivable temperature ranges, measures are being taken to ensure their survival.

Upcoming internal reviews will dictate the steps to be taken in the future, as well as possible changes to make the thermal models more accurate at determining the temperatures experienced by the satellites and their components.

Mentor(s):

Alina Alexeenko, College of Engineering, Aeronautics & Astronautics

Petr Kazarin, Purdue University

System on Chip Extension Technologies: Printed Circuit Board and Post-Silicon Team

Author(s):

Connor Davin, College of Engineering

Akshaj Prasannakumar, College of Engineering

Lawrence Lo, College of Engineering

Abstract:

The AFTx05 PCB board is being designed for various application-based testing. The applications are based on machine learning using sparse optimization methods. Sparse optimization is a form of optimization in which the chip can skip calculations by dynamically checking an instruction table to see if it is worth executing the instruction with values that result in a zero or close to zero. Skipping calculations of this type would benefit the runtime of the program.

The general layout of the AFTx05 board begins with a barrel jack that is connected to a power supply that acts as step down converter to 3.3 V and 1.2 V. The power supply provides 3.3 V to the Max10 FPGA and 1.2 V to the x05 chip. The Max10 clock output is connected to the x05 while the x05 GPIO/memory output is connected to the Max 10. The Max10 acts as a memory that allows variable sizing. Both of these share a common high frequency line. The design also contains LEDs for different functionalities set in our design. The FPGA board as a chipset is unique to this board as it can be used to configure the memory size and the clock speed of the AFTx05 chip. This allows for trace-based debugging that the FPGA provides.

Currently, the PCB Team is working on the continued development of the board. Our current effort is focused on finalizing the schematic design by using KiCad's Electrical Rule Check (ERC) and searching through components datasheets to find previous team's design errors. The main issue with the schematic is incorrect pin types of the integrated circuits, causing KiCad (ERC) to fail. The PCB Team is also doing post-silicon testing of the AFTx04 board.

Mentor(s):

Raghul Prakash Prakash, College of Engineering, Electrical & Computer Engineering

Matthew Swabey, Purdue University

Determining the Synergistic Effect of Lippia origanoides and Cisplatin on the Viability of MDA-MB-231 Cells

Author(s):

Chyna Davis, College of Science

Abstract:

Triple-negative breast cancer (TNBC) is a subtype of breast cancer characterized by a lack of estrogen, progesterone, and human-epidermal-growth-factor 2 receptors. Compared to other subtypes of cancer, TNBC has poor survival rates and is described as aggressive, invasive, and drug resistant. In an attempt towards developing novel therapeutic options for TNBC, we sought to determine the synergetic effects of the chemotherapy drug Cisplatin (Csp) and an extract of the plant Lippia Origanoides. Csp is a commonly used agent and can suppress TNBC growth by binding to DNA and inducing cell apoptosis. Our recent work reveals Lippia Origanoides extract (LOE) treatment leads to decreased proliferation of MDA-MB-231 TNBC cells by inducing cell cycle arrest and promoting apoptosis. Overall, the purpose of our current studies is to determine if and how LOE can enhance the efficacy of Csp in TNBC cells. This was tested by measuring the effects of LOE and Csp combination treatment on MDA-MB-231 cell viability and metabolism, through MTT and Glucose Glo Assays, respectively. Ultimately, these studies will support LOE as a valuable source of bioactive compounds important for the development of novel inhibitors that have the potential to enhance the actions of Csp based chemotherapy agents in TNBC. This is a critical area of study as currently there are no viable treatment options for TNBC.

Mentor(s):

Ignacio Camarillo, College of Science, Biological Sciences

Raji Sundararajan, Purdue University

Robotic Exploration: Design and Construction of Spider Movement Based Robots

Author(s):

Ben Davis, College of Engineering

Henry Wang, College of Engineering

Leo Seo, College of Engineering

Marc Zabit, College of Engineering

Owen Hoerner, College of Engineering

Abstract:

Leg based robotic movement is challenging to accomplish over uneven terrain, as it requires the robot to remain balanced throughout the movement. Spiders are an excellent example of something that can stay balanced while climbing over obstacles, as their eight legs allow them to keep multiple points of contact on the ground while moving. Another benefit of a spider's anatomy is their ability to extend their long legs. This length allows them to overcome high clearances while maintaining their balance, and then propel their body upwards over the obstacle. A prototype spider leg and chassis have been constructed in order to simulate how the final robot would move. The goal of this team is to design an electronic system to power the various components of the spider bot and have it move based on pre-recorded movements. Testing of this prototype will demonstrate what components need to be changed and if the spider robot is a viable design for overcoming large clearances and obstacles in different environments. This project's goal is to design and construct a semi-autonomous robot that mimics these behaviors so that it can climb over obstacles and clearances while exploring uneven areas. These robots could be used to replace the human task of performing ship inspections, saving money and promoting a safer working environment.

Mentor(s):

Eric Nauman, College of Engineering, Mechanical Engineering

Preet Dhir, Purdue University

How Facial Recognition Experts Present Information in a Congressional Setting

Author(s):

Zachariah Davis, College of Science & Honors College

Abstract:

Facial recognition is a technology that impacts everyone in the world and is a concern for many. In a congressional testimony setting, experts convey meaningful information on facial recognition by using real-world examples and analogies. Recordings of congressional testimonies from facial recognition experts from the C-SPAN archives were taken and analyzed to see how the experts would communicate about facial recognition to decision-makers. Data was gathered across four different hearings and eleven testimonies. As a result, it was seen that while facial recognition experts use analogies and real-world examples, they failed to explain facial recognition and rather presented the effects. Other conclusions drawn from the testimonies were that the experts failed to use eye contact effectively and did not use many vocal inflections or hand gestures. Through this, it can be determined that experts in facial recognition and related fields take note to try to connect to the audience by taking a more friendly tone to the audience and engaging with them, rather than conveying the information as efficiently as possible.

Mentor(s):

Jennifer Hall, College of Liberal Arts, Communications

SWARMS Simulation Platform - Infrastructure Development

Author(s):

Tyler Fedrizzi, College of Engineering

Harrison Wongsonegoro, College of Science

Jason Park, College of Engineering

Abstract:

The SWARM Simulation platform provides a collaborative system to design, implement, and evaluate multi-agent control algorithms. SWARM combines advancements in cloud-computing infrastructure, autonomous agent control, and web-based applications to deliver an innovative algorithm design and evaluation portal. By leveraging the power of Amazon Web Services, SWARM is a scalable, realistic and user-friendly simulator, which enables academic researchers and industry partners from around the world to collaboratively develop and test new swarm algorithms. Through the addition of pre-built scenarios, specific control algorithms can be designed and evaluated, thereby establishing a common benchmark for the robotics and control systems communities. For each simulation, a set of predefined algorithms for basic drone swarm control methods are provided, such as obstacle avoidance and path planning. Upon completion of a simulation, a data analysis toolbox provides users with a robust platform to evaluate the performance of their algorithms, along with a detailed report of overall performance. Upon completion of a simulation, the data analysis section will provide researchers with standard metrics useful for drone research, such as position and collision rates. We also provide a custom entry field for manual equation entry. This is supported by a robust backend structure, with various data sources being parsed via Amazon Web Services and fed back into the portal. Our main focus in cybersecurity was to develop and implement secure communications between SWARMS agents. To prevent unauthorized access and/or communications between drones, we have developed encryption and a secure key exchange algorithm to verify sender and receivers.

Mentor(s):

Shreyas Sundaram, College of Engineering, Electrical & Computer Engineering

Distracted Driver Detection on Garmin Embedded System

Author(s):

Gautam Fotedar, College of Engineering & Honors College

Abstract:

Distracted and drowsy driving is a major contributor to the number of traffic incidents, crashes, and casualties each year, with over “3,142 people killed and 424,000 people injured in motor vehicle crashes involving distracted drivers,” according to the NHTSA. A dash-camera application that can identify when a driver is distracted would reduce the prevalence of these accidents. The purpose of my project during my internship at Garmin is to develop a driver-monitoring system (DMS) that uses camera input to identify distraction and alert the driver. The primary method for driver drowsiness/distraction detection used neural networks trained on image data to make predictions based on the driver’s eyes being closed and head pose. It will also be running on an embedded platform, which has special challenges related to power management and processing power trade-offs. One challenge faced was about usage of a specific neural network accelerator that can run machine learning models on embedded systems. Eventually, a neural network was run for the first time on the dash-camera system through converting the model to an appropriate binarized format, which was a novel step for the platform. The output of the network performs to an appropriate degree of accuracy. So far, an image pipeline has been developed, an object-oriented software architecture for the DMS was built, and neural networks were run on the embedded platform. The final challenge remaining includes the integration of all these achievements into a full DMS that operates in real-time, which is the ongoing work on this project.

Mentor(s):

Raghavendra Desai, Garmin Ltd.

Characterization of Landfill Leachate for Enhanced Metal Recovery

Author(s):

Hanna Fulford, College of Engineering & Honors College

Umut Bicim, College of Science & Honors College

Abstract:

Landfills contain a trove of valuable materials, such as critical, precious, and rare earth metals, that are integral to the United State's economy and national security. The leachate that filters through landfills picks up these materials, which allows for the possibility of recovery. For this research, samples will be analyzed from landfills throughout the Midwestern United States to provide a baseline on water quality constituents, elements present, and microbial activity. Preliminary data for this study was acquired by analyzing samples of landfill leachate from a landfill in northern Indiana. pH readings indicate that the leachate is slightly basic. It also contains around 1-2% total solids. Inductively coupled plasma optical emission spectrometry (ICP-OES) was also used to identify elements present in the samples. Of the 66 elements considered in the analysis, 35 were detectable in quantifiable amounts. The most common elements present were sodium, potassium, magnesium, calcium, boron, and sulfur. Critical elements such as lithium and chromium were also found in the leachate. Future research will develop an integrated method applying microbial bioleaching, physico-chemical processes, and membrane filtration to recover critical elements from landfill leachate.

Mentor(s):

Amisha Shah, College of Engineering, Civil Engineering

Inez Hua, Purdue University

Lori Hoagland, Purdue University

Nadezhda Zyaykina, Purdue University

The Future of Facial Recognition

Author(s):

Avika Garg, College of Science

Abstract:

As the world technologically transforms, facial recognition and its infinite uses are under a bright spotlight. Of course, with using technology to track faces, there come many ethical disputes and clashing of opinions. On one hand, it is apparent that facial recognition allows for advancements in security, healthcare, at-home learning, financial interactions, and so much more. It can tighten security, serve as a healthcare assistant, and monitor at-home exams and learning, just to name a few. The list goes on and on to highlight the positive outcomes of this technological advancement. However, on the other hand, it is necessary to acknowledge the lack of privacy. Giving authority to have cameras constantly pointed at our faces is not an easy give as we are, in a way, sacrificing an amount of our physical privacy. We will explore the ways in which facial recognition continues to stir debate with its strong benefits and consequences.

Mentor(s):

Jennifer Hall, College of Liberal Arts, Communications

Constructing Approximately Diagonal Unitary Gates

Author(s):

Colton Griffin, College of Science & Honors College

Abstract:

We study a method of producing approximately diagonal 1-qubit gates. For each positive integer, the method provides a sequence of gates that are defined iteratively from a fixed diagonal gate and an arbitrary gate. These sequences are conjectured to converge to diagonal gates doubly exponentially fast and are verified for small integers. We systemically study this conjecture and prove several important partial results. Some techniques are developed to pave the way for a final resolution of the conjecture. The sequences provided here have applications in quantum search algorithms, quantum circuit compilation, generation of leakage-free entangled gates in topological quantum computing, etc.

Mentor(s):

Shawn Cui, College of Science, Mathematics

Strength of Preference for Anuran Blood by *Uranotaenia lowii* and Its Effects on Fecundity

Author(s):

Ethan Guardado, College of Science

Abstract:

Redacted by request.

Mentor(s):

Ximena Bernal, College of Science, Biological Sciences

Katherine González, Purdue University

Facial Recognition and Congressional Testimonies

Author(s):

Krish Gupta, College of Science & Honors College

Avika Garg, College of Science

Ryan Walter, College of Science

Sharon Wang, College of Science

Zachary Davis, College of Engineering

Abstract:

Faces - that's what humans use to identify each other. Not hands, not legs, not eyes, not a nose, but rather your face is what people equate you with within their memory.

This has made facial recognition technology an extremely hot-button topic in congress. One should understand and appreciate that while this technology can bring convenience to many lives, it also might infringe upon some basic freedoms and liberties.

Experts in congressional testimonies use to appeal to ethics (ethos) along with voice inflection to lobby their agenda in congressional testimonies.

Many discuss how technology has different roles in different sectors. For example, the use of facial recognition for ease of business is much different than surveillance in schools.

Experts will also use anecdotes and examples to support the wonders the technology has done for certain industries. But skeptics will continue to apply pathos and ethos to say how facial recognition violated many of our basic liberties.

Mentor(s):

Jennifer Hall, College of Liberal Arts, Communications

Inhibitory Control

Author(s):

Haris Hasan, College of Science

Abstract:

Inhibitory control is a critical aspect of our daily lives. For example, the average person has the ability to inhibit the desire to hit someone in the heat of anger. The inability to have inhibitory control is linked to some neurological and psychiatric disorders, and more generally, a wide range of behavioural and health problems involving impulsive decision making. However, inhibitory control is variable across subjects. The use of a stop-signal task (SST) has allowed researchers to model how quickly response inhibition is implemented at the individual subject level. Here we combined the SST with electroencephalography (EEG) to validate a procedure that will allow us to extract with a behavioural and a physiological index of inhibitory control at the individual subject level. In the next stage of the project, we will then use these indices to investigate how inhibitory control can be modulated by other variables, such as reward incentives.

Mentor(s):

Yu Chin-Chiu, College of Health & Human Science, Psychological Sciences

Minecraft Modders and Their Ownership of Mods.

Author(s):

Robert Hastidt, Polytechnic Institute

Abstract:

Video game communities, especially who's game of choice is a PC or Computer game, have a prolific modding scene. Modders, creators of downloadable addons or modifications to the video game, have come to dominate a part of how gamers consume gaming content. Yet very little research has been conducted into how the Modders feel about their mods, or more specifically, who owns the mod as a piece of intellectual property. Its common that mod teams becoming video game developers, either working for the video game companies, or working on an independent project using the mod as a design basis. The objective of the study will be asking Minecraft Modders, who both are over the age of 18, have at least one mod with over 100,000 downloads on the website Curse Forge, and have a mod currently available for the current version of Minecraft, version 1.17, to answer a questionnaire related to their experience with Modding, their feelings about their mods, their relationship with Minecraft, and who they feel owns the mods they create. The hypothesis is that Modders will feel that they own the mods they created. Minecraft's community was chosen due Minecraft being one of the best-selling video games of all time, along with having an active modding community across numerous websites. The website CurseForge was chosen due to ease of access to data, popularity for modding, and the embedded feature for contacting Modders. The questionnaire has been developed but data about the Modders has yet to be collected.

Mentor(s):

Kathryn Seigfried-Spellar, Polytechnic Institute, Computer Information

Project Rekor - Fuzzing Cryptographic Protocols

Author(s):

Brandon Hernandez, College of Engineering

Abstract:

Software Supply Chain compromises are a rising threat that, as evidenced with the recent Solar Winds hack, can have devastating impact on even top-security agencies of the US government. To combat Software Supply Chain attacks, The Project Rekor, now renamed to Sigstore, VIP Team is collaborating with the open source Sigstore community in their efforts to protect the open source software supply chain by cryptographically signing their software contributions. Due to the heavy dependence on open source software libraries, software products are often targeted through their open source components. Further, a compromise on a single library in the supply chain will affect all projects that currently use said library. To combat this, Sigstore is creating a software signing service that allows developers to cryptographically sign and contribute artifact meta-information. This gives way to the ability to continuously monitor the log for potentially suspicious behavior. The VIP Team is currently working towards creating a supply chain transparency monitor to continuously scan and audit transparency logs to inform users when there is potentially malicious behavior. The certificate transparency monitor will be able to serve as a starting point in future renditions that may require further specialized capabilities. The component of the project I will be focusing on is the creation of a fuzzing harness tailored to signature forgery within the Cosign verification capabilities. The impact of this work will be a continuous testing pipeline allowing us to detect and mitigate cryptographic vulnerabilities with container signing functionalities.

Mentor(s):

Santiago Torres Arias, College of Engineering, Electrical & Computer Engineering

Investigating Bioelectricity Via Fluorescence Labelling

Author(s):

Lauren Hesting, College of Science

Abstract:

Zebrafish models have become a highly useful tool for in vivo biological research. The zebrafish genome is more than 70% genetically similar to humans, allow easy genetic manipulation, offer translucent development that benefits imaging, and produce large numbers of offspring. By creating these transgenic fish lines with fluorescence labelling, researchers can easily locate and study biological processes such as cell bioelectricity or cell membrane potential in vivo.

This study aims to utilize the Tol2 transposase system to screen and isolate F0 transgenic fish lines. In a previous experiment, F0 fish were injected with plasmid DNA as well as Tol2 RNA and then raised to adults. These F0 adults were bred with wild type fish to produce F1 embryos that carry stable genetic markers/reporters. The F1 embryos were examined under a fluorescence scope to determine results based on expected temporal and spatial location in early embryogenesis. The initial trial of this procedure did not result in any positive embryos with fluorescence. This could be explained by a low trial number, bad Tol2 mRNA injection, etc. In the future, more transgenes will be screened to investigate bioelectric activity in zebrafish models.

Mentor(s):

GuangJun Zhang, College of Veterinary Medicine, Comparative Pathobiology

Martin Silic, Purdue University

Characterizing Mechanistic Reasoning in the Context of Biofilm Formation by Biology Undergraduate Students

Author(s):

Kal Holder, College of Science & Honors College

Abstract:

Mechanistic reasoning is a method of thinking that can be used to describe complex systems and processes across multiple levels of organization. This qualitative research study seeks to better understand mechanistic reasoning about biological systems of undergraduate biology students at a large, research-intensive Midwestern university by answering the question: What are the features of students' mechanistic reasoning about systems in the context of biofilm formation?

We recruited 9 biology undergraduates and conducted semi-structured interviews. We then performed inductive and deductive thematic analysis coding to identify features of connections made during their mechanistic explanations and characterize the connectedness of their models between the modules of gene regulation, cell-cell communication, and phenotype.

Current results demonstrate that 4/9 students produced a fragmented model, 4/9 students produced a transitional model, and 1/9 students produced a connected model. Fragmented models lacked mechanistic connections between modules. Transitional models may contain mechanistic connections with some sequential connections between modules with correct entities and/or activities. Connected modules contained mechanistic connections that connected modules with correct entities and activities.

These data suggest that the usage of mechanistic reasoning is associated with more robust explanations of biological phenomena, as students in our sample who did not include mechanistic connections often lacked other important explanatory features in their model, such as linking appropriate entities and activities to produce a productive mechanistic explanation. Increased instructional support of mechanistic reasoning and modeling could serve to deepen student comprehension of complex biological systems.

Mentor(s):

Sharleen Flowers, College of Science, Biological Sciences

Stephanie Gardner, Purdue University

Using Riboflavin Fluorescence Spectroscopy to Determine Aqueous Bromide Ion Concentration

Author(s):

Yiliu Hu, College of Science

Abstract:

Our experiment uses visible spectroscopy to measure the fluorescence quenching of riboflavin by bromide anion in order to determine the concentration of aqueous bromide ions in a solution. Bromide ions quench riboflavin fluorescence and the higher the concentration of bromide, the lower the fluorescence intensity. Our method uses standards of known bromide ion concentration to create a fluorescence emission vs bromide ion concentration calibration curve. The calibration curve yields an exponential plot of fluorescence intensity vs KBr concentration: $y = 0.4303e^{(0.04569x)} + 0.2553$. We measured the fluorescence intensity of a sample bromide solution to be 0.593. Calculating the bromide concentration using formula from calibration plot, the concentration of the unknown was determined to be 5.30 mM. The percent error compared to the actual sample concentration is 6.0%. Further analysis using a Stern-Volmer analysis similarly yields a concentration of 5.26 mM. This laboratory experiment is suitable for students in physical chemistry or even general chemistry as a means of introducing to students the concept of analytical fluorescence methods.

Mentor(s):

Jonathan Rienstra-Kiracofe, College of Science, Chemistry

Hand gesture recognition

Author(s):

Dainong Hu, College of Engineering

Connie Kang, College of Engineering

Duncan Van, College of Engineering

Abstract:

The goal of the project is to automatically classify the gesture of a human hand image signaling the letters in American Sign Language. Given 3D input from a high-resolution 3D scanner, we converted 3D data into 2D images in order to simplify the calculation. During the conversion process, most of the image background is removed in order to generate better results. The MediaPipe library can help us extract positions of finger joints in a 2D image. These coordinates written in x and y components are used to detect the gesture for fingers. For each finger, we have to write a function to define the poses we want. Meanwhile, we assume that the hand image has palm faces to the front and fingers point to the left. Only if all the fingers are in the right pose, the gesture could be translated into an alphabet letter. So far, our team has finished writing 24 letters classification. The next step for our project is to write a rotation function to have a consistent hand image. With any hand image given, the rotation function must automatically adjust the image to have the palm of the hand pointing right and the fingers pointing left. By having this consistency, it will make it much easier to train the computer to recognize the gestures. By the end of the semester, we would like to complete the prerequisites for setting up the image to be identified which includes the rotation, noise removal, and letter classification with 26 letters in Alphabet.

Mentor(s):

Song Zhang, College of Engineering, Mechanical Engineering

Study Spot Availability Tracker

Author(s):

Byeongchan Jeong, College of Engineering

Youngjoo Moon, College of Engineering

Juhyung Kim, College of Engineering

Heera Choi, Polytechnic Institute

Abstract:

Purdue University has now seen the largest incoming class for Fall 2021 with more than 10,000 freshmen. The increasing trend of the student population has impacted students' daily lives and studies. From the survey that we have deployed over the summer, out of 57 students who had participated, 45 students or 80% of students felt uncomfortable finding seats to study. We have identified that the majority of students were studying at WALC and HICKS mostly around 6 – 8 pm, but not at other studying areas. Overall, students were having trouble finding places to study, while there were plenty of vacant spaces around the West Lafayette campus.

To overcome this problem and effectively take advantage of the various studying spots around Purdue, we propose the 'Study Spot Availability Tracker', a system that indicates seat occupancy in buildings that have a place to study. The tracker will detect the availability of each seat and display its occupancy through a web environment as well as a mobile application. The first and current existing prototype that was used to present at Purdue PESC Pitch Competition, utilizes a single ultrasonic sensor, but the team is planning on improving the detecting capability of the trackers for better accuracy. The current option for future improvements is either using multiple ultrasonic sensors or a single passive infrared (PIR) sensor, and the decision will be made by going over its cost-efficiency and practicality after thorough testing of the prototypes created using each sensor. To consider for diverse environments of the studying spots, we are also considering implementing thermal grid sensors for spots where the previously discussed two sensor options would be less applicable. Furthermore, statistic data regarding library usage trends will be collected and stored on the database through the PAL network and displayed on the website or mobile application on the room schematic.

The mobile application will be provided through the web environment, where the students can easily look up through their mobile devices. The website will be updated whether the seat is available or not simultaneously as the data gets updated. The website will use the link through Purdue pages on the World Wide Web, and the layout will be formed by libraries and the image of the spot so that students can easily know which seat they are looking at. By using an easily accessible platform, students will have real-time information on seat occupancy and effectively plan their place to study for the day.

Mentor(s):

Xiaokang Qiu, College of Engineering, Electrical & Computer Engineering

Security Education for All

Author(s):

Yeonseung Jin, College of Engineering

Neha Priyadarshini, College of Engineering

Harim Song, College of Engineering

Daniel Chun, College of Engineering

Jiaxuan Han, College of Engineering

Abstract:

The purpose of this project is to create a product that can automate the grading process for programming instructors. This entails having a deployable system using parallel fuzzing to create test cases. There are three sub-teams handling each of the main tasks.

The deployment team is focused on the functionality of the auto-grading script, enhancing and better utilizing the program based on feedback from teaching assistants in ECE 26400. We are working on fixing existing bugs, a feature that tracks students potentially falling behind, and a script that detects plagiarized code. The aim is to produce a professional deployable product able to run self-sufficiently, from handling package instalments to producing readable error messages.

AFL team is working on implementing a system using AFL to create test cases for grading in coding classes. AFL can generate test cases by parallel fuzzing. With a professor's code and a student's code, it will find out all the possible paths and create test cases. We can use the generated test cases as inputs and run AFL again with other students' code, and so on. Our goal is to make an automated system to do this process to create the best test cases for any coding homework.

The proposal team aims to find plausible implementations of our deployable product in other computer science courses and use student data from courses for testing. We have generated an auto script to run student homework submission and gather crash data from the submission file to detect the necessity of security education, and have reached out to computer science security instructors from other universities for their viewpoints on the need for security education within foundational computer science courses.

Mentor(s):

Aravind Machiry, College of Engineering, Electrical & Computer Engineering

Radio Frequency Modelling of Silicon Photonic Phase-Shifters

Author(s):

Scott Kenning, College of Engineering

Abstract:

Silicon photonics is a broad field applicable to high-speed telecommunications. A key challenge involves converting electrical signals into light-based signals, which is task often performed by a modulator consisting of two phase-shifters. Phase-shifters of a certain variety require an electronic signal to be propagated down a transmission line that modifies the refractive index of a nearby optical waveguide through electro-optic effects. A full simulated model for this device would be extremely challenging: it involves two electromagnetic waves at vastly different frequencies interacting in a complicated structure. Therefore, we utilize a circuit approach to aid in modeling a silicon-organic phase-shifter to optimize transmission line geometry. Commercial software is used to model the transmission line and extract characteristic parameters, while an adaptation of other work allows equivalent-circuit parameters for the slot waveguide to be approximated. This technique is then used to tune the structure to have a characteristic impedance of 50 ohms to match it with commonly used radio-frequency drivers. The resulting device will be present on future manufacturing runs.

Mentor(s):

Andrew Weiner, College of Engineering, Electrical & Computer Engineering

Lucas Cohen, Purdue University

Navin Lingaraju, SRI

Vision-based Multi-robot Navigation in Outdoor Environments

Author(s):

Jae-eun Kim, Polytechnic Institute

Abstract:

This study introduces a new method to engage multi-robot systems in outdoor navigation using affordable and reliable vision-based approaches.

Outdoor navigation has been a challenge to many robotics systems, especially for multi-robot systems. Existing methods such as simultaneous localization and mapping (SLAM), motion capture system, or global positioning system (GPS) often require expensive equipment or compensate for precision.

The proposed method only requires a generic webcam and OpenCV library. This allows, in a leader-follower problem, follower robots to identify and follow the front robot through image processing. And the leader robot receives input from a human operator who uses an external computer to control the robot. We tested and validated this proposed method with Clearpath Jackal mobile robots.

Mentor(s):

Wonse Jo, Polytechnic Institute, Computer Information

Byung-Cheol Min, Purdue University

Project - Rekor (VIP)

Author(s):

Han Soo Kim, College of Engineering

Jongkyu Hwang, College of Engineering

Abstract:

.Supply chain management software (SCMS) is a software tool used to execute supply chain transactions to help improve performance and logistics by automating operations. However, the Software supply chain can have a devastating impact on even top-security agencies of the US government.

The VIP Team is collaborating with the open source Sigstore community in their efforts to protect the open source software supply chain by cryptographically signing their software

contributions. Software supply chain security is a rising area of focus for anyone involved in the development and release of software. Due to the heavy dependence on open source software libraries, software products are often targeted through their open source components. Since a compromise on a single library in the supply chain will affect all projects that currently use said library, Sigstore is creating a software signing service that allows developers to cryptographically sign and contribute artifact meta-information.

The VIP team is developing a remote boot attestation using Keylime to monitor remote nodes of a device using a hardware based cryptographic root of trust. A virtual machine with a virtual TPM would test node's malicious activities and constantly check surveillance of a monitor to ensure trust for open source components.

Mentor(s):

Torres Arias Santiago, College of Engineering, Electrical & Computer Engineering

The effect of thin interfacial layer on the mechanical properties of metal/Zerodur heterogeneous bonding

Author(s):

Katherine Klokkevold, Polytechnic Institute

Weston Keeven, Polytechnic Institute

Abstract:

Ceramic materials have been gaining increasing attention in a broad range of research and industry fields due to their unique mechanical, electrical, and optical properties. Because of this there has been an increase in ceramic to metal bonding in the use of displays, sensors, and other advanced applications. However, the bonding of ceramic to metal has been challenging due to the low wettability of ceramics, on which the adhesion of molten adhesive bonders is limited. In addition, the large difference between the coefficients of thermal expansion of the two dissimilar bonded materials develops significant mechanical stresses at the interface and potentially leads to mechanical failures. The three parts of research that were done to strengthen the ceramic to metal bond included optimization of interfacial thin metal films at the bonding interface, selection of bonding material, and creating a low-temperature bonding process at 250 C or below.

Vapor-phase deposition is a widely used thin-film processing technique in both academic research laboratories and manufacturing industries. Since vapor phase coatings do not require wettability or hydrophobicity, a uniform and strongly adherent layer is deposited over virtually any substrate, including ceramics. Through research, we will report on the effect of vapor phase-deposited interfacial metal layers on the mechanical properties of bonding between stainless steel and Zerodur (lithium aluminosilicate-based glass-ceramic). Direct-current magnetron sputtering was utilized to deposit various thin interfacial layers containing Ti, Cu, or Sn. In addition, to minimize the unfavorable stress at the bonded interface due to the large coefficient of thermal expansion difference, a low-temperature alloy solder, that is chemically and mechanically activated at temperatures of approximately 200 °C, was used.

Mentor(s):

Sunghwan Lee, Polytechnic Institute, Engineering Technology

Michael Clevenger, Purdue University

NASA Solar Cruiser Sail Camera Software Development

Author(s):

Katherine Kneeland, College of Engineering

Dylan Huntoon, College of Engineering

Elliot Wong, College of Engineering

Abstract:

Solar sails are an emerging method of propulsion that utilizes photons from the sun to propel a spacecraft. NASA's 2025 Solar Cruiser mission will be using this new technology with the Earth-Sun Lagrange Point 1 as its planned destination. As an unmanned mission, Solar Cruiser requires constant visual monitoring to verify sail deployment, analyze topography through photogrammetry, and capture high-quality images for public engagement. The objective of this portion of the research is to develop a method of remote communication for control of the spacecraft's imaging system to satisfy these requirements.

Using Python as the primary coding language, software capable of accepting inputs to upload camera settings, trigger the camera discreetly, and control camera shutter will be developed. A text file is currently used as a main input method for remote communication with the camera; however, a graphical user interface (GUI) is being developed as a secondary method to make file generation more user friendly and remove some risk of program failure.

This research during the Fall 2021 semester, using Purdue University's camera system, will allow for expedition of the development process for similar software in the future once NASA's selected imaging system is revealed. Upon completion of the current task, research on data compression will become more relevant as we begin to explore methods of transporting and storing the images captured by the camera.

Mentor(s):

Katherine Gasaway, College of Engineering, Aeronautics & Astronautics

Alina Alexeenko, Purdue University

Distance Perception Using Object Detection in Autonomous Cars

Author(s):

Seoyoung Lee, College of Engineering

Scott Fang, College of Engineering

Aditya Agrawal, College of Engineering

Xiangyu Guo, College of Engineering

Chun Lee, College of Engineering

Heath Lovell, College of Engineering

Angel Rajpal, College of Engineering

Abstract:

The purpose is to create a system that connects the YOLOv5 object detection models and the lidar sensors. The YOLOv5 models have efficient runtime speed and high accuracy and the lidar sensors compute the distances to objects from the sensor. Incorporating these two, the system detects objects in camera footage and returns the object classifications and distance between the object and the vehicle. In order to integrate object detection and distance perception, we will use a camera to get the images and run the YOLOv5 object detection algorithm. We will also use ROS to integrate a LiDAR onto our vehicle. Once we have an image, we can use bounding boxes to find where the object is relative to the LiDAR. Using the data we get from the LiDAR, we can look for distances within that region. By doing this, we can process an image from the camera, run an algorithm on it, feed the relevant data to the LiDAR, and finally get a distance and classification of said object. We have run the YOLOv5 models on image datasets and assessed its accuracy and runtime. The model has relatively low run-time speeds of about 0.10s per image on average and consistently generates accurately labeled bounding boxes around the classified objects with average precisions of about 0.58 and average recalls of about 0.68 . This step has helped us analyze and assess the YOLOv5 model as well as customize the datasets and models.

Mentor(s):

Aly El Gamal, College of Engineering, Electrical & Computer Engineering

Shreya Ghosh, Purdue University

Predicting Workload Variations Using Human Neurological Reactions

Author(s):

Eugene Lee, College of Engineering

Deepthi Kumar, College of Engineering

Kevin Davis

Abstract:

In current times, it is important to understand what affects a person's performance as it could influence the success of the system the person is involved in. Furthermore, workload is known as one of the sources which could influence performance. Therefore, controlling workload in a center range is essential to maintain a person's performance. One vital factor which makes the workload controllable is to make sure the workload is accurately measured. Therefore, the purpose of this study is to see if human functions measured via Electroencephalography (EEG), eye tracking, and heart rate variability data can help measure different workload variations accurately. The study uses game simulations for data measurement as it allows for configuration of workload difficulties, allowing the team to easily compare amongst the different levels for analysis. Users are put through two different simulations. In the first simulation, the user drives around the map to different checkpoints. Each checkpoint will present a set of arithmetic or verbal questions and the user must answer as many questions in 30 seconds. In the second simulation, participants must diffuse a bomb in 5 minutes. While users participate in the simulations, measurements of body functions such as brain activity, heart rate, and eye movement will be used to observe how the body responds to different workload difficulty levels. In conclusion, the study is looking to draw conclusions about the data and see which combination indices from EEG, eye tracking and heart rate variability data could measure workload in the most accurate way.

Mentor(s):

Denny Yu, College of Engineering, Industrial Engineering

Jingkun Wang, Purdue University

Go-Kart Vehicle Design, Assembly, and Testing

Author(s):

Alexander Loney, College of Engineering

Muyiwa Arowolo, College of Engineering & Honors College

Olan Sodunke, College of Engineering & Honors College

Abstract:

In collaboration with the Vertically Integrated Project(VIP) Minority Engineering Program(MEP) Go-Kart team, participants disassembled old karts, developed assembly procedure documentation, reassembled the vehicles, performed rigorous safety evaluations, and conducted vehicle testing and analysis. The VIP MEP Go-Kart team is a credit bearing course designed for undergraduate engineering students to develop valuable skills that focus on the automotive engineering discipline. Participants were first trained on safety procedures for vehicle testing, assembly practices at the laboratory, and vehicle components. Sub-teams were given the task to disassemble outdated vehicles that needed maintenance, cleaning, and safety evaluations. Once each vehicle was disassembled, all components were documented for the assembly procedure documentation. Utilizing these procedures, sub-teams worked to reassemble the karts to include an internal combustion engine and any new parts that were deemed necessary. The vehicles were thoroughly inspected to ensure the safety of the driver, the vehicle, and the driving area. The vehicles were then tested through a series of races between sub-teams. The team currently has completed all testing and analysis without any major safety incidents. Looking forward, the team plans to innovate by competing in the Purdue Grand Prix, introduce electric engines to the vehicles, and continue to promote collaboration and work amongst the team. The skills that participants develop throughout the course are designed to be implemented into all aspects of the future professional careers of the participants as the project continues to innovate.

Mentor(s):

Matthew Swabey, College of Engineering, Engineering Administration

Lab Localization with Deep Learning and AI Tracking

Author(s):

Benjamin Loshe, College of Engineering & Honors College

Ryan Boyd, College of Engineering

Joseph Attardo, College of Engineering

Timothy Zhou, College of Engineering & Honors College

Kaiwen Shen, College of Engineering & Honors College

Shiqi Wang, College of Engineering

Abstract:

The purpose of this project is to enable the members of a lab to quickly get information about the usage of lab tools in a lab. This process will expedite the process of troubleshooting because users will have an easily accessible, detailed record of who used what equipment. Inputs for the project will be lab video recordings of the lab room as well as a designated areas of interest, drawn by a lab administrator. The outputs of the project will be a comprehensive database with tracking data for desired parameters and an interactive UI for easily viewable videos for desired zones/cameras/times. To produce the output, Tensorflow Object API will be used for human tracking and Flask framework will be used to develop the web application. The results of this project could be a great use case showing how to use artificial intelligence to create a useful database from video input.

Mentor(s):

Mithuna Thottethodi, College of Engineering, Electrical & Computer Engineering

Shock Induced Virtual Glass Transition to Rapidly Reduce Deviatoric Stress in Polystyrene

Author(s):

Jalen Macatangay, College of Engineering

Abstract:

Shock compression introduces a near-instantaneous increase in temperature and deviatoric stress as the shockwave propagates within a condensed matter system. When polymers are subjected to strong shocks, relaxation mechanisms, such as cooperative intramolecular motion and chain rearrangements, operate to reduce deviatoric stress towards a hydrostatic equilibrium state. However, these mechanisms and their associated rates are poorly understood, especially challenging are the initial response following shock loading. Therefore, we simulate shock loading on glassy polystyrene using molecular dynamic simulations with the multiscale shock technique (MSST) and characterize the stress relaxation processes. For strong shocks, the relaxation of deviatoric (Von Mises) stress exhibits two regimes: i) an initial fast relaxation lasting 2-5 ps, ii) followed by a more gradual process. Analysis of the torsional transition events in the polymer backbone bonds (dihedral angles switching between low-energy states) indicate that the fast relaxation is associated with shock-induced virtual melting. The second regime corresponds to glassy dynamics.

Mentor(s):

Brenden Hamilton, College of Engineering, Materials Engineering

Alejandro Strachan, Purdue University

Designing an Unmanned Surface Vehicle to Analyze the Water Quality of the Amazon River

Author(s):

Riya Mahajan, College of Engineering

Elan Mulchandani, College of Engineering

Melchizedek Robinson, College of Engineering

Griffen Skoumal, School of Management

Nick McKenzie, School of Management

Ethan Kovalan, College of Engineering

Robert Heying, School of Management

Abstract:

It is known that human activities like agriculture and industries significantly impact the quality of the water and soil around rivers surrounded by densely covered farmland. The runoff from farms and the waste products from industries contain toxic chemicals like pesticides and fertilizers and organic pollutants from chemical processes. These harmful chemicals have adverse effects on the marine life within the rivers and the Gulfs, leading to large dead zones hundreds of square miles in area. Building off a previous design by a Purdue graduate student of an unmanned surface vehicle (USV), we aim to design an improved USV to test the water quality in the Amazon River. This novel, compact design allows the boat to maneuver the constantly changing floodplains and collect water samples autonomously and remotely while conserving energy to be used for long periods. We will be using sensors to make real time measurements of temperature, pH, total dissolved solids, total dissolved oxygen, and electrical conductivity, which will allow us to evaluate whether the water is suitable for marine life. Using this revolutionary new boat design, we will be able to monitor the runoff in one of the world's most important rivers.

Mentor(s):

Eric Nauman, College of Engineering, Mechanical Engineering

Prabhpreet Dhir, Purdue University

VIP Child Automated Speech to Text (CAST)

Author(s):

Alexander Marks, College of Engineering

Abstract:

The purpose of the Child Automated Speech to Text (CAST) project is to create a speech-to-text machine learning model that accurately transcribes the speech of 3 to 5-year-old children. This model will then be accessible through a simple user interface that will allow child psychologists to more quickly transcribe child speech files that they need for their research. Previously, the team researched data alignment using audio and transcription files, data pre-processing methods, and natural language processing model architectures. As a result, the team is using a hybrid architecture machine learning model with a Deep Learning component, a Hidden Markov Model component, and an N-Gram probabilistic model component. Through the combination of these three components trained on the aligned and preprocessed data, the team believes that the combined model will be able to achieve accurate results despite clarity and inconsistent speech pattern challenges. Over this semester, the team has implemented and improved the data alignment and preprocessing processes, so that the data is ready for model training. In addition, the team is currently researching and developing the Deep Learning and Hidden Markov Model components of the system to create and benchmark a first iteration of the model by the end of the semester. Through next semester, the team will continue research, development, and training of the model components as well as add more training data in order to improve the combined model's accuracy. Moreover, the team will develop a simple user interface for researcher use of the combined model.

Mentor(s):

David Purpura, College of Health & Human Science, Human Development & Family Studies

The Lyophilization Of Watermelon

Author(s):

Christine Mayo, College of Engineering

Aidan Jennewein, College of Engineering

Vedha Srigiri, College of Engineering

Abstract:

Food waste plagues farms across our country, as imperfect produce is discarded in favor of profit. Over 20 billion pounds of produce is lost on farms each year, a problem that our team has been made aware of by a contact in the watermelon farming industry in Indiana. Watermelon is especially difficult to harvest due to the necessity for manual labor and its heightened potential for damage and bruising. This combined with the high water activity of watermelon results in an estimated 20 to 30 percent of the fruit being left to rot each season.

Similar to the instability and fragility of watermelon, many medications cannot be kept in liquid or frozen states for long periods of time. As a solution, these pharmaceutical products are often subjected to lyophilization, which removes moisture and allows them to exist in a stable, solid state that can be reconstituted for later use. The purpose of this experiment is to apply the pharmaceutical process of lyophilization to watermelon to reduce food waste and increase its potential for commercial products. Watermelon is not only a popular summer fruit, but also has a multitude of health benefits due to the chemical composition of the flesh and rind, which are high in lycopene and citrulline, respectively. The obstacles being explored in this project are the high water content of watermelon, which creates a lengthy and costly lyophilization process, as well as the issue of preserving watermelon content for taste and health benefits in consumer products.

Mentor(s):

Alina Alexeenko, College of Engineering, Chemical Engineering

Andrew Strongrich, Purdue University

Retracted.

Ethnic Disparities in Depressive Symptoms as a Function of Support Networks

Author(s):

Sanjana Murthy, College of Health & Human Science

Abstract:

This study examined ethnic disparities in depressive symptomatology by exploring how differences in social support predict prevalence rates across groups. We hypothesized that the organization of social support network and depressive symptoms differs by ethnic group. A population of 1262 self-identified White, Black, and Hispanic adjudicated adolescents completed the Brief Symptom Inventory, assessing depressive symptom severity on a scale from 0 = “not at all” to 4 = “extremely”. Social support was measured using the Contact with Caring Adults inventory, in which participants identified the total number of adults they found to be supportive within eight areas (higher scores indicate a greater number of relationships, or greater “breadth”) and in which participants identified the number of areas in which they had at least 3 supportive relationships (higher scores indicate a greater number of areas, or greater “depth”). Both breadth and depth of social support networks significantly predicted depressive symptoms across groups. Hispanic participants reported significantly lower breadth of social support than White or Black participants. Black participants showed significantly lower depth of social support than White or Black participants. Black respondents, furthermore, reported significantly greater depressive symptoms than Whites or Hispanics. Type of social support as a risk factor that accounts for prevalence of depressive symptoms thus appeared to depend on the ethnic groups being compared. Social support and ethnic group membership appeared to have separate relationships with depressive symptoms. Social support seemed to function similarly as a risk factor across groups. Implications of these findings are discussed.

Mentor(s):

David Rollock, College of Health & Human Science, Psychological Sciences

Detection of Cardiomegaly in Dogs using Deep Learning

Author(s):

Rohan Narasimha, College of Science

Abstract:

Computer Aided Diagnosis (CAD) is rapidly being integrated as a practice in the medical field through the use of deep learning. Radiographic evaluation of specific chamber enlargement is of importance in diagnosing dogs with cardiomegaly, which is a measurement of congestive heart disease. The primary radiographic feature of cardiomegaly associated with left-sided congestive heart disease is left atrial enlargement. A prominent bulge at the caudodorsal aspect of the heart is evidence of left atrial enlargement. The purpose of this study is to assess the effectiveness of deep learning in diagnosing left-sided cardiomegaly in dogs. We try to develop a deep learning solution that can learn the correlation between heart shape and disease status and learns to diagnose disease with reasonable accuracy. The deep learning algorithm we use in our study is a Convolutional Neural Network(CNN), specifically the Resnet50 architecture. We attempt to train the neural network to predict disease status by analyzing a dataset of thoracic radiograph images labelled positive or negative for left-sided cardiomegaly. Through our efforts we were able to achieve an accuracy of about 75% with disease prediction, which is close to the accuracy of manual diagnosis by radiologists of about 78%. Thus, the results of our study demonstrate that the use of deep learning could be effective in evaluating left-sided cardiomegaly in dogs. Future developments in computer aided diagnosis could include deep learning that could additionally provide the features and information to the user that it used to arrive at a certain diagnosis.

Mentor(s):

Daisuke Kihara, College of Science, Computer Science

Masahiro Masahiro, Purdue University, College of Veterinary Medicine, Department of Veterinary Clinical Sciences

Xiao Wang, Purdue University, College of Science

Sai Subraman, College of Science

Automated Data Processing: Making Community Indicators Possible for Lafayette, Indiana

Author(s):

Jace Newell, College of Engineering

Eli Coltin, School of Management

Eric Flaningam, College of Engineering

Abstract:

The City of Lafayette is actively seeking to improve livability in six specific neighborhoods in the Northend Region of Lafayette utilizing community indicators. The city requested the Ware Community Indicators Research Group develop a sustainable, digestible data system to help the city analyze desired indicators. To address the city's needs, the research group is developing an automated data analytics dashboard to help the city make adaptable, optimal, and informed decisions on existing and future community development initiatives.

This project centers on three specific indicators: homelessness, affordable housing, and neighborhood revitalization. Homelessness and affordable housing are two indicators that have become increasingly important to measure throughout the COVID-19 pandemic. To clarify: neighborhood revitalization refers to various measures of property conditions across Lafayette, such as street light, garage, and window conditions.

The data dashboard highlights an interactive visualization measuring the three aforementioned indicators. The team is gathering data from manual property conditions surveys, economic databases, and housing price sources. Then, the data is converted to a CSV file and pulled into a visualization software called Plotly. Finally, the data is organized into an interactive heat map which provides insights into the various community indicators. Currently, the team plans to complete the map regarding neighborhood revitalization by the end of the Fall 2021 semester. Afterward, the team will develop visualizations for homelessness and affordable housing. These results will continuously and positively impact the outcomes of the decisions our partners, the City of Lafayette, commit to concerning the well-being of its members.

Mentor(s):

Jason Ware, Ph.D., Honors College, Academic Affairs

A discrete mathematical model of the crayfish life cycle for predicting trapping efficacy

Author(s):

Dev Patel, College of Engineering & Honors College

Abstract:

The red swamp crayfish (*Procambarus clarkii*) is an invasive species native to the southeastern United States that was introduced into multiple Santa Monica Mountain (SMM) streams after use as live fish bait. *P. clarkii* is decimating native flora and fauna through predation, competition, and the spread of disease/parasites. *P. clarkii* has a lifespan of about 2-3 years, and they reproduce about 2-3 times a year with eggs maturing to adulthood in about three months. To combat this invasive species, the Mountains Restoration Trust (MRT) has regularly trapped crayfish and recorded trapping data in Malibu Creek, which has experienced local extirpation of some native species such as California newts. We create a detailed mathematical model of the crayfish life cycle in order to explore how trapping different crayfish sizes and ages impacts the effectiveness of crayfish removal. The mathematical model is a discrete-time stage- and size-structured model of crayfish eggs, juveniles, small adults, and large adults. We simulate each life stage over time and examine the sensitivity of model predictions to parameters to understand what part of the life cycle is having the greatest impact on crayfish population growth. Our modeling reveals that cannibalism of juveniles is a critical population control for crayfish. Model results also suggest that crayfish eradication may be possible with enough human effort. It also demonstrates that using trap mesh sizes small enough to trap juveniles may not be critical for controlling crayfish population.

Mentor(s):

Courtney Davis, Pepperdine University

AI for Small Unit Manuever

Author(s):

Kartik Pattaswamy, College of Engineering

Saurabh Singhal, Polytechnic Institute

Abstract:

The focus of this project is to assist the US Navy with beta testing for a challenge they are hosting on autonomous robotic systems – AI for Small Unit Maneuver (AISUM). The objective of the challenge is to enable a drone to autonomously explore a building of interest, perform object detection and deploy our code on a real drone. This research focuses on two areas: (1) Transitioning from a simulation environment to flying a real drone and (2) Enabling the drone to perform object detection.

For the first objective, we focused on writing software to fly a real-life drone. Previously, we used the Microsoft Airsim simulator to simulate a 3D map of the building of interest to test navigation scripts. To transition our software for a real drone, we utilized the PX4 Controller to bridge the gap between simulation and actual actuators that fly a drone. We used VOXL m500 drone to test the navigation algorithms using PX4 Software-in-the-loop.

For the second objective, we developed a YOLOv5 for object detection on ordinary objects (tables, chairs, drums). We created a dataset on objects-of-interest to the Navy to create a model to determine the feasibility of how potential competitors could perform in a competition setting. We looked at metrics like confusion matrices, testing accuracy and precision to set a baseline of how our model performs on our dataset. Currently, we are looking into methods such as reinforcement learning to improve the testing accuracy and reduce misclassifications and low confidence of correction object detections.

Mentor(s):

Aly El Gamal, College of Engineering, Electrical & Computer Engineering

Shreya Ghosh, Purdue University

Investigating the Frequency and Nature of Social Justice References in the Teacher Education Program Curriculum at Purdue University

Author(s):

Julia Pirrello, College of Education

Abstract:

During this time of heightened awareness of social injustices via Black Lives Matter protests, the Me Too movement, and the COVID-19 pandemic, it is important to ensure that teacher preparation curriculum includes attention to knowledge and skills related to social justice issues in education. The purpose of this study was to investigate the ways in which social justice, diversity, and equity are addressed in the foundational courses of the teacher education program at Purdue University. In this study, a report of the frequency and nature of social justice references in the program curriculum was generated through focused, thematic analyses of the required course syllabi, readings, and assignments. Preliminary analyses revealed the presence of explicit and implicit references to social justice and related ideas. Social justice, diversity, and/or equity were specifically addressed in at least one reading in each course, but to varying degrees. Other social justice related ideas that were referenced across multiple courses include stereotypes, accessibility, as well as teacher and student rights. These findings will evolve into a report that uses curricular analyses, faculty input, and student experiences to identify the ways that social justice, diversity, and equity are incorporated into the curricula, and also highlight productive connections that begin in the foundations courses and could be continued into the methods courses that are completed later in the program. With a better understanding of the current curriculum, program personnel can both enhance opportunities in their own courses, as well as capitalize on experiences offered in other courses.

Mentor(s):

Jill Newton, College of Education, Curriculum & Instruction

Beyond 5G

Author(s):

Ayush Praharaj, College of Engineering

Michael Scirocco, College of Engineering

Adhitya Ramkumar, College of Engineering

Po-Ying Huang, College of Engineering

Bo-Yang Wu, College of Engineering

Abstract:

The purpose of this team is to apply communication-based signal processing on 5G-based wireless communication systems. We plan to accomplish this goal by splitting up into three sub-teams and gaining an overall understanding of the vast field from different angles.

Our first sub-team is focused on various codes that are used in digital communication. These include OFDM, error codes, and Space-time Block codes. We will observe why they are required in modern communication systems and discern their effectiveness in a real-world setting.

Our second sub-team is focused on the theory behind 5G and 6G technologies with a focus on mmWaves, eMBB, mMTC, and uRLLC. We will compare the different parts of these newer technologies with 4G technology by surveying the information from prior research to understand contemporary mobile communication systems.

Our third and final sub-team is focused on the practical operation of communication systems. Several simulations will be run through GNU Radio, a software development toolkit that allows us to implement signal-processing systems. Furthermore, we will perform experiments using a software-defined radio (the USRP N210) to observe the non-ideal behaviors experienced when signals are transmitted through real-world environments and mitigate any errors caused by these non-idealities.

Mentor(s):

Chih-Chun Wang, College of Engineering, Electrical & Computer Engineering

David Love, Purdue University

James Krogmeier, Purdue University

Molecular Alternatives for Combating Acrolein in CNS-trauma

Author(s):

Anna Prall, College of Science

Abstract:

Acrolein is a potent alpha,beta-unsaturated aldehyde that has been identified to accumulate after spinal cord injury, contributing to cell death and loss of motor function. Hydralazine, commonly used to treat hypertension, has also been identified to scavenge for acrolein and decrease its accumulation following spinal cord injury. However, spinal cord injury patients are already susceptible to low blood pressure, so administering hydralazine is not feasible without targeted delivery measures. This study aimed to determine if using folate-conjugated hydralazine distributed via targeted drug delivery to the injury site in the central nervous system would decrease the accumulation of acrolein without causing a drop in blood pressure in rats. Injection of a folate-NIR dye administered seven days following spinal contusion injury provided evidence for targeting, showing increased uptake at the epicenter of the injury compared to a site rostral to injury. Folate-conjugated hydralazine (F-HDZ) was administered daily for one week following injury and visualized using DAB staining. Results indicated a significant decrease in acrolein accumulation in rats where F-HDZ was administered compared to injury rats. Blood pressure was also monitored to determine the efficacy of the targeted delivery of hydralazine. Results showed no significant difference in blood pressure between rats with F-HDZ administered and control rats, illustrating that targeted delivery using folate-conjugated hydralazine effectively decreases the acrolein accumulation at the injury site while maintaining blood pressure.

Mentor(s):

Peter Bermel, College of Engineering, Electrical & Computer Engineering

Seth Herr, Purdue University

Physics-Informed Machine Learning to Predict Extreme Weather

Author(s):

Rthvik Raviprakash, College of Science

Mahdi Mohammed M, College of Science

Jonathan Buchanan, College of Science

Abstract:

Extreme weather events refer to unexpected, severe, or unseasonal weather events, which are dynamically related to specific large-scale atmospheric patterns. These extreme weather events have a significant impact on human society and also natural ecosystems. For example, natural disasters due to extreme weather events caused more than \$90 billion global direct losses in 2015. These extreme weather events are challenging to predict due to the chaotic nature of the atmosphere and are highly correlated with the occurrence of atmospheric blocking. A key aspect for preparedness and response to extreme climate events is accurate medium-range forecasting of atmospheric blocking events.

Unlike the conventional approach based on numerical weather forecasting, we propose a new machine learning approach to make binary classification predictions based on recurring patterns from multi-dimensional data of time-evolving atmospheric flow patterns. This approach enables us to focus on the intrinsic connection between extreme weather events and the surrounding large-scale atmospheric patterns. We build an empirical model using Convolutional Neural Networks to classify the 2D atmospheric flow patterns images to predict whether that would cause an extreme weather event or not. We retrieve the spatio-temporal data from the dataset by converting them into coarse-graining images and categorizing and labeling them to predict extreme weather events. These categorized images are then fed to the Neural Network to give us the final prediction. We use a CNN with 4 Convolutional layers, which provides the best accuracy compared to when we have more or fewer layers.

Mentor(s):

Lei Wang, College of Science, Earth, Atmospheric, & Planetary Sciences

Zhaoyu Liu, Purdue University

Stratigraphic and Structural Characterization of the Eocene Blue Mountain Unit, Olympic Peninsula, WA: Implications for basin formation and volcanism following Siletzia's accretion

Author(s):

Nicholas Regier, College of Science

Abstract:

During the Eocene, a ridge-centered oceanic plateau (Siletzia) accreted to the margin of North America at the latitude of Washington and Oregon. Accretion of Siletzia had a remarkable impact on the regional geology and set the stage for the formation of the modern Cascadia arc. The terrane rapidly subsided following its accretion generating a regional basin and a thick section of Cenozoic sedimentary strata. These basin deposits are exposed along the margins of the Olympic Peninsula. Recent U-Pb zircon geochronologic data demonstrate that the Blue Mountain Unit (BMU), a continentally derived turbidite sequence originally thought to be interbedded with basalts at the base of the Siletzia terrane, is, in fact, younger than (<45 Ma) and thrust under Siletzia (56-48 Ma). In the Dungeness Forks area, the Lower Elwha fault places the BMU and interbedded lower Crescent formation under basalts of the upper Crescent formation, which is part of the Siletzia plateau. This implies that the BMU and at least part of the lower Crescent Formation represent a distinct period of sedimentation and volcanism that is <45 Ma. To help understand these units, our analyses include new detailed geologic mapping, measured stratigraphic sections, and lithofacies characterization of the Blue Mountain Unit and interbedded volcanic rocks on Tyler Peak of the Dungeness Forks area. We discuss how these sedimentary and volcanic rocks fit into the regional tectonic history during the time period between accretion of Siletzia and establishment of the Cascadia arc.

Mentor(s):

Mike Eddy, College of Science, Earth, Atmospheric, & Planetary Sciences

Erin Donaghy, Purdue University

Structural determination of bacterial effector CteC

Author(s):

Hannah Rondon Cordero, College of Science

Abstract:

ADP-ribosylation is a post-translational modification strategy that various pathogens employ to interfere with host cellular processes. One of the targets for ADP-ribosylation is ubiquitin, a small globular protein vital in host immune response and protein degradation. Recently, a bacterial effector, CteC, from *Chromobacterium violaceum* has been found to ADP-ribosylate ubiquitin on Threonine-66. This modification on ubiquitin hinders normal host ubiquitination by disabling ubiquitin transfer from E1 activating enzyme to E2 conjugating enzyme. However, the molecular basis of this ADP-ribosylation is not well understood, which limits our current understanding of this bacterial ADP-ribosyl transferase. To address this, protein crystallography technique is applied to gain structural details of this bacterial effector and its interactions with the substrates. So far, I have successfully crystallized CteC in its apo form and collected a 2.8 Å dataset. Meanwhile, I also conducted a gel-based assay to clearly show the enzymatic activity of CteC. Currently, I am working on optimizing the crystals and trying to obtain co-crystals of CteC in complex with its substrates. Eventually, I hope to elucidate the catalytic mechanism of this bacterial enzyme and provide insights into how *C. violaceum* hijacks the host ubiquitination pathway.

Mentor(s):

Zhengrui Zhang, College of Science, Chemistry

Chittaranjan Das, Purdue University

Research Talk Presentation: 73 :: Life Sciences

Elastin-like Polypeptides as Biosensors in Metabolic Engineering

Author(s):

Ben Rubino, College of Science

Abstract:

Redacted by request.

Mentor(s):

Kevin Solomon, College of Agriculture, Agricultural & Biological Engineering

Mrugesh Parasa, Purdue University

Getting a Better Sense: Acetylcholine, Glutamate, and Potential Difference Detection in Implantable Biosensor Research

Author(s):

Carl Russell III, College of Engineering

Abstract:

The detection of biomolecules has historically been a challenging process. The specificity and scale of previous neurological biosensor designs have not allowed for adequate visibility when sensing molecules of interest. However, recent advancements in technology, collaborative techniques, and research in the field of neurological biosensing have allowed for the development of increasingly more advanced platforms to explore this elusive area of study. The detection of neurotransmitters, applying surface coatings, and packaging techniques were used to assist in the development of novel biosensor platforms with the goal of improving specificity and clarification of biomolecule detection and allowing applications in diagnostics. Electrodes functionalized with enzymes of interest, such as acetylcholine oxidase and glutamate oxidase can detect the presence of molecules, such as acetylcholine and glutamate that bind and react with them, through chronoamperometry. I execute such studies to verify that new designs of biosensors functionalized with specific enzymes can detect such molecules of interest. The utilization and replication of previously published research allows me to use such research for other applications. Such is the case with a paper detailing surface coating procedures with electrodes. I seek to replicate the results from it to apply the coated surface to a new biosensor design. However complex the design of the sensor, they all to be able to interface with a computer. I also seek to share the process in which I package biosensors in a way that they can interact with a computer to generate various outputs. Such outputs include characterization techniques (Electrical Impedance Spectroscopy, Cyclic Voltammetry) and verification techniques (Chronoamperometry).

Mentor(s):

Hugh Lee, College of Engineering, Biomedical Engineering

Jongcheon Lim, Laboratory of Implantable Microsystems Research, Purdue University

Angel Enriquez, Laboratory of Implantable Microsystems Research, Purdue University

Geowhen - Earth history visualization

Author(s):

Ibrahim Saeed, College of Science

Will Oberley, College of Engineering

Aarini Panzade, College of Science

Abstract:

In the world, different countries have different names for the geological stages of Earth history. Using the data given from Dr. Bruno Vrielynck (Commission of the Geological Map of the World, UNESCO), we created a search website that:

- Allows geologists to look up the different geological stages and find information about them, such as the region, the age span, the calibration, etc.
- Displays a chart that has information about the stages chronologically surrounding the selected stage.
- Has a search bar that can be used to query the different stages by the name. The stages are also organized by the periods and once we click on any of the stages, the information for that specific stage will be shown.
- Has a filter menu that filters by different regions, periods, and age.
- Sorts the stages alphabetically and by age.

The website was created using React, JavaScript, and the formatting was done by HTML and CSS library Bootstraps. To expand this project, we will be working on sorting the geological stages by region. Eventually, this website will help unify information for the different stage names between regions.

Mentor(s):

Jim Ogg, College of Science, Earth, Atmospheric, & Planetary Sciences

Aaron Ault, Purdue University

Antibiotic activity of Streptomyces strain N3

Author(s):

Diane Santos, College of Science

Abstract:

Redacted by request.

Mentor(s):

Amir Alwali, College of Science, Chemistry

Elizabeth Parkinson, Purdue University

Applicability of different analytical techniques to evaluate particle and powder properties for food and pharmaceutical relevant materials

Author(s):

Anthony Scott, College of Engineering

Abstract:

Anthony Scott¹, Hector Lozano Perez² and Teresa Carvajal²

¹Chemical Engineering and ²Agricultural and Biological Engineering, Purdue University, West Lafayette, IN

Powder characterization in the food and pharmaceutical industries is an extremely important step during processing and manufacturing to create an efficient and stable product. The particle and powder properties in this research include particle size, shape, flowability, and surface energetics. The analytical techniques such as laser diffraction, Inverse Gas Chromatography, and shear cell testing were used to quantify the material properties. Various types of starches and plant-based proteins were used in this study. The results showed that the protein-based materials with similar particle sizes and shapes, the cohesiveness varied greatly among the materials; this in turn, was reflected in the powder flow behavior. The surface characterization of the starches indicated that the surface chemistry is different, hence, likely to affect powder performance. Thus, when working with powders, towards creating a final product for the consumer, it is necessary to quantify the material properties to understand and manipulate the behavior of powders to a desirable outcome.

Mentor(s):

Schemeka Robinson, Procter & Gamble

Hector Lozano-Perez, Purdue University

Food Detection

Author(s):

Robert Sego, College of Engineering

Tiffany Yu, College of Engineering

Santiago Guada, College of Engineering

Burkay Sahin, College of Engineering

Preethi Goli, College of Science

Rahul Ashok, College of Engineering

Abstract:

Dietary information for cooked meals is often inaccessible, and while packaged foods have nutrition labels, the amount of calories per serving can be difficult for customers to parse if there is more than one serving in the container. As awareness of the negative effects of obesity and food allergies increase, and consumers become more health conscious, the need for detailed and accurate documentation of dietary information increases as well. The purpose of this project is to classify images of food and estimate their calorie count so that users may both stay informed about the contents of their food and log their eating habits for future dietary decisions. Modeled after the TADA Project, the goal of this project is to analyze individual images of food for relevant information about its content using fiducial markers to calculate shape and volume of such items. Using Convolutional Neural Network models, we will detect multiple food items in an image, classify them to find their nutritional content, and output an estimation of their caloric content. By creating a tool that removes the need for prior user knowledge about these dishes, we can remove dietary risks and provide a more accurate calorie count than a user could estimate.

Mentor(s):

Carla Zoltowski, College of Engineering, Electrical & Computer Engineering

Edward Delp, Purdue University

VIP BIDC IoT

Author(s):

Pranav Shashidhar, College of Engineering

Vichapat Upatising, College of Engineering

Gladys Jordana, College of Engineering

Saket Kallam, Polytechnic Institute

Shaan Chanchani, School of Management

Rohan Patil, School of Management

Lael Keller, College of Liberal Arts

Naren Ram, Polytechnic Institute

Abstract:

The Bechtel Innovation Design Center (BIDC) at Purdue facilitates students creating and exploring advanced manufacturing. This dynamic environment of innovation and creativity also presents safety risks for the people working inside the building. The VIP BIDC IoT team aims to mitigate and manage the risks through leveraging data analytics and machine learning on IoT edge nodes. The project aims to collect data using Internet of Things nodes that monitor the environment of the space through the sensors attached to the device. By processing the data through various algorithms we can get a better understanding of the present situation. The BIDC employees and volunteers can not know about every single safety issue that happens in their facility, especially if it is invisible. However, a widespread sensor array with a built in analytics system can provide them feedback and information in real time that allows them to make safety focused decisions to better protect their students. We use an STM32 prototyping board that allows us to create a modular and adaptable hardware system along with a wide series of algorithms that we parse our data through. This gives us an immense amount of flexibility in our deployment of the project. Our end goal is to develop a system that efficiently and effectively monitors a building to provide swift and accurate safety information.

Mentor(s):

Matthew Swabey, College of Engineering, Engineering Administration

Pairing nanoHUB Users with Their Respective ResearchGate User Space

Author(s):

Poonyapat Sinpanyalert, College of Science

Abstract:

The purpose of this project is to create a one-to-one mapping between the user space of nanoHUB to the user profiles in ResearchGate. By using common links between the two spaces, in this case, the publication of nanoHUB resources or tools, we can determine the connections between the two user spaces. The discovery information we have is the list of the resources and tools that have been referred from ResearchGate, acquired through the Apache logs for nanoHUB.org. We will use that information to link the authors of such resources with their respective user profiles in ResearchGate if those resources are also published on ResearchGate.

By crawling and scraping both given resource ids and the ResearchGate website, we have written a python script that finds the name of the correlated resources and their respective authors and then matches them up with the corresponding publications on ResearchGate.

With these matched pairs of authors' user IDs of nanoHUB and their ResearchGate, we can use this information to create connections between users for further user analysis and maybe to grow the user base for nanoHUB in the future.

Mentor(s):

Joe Cychosz, Discovery Park, Network for Computational Nanotechnology (NCN)

Gerhard Klimeck, Purdue University

Coupling Metabolic Source Isotopic Pair Labeling and Genome Wide Association for Metabolite and Gene Annotation in Plants

Author(s):

Abigail Sipes, College of Agriculture

Abstract:

To deepen our understanding of plant gene function, it is important that we advance our knowledge of plant genomes and metabolic activity. With metabolite synthesis information in hand, we will have the capability to unlock higher plant productivity, develop new strategies to protect plants from stressors, and develop new plant-based products. This project applies isotopic labeling to characterize amino acid-derived metabolites in Arabidopsis and then applies Genome-Wide Association (GWA) to identify the genes responsible for their synthesis. A computational pipeline was utilized to generate metabolic features that are derived from the labeled amino acids and then we applied criteria to determine mass features of interest. This project aims to classify metabolites based on the precursor-of-origin and to provide the function of annotated genes that are associated with plant metabolism.

Mentor(s):

Clint Chapple, College of Agriculture, Biochemistry

On the Use of Sonication as a Means for DNA Extraction on Live Drosophila Larvae

Author(s):

Isabella Sirit, College of Science

Abstract:

The viability of entomological evidence is an important aspect for many criminal and civil cases. However, typical DNA extraction methodologies that rely on tissue homogenization presents difficulty in the preservation of specimens. Preserving entomological evidence can provide more information as the specimen's life cycle progresses, such as a more accurate time of death. This paper responds to this by using sonication as a method for DNA extraction on live drosophila larvae. By using and recording survivorship measurements throughout the trial the viability of the methodology as a means for preserving entomological evidence was measured. In addition, amplification of the extracted DNA collected was used to measure the amount of nucleotide base pairs extracted. Overall, it was found that as sonication times increase the survivorship proportion decreases. Although this technique requires far more standardization and approval before moving forward, this is a more effective manner to pursue criminal and civil convictions and should be implemented as a manner to provide the best possible evidence for the mitigation of wrongful convictions.

Keywords: drosophila, survivorship, larvae, life cycle, sonication, DNA extraction

Mentor(s):

Stephen Cameron, College of Agriculture, Entomology

Krystal Hans, Purdue University

Christopher Wirth, Purdue University

GO-kart Design and Assembly

Author(s):

Olanrewaju Sodunke, College of Engineering & Honors College

Muyiwa Arowolo, College of Engineering & Honors College

Alexander Loney, College of Engineering

Abstract:

Each semester, undergraduate students at Purdue are provided with the opportunity to participate in a Vertically integrated project (VIP), earning academic credit while engaging in authentic and extended research related to national, international, and industry-sponsored design challenges. The Go-Karting industry is one that has only seen exponential growth over the years. It has developed as a more convenient and safer alternative to the professional level racing like 'Nascar' and 'Formula 1'. Some drivers in this category have also attributed their early developed skills to Go-karting. Consequentially, the project chosen was the design of internal combustion engine Go-karts. The aim of this project was to utilize old and abandoned Go-karts as well as analytical and construction and design techniques to develop Karts for recreational use and the long-term goal of racing in the Purdue Grand Prix. The old karts are disassembled to the very framework, pieces are thoroughly cleaned, inspected, and lubricated before passing the check to the inventory for reconstruction. Before being allowed to race, the karts must undergo several intensive safety checks and ground tests to ensure the well-being of the driver, the Kart, and the track. Currently, the project is entirely completed and has passed all safety tests and has been adjusted to compensate for real-life racing complications. Future developments would focus primarily on developing electrical engine Go-karts; eliminating the complications of carbon emissions, engine overheating, as well as increasing the portability and functionality of the Karts. The design process of the Go-Kart offered constructional and mechanical insight that would only prove to be valuable in future developments and projects.

Mentor(s):

Lin Xu, College of Engineering, Mechanical Engineering

Morgan Fuller, Purdue University

Colin Keyes, Purdue University

Investigating prenatal marijuana use and child internalizing symptoms in a sample of children adopted at birth

Author(s):

Elena Stanczykiewicz, College of Health & Human Science

Abstract:

Prenatal marijuana exposure can have many long-term effects on childhood development including increased internalizing symptoms (Paul et al., 2020). Gray et al. (2005) found that prenatal marijuana exposure in the first and third trimesters significantly increased symptoms of depression. However, Min et al. (2021) analyzed the effects of prenatal alcohol, tobacco, marijuana, and cocaine exposure on internalizing and found that only prenatal tobacco exposure increased risk of internalizing in children. Furthermore, all studies measuring prenatal marijuana use on childhood internalizing have been conducted within families where parents raise their biological children, creating gene environment correlation (rGE). To address the conflicting literature and limitation of rGE , the current study used an adopted-at-birth design to tease apart the influence of prenatal, heritable and postnatal influences on the development of child internalizing. Data came from the Early Growth and Development Study ($n=561$), a longitudinal adopted-at-birth design. Prenatal marijuana use and other substances were self-reported by the birth mothers shortly after birth. Child internalizing symptoms were reported by the adoptive parents using the Child Behavior Checklist at 6-8 years old. Additionally, heritable risk indicators for psychopathology and substance use were derived from birth parent measures and adoptive parents self-reported their own overreactive parenting and depression symptoms. A multiple regression model was used to test the association between prenatal marijuana exposure and child internalizing as well as covariates. No association was found between prenatal marijuana exposure and child internalizing ($\beta=-.01$, $SE=.05$, $p=.863$). Overreactive parenting ($\beta=.18$, $SE=.05$, $p<.001$) and heritable risk for psychopathology ($\beta=.13$, $SE=.06$, $p=.018$) were the only predictors of child internalizing which has been found in one cohort of this sample before (Marceau et al., 2015). The current study did not find any evidence for an association of prenatal marijuana exposure or other substance for child internalizing despite the sample being at risk for prenatal substance use.

Mentor(s):

Kristine Marceau, College of Health & Human Science, Human Development & Family Studies

Olivia Robertson, Purdue University

Communication Techniques used in Conversations of Space Regulation

Author(s):

Shannon Sturt, College of Science & Honors College

Abstract:

The regulation of space debris is an important topic due to its increasing relevance as more private companies enter space, and it is currently being discussed at a congressional level. Areas of concern include the science of removing existing debris, research into how to prevent the creation of further debris, and what national and international legal action needs to be taken to prevent more debris. I analyzed various communication techniques that various presenters used in order to persuade congress members of the importance of this issue and what solutions are available. Certain communication techniques are more effective than others for emphasizing the presenter's points, and analyzing the differences in these techniques was the purpose of my research. I focused on what those different techniques were, which were most effective, and in what scenarios they were most effective. I utilized a Ground Theory analysis approach and used the topic of space regulation as my focus material. This research can help us to better understand what communication techniques are most effective in a scientific conversation geared toward a general audience without background knowledge, thereby allowing important scientific conversations to become more accessible to a larger audience.

Mentor(s):

Jennifer Hall, College of Liberal Arts, Communications

Thruputer: Digital Computer With Software Acceleration

Author(s):

Huy-Minh Tran, College of Engineering

Christopher Priebe, College of Engineering

Raymond Ngo, College of Engineering

Chris Morrison, College of Engineering

Matt Kraynik, College of Engineering

Tomas Kolar, College of Engineering

Chase LaCoursiere, College of Engineering

Nicholas Verastegui, College of Engineering

Abstract:

In recent years, the surge of studies in machine learning and data analysis has created a lot of demand for hardware acceleration to have better run time. ThruPuter (TP) is a Dynamically Programmable Logic Element (DPLE) designed with the intention to support those software systems. Its application is somewhat similar to a Field Programmable Gate Array (FPGA), a type of Integrated Circuit that is often used by hardware designers to verify their designed hardware. Despite not being as versatile as an FPGA, TP consumes lower power and is significantly faster than FPGA for hardware acceleration applications in general and existing software models in specific. TPs are operated together creating an array of DPLeS called ThruPuter system. This system is designed around an Instruction Set Architecture (ISA) called Very Large Instruction Word (VLIW). VLIW works differently from other ISAs because of the speed at which it operates. Modern standard ISAs typically perform 1 data move and 1 data operation per clock cycle; however, VLIW can operate up to 4 data moves and 2 data moves per clock cycle.

The team is divided into 2 subgroups: Compiler and Microarchitecture. Compiler team is tasked with compiling a programming language to VLIW that TP supports. The microarchitecture team is responsible for creating a hardware architecture of TP with a current goal of being able to implement said hardware on an FPGA for operation demonstration.

Mentor(s):

Raghul Prakash, College of Engineering, Electrical & Computer Engineering

Cole Nelson, Purdue University

David Meyhew, Universant Processors, Inc.

Mark Johnson, Purdue University

Implementation of Simtools into Nanohub's nanotechnology simulation tools

Author(s):

Darin Tsai, College of Engineering

Alan Zhang, College of Engineering

Aloysius Rebeiro, College of Engineering

Abstract:

Nanohub is an exceptional website that allows students, researchers and teachers to globally collaborate to advance the understanding and uses of nanotechnology and related fields. The site is a repository of published simulation tools with several aspects of physical nano- level study. SimTool is a library published in June 2021 that greatly increases time efficiency, through several syntactical and database implementations. Currently, with less than 5 simtools published that comply with SimTool requirements, our team aims to integrate SimTool into all of Nanohub's popular tools. Our first published tool, CaeCipher, is an interactive encryption simulation that fully utilizes all fundamental aspects of SimTool. With widgets that allow for an immersive user interface, tuning of difficulty, and answer inputs, users can easily cache in inputs and outputs due to the integration of SimTool database. Data storage and functions are managed with the SimTool ipynb file while the workflow file parses inputs, outputs, and configures the user interface. The next tool, St4Nanowire, is a wrapper script for using the silicon nanowire simulator with Rappture. Since the previous version did not allow for permanent storage of data in NanoHUB servers, the new improvised version allows the nanowire simulation to run off user interface and caches input and output data using Yet Another Markup Language (YAML) magic and Swagger API. With the removal of the previous temporary single XML data storage, inputs and outputs are now stored with ease of access and modification. With transformation of the Rappture and XML file into a simTool and workflow file, data caching and graphical user interface can be properly separated and prepared for potential future improvements. Documentation for all specific functions and features are being created since SimTool was created recently and lacks in-depth documentation.

Mentor(s):

Daniel Mejia, Discovery Park, Network for Computational Nanotechnology (NCN)

Gerhard Klimeck, Purdue University

Regulation of Meiosis Progression through Phosphatase and Kinase Activity

Author(s):

Ilakkiya Venkatachalam, College of Science & Honors College

Abstract:

Kinase and phosphatase activity control changes in the phosphorylation state of proteins that regulate cell cycle progression. To understand the machinery regulating how mammalian eggs (oocytes) go through meiosis, our study focused on Protein Phosphatase 1 (PP1) and Microtubule-Associated Serine Threonine-kinase Like (MASTL) that are candidates for regulatory function in this important cell type. Our approach was to experimentally manipulate PP1 and MASTL to disrupt their normal pattern of activity during meiosis to test hypotheses about what these enzymes do in oocytes. This research will increase our knowledge of factors affecting female fertility.

Analysis of PP1 in starfish and mouse oocytes suggests PP1 is inactive during prophase I exit. We tested the hypothesis that inappropriate activity of PP1 at this stage would cause abnormalities in the G2/M transition by culturing oocytes in medium containing PDP-Nal, a PP1 activator. Prior studies show that MASTL is involved in meiotic progression in mammalian oocytes, but gene knockdown and gene knockout of MASTL have different meiosis progression results. We hypothesize that expressing a dominant-negative form of MASTL that will inhibit endogenous MASTL activity can identify MASTL's function at various stages of meiotic progression. The PP1 experiment results show that inappropriate PP1 activation at prophase I exit kills oocytes and inhibits meiosis. PP1 inactivity is essential for successful prophase I exit and M-phase entry. The MASTL experiment is at the stage of creating the dominant-negative form of MASTL for oocyte insertion.

Mentor(s):

Janice Evans, College of Science, Biological Sciences

Nicole J. Camlin, Purdue University

Health Perceptions and Longevity in Adults with Chronic Illness

Author(s):

Lauren Voss, College of Health & Human Science

Abstract:

Chronic conditions become more common with age and greater numbers and severity of chronic conditions, in turn, increase the risk of mortality. However, individuals with similar disease burden often experience mortality at different rates. The purpose of the present study is to examine potential explanations for divergent mortality outcomes. Self-rated health (SRH), or perceptions of one's own health, consistently predicts mortality. Thus, we hypothesized that participants' SRH would modify the association between chronic conditions and mortality. Data were from the second wave of the Midlife in the US (MIDUS study, N=5,524). Mortality data were collected through 2018. Multimorbidity was measured in two different ways. To assess disease severity, each chronic condition was weighted by its propensity to cause disability; these were then summed. The second was a sum of chronic conditions, a common measure in many studies. SRH was measured on a scale of 1-5 (1 = poor, 5 = excellent). Results from logistic regression models predicting odds of mortality showed that greater disease burden (measured both as counts and severity of conditions) predicted increased odds of mortality. Additionally, lower ratings of SRH predicted greater risk of mortality. However, SRH did not strongly modify the association of chronic conditions and mortality risk, although results were in expected directions. Based on the results, SRH was not a strong moderator of the link between multimorbidity and mortality, leaving open the question of variability in mortality outcomes in older adults with multimorbidities. Future work could explore other possible moderators.

Mentor(s):

Elliot Friedman, College of Health & Human Science, Human Development & Family Studies

Elizabeth Teas, Purdue University

Wireless Radio

Author(s):

Matthew Waldren, College of Engineering

Sam Elkin, College of Engineering

YaLing Tsai, College of Engineering

Abstract:

The objective of this project is to design a 5G wireless radio for the SoCET team's latest microprocessor tapeout. This radio will operate at a frequency of 28 GHz with a bandwidth of 850 MHz for lower signal latency and faster data upload and download speeds. The components will be designed using Cadence Virtuoso with a 22nm Silicon-on-Insulator Process Design Kit (PDK). The radio architecture uses a direct conversion receiver with an antenna array enabled through phase shifting of the local oscillator (LO). The transmitter will be designed to achieve a saturated output power of 23 dBm to allow the range between the transmitting antenna and base station to reach 200 m. Linearity and power efficiency are also important specifications for the transmitter, which are dominated by the performance of the power amplifier. In the receiver, a downconversion mixer will reduce the input signal's frequency from 28 GHz to the baseband frequency within range of the chip's Analog to Digital Converter. The local oscillator that feeds into the downconversion mixer will be generated from a voltage-controlled oscillator (VCO), which contains a phase-locked loop (PLL). The mixer will be designed to achieve an amplitude mismatch of 0.3 dB, phase mismatch of 3 degrees, and a conversion gain greater than 6 dB. This project will allow the SoCET team and its sponsors such as Crane Naval Base to build a chip that can effectively and efficiently send and receive data and lays the groundwork for a wifi module.

Mentor(s):

Sutton Hathorn, College of Engineering, Electrical & Computer Engineering

Mark Johnson, Purdue ECE

Data-driven Workload Prediction and Resource Planning for COVID-19 Preparedness

Author(s):

Hang Wang, College of Science

Abstract:

Since the first outbreak of COVID-19, the United States has tragically turned into one of the most impacted countries. Our research team has been collaborating with IU Health with the goal of helping hospitals in Indiana make quick adjustments and design strategies to meet anticipated demands for space, staff, and other resources during the disruptive pandemic. With hospital records provided by IU Health, we have made sophisticated analyses of patient census, arrival, and discharge in different hospitals across multiple regions in Indiana. Meanwhile, we designed and fine-tuned a brute-force algorithm that learns from aforementioned descriptive statistics and makes daily census prediction. Later, we focused on more advanced machine learning algorithms including linear and logistic regressions, random forest, and neural network to generate more accurate discharge predictions from both the individual and hospital levels. Furthermore, we incorporated new layers and loss functions into our neural network to predict a full distribution of desired statistics under various probability distribution assumptions. So far, we have found that while our neural network model can make highly accurate hospital-wise discharge prediction, errors accumulated when the predicted discharge were used to produce census prediction. However, when we directly trained the network to predict the distribution of daily patient census using models like Gaussian and Poisson, we were able to obtain extremely accurate predictions for several major hospitals in Indiana.

Mentor(s):

Pengyi Shi, School of Management, Operations Management

Health Information Technology

Author(s):

Zongdao Wen, College of Engineering

Katherine Zhang, College of Science

Nimal Padmanabhan, College of Engineering

Shuihan Liu, College of Engineering

Wang Ning Lo, College of Engineering

Abstract:

In this project, we are developing a web application for emergency medical service agencies to better manage their nursing staff and their community-dwelling clients, who have recently experienced acute episodes of chronic conditions. This is the first step of developing a digital health platform with the main functionality of relaying self-reported data from clients in community-based care support programs to the paramedics. As a result, nursing staff in a community paramedics agency can closely monitor their clients' health state and make necessary ambulatory care referrals. The overarching goal of our development is to help reduce the overuse of critical care resources in hospital emergency departments.

The whole project will construct a dashboard that will be used by an emergency medical service (EMS) that is providing out-of-hospital acute care and transport to definitive care. Our team has designed and implemented the web application via Dash Python. Components of the project include: 1) user-friendly dashboard for both nurses to track their attending clients' health status and agency administrators to track the nurses' work progress, 2) daily self-administered survey to at-risk community dwellers on chronic conditions via SurveyJS, 3) nurse and patient information database working with the dashboard via Cloud Firestore, and 4) calendar functionality for nursing home-visit scheduling via Google Calendar API. This project is in collaboration with Dr. Nicole Adams from the School of Nursing, and its community partner is Empress EMS, a top-tier EMS provider located in Westchester County, NY.

Mentor(s):

Nan Kong, College of Engineering, Biomedical Engineering

Nicole Adams, Purdue University (School of Nursing)

The privatization of space travel

Author(s):

Taylor Williams, School of Management

Abstract:

The National Aeronautics and Space Administration (NASA) has been the leading corporation widely heard for space travel and exploration. This agency has taken major leaps in the world outside of Earth, being funded by the United States government. This meant that the rules and laws of space were through the government's approval, which is now being questioned through the privatization of such space travel and exploration. Companies, like SpaceX, funded by billionaire, Elon Musk, have been taking a rise to the stage of space. These such companies are private companies, not through the United States government, funded independently. This independence has opened up questions such as: how space privatization affects different entities financially and socio-economically, the rules of space, and how NASA and private companies team up for the space race.

Mentor(s):

Jennifer Hall, College of Liberal Arts, Communications

The Explanation Techniques of Cryptocurrency Experts

Author(s):

Sean Woerner, College of Science

Abstract:

The Explanation Techniques of Cryptocurrency Experts

Abstract

Cryptocurrency or crypto is a recent phenomenon that has taken the media, investors, and government's attention. Cryptocurrencies utilize a technology called "Blockchain " as certification for authenticity, but are not backed by any organization like cash and thus have volatile price fluctuations. This decentralized verification allows cryptocurrency to be traded fairly anonymously and without being subject to taxation. Organized crime groups have taken advantage of this anonymity to launder money and store their wealth.

The volatility and crime opportunities of cryptocurrency have caught the attention of regulators, in particular the United States Congress. Congress has called several experts to testify on the subject and we have analyzed their testimony. We coded for techniques that the experts used to explain concepts in cryptocurrency and sorted those techniques into three categories: worded, visual, and emotional. We found that experts most often used worded techniques to explain cryptocurrency to congress people. Almost no experts used any kind of visual techniques, visual aids or gestures. Most often cryptocurrency experts tried to establish shared beliefs with congress members and then explained the concepts along those lines.

Mentor(s):

Jennifer Hall, College of Liberal Arts, Communications

License Plate Detector

Author(s):

Bo-Yang Wu, College of Engineering

Po-Ying Huang, College of Engineering

Abstract:

The purpose of this project research was to create an automatically functioning system to identify license plates numbers and characters in real-time, especially determine American license plates which have many different designs compared to other countries which usually only have one design. The license plate detector system uses image processing, and machine learning techniques. The algorithm determines where the license plate is in the image using the license plate localization model. Then, character segmentation techniques are used to locate and segment the specific characters and numbers in the license plate. Lastly, the characters and numbers are used as input for the neural network to determine what character or number it is and translate the image into texts. Also, compare to most license plate research, this project uses many image processing techniques rather than just using machine learning techniques to guess the character on the license plate. The completion of this project is available for use in smart cities. Some of the common use cases include parking assistance systems, vehicle registration and identification for police systems, highway payment systems, and medical supply or logistics transporting warehouses.

Mentor(s):

Edward Delp, College of Engineering, Electrical & Computer Engineering

Carla Zoltowski, Purdue University

Membrane Energy Exchanger for Air Cooling and Dehumidification

Author(s):

Songhao Wu, College of Engineering

Hemanth Aroumougam, College of Engineering

Karl Akert, College of Engineering

Meghan Thai, College of Engineering

Abstract:

Heating, ventilation and air conditioning (HVAC) equipment consume 35% of total building energy use in the US, among which a large share is used for cooling and dehumidification. The majority of air dehumidification systems take the conventional approach of moisture condensation removal. It requires air to be cooled below its dew point temperature and is an energy-intensive process, especially for areas with hot and humid climates. Vapor selective membrane systems are promising alternatives for air dehumidification as they do not require cooling energy for latent (humidity) heat removal. It allows water vapor transport through the membrane while blocking air. Previous thermodynamic modeling and preliminary testing of a membrane-based HVAC device developed by our group, referred to as the Membrane Energy Exchanger (AMX), has shown great potential for energy savings. High air/water selectivity membranes were fabricated and tested. A prototype of AMX with the outdoor air simulation (OAS) system was designed and assembled to test the performance of a real system and compare it against modeled performance. Temperature and humidity supplied to the prototype were varied across a broad range to simulate different climate conditions. The humidity removal rate was investigated for the effect of airflow rate and simultaneous cooling. The results complement the previous modeling studies of AMX that investigated the potential improvement in air conditioning energy consumption. The prototype design demonstrates the constructability of the proposed AMX system and serves as a pivotal step towards system scale-up for energy savings at the building level.

Mentor(s):

David Warsinger, College of Engineering, Mechanical Engineering

James Braun, Purdue University

Andrew Fix, Purdue University

Probabilistic Computing for NP Problems

Author(s):

Zhengxiang Xie, College of Engineering

Abstract:

Hard drive storage is generally based on stable magnets that point up and down, and cannot easily flip on their own – not unlike refrigerator magnets. At small scales, there is also a related class of unstable magnets that can spontaneously flip back and forth with thermal noise. They can be used for a different application – probabilistic computing. In this study, we show that unstable magnets can represent probabilistic bits: p-bits, for short. By connecting them together in certain ways, p-bits can be used to efficiently solve some non-deterministic polynomial (NP)-hard problems, which generally take a long time for classical computers to solve. More specifically, by connecting them based on the Ising model, and setting the solutions of the problem to zero energy, one naturally finds the solution as the most probable state. Because the Landau–Lifshitz–Gilbert (LLG) equation used to solve magnetization dynamics has a similar structure with the capacity equation of nonlinear circuits, we can analyze it using the industrial level circuit simulation tool – PrimeSim HSPICE. In a collaborative effort, my graduate mentor Jie Zhu and I are trying to show the wide range of problems p-bit can solve by developing new algorithms. In addition, we are also trying to scale up the size of numbers in each type of problem by adding more p-bits into algorithms. Eventually, our work could pave the way for future applications of p-bit computing.

Mentor(s):

Peter Bermel, College of Engineering, Electrical & Computer Engineering

Jie Zhu, Purdue University

Undergraduate Research mentoring during COVID-19

Author(s):

Wencong Xie, College of Science

Abstract:

Due to the global covid-19 pandemic and subsequent campus closures, most undergraduate research students had to shift from in-person to virtual mentoring. The switch communication had both positive and negative effects. Many undergraduate mentees and graduate mentors felt that their relationships improved in a virtual mentoring environment. This work investigated the impact of COVID-19 restrictions on undergraduate research mentoring.

The COVID-19 Survey for undergraduate researchers was analyzed with the focus on Impact of COVID-19 on mentoring. The Chi-Square test of independence was used in analyzing the relationship between frequency of mentor-mentee communication and the impact of COVID-19 restriction on mentorship support. Interestingly, the result showed that the chosen 5 groups of data (forms of mentor support) show that there was no relationship between frequency of mentor-mentee communication and the impact of COVID-19 restriction on the selected forms of mentor support.

This conclusion could be due to the undergraduate researchers who responded to the survey. Those who volunteer to respond to the variables of interest are those people who are willing to keep the research communication stable no matter how the outside environment changes (epidemic).

Mentor(s):

Ibukun Phillips, College of Engineering, Industrial Engineering

Research Talk Presentation: 99 :: Social Sciences/Humanities/Education

Web Content Accessibility Guideline Comparison of the Average Number of Known Errors in Implementation Across Tradeshow Websites

Author(s):

Victoria Young, College of Health & Human Science

Moved to Poster Presentation #179.

Mentor(s):

Shawn Jung, College of Health & Human Science, Hospitality & Tourism

Statistical Machine Learning and Decision Analytics for Global Supply Chain and Health

Author(s):

Hui Zeng, School of Management

Congyu Pu, School of Management

Yuxuan Wu, College of Science

Abstract:

During the COVID-19 pandemic, more than 45 million cases and 740 thousand deaths have been confirmed, posing a massive threat to public health. Fortunately, the COVID-19 vaccine was developed and approved at the beginning of this year. However, the effectiveness of vaccination and vaccine distribution remains an open question. Our research aims to address the following research questions: How is the vaccine distributed and what are the corresponding policies? How did the vaccine allocation impact the hospitalization rate on the general population, especially targeted high-risk communities (e.g., elderly people)? What are the characteristics of the hospitalized covid-19 patients and the implications for vaccine allocation? How to improve the vaccine distribution and allocation policy to minimize mortality and hospitalization rate?

We collect the real-world data and perform exploratory data analysis and time series analysis to analyze the patterns of vaccination and the relationship between vaccination and mortality or hospitalization for COVID-19 patients. Moreover, we employ the Bass diffusion model to characterize the dynamics of the vaccine allocation and the difference-in-difference analysis to examine the effect of vaccine distribution policy on mortality rate. We also propose a decision-tree-based machine learning model to predict the mortality rate among the hospitalized patients and interpret the characteristics of patients and then use Long Short Term Memory and recurrent neural network models to identify the most effective vaccine allocation strategy. Our preliminary findings indicate that vaccination has reduced mortality and hospitalization rates, but whether the current vaccine allocation policy is optimal remains unclear.

Mentor(s):

Zhan Pang, School of Management, Operations Management

Automation of Unmanned Lunabot Rover using Obstacle Detection, Terrain Mapping, and Optimal Pathing Algorithms

Author(s):

Kaiqi Zhang, College of Engineering

Jerry Wang, College of Engineering

Sanjeev Kummarapurugu, College of Engineering

Aaditya Pai, College of Engineering

Abstract:

The goal of this project is to make the Lunabot fully autonomous. The fully developed Lunabot will have the ability to drive itself on the moon surface and pick up as much gravel as possible and will enter the Lunabotics competition held by NASA. But in this project, the focus is to make a prototype that can automatically detect terrains and objects to avoid collision, as well as planning the path to a desired spot. Input will be fed from the camera and lidar, the information will then be processed by the integrated programs, and the output actions will be made by providing commands to the DC motor which will drive the robot and turn the robot using the servo motor. Based on the required equipment, the size of the chassis is determined, and the power requirement is determined by using an estimated weight of all components. A prototype chassis and drivetrain are designed in CAD and partially manufactured, and a program is developed to track an object through a camera and Raspberry Pi. Programming and testing are currently done on separate Raspberry Pi, and the final program will be integrated to a single Nvidia Jetson Nano with all the hardware installed onto the chassis. The end goal is to use the product as a testbed for testing multiple different path based algorithms.

Mentor(s):

Eric Nauman, College of Engineering, Mechanical Engineering

Preet Dhir, Purdue University

POSTERS

**Investigation of Sequential Post-Translational Modifications in Photosynthetic Cyanobacteria
Cyanothece 51142**

Author(s):

Lauren Anderson, College of Science

Abstract:

Cyanothece 51142 is a unicellular photosynthetic organism in the cyanobacteria phylum with unique metabolic attributes that allow them to adapt to varying environments. These bacteria have attracted attention from researchers due to their unique ability to temporally separate photosynthesis during the day and nitrogen (N₂) fixation during the night within a single cell. Understanding molecular mechanisms that enable them to perform these incompatible biological processes is important to engineer them for renewable energy sources. Many proteins involved in these processes function through post-translational modifications (PTMs) and protein-protein interactions. However, such information is very limited in cyanobacteria, particularly in *Cyanothece*. Expressed proteins can form complexes within metabolic pathways, which may indicate their ability to survive in altered environments. Our group has recently mapped ~1,300 *Cyanothece* 51142 proteins, with ~800 being putative complexes. The amounts of proteins undergoing post translational modifications and how such modifications impact protein complex formation are still being investigated. Simultaneous phosphorylation and N-glycosylation may permit an assessment of the potential for cross-talk between these two vital PTMs and their roles in cellular regulation. In this study, we were interested in developing a method that allows sequential purification of protein phosphorylation and N-glycosylation in *Cyanothece* 51142 at the same time. Cultures were grown for 5 and 12 days under N₂ non-fixing conditions (medium containing nitrate). Cells were lysed for protein extraction and digested into peptides using trypsin and LysC proteases before purification of phosphorylated peptides using the PolyMAC Phosphopeptide Enrichment Kit and N-glycosylated peptides using Glycoprotein Enrichment Resin. Peptides were subsequently analyzed using LC-MS/MS. In both 5 and 12 day sample sets, we identified 38 proteins that underwent glycosylation as determined by deamination sites, and 23 proteins that underwent phosphorylation as determined by phospho STY sites. Only 9 proteins were found to undergo both phosphorylation and glycosylation. Modified proteins were identified to be involved in the regulation and maintenance of photosynthesis and central metabolism, specifically proteins *cpcA*, *cpcB*, and *cpcG1* which are proteins within the phycobilisome, a light-harvesting antenna protein complex. It is likely that these antenna proteins need to undergo both modifications and to facilitate photosynthesis. Future studies will further optimize enrichment methods and focus to investigate the cross-talks and interdependency between these two important PTMs.

Mentor(s):

Uma Aryal, College of Veterinary Medicine, Comparative Pathobiology

Jackeline Franco Marmolejo, Bindley Bioscience Center, Purdue University

Rodrigo Mohallem, Department of Comparative Pathobiology, Bindley Bioscience Center, Purdue University

Effects of NEDD4 and endosulfine alpha on synuclein pathology in Parkinson's disease

Author(s):

Brianna Arinze, College of Pharmacy

Abstract:

Parkinson's disease is a neurodegenerative disorder that leads to a loss of dopaminergic neurons. One of the common hallmarks of this disease is the presence of protein aggregates called Lewy bodies that are largely comprised of α -synuclein (aSyn), a presynaptic protein involved in the pathogenesis of Parkinson's Disease (PD). Misfolding of soluble aSyn could lead to the protein's assembly into amyloid-like fibrils. There have been reports that fibrils from recombinant aSyn, referred to as pre-formed fibrils (PFFs), are internalized via an endocytic mechanism and can then induce pathology in healthy cells by recruiting the endogenous/cytosolic protein to aggregate. Research has identified aSyn-interacting proteins that may have the potential to interfere with the process of aggregation. Studies have shown that overexpression of neuronally expressed developmentally down-regulated gene 4 (NEDD4), a ubiquitin ligase, leads to aSyn degradation by an ESCRT-mediated lysosomal pathway and could possibly promote clearance of aggregated aSyn. Nedd4 catalyzes aSyn ubiquitination, leading to degradation of the protein via the endosomal lysosomal pathway. Additionally, the protein endosulfine- α (ENSA), a cAMP regulated phosphoprotein, has been shown to interact with membrane-bound aSyn and thus interfere with aSyn aggregation. In this project, we are examining whether the transport of aSyn PFFs from endocytic compartments into the cytosol can be inhibited by interfering with aSyn-mediated vesicle disruption (via co-expression of the aSyn-interacting protein ENSA) or by stimulating the repair of endosomal membranes (via co-expression of the ESCRT protein Nedd4). We will address these questions in a PFF-treated primary neuronal cell culture model using imaging tools to visualize and quantify PFF endosomal escape and detecting pSer129-aSyn⁺ inclusions. We expect to find a decrease in PFF escape from the endocytic compartment into the cytosol and the presence of aSyn pathology when ENSA or Nedd4 are over-expressed, suggesting in turn that both proteins could potentially alleviate neurotoxicity in PD.

Mentor(s):

Dr. Jean-Christophe Rochet, College of Pharmacy, Medicinal Chemistry & Molecular Pharmacology

Chandnee Chandrasekaran, Department of Medicinal Chemistry and Molecular Pharmacology, Purdue Institute for Integrative Neuroscience, Purdue University

Effects of siRNA-Mediated PRL2 Knockdowns on Cell Signaling in Pancreatic and Lung Cancer Cell Lines

Author(s):

Jinan Ayub, College of Science

Abstract:

Phosphatase of regenerating liver (PRL) is an enzymatic phosphatase whose oncogenic properties warrant its investigation as a therapeutic drug target. Of all three variants, PRL2 is the most abundantly expressed in cells and dephosphorylates proteins involved in preventing oncogenesis. A recent publication by Dr. Zhong-Yin Zhang's lab showed that PRL2 downregulates PTEN by dephosphorylating its Y336 residue, activating ubiquitin-mediated PTEN degradation and increasing the cell's susceptibility to malignancies. This project investigated if lower PRL2 expression in pancreatic and lung cancer cell lines, which confer high mortality rates, can suppress its oncogenic effects in signaling pathways. In this study, five different pancreatic and lung cancer cell lines, PaCa2, A549, H358, HPAF, and CFPAC, were transiently transfected with small interfering RNA (siRNA) to knockdown PRL2 expression. After 48 hours, the protein expression of ERK/AKT, STAT3, PCNA, PTEN, and PARP in these cells were analyzed on Western blots. The preliminary results were mixed, with only the A549, H358, and PaCa2 cell lines showing the expected increase in PTEN levels. All cell lines showed increased apoptosis, as demonstrated by increased cleaved PARP levels. These results may help determine if disrupting PRL-regulated pathways can prevent pancreatic and lung cancer cell development. In the future, CRISPR-Cas9 will be used to generate PRL2 knockout stable lines, as the signaling studied under transient transfections may be too short-lived to accurately capture the effect of PRL2 loss on cell signaling. Additionally, experiments with mouse xenograft models will be performed to further evaluate tumorigenicity *in vivo*.

Mentor(s):

Frederick Nguele Meke, College of Pharmacy, Medicinal Chemistry & Molecular Pharmacology

Zhong-Yin Zhang, Purdue University

Developing an Approach to Real-Time Lane Detection Across Run-Time Environments

Author(s):

Vishnu Banna, College of Engineering

John Bullock, College of Engineering

Ting-Han Chen, College of Engineering

Pume Tuchinda, College of Engineering

Brad Jeon, College of Engineering

Abstract:

With the prevalence of autonomous vehicles, the vision algorithms utilized for autonomous driving must be robust and accurate enough to assess road features through images captured in real-time. In our previous work, a neural network model was constructed according to the YOLO network architecture using a Dilated Darknet backbone and a path aggregation network decoder. The model was then trained on the BDD100k dataset to give keypoint predictions of where lanes are in an image. With the success of last semester's proof-of-concept model, this semester's focus is on making the model more robust and accurate to transition to a fully deliverable model. This process includes transitioning from keypoint predictions to segmentation predictions, which encompasses more general lane objects and safe drivable area predictions, and allows for more accurate lane classification. Building on this, the proof-of-concept model is being improved to target real-time inference without significant loss in accuracy. This will be achieved by implementing a new decoder that combines the work done in the SWIN transformer paper by Microsoft and the Bidirectional Feature Pyramid Network paper by Google. The new decoder design is intended to aggregate backbone features at multiple resolutions by paying attention to information encoded at each resolution. This will allow the model to selectively merge shallow and deep information to increase the receptive field of the model and allow for better predictions with fewer parameters. These alterations will reduce the model size by ~15% and create a new proof-of-concept model for future work to build on.

Mentor(s):

Edward Delp, College of Engineering, Electrical & Computer Engineering

Carla Zoltowski, Purdue University

Informed Designers: A Study of Design Skills within an Engineering Curriculum for Former Street Youth

Author(s):

Joanna Bastian, College of Engineering

Rachel Damge, College of Engineering & Honors College

Samantha Friedman, College of Engineering & Honors College

Arshee Krishnan, College of Engineering

Sitara Simons, College of Engineering

Abstract:

The purpose of this study was to evaluate the development of informed design behaviors as a product of an engineering curriculum specifically designed for former “street youth.” The 17 students evaluated in this study were aged 12 to 19 and belonged to a Center (name blinded) that accepts former street-connected youth and teaches them both general education and engineering classes. The Center provides a formal, yet non-traditional, primary school setting located in Eldoret, Kenya.

The research team taught engineering focused classes and conducted assessments, including qualitative observations of behaviors during engineering activities. These were used to classify the Center’s students on the continuum of novice to informed designers while actively applying their knowledge. The actions of the students were compared to the Informed Design Teaching and Learning Matrix developed by Crismond and Adams in 2013 to distinguish the novice from the informed designers. Questionnaires were also used to evaluate the student’s pure knowledge regarding the engineering design process. The responses to these surveys were used to quantitatively summarize the trends in informed design development throughout the Center.

The results of this study found that the engineering curriculum has developed the students in the areas of representing their ideas and reflecting on the design process. However, other informed design behaviors that were assessed indicate that all the students at the Center are still progressing towards becoming fully informed designers.

Mentor(s):

Jennifer DeBoer, College of Engineering, Engineering Education

Dhinesh Radhakrishnan, Purdue University

Software Development on FPGA

Author(s):

Viranch Bateriwala, College of Engineering

Abstract:

An FPGA is a flexible integrated circuit that can be continuously reprogrammed according to a particular design's requirements. The objective is to design software to verify hardware directly on the FPGA. The project incorporates a methodology to gather statistical information and alter the memory contents of the FPGA without requiring a full resynthesis. Python scripts are used to gather post-synthesis statistics from the FPGA, and run-time data collection is done with a CPU tracker. The CPU tracker is a hardware monitor that collects and displays traces such as RISC-V instruction executions. The tracker's respective System Verilog components are compiled on the FPGA and is used with the preceding data collection script to stream relevant information to the end user. Interfacing with the FPGA is accomplished via a UART serial communication protocol in conjunction with a C-like printf() buffer to output characters. Tools such as Intel's Quartus II software are used to compile and implement hardware designs. The NIOS II soft-core processor provides C compilation capabilities that allows for the UART implementation as well as enables access to FPGA memory contents for modification. The overall goal is to provide a framework for writing software for in-progress versions of the team's AFTx0N chip to streamline the verification process and reduce time commitments.

Mentor(s):

Mark Johnson, College of Engineering, Electrical & Computer Engineering

John Martinuk, Purdue University

Cole Nelson, Purdue University

Characterization of Neutrophil Subtypes and Their Response Towards Inflammation

Author(s):

Jennifer Beckman, College of Science

Abstract:

As the first responders to infection and injury in the immune system, neutrophils show adaptability and functional plasticity to defend the host organism from harm. Neutrophils are the most abundant type of granulocytes, and they exist in heterogeneous populations with various levels of maturity and age. However, it is not very well understood how neutrophils of differing age and maturity respond to injury. Thus, the aim of this research project is to utilize the zebrafish model to determine how mature and immature neutrophils respond to primary inflammation and how emergency granulopoiesis affects the course of inflammation in secondary infection. In this project, the timer protein is used to indicate the maturity of neutrophils with the fluorescence going from green to red over a 24-hour time period. Timer protein has no effects on normal neutrophil function, so the fish are functionally like wild-type fish. Starting on day 2, neutrophils are produced, and overtime, the red fluorescence indicating maturity gets more intense, peaking at day 7. It is hypothesized the immature and mature neutrophils will respond differently upon secondary infection due to the role of emergency granulopoiesis and priming. However, it was found that emergency granulopoiesis does not guarantee a better survival rate for the fish. The results from these experiments will help us better understand the complex nature of neutrophil response mechanisms and can have therapeutic applications for inflammatory diseases.

Mentor(s):

Ramizah Mohd Sabri, College of Science, Biological Sciences

Dr. Qing Deng, Purdue University

Automatic Process Synthesis for Olefin Production from Shale Gas

Author(s):

Arsh Bhatia, College of Engineering

Abstract:

As the world transitions toward sustainable energy sources, shale gas provides a strong option as a carbon source for this period. Shale gas is rich in natural gas and is a good source for olefin production which is used in manufacturing plastic, rubber etc. The current shale gas manufacturing processes use a sequence of front-end separation, natural gas activation and back-end separation. This has led to repeated separations which drive up costs and energy consumption. As a result, large amount of shale gas at remote areas are directly flared, leading to increased wastage of shale resources and carbon emission. Recently, developments by Chen et al. [1] [2] have shown that eliminating some of the front end separation and postponing them for after NGL activation reduces costs and energy consumption, leading to a more intensified process design.

Chen et al.'s work, although provided a systematic procedure to rearrange the process sequence, still highly rely on researchers and practitioners' engineering intuition. In this study we investigate the automation of the synthesis procedure using mathematical programming and relying on the optimization framework to decide the optimal process arrangement. By creating an algorithm that can construct the proper search space and sort through configurations based on deciding factors such as cost and energy demand, we are able to identify unique alternatives which are more efficient.

We consider a small-scale liquid production plant from natural gas liquid in shale gas consisting of a dehydrogenation reactor and an oligomerization reactor. The algorithm considers a reaction-separation network wherein all reactions and separations are nodes and all submixture streams are edges. The algorithm can synthesize the conventional configuration, the configurations in Chen et al's work as well as several other attractive process options.

References

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Mentor(s):

Rakesh Agrawal, College of Engineering, Chemical Engineering

Zewei Chen, Chemical Engineering, Purdue University

A Meta-Analytic Review of Polychronicity

Author(s):

Javier Camarillo, College of Health & Human Science

Abstract:

Polychronicity, or better known as multitasking preferences/attitudes, is a topic that is explored through a plethora of studies that claim to suggest practical information on how it impacts performance. The dilemma that is caused by this is that many of these studies have not used a consistent definition of polychronicity and a lack of standards to measure it as outlined by previous research (e.g., Koning & Walter, 2010). Using multiple scholarly databases, we have compiled and are reviewing available studies pertaining to polychronicity. The purpose of this ongoing study is to conduct the first thorough meta-analysis organizing the empirical findings related to polychronicity. This meta-analysis is still in the early stages as these studies are still being determined if they are applicable through multiple rounds of coding performed by different research assistants to assure the information is reliable and valid.

Mentor(s):

Franki Kung, College of Health & Human Science, Psychological Sciences

Rick Yang, Purdue University

Ignacio Camarillo, Purdue University

The impact of tau hyperphosphorylation and splice variant identity on pathological aggregate formation

Author(s):

Raul Castro, College of Science & Honors College

Abstract:

The brains of post-mortem Alzheimer's disease patients are characterized by the presence of hyperphosphorylated tau protein aggregates named neurofibrillary tangles. Previous studies have highlighted the role of pathological tau protein species in the formation of neurofibrillary tangles, but the mechanism of how tangles spread from neuron to neuron and across brain regions remains elusive. This study aims to address this question by isolating pathological tau species and studying whether these alone are responsible for neurofibrillary tangle propagation from cell to cell. The methods to be used in this study include using Sf9 insect cells to produce hyperphosphorylated tau species, converting the hyperphosphorylated protein to amyloid-like fibrils, and assessing the fibrils' pathological activity in a HEK-tau biosensor cell line that is widely used to assess the propagation ability of tau seeds. The expectations of the study are that (i) we will clarify the role of hyperphosphorylation on the propagation of tau pathology in cellular models, and (ii) our results will lay a foundation for developing medical therapies targeting tau hyperphosphorylation and/or propagation in neurodegenerative diseases.

Mentor(s):

Chris Rochet, College of Pharmacy, Medicinal Chemistry & Molecular Pharmacology

Sehong Min, Purdue University

Amazon Organic Ranking Factor Analysis

Author(s):

Harsabreen Chadha, College of Engineering & Honors College

Abstract:

Amazon is the world's largest online retailer with presence now spanning in 58 countries and reaching the greatest international online population, 1.2 billion people, according to Website Builder Expert (WBE), which used data from Amazon's Alexa Internet. Like many other online retailers, Amazon uses a specific search algorithm to ensure customers are shown the most accurate results for their search with the most benefit of the product. A fit gap analysis of a few products on the market in the healthcare industry is formulated to see to understand what aspects are missing in contrast to what guidelines Amazon has given out. Results are gathered and a correlation model is derived to see what parts of an amazon listing are proving to play an important role in the position the listing is being ranked. The goal is to highlight common mistakes and areas vendors are likely to miss or overlook. The most notable features missed were backend keywords, following style guides provided by Amazon, and repeated keywords in the listings. Understanding the algorithm, allows vendors to list items in a fashion to ensure a high position of the search page which increases impressions on the items and drives conversions to unlock incremental sales. Based on interactions, impressions, and conversions as well as pertinent keywords the listing is given a certain rank in the way it is shown to the buyer. When the organic rank increases vendors can decrease media spend on sponsored ads which increase profits on each sale.

Mentor(s):

Morajikumar Kumar, Reckitt

The Relationship Between Voice Disorders in Singers and Singing Genre: A Scoping Review

Author(s):

Evan Chambers, College of Health & Human Science

Abstract:

Background: Varying musical genres place different physiological demands on the vocal mechanism. The impact of singing genre on risk for vocal pathology, however, remains unknown. This scoping review details the literature examining the relationship between singing genre and voice disorder prevalence and symptoms.

Methods: Research articles were obtained via PubMed, Purdue Libraries, and Google Scholar search bases. For inclusion in this review, research reports were required to 1) examine prevalence of voice disorders, 2) specify genre of singer examined, 3) include singer demographics, and 4) be available in English.

Results: A total of 298 articles were screened for this review and 21 met inclusion criteria. Studies examined the following singing genres; classical, musical theater, choral, rock, Jewish cantors, Carnatic, and pop music. Reported prevalence of voice disorders varied widely across and within singing genre. Methodological differences between studies account for this finding. Vocal fatigue and throat pain were the most reported voice symptoms, and high vocal load was the most prevalent performance risk factor.

Conclusions: Singer's risk for voice disorders may vary across singing genre. Differences in performance and physiological singing demands likely account for this variation. More across-genre studies are needed to compare genre-associated risks, and individualize dysphonia treatment.

Mentor(s):

Preeti Sivasankar, College of Health & Human Science, Speech, Language, & Hearing Sciences

Robert Fujiki, University of Wisconsin

Biomedical Drone for Narcan Delivery

Author(s):

Brandon Dimitri, College of Engineering

Seejay Patel, College of Engineering

Jeremy Frederick, College of Science

Matthew Murday, College of Engineering

Abstract:

Opioid overdose has rapidly evolved into a public health epidemic. Naloxone is a drug which is very effective in reversing the effects of an overdose incident, however, the drug must be delivered rapidly once an overdose occurs as permanent damage may result in as little as 6 minutes from the overdose. Currently, many communities, especially those in rural locations, experience barriers to the access of necessary EMS personnel to obtain treatment, thus decreasing the likelihood of surviving an overdose if one occurs. The ability to anticipate overdose events and rapidly deliver naloxone will be extremely beneficial in helping to reduce opioid related deaths. Delivery time currently can be delayed due to factors such as distance from a dispatcher station to the victim, traffic, or lack of ambulances ready to respond, among others as well. Fortunately, naloxone can be administered easily as a nasal spray by bystanders, but the issue remains in getting the drug to bystanders.

This project aims to develop a prototype drone to deliver Narcan for EMS missions. Drones will be advantageous over traditional methods of responding to overdose incidents because of their ability to take advantage of a direct route to the victim via aerial travel, therefore arriving faster than first responders. The drone being designed will be capable of autonomous navigation to the overdose victim upon being dispatched. It will then deliver Narcan to the site and provide audio and/or visual instructions to assist the bystander with administration of the Narcan to the victim.

Mentor(s):

James Goppert, College of Engineering, Aeronautics & Astronautics

Nan Kong, Purdue University

Riley Franklin, Purdue University

Photon Statistics and Quantum Optics Experiments

Author(s):

Alice Dragnea, College of Engineering

Caitlin Heinowitz, College of Engineering

Abigail Roy, College of Engineering

Abstract:

Emerging quantum technology developments are promising for advancements in the 21st century, especially in revolutionizing information processing with faster computational speeds and improved security. Quantum information can be encoded in many attributes of photons, and because they experience essentially no decoherence they have the potential to carry quantum information over long distances. Quantum states, however, are fragile. Here, we performed a parametric down conversion experiment to understand the challenges of working with quantum states. By sending classical laser light into a nonlinear crystal, we can occasionally generate time-energy entangled photon pairs by a process called spontaneous parametric down conversion (SPDC). Due to the nature of time-energy entanglement, each individual photon of a down converted photon pair is created at the exact same time. By viewing delays between detection clicks with a time interval analyzer, we can view the quantum signature of the down converted photons. This experiment forms the basis of measuring photonic quantum information in the frequency domain.

We will continue to perform such foundational benchtop quantum optics experiments. Currently, one challenge with many quantum optics experiments is distinguishing quantum events from classical events. As a result, our goal is to build a time interval analyzer (TIA) that will make this distinction by time tagging photon events. Single-photon detectors produce an electrical signal when a photon strikes them. TIA will measure and record the time difference between the two electrical signals caused by the two photons whose behavior we are analyzing.

Mentor(s):

Andrew Weiner, College of Engineering, Electrical & Computer Engineering

Andrew Weiner, Purdue University

Polarity Analysis Model: Creating NLP Model with BERT Framework

Author(s):

Claudia Duncan, College of Science & Honors College

Abstract:

The overall goal of the project is developing a pipeline of Natural Language Processing (NLP) methods that identifies candidate casual indicators for significant factors in device failure via service log text. The model of focus within this project is the Polarity Analysis model. Verbs within the input text are assigned a polarity ("positive" or "non-positive"), and the verb's associated tokens of interest are identified as candidate causal indicators if the verb is labeled "non-positive". The significance of this project lies in the advanced method of the Polarity Analysis model which uses the BERT (Bidirectional Encoder Representations from a Transformer) model and a recurrent neural network (RNN). BERT is a newer language representation model from TensorFlow Hub. It uses state of the art neural network architecture to represent words as a vector numbers. The model is pre-trained on 3.3 billion words from Wikipedia, making it an advanced model with performative results. Traditional NLP methods of word embeddings can be limited by the word-to-vector approach and one-dimension representation. The model was tested using simple binary accuracy and produced a test accuracy of 85.14% with a test loss of 0.349. BERT achieves this performance by finding the meaning of words with a bi-directional approach, searching both left and right of a token within a specified window. This poster aims to demonstrate the application, benefits, and performance of BERT within the context of the causal indication pipeline.

Mentor(s):

Justin Gould, Capgemini

Impact of Pre-Diabetes and Type 2 Diabetes on Patellar Tendon Morphology Assessed with MRI

Author(s):

Chinonso Emenim, College of Health & Human Science & Honors College

Dominick Farino, College of Health & Human Science

Abstract:

Tendon degeneration is a significant clinical challenge for the millions suffering from diabetes. Many patients remain asymptomatic for years despite underlying degeneration. Several studies have demonstrated that magnetic resonance imaging can be used to assess tendon morphology and estimate the extent of tendon degeneration in persons with tendon pathology. We wished to determine if we could detect differences in patellar tendon morphology in persons with pre-diabetes and type 2 diabetes when compared to healthy age-matched individuals without diabetes. Healthy controls, (n=14, Age:45±5y, BMI:24±1, HbA1c:5.3±0.1%), persons pre-diabetes (n=14, Age:54±5y, BMI:29±2, HbA1c:5.7±0.1), and those with type 2 diabetes (n=13, Age:55±3y, BMI:33±2, HbA1c:6.7±0.3) were recruited to participate in this investigation.

T1-weighted MRI scans of the tendon were completed on each subject. After normalization to body weight, we found that tendon cross-sectional area was lower in patients with type 2 diabetes (5.6±0.3 mm²/kg body wt, p<0.05) than controls (6.9±0.3 mm²/kg body wt) and pre-diabetes (6.5±0.3 mm²/kg). Tendon MRI signal, which has been shown to reflect the extent of tendon fibril organization was also evaluated. No differences (p>0.05) in MRI signal were observed between groups (control: 135±12 AU; pre-diabetes: 119±11 AU; type 2 diabetes: 160±18 AU). Loading of tendons has been shown to result in an increase in tendon mass and animal studies have suggested that diabetes impairs tendon fibril organization. However, even with a great BMI in our patients with type 2 diabetes, patellar tendons were smaller in CSA after normalization of body weight. Further, we did not observe a difference in MRI signal.

Mentor(s):

Chad Carroll, College of Health & Human Science, Health & Kinesiology

Nathan Campbell, Purdue University

MD Audit Sync Tool at Procter & Gamble

Author(s):

Rachael Feinberg, College of Engineering & Honors College

Abstract:

The purpose of this project was to create a tool that would automate the data extraction process used by multiple business units within Procter & Gamble to perform audits. This project was achieved by first identifying the various data sources included in audits and understanding the manual data extraction process via experimentation and expert interviews. Then, SQL code was developed and tested to determine which data sources were structured to enable automated extraction. The final deliverable was a KNIME workflow with connections to data sources that, when set up correctly and ran, extracted seven data sets in one click. The result of this tool development was that the amount of time needed to extract the data included in an audit was reduced by 85%. The implications of this time reduction are that it both enables audits to happen more frequently by reducing the workload of performing an audit, and that it frees time in an employee's day for more cognitively taxing tasks. This will increase the efficiency and output of multiple business units, as well as the quality of data produced.

Mentor(s):

Schemeka Robinson, Procter & Gamble

Food handling analytics using Open-Pose

Author(s):

Xinyi Feng, College of Engineering

Abstract:

We study the use of Open-Pose, a real-time multi-person key point detection library, to identify and analyze activities at the Purdue Student Farm in order to assure food safety. We present an analysis of the accuracy of the joints detected by Open-Pose when analyzing videos of daily activities happening in the farm. During the activities, workers at Purdue Student Farm sanitize their working environment, cleanse freshly picked produce, and clean up after themselves. We demonstrate consistency and accuracy by using the number of key points that the method detects with different scenarios in the farm. Since the software requires significant computational resources, we also consider the impact of video compressions to speed up the process. The insights gained from this study on the performance of Open-Pose contribute to our overall project to monitor the food safety in post-harvest facilities like the Purdue Student Farm.

Mentor(s):

Amy Reibman, College of Engineering, Electrical & Computer Engineering

A novel LED technology, Pulsed Alternating Wavelength System, has no effect on layer chicken eye morphology

Author(s):

Claire Fisher, College of Agriculture & Honors College

Abstract:

Eye morphology directly impacts an animal's ability to perceive its environment. Elongation or shortening of the eye globe prevents correct image formation on the retina. Similar changes to the lens also have detrimental effects on vision. Certain lighting systems have been shown to alter eye morphology, and therefore reduce birds' ability to see, their health and welfare. Therefore, lighting can have profound effects on the health, production, and welfare of all poultry species. However, there are no standards for lighting in commercial layer houses. A novel LED technology has recently been introduced referred to as Pulsed Alternating Wavelength System (PAWS) that provides a new approach to delivering multiple wavelengths of light to animals. The goal of our study was to begin to determine if PAWS alters eye morphology. We compared laying hens in conventional cages that were housed under either PAWS lighting or traditional lighting. We analyzed eyes from 10 hens in each house at 32 and 38 weeks of age, ages during peak production. Birds were euthanized and enucleated, and right eyes placed into 5% neutral buffered formalin and stored at 4°C until analyzed. Eyes were weighed and digital calipers were used to measure the rostral-caudal distance of the globe at the pupil, the medial-lateral diameter of the globe at its widest point, and similar measures on the lens. All analyses were done using a two-way ANOVA with age and lighting as the independent variables and a $p < 0.05$ considered significant. We found no significant differences in any aspects of eye morphology measured. The most important outcome of this study was that the novel PAWS technology had no negative impact on eye morphology, suggesting no effects on vision due to altered morphology. This was a small initial trial, but these data combined with the other welfare and physiological measures warrants future studies on this exciting new technology.

Mentor(s):

Greg Fraley, College of Agriculture, Animal Sciences

VIP SoCET - Rust ML/AI Benchmarking

Author(s):

Aidan Fisher, College of Engineering

Oliver Krefta, College of Engineering

Adam Zurek, College of Engineering

Abstract:

This project is based around benchmarking AI applications on System-on-Chip Extension Technologies' (SoCET's) AFTx06 System-on-Chip (SoC); we also plan to develop AI applications using the AFTx06. The AFTx06 has built-in sparsity optimizations, which makes it a great fit for AI applications. Sparsity optimizations reduce the amount of redundant calculations by skipping calculations that guarantee a result in zero. Hence, we are utilizing the AFTx06 SoC to see how well it performs on said AI applications in both a benchmarking setting and a real-world setting. Various methods of machine learning will be tested on the AFTx06 using the TensorFlow Lite framework. These methods are graph neural networks, convolutional neural networks, and recurrent neural networks. The models will be trained offline on a separate machine and will then be imported onto the AFTx06. The models will first be run without the sparsity optimizations; then, they will be run with the sparsity optimizations. Both trials will focus on the computation time to run test data on the given models. The results will then be compared to determine how effective the sparsity optimizations are for each method and machine learning in general. By testing the SoCET chip's sparsity optimizations in this way, we will be able to evaluate how well these optimizations improve efficiency in real world edge computing applications. We will also be able to evaluate the chip's overall suitability for edge machine learning, an area that has many potential applications in situations requiring faster and more efficient ML inference.

Mentor(s):

Mark Johnson, College of Engineering, Electrical & Computer Engineering

Cole Nelson, Purdue University

Reconstruction of Top Anti-Top Quark Events in CMS Detector Using Graph Neural Networks

Author(s):

Mason Giacchetti, College of Science

Mitchel Craven, College of Engineering

Sean Flanary, College of Science

Sagnik Ballabh, College of Science

Daksh Guard, College of Science

Abstract:

The Standard Model of particle physics compiles all of the known elementary particles and describes their interactions through fundamental forces. Of the many theories that compose the Standard Model, quantum chromodynamics (QCD) serves to describe the interactions of quarks, a subgroup of fundamental particles which constitute the building blocks of matter, through the strong nuclear force. QCD's complexity makes producing accurate predictions difficult, and thus further testing is necessary. Among the various testable predictions made by QCD, one states that an interaction between the top and anti-top quarks (toponium) is impossible due to their near-instantaneous decay. This interaction, if observed, would suggest a shortcoming of QCD, and could lead towards a more robust theory. Top and anti-top quark events are being explored at the Compact Muon Solenoid detector at the LHC for instances of toponium. The instability of these quarks requires that these events are reconstructed from their decay products. One issue is that top and anti-top quarks decay into various other fundamental particles, some of which are undetected such as neutrinos. Therefore, it is imperative we develop techniques to reconstruct these decay products. Graph neural networks (GNNs) have proven useful in neutrino reconstruction at places such as the IceCube neutrino observatory. We aim to apply GNNs to the reconstruction of decay products from top and antitop events in the CMS detector. Hopefully, such GNNs will enable us to explore top and anti-top quark events within the detector for toponium, and thus allow us to test the predictions of QCD.

Mentor(s):

AJ Wildridge, College of Science, Physics & Astronomy

Andreas Jung, Purdue University

Poster Presentation: 123 :: Innovative Technology/Entrepreneurship/Design

Understanding Autonomous Gear Shifting and Braking in a Racing Environment

Author(s):

Akshay Godhani, School of Management & Honors College

Max Lee, School of Management

Ian Quan, College of Engineering

Jasper Hochbaum, School of Management

Abstract:

Redacted by request.

Mentor(s):

Aly El Gamal, College of Engineering, Electrical & Computer Engineering

Shreya Ghosh, Purdue University

Investigating Stability of Monoterpene-derived Secondary Organic Aerosols with Respect to Hydrolysis and Photolysis

Author(s):

Matthew Graber, College of Science & Honors College

Abstract:

Atmospheric aerosols are a suspension of solid and liquid particles in the air that can impact the climate and human health. Organic aerosols (OA) are either directly emitted from various sources as primary organic aerosol, or formed from complex multi-phase chemistry, where gas-phase organic species are converted into secondary organic aerosol (SOA). SOA have substantial impacts on climate forcing, contributing either to climate warming or cooling by absorbing or scattering light, respectively. Although the sources of SOA have been previously investigated, the stability with respect to hydrolysis and photolysis are not well understood. Furthermore, the rates of these processes of different SOA systems from structural isomers has not been directly compared. In this work, we investigate photolysis and hydrolysis of SOA formed during the ozonolysis of α -pinene and limonene. The two systems of α -pinene and limonene are both biogenic volatile organic compounds (BVOCs) with the same chemical formula but different chemical structures, and therefore undergo unique reactions. We performed photolysis and hydrolysis of both α -pinene-SOA and limonene-SOA at pH's 1, 3, and 5 to mimic different atmospheric environments. The reactions were monitored by employing mass spectrometry and UV-Vis absorption measurements to monitor compositional changes and optical properties. It was found that the optical properties of both systems did not change with respect to hydrolysis, indicating these systems are stable. In contrast, photolysis reactions of both systems were catalyzed by pH, we observed that the reaction rates for both α -pinene-SOA and limonene-SOA systems was greater for photolysis at lower pH's.

Mentor(s):

Alex Laskin, College of Science, Chemistry

Kyla Siemens, Purdue University

Ana Morales, Purdue University

Analyzing the Impact of Global Social Justice in Mathematics Education Activities

Author(s):

Lily Green, College of Education & Honors College

Audrey King, College of Science

Abstract:

The purpose of this study is to investigate the impact the GSJME course has on Prospective Mathematics Teachers' (PMT) awareness of global social injustices as they interact with the mathematics tasks. GSJME's primary goal is to promote mathematics as a tool that can be used to analyze and act upon issues of global social justice addressing the UN 2030 agenda Sustainable Development Goals. The GSJME incorporates carefully scaffolded mathematical explorations of social justice issues into required mathematics content which serves as both models for effective mathematics instruction as well as tools for the inculcation of social consciousness in prospective teachers providing them with opportunities to increase their awareness and sensitivity to social justice issues and develop greater empathy for their future students. Preliminary findings indicate that although some participants had some previous knowledge of social justice issues, the incorporation of social justice into math content educated them about the most pressing issues of today, thereby creating an increased awareness. PMTs showed an expanded view of connections between mathematics and the real world through their descriptions of the various ways in which GSJME had helped them to apply mathematics concepts and understand the issues they were exploring. Participants also reported using math tasks as evidence of the severity of current social justice issues, relating mathematics to the issues in the real world, and an overall effect of developing a strong connection with the social justice issues.

Keywords: Prospective Mathematics Teachers, Global social justice

Mentor(s):

Jill Newton, College of Education, Curriculum & Instruction

Rose Mbewe, Purdue University

Diversity, Equity and Inclusion in Human-Animal Interaction

Author(s):

Nira Grynheim, College of Agriculture

Abstract:

Human-Animal Interaction (HAI) is a growing field investigating the complex relationships humans have with animals. Human diversity in HAI, or lack thereof, may have a direct influence on the way HAI data is interpreted and presented. Previous research has studied how apparent disability, racial, sexual or other diversifying identities might affect how humans interact with the world and their pets. However, thus far, there has been little research published on how inequitable barriers towards underrepresented minorities (URM) might play a role in how HAI is studied, interpreted and presented. The present study investigated human diversity among leaders in the HAI field. A survey was sent to HAI research and education center directors to collect their demographics and gauge their perception of diversity, equity and inclusion within their own respective departments. Preliminary data included a 57% response rate (n=15). The majority of directors self-identified as heterosexual (92%), white (100%), able-bodied/neuro-typical (84%), and cis-gender females (69%). When asked about perceived diversity in the field overall, 78% of responding center directors reported HAI professionals as being only "Slightly Diverse". From these results, we found a limited range of several areas of diversity within HAI. Having full and direct participation from members of the group(s) affected by the research topics in HAI is beneficial to the way in which the research is designed and data are interpreted. These findings highlight the lack of diverse representation among leadership in HAI, emphasizing the need for continued diversity, equity, and inclusion efforts in the HAI field.

Mentor(s):

Clare Jensen, College of Veterinary Medicine, Comparative Pathobiology

Maggie O'Haire, Purdue University

Quantifying Impacts of Drainage Water Recycling on a Soybean Field in West Lafayette, Indiana

Author(s):

Neha Gunapati, College of Agriculture & Honors College

Abstract:

Indiana has been undergoing a change in climate with wetter and warmer winters and springs along with hotter and drier summers, affecting the yield consistency of crops across the state. Along with a lack of precipitation during the peak growth season, there is a higher risk of underperforming seasons. To combat this, the use of supplemental irrigation has been increasing. However, irrigation in Indiana primarily uses groundwater, an unsustainable method in the long run when used in large quantities. Therefore, to support climate change adaptation and agricultural sustainability, the Drainage Water Recycling (DWR) project looked at storing water from a wetland located at the Agronomy Center for Research and Education (ACRE) in West Lafayette, Indiana. This stored water was recycled to irrigate a neighboring 9-acre soybean field (Field 70) via surface driplines when the soil moisture deficit exceeded a target threshold. In 2021, Field 70 was divided into three repetitions of three treatments in order to quantify the potential different levels of impact: no irrigation (the control), half irrigation, and full irrigation. Additionally, soil moisture sensors were placed in Field 70 to monitor and adjust irrigation schedules and calculate plant available water and soil moisture deficits. Throughout the season, imagery from satellites and unmanned aerial vehicles (UAVs) were processed and assessed for above-ground biomass. This project quantifies the variation in biomass across the experimental field in response to plant available water between Summer 2020 and 2021 and supports on-going research to help farmers adapt to the changing climate in Indiana.

Mentor(s):

Laura Bowling, College of Agriculture, Agronomy

Katy Mazer, Purdue University

Kevin Lee, Purdue University

Keith Cherkauer, Purdue University

Communication Strategies in Congressional Testimonies on Cryptocurrency

Author(s):

Josephine Haydock, School of Management

Abstract:

This study was conducted to evaluate communication strategies in Congressional Testimonies surrounding the topic of digital cryptocurrency. We aimed to quantify the frequency of several presentation techniques of experts in hope that we might eventually gain a better understanding of how their explanations influence public policy. For our research, we determined a coding scheme of various communication strategies and used it to evaluate multiple Congressional Testimonies relating to digital cryptocurrency from a recent timeframe prior to January 2020. Our analysis revealed trends among several techniques. We found that many experts were strong with strategies such as eye contact, belief sharing, and use of single stories. Weaker areas of communication were highly consolidated in the category of visual techniques. Using this analysis, we went on to conclude that cryptocurrency is a relatively new topic in law and therefore requires more emotional appeal in testimonies as there is minimal historical evidence on the matter and arguments tend to be more opinion-based.

Mentor(s):

Jen Hall, College of Liberal Arts, Communications

Understanding Russian Vocabulary: Upper Elementary to Intermediate Level

Author(s):

Drake Hershberger, College of Science

Abstract:

Learning Russian vocabulary is often difficult for students due to the sheer vastness of the language, and this can be quite daunting. Without understanding what roots, prefixes, endings, and suffixes do to the meaning of a word, it is a mountainous task. My research examines and analyzes the structure of Russian words and how they are divided into multiple different parts. Of all these parts: prefixes, roots, suffixes, and endings, I am primarily focusing on suffixes-- personal, abstract, and more-- and the overall meaning that they contribute to a word in Russian. I explored the vocabulary of Russian commonly taught at the university level with textbooks such as *Голоса: A basic Course in Russian* 5th edition (Golosa) books 1 and 2 by Richard Robins, Karen Evans-Romaine, and Galina Shatalina and *Russian: From Intermediate to Advanced* by Olga E. Kagan, Anna S. Kudyma, and Frank J. Miller. I organized words that share the same suffix into tables complete with their meaning and their classifications as a noun, adjective, or adverb. The objective is to utilize these tables to create a better foundation for understanding Russian vocabulary for students looking to learn vocabulary at an accelerated pace by introducing the vocabulary based on similar suffixes, and roots and prefixes; thus, creating a more intuitive way of learning vocabulary.

Mentor(s):

Olga Lyanda-Geller, College of Liberal Arts, Languages & Cultures

Airfoil for Autonomous Go-Kart with Adjustable Angle-of-Attack

Author(s):

Austin Hiner, College of Engineering & Honors College

Andrew Thalos, College of Engineering

Tyler Kim, College of Engineering

Jackson Thompson, College of Engineering

Casey Truppner, College of Engineering

Zach Bernstein, College of Engineering

Abstract:

The purpose of this project is to design a rear wing system and generate a lookup table for the usage of an infinitely variable angle of attack rear wing for the Autonomous Motorsports Purdue (AMP) Go-kart. Since the autonomous kart can have access to and can control more systems than a traditional driver, it may be advantageous to have a wing that has a controllable and selectable downforce and drag force to fill racing needs more efficiently at any point on the track. We are designing the airfoil and optimizing it with air flow simulations on what will be our working domain of angles. In addition we are designing the mounting and actuation hardware in order to ensure good integration into the go-kart. Specifically with the wing itself we are designing it to have a low drag and low downforce at no angle and at higher angles we want it to create a lot of drag for braking needs. After we are done optimizing and designing the wing we will create a lookup table for the outputs of the wing so that commands can be sent to have it produce certain amounts of downforce or drag, and it can compute the angle to go to quickly and efficiently. Our project is currently in the design phase, we are still working on optimization and designing the mounting system. The ultimate goal of this project is to give more options to the go-kart while it is running to ensure that it can squeeze the best time out of any track.

Mentor(s):

Aly El Gamal, College of Engineering, Electrical & Computer Engineering

Alternatives To Single Use Plastic: A Life Cycle Analysis

Author(s):

Madison Hodges, College of Engineering & Honors College

Abstract:

The purpose of this project was to determine the most environmentally-friendly alternative to single use plastics for Cummins' employee dining facilities in North America. The study quantified environmental impact calculating the lifetime greenhouse gas emissions of each alternative and various waste disposal methods. A cradle-to-grave, comparative life cycle analysis (LCA) was completed using over 60 inputs, including emissions factors provided by the EPA and site-specific information, such as distance to waste vendors and average amount of waste produced. Different LCAs were conducted for cups, cutlery and plate-like items due to the varying products available in the market. The project deliverable was an interactive Excel LCA tool, in which site employees input their site-specific information and receive a dashboard ranking the available alternatives. The tool will be utilized in the 10 North American sites with cafeterias and edited for global use. The tool also features a tab listing the environmental impacts not considered in a lifetime emission calculation, such as bioaccumulation, land footprint of bioplastics, and more. Cummins' Columbus Engine Plant was used as a case study, and for this plant, polyethylene plastics produced the most emissions, regardless of the disposal method, and single-use wood products produced the fewest, likely due to its lightweight.

Mentor(s):

Kelly Yochum, Cummins HSE

Impact of improved diet and resistance training on serum markers of cardiovascular risk in women ages 60 and older

Author(s):

Samantha Holesha, College of Health & Human Science

Abstract:

Resistance training and a healthy diet has been shown to increase muscle mass and improve the health of older individuals. The purpose of this study was to determine if the transition to a USDA approved diet along with chronic resistance training would improve muscle mass and serum markers of cardiovascular and diabetes risk. In a double-blinded manner, women (n=17, 64±5y, BMI: 27±2) completed a 12-week progressive resistance training program emphasizing the thigh muscles. Each woman trained 3 times a week and was randomly assigned to a one of three diets, each with a different level and sources of protein. All foods were supplied by the investigative team along with counseling on food preparation, portioning, and documentation of consumption. We hypothesized that muscle mass and strength increase and serum risk factors such as, blood glucose, total cholesterol, and LDL cholesterol would decrease. Overall, the mean dietary compliance was 90% and the mean training compliance was 88%. Blood draws and tests were performed before, halfway, and after the study. Blood glucose was reduced by 9.5% with diet and exercise ($p<0.05$). Surprisingly, HDL declined by 11% with diet and exercise ($p<0.05$). The diet and exercise intervention did not alter total cholesterol, LDL cholesterol, triglycerides, or HbA1C ($p>0.05$). Our findings regarding muscle mass indicates an increase in mass and strength which is consistent with previous studies. The next step is to further break down the dietary groups to assess additional parameters.

Mentor(s):

Chad Carroll, College of Health & Human Science, Health & Kinesiology

Nathan Campbell, Purdue University

Harrison Cottingham, Purdue University

Anna Barker, Purdue University

Facemask Detection for Mobile Applications

Author(s):

Joseph Huang, College of Engineering

Laula Huang, College of Engineering

Ariana Larrea, School of Management

Jingyuan Liu, College of Engineering

Rushabh Ranka, College of Engineering

Xingjian Wang, College of Engineering

Alice Dinh, School of Management

Abstract:

Recently, the facemask is very useful due to pandemics. According to data published by the Center for Disease Control, multi-layer cloth masks can both block up to 50-70% of the exhibit virus. Wearing a facemask is required in restricted areas. The project provides a method to detect whether a person is wearing a mask using image processing on an Android device. It allows the user to take or upload a picture, send it to the image recognition program, receive feedback, and inform the user of whether it detects the facemask or not. We have three subteams to build the project: algorithm team, app team, and tutorials team.

The algorithm team is responsible for establishing facemask detection algorithms through image processing concepts at the pixel level. The team is working on a skin segmentation algorithm as a means to detect whether a person is wearing a mask or not. The app team focuses on building the user interface of the mobile application. It offers a clear user interface, which supports the function of “taking photos” and “uploading photos.” It also links the program of the algorithm team. The tutorials team uses Jupyter Notebook to write tutorials about basic image processing methods such as Gaussian Filters, Sobel Edge Detection, etc. The purpose of these tutorials is to flatten the learning curve for future students in their first semester of image processing.

Mentor(s):

Edward Delp, College of Engineering, Electrical & Computer Engineering

Carla Zoltowski, Purdue University

Implementation of a Two-Hop Channel Testbed

Author(s):

Mohamed Ibrahim, College of Engineering

Abstract:

Analysis of a wireless communication system typically focuses on evaluating strategies to communicate between a single transmitter device and a single receiver device. This wireless communication link is known as a single-hop channel. However, many practical communication systems often have one or multiple intermediate destinations between the information source and the final intended destination of information over a wireless communication link. A channel, or wireless communication link, where there are intermediate destinations between the transmitter and receiver is known as a multi-hop channel. While it is very useful to evaluate communication strategies across multi-hop channel, such evaluation is often limited to either simple analytical methods or computer simulations based on analytical models. We would like to implement a two-hop channel testbed using software-defined radios to facilitate practical evaluation of multi-hop communication strategies.

We will be using three USRP X310 software-defined radios to implement the simplest case of a multi-hop channel, a two-hop channel. The considerations that need to be taken when setting up the hardware required for this project will be discussed. The USRP Hardware Driver, UHD, is used to configure the USRP as required, and we will discuss the software architecture within which the driver is used along with signal processing blocks to achieve our goal. Finally, we will evaluate the quality of the wireless communication link that has been implemented and outline future work that can be performed using the two-hop channel testbed.

Mentor(s):

David Love, College of Engineering, Electrical & Computer Engineering

Chih-Chun Wang, Purdue University

James Krogmeier, Purdue University

Self - Driving Car

Author(s):

Adhiksit Kalra, College of Engineering

Abstract:

Design a car using Ultimate 2.0 kit, using skills such as 3-D modeling, 3-D printing, and Arduino. These skills will allow the team to design and make the physical body of the car, and they will allow for programming the car's actions. The car will be able to follow a track and traverse a course on its own without human interference. This research is related to designing not just self-driving cars, but also to other autonomous, as it delves into the research of automatic path-making, and object detection and avoidance.

Mentor(s):

Nicolas Leiva Molano, College of Engineering, Biomedical Engineering

Eric Nauman, Purdue University

Rick Womack, Purdue University

Tong Yao, Purdue University

Syntheses and Characterization of Uranium(VI) Multiple Imido Complexes

Author(s):

Colby Kayrouz, College of Science

Abstract:

A prominent obstacle in the environmental sustainability of the nuclear fuel cycle is that spent nuclear fuel contains uranyl (UO_2^{2+}) derivatives, which are characterized by very short, stable oxygen double bonds trans- to the uranium center, preventing the separation and recyclability of nuclear waste. These compounds' radioactivity, toxicity, and potential mobilization in water pose an environmental threat, and spent nuclear fuel is currently building up at storage sites. Uranium imido complexes, characterized by stable uranium-nitrogen double bonds, provide an analog to the uranyl moiety and give insight into the behavior of uranyl bonds. This research focuses on the synthesis and characterization of uranium(VI) multiple imido complexes using the 2,6-diethylphenyl (Ndetp) ligand; the synthesis of uranium tris-, tetrakis-, and pentakis(imido) complexes using this ligand could provide further insight into the previously reported effects of π -donation on the activation of uranium element multiple bonds. Characterization of these complexes via single-crystal X-ray diffraction could also help to further establish the trend of increased bond activation with an increasing number of imido substituents while elucidating the role that steric factors have on their bonding geometries.

Mentor(s):

Suzanne Bart, College of Science, Chemistry

Tyler Collins, Purdue University

Community Health Worker Reimbursement Models in the United States of America

Author(s):

Lynnet Francesca Kimera, College of Pharmacy

Abstract:

A community health worker (CHW) is a frontline public health worker who is a trusted member of and/or has an unusually close understanding of the community served. CHWs improve community health outcomes by increasing health knowledge and self-sufficiency through a wide range of activities such as outreach, community education, informal counseling, social support, advocacy, and community-based research and evaluation. Since CHWs play a critical role in addressing social determinants of health, expanding the CHW workforce is a powerful way to catalyze economic self-sufficiency in neighborhoods with incomes below federal poverty levels. However, creating CHW jobs and establishing mechanisms to sustain the workforce has been challenging. There is a lack of awareness of and guidance on legislation on reimbursement of CHW services often resulting in organizations' inability to financially sustain CHW programs. We set out to put together a resource that highlights different CHW reimbursement models across the country as well as what services are eligible for reimbursement. We gathered information from CHWs, CHW state associations, state departments of health, and the National Academy for State Health Policy. This resource will be shared with CHWs and their employers to increase awareness about the various avenues for reimbursement that are potentially available to CHWs and hopefully move toward more sustainable financing models.

Mentor(s):

Natalia Rodriguez, College of Health & Human Science, Public Health

Jasmine Gonzalvo, Purdue College of Pharmacy

Carlyn Kimiecik, Purdue Department of Public Health

Autonomous Drone

Author(s):

Ayden Kocher, College of Engineering

Alex Rogers, College of Engineering

Avi Patel, College of Science

Erica Cheng, College of Science

Vaibhav Pachalla, College of Science

Vinitha Marupeddi, College of Science

Long Nguyen, College of Science

Ken Chen, College of Science

Abstract:

Drones are a flexible and rapidly advancing technology that can benefit from low power artificial intelligence and autonomous systems. Therefore, we are proposing a competition for teams to design a fully autonomous drone that chases a ground robot throughout a set course. The drone must avoid obstacles whilst tracking the ground robot as it maneuvers around the course. Common object tracking challenges like occlusion of the target and low inference latency will need to be considered. This competition will facilitate the development of low-power computer vision algorithms that can be run from on low-power edge processing devices. It could also allow for more reliable autonomous piloting systems in UAVs/Drones that do not rely on server connections for processing through a network (WiFi/5G). Competitors will be scored based on how close their drone tracks the ground robot. Scoring will be done through the use of the Purdue UAV hanger motion capture system. This system can track and position objects up to a millimeter of accuracy. The drone platform we have chosen for processings is a PX4 Vision drone with an Intel Atom and Movidius compute stick. We are currently designing, building, and testing a sample solution against our scoring system and competition course, to serve as an example for what competitors will need to accomplish.

Mentor(s):

Wei Zakharov, Libraries, Libraries Administration

Qiang Qiu, Purdue University

Vishal Purohit, Purdue University

DMA Controller

Author(s):

Jagan Krishnasamy, College of Engineering

Victor Le, College of Engineering

Abstract:

The purpose of this project is to design, develop, and implement a DMA Controller for a RISC-V SoC. In the current iteration of the SoC, memory and I/O operations are very slow because the CPU wastes a significant amount of cycles stalling the pipeline while waiting for I/O and memory operations to complete. Modern CPUs must stall on the scale of hundreds of cycles to do a single memory operation, and many I/O devices can take on the scale of thousands of cycles to fulfil an I/O operation. In order to improve these operations, the addition of a DMA Controller in practice, would provide improvements in terms of effective cycles for data transfers across the SoC. Rather than forcing the CPU to wait for a memory or I/O operation to finish prior to executing further instructions, the DMA controller can fulfil these operations in parallel with the CPU. The CPU configures the DMA controller by providing the source address, destination address, and size of the transfer. The DMA controller design consists of three main components: control registers, read control unit, FIFO, and write control unit. The control registers allow the DMA controller to be configured. The read control unit reads data from the source address and places it in the FIFO. The write control unit takes data out of the FIFO and writes it to the destination address.

Mentor(s):

Cole Nelson, College of Engineering, Electrical & Computer Engineering

Mark Johnson, SoCET

Working in a Feminized Career: Male Pre-Service Teachers' Attitudes towards Teaching

Author(s):

Jackie Krutsch, College of Education & Honors College

Abstract:

There is a wide variation in the extent to which society values educators. Elementary school teachers are predominantly women, and the career's feminization means that teaching continues to be perceived as a subordinate profession. As a result, men who pursue careers as elementary school teachers have experiences that are significantly different than those of their female counterparts. This research examined male pre-service elementary teachers' attitudes towards the professional status of teaching. Their experiences in a Teacher Education Program and elementary schools, career aspirations, and perceptions of pursuing a predominantly female profession were investigated. Four male, pre-service elementary education students were interviewed following a semi-structured protocol with guiding questions. Participants reported similar experiences relating to time in their undergraduate program, bias and stereotypes, reactions from others in response to their career choice, and their perceived role and status as a future male teacher. This project highlighted the underrepresentation of men in elementary classrooms and the persistence of gender roles, as well as examined research pertaining to men in female dominated careers.

Mentor(s):

Nancy Gabin, College of Liberal Arts, History

Demographic Characteristics Correlated with the Number of Brownfields and Superfund Sites per Census Tract in Indiana

Author(s):

Sharon Kulali, College of Agriculture & Honors College

Abstract:

Brownfields and superfund sites contain harmful chemicals that can lead to high exposures for people living near the sites. The goal of this analysis is to determine whether the demographic characteristics of individuals living near sites correlated with the number of sites at the census tract level. The Environmental Protection Agency (EPA), the Indiana Department of Environmental Management (IDEM), and U.S. Census websites were used to obtain publicly-available data from 2010 on locations of hazardous sites and demographics in Indiana. Demographic data included age, gender, income, unemployment rate, race, and ethnicity; and was available for 3,001 census tracts with 2,380 brownfields and 2,488 superfund sites. The mean number of brownfields per census tract was 1.0 (minimum: 0, maximum: 20); for superfund sites the mean was 1.0 (minimum: 0, maximum: 17). In adjusted linear regression models, percent Hispanic was significantly associated with a more brownfields ($\beta = 0.11$; 95% confidence interval (CI) = 0.03, 0.20), superfund sites ($\beta = 0.30$; 95% CI = 0.24, 0.36), and total sites ($\beta = 0.41$; 95% CI = 0.29, 0.53). Income was significantly associated with fewer brownfields ($\beta = -0.01$; 95% CI = -0.01, -0.006), superfund sites ($\beta = -0.004$; 95% CI = -0.007, -0.001), and total sites ($\beta = -0.01$; 95% CI = -0.02, -0.009). Percent White was significantly associated with fewer brownfields ($\beta = -0.07$; 95% CI = -0.10, -0.03) and more superfund sites ($\beta = 0.05$; 95% CI = 0.02, 0.07). These results contribute to our understanding of social injustice and environmental contamination.

Mentor(s):

Ellen Wells, College of Health & Human Science, Health Sciences

VIP MEP Go-Kart Fall 2021

Author(s):

Mateo Llerena, College of Engineering

Charles Dickerson, College of Engineering

Kameryn Davis, College of Engineering

Christian Vargas, College of Engineering

Abstract:

The goal of this VIP course, in collaboration with the Minorities in Engineering Program, was to develop hands-on skills, teamwork, and documentation skills to assemble a Go-Kart. Before commencing any lab activities, students underwent a lab safety briefing and completed their certifications to work at the Bechtel Innovation and Design Center and the class was split into sub teams, each to assemble a different kart. Our subteam delegated responsibilities by assigning the roles of Team Lead, Build Lead, and Co-Quality Control Leads. The subteam also developed a preliminary build plan as a guide to disassemble the prior year's kart methodically and to document any issues or roadblocks in the process. Throughout the deconstruction, diligent notes and photographs were taken to document each component of the kart. Each member of the subteam was tasked with disassembling a large section of the kart: front and steering, seat, and rear axle, while the team lead coordinated the disassembly and ensured that everything was properly documented. Once the disassembly was complete, the build plan was optimized and reassembly began; this used the documentation that was taken during disassembly to facilitate the process. Once Assembly was completed, the quality leads inspected the kart to ensure all components were fitted properly before proceeding to a final inspection performed by the mentors. Finally, the karts were taken to the track to evaluate performance; this included three events: a five lap time qualifier, a thirty lap pit stop race, and a 25 lap endurance race.

Mentor(s):

Rick Womack, College of Engineering

Deep Learning Approach to Improving Image Quality for Medical Diagnostics

Author(s):

Olivia Loesch, College of Engineering

Abstract:

The United Nation's health-related Sustainable Development Goals are difficult to achieve in low- and middle-income countries due to workforce shortages and inadequate health surveillance systems. However, with the growth of artificial intelligence (AI) and computer algorithms, it is possible to apply AI to healthcare technologies to improve progress towards these UN standards. This project aims at using and improving computer algorithms and deep learning to aid in the extraction of important structural and functional information from murine carotid artery ultrasound and photoacoustic images. First, we created a large database of simulated photoacoustic images to optimize the algorithms. These images were augmented binary masks of murine carotid arteries extracted from ultrasound images, which were then passed through MATLAB's k-Wave toolbox. We used the toolbox's time reversal reconstruction algorithm to simulate and reconstruct a photoacoustic image from the original ultrasound image. These simulated photoacoustic images were then passed through a convolutional neural network to improve image quality by increasing contrast-to-noise and signal-to-noise ratios, as well as reducing unwanted artifacts. Additionally, we acquired data from optimized phantoms and tested the algorithms on in vivo preclinical data to determine their effectiveness in improving image quality for cardiovascular applications. While preliminary, these initial results suggest improved image quality and allows us to use these algorithms for applications beyond carotid artery imaging. Using our deep learning approach, we will continue to add to the database of images available in order to perform more advanced tasks including pixel-wise classification and vessel segmentation.

Mentor(s):

Katie Leyba, College of Engineering, Biomedical Engineering

Craig Goergen, Purdue University

Optimizing Solar Energy ROI: A Case for System-Level Monitoring Dashboards to Validate Performance Expectations

Author(s):

Amaya McNealey, Polytechnic Institute

Abstract:

Solar power generation has increased exponentially in the last decade. It is expected to play an essential role in generating renewable energy in the United States and the world in the future. One of the critical points for the return on investment of photovoltaic systems within the solar energy industry is to maximize energy generation. Yet, the problem is that solar energy systems

do not have a system-level monitoring, so there is no way to know, in real-time, if the solar energy system is performing as expected. This study evaluates the estimated performance (via industry standard, PVWatts) to the theoretical performance (via weather sensors) to the actual performance (via power sensors) based on a variety of derate factors: age, seasonal generation, inverter type, and panel type. The findings justify the problem and demonstrate the need for a solution (e.g., solar energy system-level performance monitoring) to support further adoption of solar energy systems.

Mentor(s):

Lisa Bosman, Polytechnic Institute, Technology Leadership & Innovation

Esteban Soto, Purdue University

nanoHUB: Growing Global Impact Data Analytics and Machine Learning

Author(s):

Suyash Mishra, College of Engineering

Abstract:

nanoHUB.org is an open and free platform that serves to enrich people's academic and educational experiences. Researchers explore, collaborate, and publish their findings related to a wide variety of topics including nanotechnology and materials science. The goal in doing so is to increase accessibility and understanding of science and engineering related products and concepts for learners, educators, researchers, and business professionals to use. So far, nanoHUB has been well-received globally, as its been cited over 2000 times and has had research tools published to its site from 172 different countries. It also has been used extensively in classrooms as an educational tool. With so much usage comes a lot of data – data that can be sifted through to understand how people use nanoHUB and how it can be improved.

Finding these trends and making conclusions from them has been a major focus of this semester. Understanding which parts of the world nanoHUB users come from, what setting (classroom, research, self-study) it is used in, and the number of new user registrations is helping nanoHUB track how its tools are expanding, what it is doing well, and how it can improve. Additional data collection and visualization techniques with citation data, and the type of researchers making these citations helps to analyze if nanoHUB is being used by a small subset of researchers or by a wide variety of them. Where new content is generated from is another major trend nanoHUB seeks to understand, as that provides insight into how nanoHUB can increase outreach while maintaining the same level of community engagement with audiences already using nanoHUB. These data analysis techniques are helping to understand the growth nanoHUB has made and its shortcomings, and this will ultimately help in making nanoHUB a premier source for research and education.

Mentor(s):

Gerhard Klimeck, College of Engineering, Electrical & Computer Engineering

Investigating U.S. Undergraduate and Graduate Students' Dynamic Identities Through a Virtual, Cross-Cultural Course

Author(s):

Kathryn Mueller, College of Education

Daphne Fauber, Polytechnic Institute

Abstract:

Educators have limited opportunities to engage with an international community, necessitating a professional experience to explore their own identities to develop intercultural sensitivity. The goal of the project was to examine how educators from around the globe explored connections between personal identities and intercultural sensitivity when they engaged in a virtual, intercultural course, Global Social Justice Education (GSJE). In GSJE, educators from China, Kenya, Nepal, Tanzania, Turkey, the United States, and Zambia met online every other week to discuss and reflect on social-justice focused activities. Educators had opportunities to connect with people from a wide variety of cultures, backgrounds, and lived life experiences. Two of the core objectives of the course were to develop participants' intercultural attitudes and skills as well as understand multiple world views by engaging participants in diverse educational contexts. By conducting research on the course, a foundation for future professional development can be constructed.

Mentor(s):

Bima Sapkota, College of Education, Curriculum & Instruction

Lili Zhou, Purdue University

Jill Newton, Purdue University

JoAnn Phillion, Purdue University

VIP IPA: Nuclei Segmentation and Counting on Microscopy Images

Author(s):

Tikhon Pachin, College of Engineering

Annapoorna Prabhu, College of Engineering

Yu-Hsuan Lin, College of Engineering

Aubrey Gatewood, College of Engineering

Nikhil Manglore, College of Science

Niharika Narra, College of Engineering

Lydia Hanna, College of Engineering

Abstract:

Nuclei segmentation on microscopy images has been a topic of interest for over 10 years. There are multiple different algorithms that have been developed to target the issue. This project focuses specifically on Watershed segmentation with some preliminary image processing to segment and count nuclei. Nuclei segmentation is an important step in cancer detection and prediction.

Watershed segmentation is a method that analyzes an image as if it is a topographical map. Controlled flooding of the image produces the edges between basins, which are the borders of the cells. To get the topographical image, the preprocessing detects the areas of interest on the image and then the algorithm applies a distance transform on the image. Three different transforms are available and they are Chessboard, City-block and Euclidean transforms.

Image preprocessing includes important filters such as image dilation, erosion, opening, closing, blurring and Otsu's thresholding. These filters are heavily employed for image noise reduction. Without this step the topographical image of the cells would be inaccurate.

The project was split into proof of concept, algorithm altering and noise reduction. Proof of concept utilized some preexistent tools to segment the nuclei. Algorithm altering step implemented and adjusted the algorithm from scratch.

The output of nuclei segmentation is an image that shows the borders between the cells and a number that corresponds to the number of cells in the image. This output is a preliminary processing method for further research that may be conducted on such images.

Mentor(s):

Edward Delp, College of Engineering, Electrical & Computer Engineering

Carla Zoltowski, Purdue University

Tree Straightness Computation with Neural Network Integration

Author(s):

Sohan Pramanik, College of Engineering

Nick Eliopoulos, College of Engineering

Jessica Budde, College of Engineering

Collin Campbell, College of Engineering

Hoang Tran, College of Engineering

Abhiram Saridena, College of Engineering

Aaryan Garg, College of Engineering

Dainong Hu, College of Engineering

Yiting Gan, College of Science

Rohit Tokala, College of Engineering

Abstract:

Evaluating tree straightness is an important aspect of forest inventory analysis because the value of a tree depends on its straightness. Visually determining the straightness of individual trees is highly subjective. We developed a method of quantifying the straightness of a tree trunk in real time using a stereo camera. We began by writing a neural network to identify background, ground, trunk, and branches in a stereo image. We then leverage the neural network output to quantify the straightness of trees from stereo video footage.

We use sinuosity as a measure of trunk straightness. Sinuosity is the ratio of the distance along the trunk over the straight-line distance from the top to the bottom of the trunk. Sinuosity returns a value from 1 to infinity, but based on our empirical data, unusable or extremely curved trees have a sinuosity greater than 1.2, and a perfectly straight tree has a sinuosity extremely close to 1.

To evaluate our method of straightness measurement, we generated artificial neural-network images of trees in real-time. The inference-time of our network is 150-350 milliseconds, or roughly 2-3 frames per second. We evaluated the output of the network visually and by using a confusion matrix. The neural network correctly identifies pixels as ground, background, trunk, and branch 77.48% of the time. Our software then captures the portion of the image labeled as trunk to measure tree straightness in real-time. We plan to improve our straightness computation by computing sinuosity from multiple viewpoints, penalizing certain tree features, and by improving the neural network model by curating a larger dataset.

Mentor(s):

Guofan Shao, College of Agriculture, Forestry & Natural Resources

Keith Woeste, Purdue University

Yunmei Huang, Purdue University

A Two-Stage Analytics Approach to Improving Window Manufacturing Process Settings

Author(s):

Congyu Pu, School of Management

Abstract:

In the window manufacturing value stream, glass is shipped from different suppliers, and various processes occur at the manufacturing facility to ship the windows to distributors. Each manufacturing process parameter might lead to the potential risk for window breakage which leads to increased costs. Our objective in this study is to optimize process settings that decrease window breakage. During the manufacturing process, we collect data from each step of the glass making process and explore features that might impact glass quality. Using linear regression analysis, logistic regression analysis, and optimization we provide an approach to predict the window breakage in stage I and then optimize the manufacturing process settings in stage II to improve the process and save the firm money with decreased breakage costs.

Mentor(s):

Matthew Lanham, School of Management, Quantitative Methods

Investigation of Diketopyrrolopyrrole-Diazine Isomeric Semiconducting Polymers

Author(s):

John Putziger, College of Science

Abstract:

Research in semiconducting polymers have applications in organic field electronic transistors (OFETs), organic light emitting diodes, and flexible electronics. A subtle change in molecular structure can drastically alter physical properties and can affect whether a polymer will act as an n-type or p-type semiconductor. This project, which was performed in collaboration with Dr. William McNutt, other researchers in the Mei Group, researchers from the Graham Group at the University of Kentucky, and researchers from the Gu Group at the University of Southern Missouri, assessed whether variations in isomeric monomer properties drastically alter physical properties of the semiconducting polymers. Uniqueness of this study stemmed from the removal of structural dissimilarities of isomeric units which inherently altered backbone planarity. Usage of the diazine isomers, pyrimidine, pyrazine, and pyridazine, led to structural variation of polymer systems stemming from differences in noncovalent interactions between monomer units. Isomeric polymers with repeat thiophene-flanked diketopyrrolopyrrole–diazine units were synthesized via Stille coupling using a microwave methodology. UV–Vis spectroscopy indicates differences in electron delocalization about the backbones based on variation in maximum absorbance. Grazing-incidence wide-angle X-ray scattering (GIWAXS) highlighted that the DPP-pyrazine species appears the most crystalline while the pyrimidine and pyridazine materials appear far smoother. Ultraviolet photoelectron spectroscopy (UPS) and inverse photoemission spectroscopy (IPES) in conjunction with density functional theory (DFT) analysis were used to characterize the HOMO–LUMO levels for the semiconducting species and clearly showed the isomer effect. Overall, this study demonstrates how variations in isomeric monomers can lead to dissimilarities in polymer properties.

Mentor(s):

Jianguo Mei, College of Science, Chemistry, Purdue University

William McNutt, ChemistryPurdue University

Luke A. Galuska, Polymer Science & Engineering, University of Southern Mississippi

Dung Tran, Chemistry, Purdue University

Kuluni Perera, Chemistry, Purdue University

Md Aslam Uddin, Chemistry, University of Kentucky

Kenneth R. Graham, Chemistry, University of Kentucky

Xiaodan Gu, Polymer Science & Engineering, University of Southern Mississippi

Go Kart Build

Author(s):

Sabine Ramirez, College of Engineering

Julianne Rodriguez, College of Engineering

Jahsiah Castillo, College of Engineering

Essey Wondaferahu Wondaferahu, College of Engineering

Abstract:

In the VIP Go Kart course sponsored by the Minorities of Engineering learning community, teams of 4 students were assigned to build and race a Go-Kart using a detailed build plan created before the assembly. In addition, safety precautions were introduced and implemented, such as necessary attire while building and driving the karts to maintain the security of everyone and their environment. Students divided the kart into three sections: front end, middle section, and the back end. With help of reference documentation and teaching assistants, the team was able to properly build an equipped back axle with wheels, brake and acceleration system, engine setup, and the front wheel setup with the inclusion of the steering wheel. Members each adopted leadership rules including team lead, build lead, and quality leads. The team lead was in charge of managing the team's work ethic and productivity all while documenting the progress of the project. The build was in charge of guiding the team in the overall build plan. Finally, the quality leads were responsible for securing and fine-tuning each section. After a full inspection of the Go Kart, the team's kart was to undergo a series of timed trials and two final races. The races included an endurance race with 25 laps and a pit stop race with 15 laps per driver.

Mentor(s):

Rick Womack, College of Engineering

Lin Xu, Purdue University

Morgan Fuller, Purdue University

Colin Keyes, Purdue University

Evaluation of shaft-coupled turbochargers for combustor-turbine characterization

Author(s):

Patrick Ramsey, College of Engineering & Honors College

Abstract:

Pressure-gain combustors such as rotary detonation engines have been shown to function for rocket propulsion using nozzle expansion; however, air-breathing rotary detonation engines coupled to turbines for power extraction have yet to be tested using prototype hardware. In order to characterize the coupled combustor-turbine system, a power dissipation system and control system must be designed.

The use of an off-the-shelf turbocharger compressor with an actively controlled outlet valve for this purpose was evaluated against requirements for power dissipation, control stability, and mechanical loading. The system was shown to be effective in dissipating the expected turbine power (50-60kW) at low enough rotational speeds (50 kRPM) to meet mechanical requirements on the system through matching analysis based on manufacturer data. Control stability was evaluated through the creation of a dynamic simulation.

Analysis showed the system to be dynamically stable in the mass flow – power dissipation space with a constant-area valve under power shocks such as the combustor start-up. This shows the system to be reliably controlled with a low-frequency controller and slow-acting valves, allowing for the mapping of the mass-flow – power space during testing without requiring a complex control system.

Mentor(s):

James Braun, College of Engineering, Mechanical Engineering

Guillermo Paniagua, Purdue University

nanoHub User Behavior: Global Map Animation

Author(s):

Shreya Rastogi, School of Management

Abstract:

The nanoHUB VIP team primarily focuses on the development of apps and simulations, which are used by teachers, researchers, and students worldwide. As we continue to create new simulations, it is important for us to analyze the user behavior generated by our apps. Understanding who is using our apps and where they are being used around the world allows us to create predictive models for the future of nanoHUB. To do so, the team has created a global map animation that indicates the places around the world that our simulations are being used each day. The purpose of this project is to update the global map animation that displays the nanoHUB user data. The project follows two main processes; first, we will replicate the original data into the animation and overlay images to show when it is day and night around the globe. Next, we will import our new user data into a duplicate script to update the animation. Upon completion, this animation can be used to display the progress and reach of our simulations on various platforms, like our website or within certain presentations. As nanoHUB grows, we must be able to document its growth through data. By analyzing this data, we can better understand user needs and display user behavior through an appealing and comprehensible animation.

Mentor(s):

Gerhard Klimeck, College of Engineering, Electrical & Computer Engineering

Praveen Saxena, Not sure (Purdue University)

Daniel Mejia, Not sure (Purdue University)

A Computer vision approach for predicting the force in Pulling and Pushing

Author(s):

Sahana Rayan, College of Science

Abstract:

Musculoskeletal disorders present a significant burden to many workers in the industry, and overexertion due to excessive pushing and pulling are leading causes for these disorders. Preventing these injury risks would require early detection of force exertion levels which is challenging. Current methods of detecting pushing and pulling are intrusive, and thereby there is a need for an automated and non-intrusive method for assessing the force exertion levels during pulling and pushing. This study aims to develop a computer vision method for assessing the force exertion levels. To achieve this goal, a pulling and pushing experiment was conducted. 15 participants performed 15 pushing tasks (3 trials of 5 different exertion levels each) and 15 pulling tasks with two 3D cameras surrounding them. The proposed technique first extracted features from the facial expression and body posture using the OpenFace and the OpenPose techniques, respectively. Then, the extracted facial expression and body posture features were used to train a logistic regression model for classifying the force exertion levels (high or low), achieving a 0.65 AUC. In addition, the extracted body posture features were used to train a random forest model for classifying the pulling and pushing tasks, and it reached a 79% accuracy. The future work of this study will be focused on collecting more data and discovering more representative features for developing a more accurate model.

Mentor(s):

Denny Yu, College of Engineering, Industrial Engineering

Guoyang Zhou, Purdue University

Hamed Asadi, Purdue University

Molecular characterization of the Fe(III)/nitrocatechol complexes formed in the atmospheric aqueous phase

Author(s):

Alison Reed, College of Science

Abstract:

Atmospheric aerosols influence the Earth's radiative balance by scattering or absorbing light, resulting in a cooling or warming effect, respectively. Organic aerosols (OA) produced by biomass burning (BB) are known to have a significant impact on global and regional air quality, public health, and climate. One group of compounds present in biomass burning-related OA is brown carbon (BrC), a class of light-absorbing absorbing molecular components. Of these, nitroaromatic compounds (NAC) are known to contribute substantially to the overall light absorption by OA. Although the formation and physicochemical properties of NAC have previously been investigated, the subsequent multiphase reactions of these species are not fully understood. Conjointly, biomass burning fumes frequently interact with mineral dust in the atmosphere, the most abundant particulate of which is iron. BrC and iron form metal-organic complexes on SOAs, but the impact they have on climate change and their formation under light is largely understudied. Here we study an NAC, 4-Nitrocatechol (4NC), and iron in both light and dark environments to mimic ageing of atmospheric clouds and fogs in the BB impacted areas. We employ high-performance liquid chromatography (HPLC) equipped with a photodiode array detector (PDA) and high-resolution mass spectrometry (HRMS) techniques to investigate the changes in optical properties of the solution at a molecular level. We found that the optical properties are dependent on pH and that visible particles are formed in light environments under unbuffered conditions- indicating a need for further research. This study provides insight on the multiphase reactions of BrC in atmospheric aerosols.

Mentor(s):

Alex Laskin, College of Science, Chemistry

Ana Morales, Purdue University

Christopher West, Purdue University

Investigating Synergistic Effect between Chromatin Remodeling Complex Subunit Inhibitors and Enzalutamide for Prostate Cancer Treatment

Author(s):

Mallory Roach, College of Science & Honors College

Abstract:

Prostate cancer (PCa) is the second leading cause of cancer death in American men. At present, the main hormonal treatment option for PCa is enzalutamide. Enzalutamide is a second-generation small molecule inhibitor of the androgen receptor. By inhibiting androgen receptor activity, this drug can effectively stop cancer cell growth that is fueled by androgens. Unfortunately, PCa cells often develop resistance to enzalutamide. This leads to continual growth and metastasis, making them more difficult to treat. Chromatin remodeling complexes are large protein complexes that interact with chromatin, a substance made of DNA and proteins. Under certain circumstances, the DNA is unwound which impacts the frequency of transcription of particular sequences. In certain types of cancer, specific chromatin remodeling complex subunits are frequently overexpressed aiding in cell growth. In order to prevent the cancer from progressing due to enzalutamide resistance, we hypothesized that treating with inhibitors to chromatin remodeling complex subunits may aid in the effectiveness of enzalutamide treatment. To investigate this hypothesis, we employed LNCaP cells, which are prostate cancer-derived cells that are androgen-sensitive. We treated the cells with inhibitors in varying concentrations to multiple chromatin remodeling complex subunits and bromo-domains in combination with enzalutamide. This allowed us to explore if chromatin remodeling complex subunit inhibitors are able to aid enzalutamide in inducing death in PCa cells.

Mentor(s):

Emily Dykhuizen, College of Pharmacy, Medicinal Chemistry & Molecular Pharmacology

Sandra Ordonez-Rubiano, sordone@purdue.edu

Physical Activity and Nutrition in Youth Sports

Author(s):

Megan Roffers, College of Health & Human Science & Honors College

Caroline Chen, College of Health & Human Science & Honors College

Abstract:

Background: Nationally representative data show that 38% of 6-12 year olds in the U.S. play team sports on a regular basis. Team sports can play an important role in promoting physical activity (PA), healthy eating, and preventing and treating obesity. Research has shown that children and adolescents engage in high levels of sedentary behavior and low levels of PA during team sports sessions. This research literature has primarily focused on older children, adolescents, and PA. Thus, little information is known about younger child PA during team sports sessions and the snacks and beverages provided at these programs.

Methods: Participants were recruited from youth basketball and soccer programs. Accelerometers were used to measure child sedentary behavior and PA during team sports sessions. Information on snacks and beverages provided to participants were documented.

Results: Participants spent 27% of team sports sessions in sedentary behavior and 47% in moderate to vigorous PA. Percent time spent in sedentary behavior and moderate to vigorous PA differed by age group and sport. For example, 3-5 year olds spent more than twice as much time in sedentary behavior than 6-10 year olds (34% versus 13%). When snacks and beverages were provided to participants, they rarely met program guidelines.

Implications: Team sports programs have the potential to prevent and treat obesity among children and adolescents. Efforts are needed to maximize the positive impact of team sports by increasing PA during sports sessions and ensuring snacks and beverages provided meet program guidelines.

Mentor(s):

Jorge Banda, College of Health & Human Science, Public Health

RTOS Port For AFTx System-On-Chip

Author(s):

Daniel Romans, College of Engineering

Stephen Iwu, College of Engineering

Raghul Prakash, College of Engineering

Abstract:

The goal of the SoCET RTOS team is to port a functional real-time operating system (RTOS) that can be integrated into the software ecosystem of the team's AFTx06 chip. Specifically, the RTOS will provide the chip with robust prioritized, preemptive scheduling software in conjunction with dynamic memory allocation algorithms to support the use of functions pertaining to dynamic memory allocation (e.g. malloc and free). Together, these functionalities will enable the AFTx06 to simultaneously run multiple dynamically allocated tasks - meaning that the variables, data, and task structures do not need to be declared statically at compile time - dramatically increasing the system's throughput, robustness and flexibility. Along with general scheduling and memory management, the RTOS team also aims to design and incorporate security features into the RTOS.

The current build of the RTOS is tested using our QEMU hardware emulator which incorporates characteristics of the AFTx06 chip like the memory map and number of threads. The kernel and the application code are being run on this emulator and will be used to ensure that the kernel works correctly without any deadlocks and thrashing. The RTOS we are targeting is the FreeRTOS. This RTOS can run in M-mode (machine mode) on RISC-V and does not require a memory management unit. Our QEMU emulator interfaces with RISC-V-GDB which enables us to debug the code with traditional GDB functionality.

The next step of the design process will see the RTOS being compiled and run on the FPGA with AFTx06 RTL. Further goals are to run the RTOS on the actual AFTx06 chip.

Mentor(s):

Raghul Prakash, College of Engineering

Cole Nelson, Purdue University

Dr. Mark Johnson, Purdue University

Dr. Matthew Swabey, Purdue University

The Effect of Carrier Density-Tunable Work Function Buffer on Amorphous InZnO Thin Film Transistors

Author(s):

Molly Rothschild, Polytechnic Institute

Mingyuan Liu, Polytechnic Institute

Abstract:

Amorphous oxide semiconductor (AOS) thin film transistors (TFTs) have been intently explored as they are used as pixel switching elements in active-matrix liquid-crystal display technology and active-matrix organic light emitting diode displays. Metallization contact plays a major factor on the performance of AOS TFTs as high contact resistance sacrifices drain bias applied to the channel leading to power loss and inefficient carrier transport during TFT operation. Prior studies have aimed to enhance contact behaviors. However, those approaches require fabrication complexities due to factors such as chemical incompatibilities between dissimilar metals. The present study uses an interfacial buffer layer compositionally homogeneous to the channel layer to better align work functions between channel and metallization without fabrication complexities.

IZO TFTs with various thicknesses of a buffer layer were fabricated using dc magnetron sputtering. Electrical properties of the conducting buffer layer were characterized from Hall effects measurements. TFT device performance was measured using a semiconductor parameter analyzer. Chemical states of major elements and work function values were evaluated in an X-ray photoelectron spectrometer.

We found the addition of IZO as a buffer lowers contact resistance by better aligning work functions of the channel and metallization enabling improved carrier supply performance from the source to the effective channel region. The enhanced contact and carrier supply performance led to higher field effect mobility (13.41 vs 56.49 cm²/Vs) and a lower threshold voltage (7.44 vs 1.18 V) improving AOS TFT performance for fast-switching display applications.

References: M. Liu, H. Kim, X. Wang, H.W. Song, K. No, and S. Lee. "Carrier Density-Tunable Work Function Buffer at the Channel/Metallization Interface for Amorphous Oxide Thin-Film Transistors", ACS Applied Electronic Materials, 3 (2021)

M. Liu, M. Rothschild, H.W. Song and S. Lee., "Mechanisms of Carrier Density Increase of Ternary Cation-Based Amorphous Oxide Semiconductors for Thin Film Transistor Applications.", 239th Electrochemical Society Meeting (2021)

Mentor(s):

Sunghwan Lee, Polytechnic Institute, Engineering Technology

Design of a Flexible Thermal Noise Filter for Quantum Simulation Applications

Author(s):

Peter Salisbury, College of Science & Honors College

Abstract:

Background: In order to perform quantum simulation and quantum computation operations, qubits must be physically realized and protected from decoherence. One source of noise capable of disrupting the state of superconducting transmon qubits is thermal or Johnson-Nyquist noise. While the superconducting circuit is cooled to exceptionally low temperatures, the electrical lines that drive the circuit are warmer and can carry this noise to the quantum circuit.

Methods: I sought to design a low-pass filter placed at the coldest stage of the cryostat, just before the quantum circuit, in order to eliminate this noise on low-frequency lines. Additionally, this filter was designed to allow easy modification of the cut-off frequency. This was achieved by allowing alternate components to be added or removed easily and by making it possible to produce different circuit topologies by substituting a different board using common mounting.

Results: I designed a filter using Fusion 360 Circuits that satisfies the requirements for eliminating noise. To verify the operation of this filter, I will use a network analyzer to perform a frequency sweep. The resulting Bode plots will be compared with the nominal curves of an RC (resistor-capacitor) or LC (inductor-capacitor) pi-topology low-pass filter generated using the Fusion 360 Circuits integrated simulation tools during the design phase.

Conclusion: This filter design is simple, inexpensive to fabricate, and will allow flexible modification of the filter properties to meet the specific needs of various applications in a quantum simulation lab.

Mentor(s):

Alex Ruichao Ma, College of Science, Physics & Astronomy

Jeremy Cadiante, Purdue University

Visualizing 3D Data

Author(s):

Elliott Schmittenberg, College of Engineering & Honors College

Abigail Kupka, College of Engineering

Abstract:

This project explores manipulating 3D camera data in the Unity Game Engine to visualize 3D images in Virtual Reality (VR). Using the XYZT Lab's existing proprietary scanning technology, the team's goal is to create a 3D model that can be viewed on commercial Head Mounted Displays (HMDs) such as the Oculus Rift S and Quest platforms. The Holoteam has successfully converted data from the 3D camera/projector system into a procedural 3D mesh using C# scripts which is presented in a virtual playspace that can be interacted with by the VR system. Currently, the team is working on transitioning this technology to video formats from still frames which will allow real-time 3D video to be viewable from an HMD. Next steps will include taking live data from the 3D imaging sensor and importing that data into Unity in real time, thus enabling that data to be displayed virtually as data is received.

Mentor(s):

Song Zhang, College of Engineering, Mechanical Engineering

RISC-V Vector Instructions for High-Performance Embedded Computing

Author(s):

Jing Yin See, College of Engineering

Nicholas Gildenhuis, College of Engineering

Owen Prince, College of Engineering

Abstract:

Highly-intensive parallelizable programs like matrix multiplication are common and vital to many algorithms. Single-instruction, single-data (SISD) processors cannot take advantage of the parallelized nature of vector instructions. Vector processors aim to provide additional processing features in two ways: more efficient use of hardware and more processing units. The RISC-V instruction-set architecture adds the capability to handle vector instructions under the -V extension. This project covers the integration of the RISC-V -V extension into the AFTx06 processor developed by the Purdue SoCET team. We will implement this specification by modifying the final four stages of the current 6-stage pipeline. The core changes will include a larger register file, multiple “lanes” to operate on multiple data elements at the same time, and extra vector-specific instructions like permutation and reduction. We will then turn to benchmark the pipeline with programs that stress the functional units and the parallelism of the vector extension pipeline. These benchmark programs will be programmed in a serial and vectorized manner to provide reference to the speedups gained with the vector processor. The benchmarks we have chosen are a basic matrix multiplication algorithm, mergesort, Jacobi-2D from the PolyBench test suite, and Particle Filter from the Rodinia test suite. These benchmarks fully cover all the possible functional units in the design and can be executed with varying vector sizes. We expect the vector processing hardware to significantly improve performance.

Mentor(s):

Cole Nelson, College of Engineering, Electrical & Computer Engineering

Exploration of error fields and correction methods in the MUSE permanent magnet stellarator

Author(s):

Dominic Seidita, College of Science

Abstract:

MUSE is a tabletop, permanent magnet stellarator currently being developed at PPPL that aims to create a quasi-axisymmetric magnetic field using simple coils and permanent magnets. Methods to address error fields in MUSE which arise from correlated errors in the placement of permanent magnets are being explored. The FICUS and FIELDLINES codes are implemented to analyze and model the error fields generated by such correlated errors. A library of correlated errors created by construction deviations is being generated and the total error field for each is calculated. This library will inform construction tolerances and be used as a reference to correct construction deviations once MUSE is completed.

Mentor(s):

Michael Zarnstorff, Princeton Plasma Physics Laboratory

Tony Qian, Princeton Plasma Physics Laboratory

nanoHUB VIP Research

Author(s):

Benjamin Shatkowski, School of Management

Abstract:

The VIP nanoHub team has been working to find solutions to better and improve nanoHUB's technology. The group has been searching through the company's database to find how their users interact. Specifically, nanoHUB wants to look at what a user is taken to after searching for something on the internet. This will improve database's tools to help its users and direct them to a more efficient and effective output. The VIP group is looking to be a helping hand for nanoHUB in their search to improve their technology.

Mentor(s):

Joe Cychosz, Discovery Park, Network for Computational Nanotechnology (NCN)

**Design and Manufacturing of an Airtight Structural System for Resilient Extra-Terrestrial Habitat
Institute's Cyber-physical Testbed**

Author(s):

Shantanu Sinha, College of Engineering

Abstract:

The future exploration of space will rely on Earth-independent habitat systems. The habitat systems should function under various challenges, including health management during long crew absences (dormant states) and catastrophic situations. Safety and resilience to a wide range of anticipated—and unanticipated—conditions represent a multidisciplinary engineering and scientific challenge. The NASA-funded Resilient Extra-Terrestrial Habitat Institute is building knowledge toward developing such systems. To evaluate different design alternatives, each needs to be tested in a harsh environment. To this end, a multi-physics cyber-physical testbed is under development at the Ray W. Herrick Laboratories at Purdue University. When completed, the testbed will be capable of simulating a breadth of hazardous conditions, including exposure to extreme temperatures and structural collisions. An airtight dome is under development to integrate a set of systems required to simulate lunar conditions (e.g., thermal management, pressure management, command and control, robotic agents). The airtight dome will interact with a thermal transfer system to establish proper boundary conditions between cyber and physical components. An essential part of the dome is an inflatable bladder that will integrate the systems while also simulating the interior conditions of the habitat. The result of this study is essential to establish this cyber-physical testbed that will pave the way for experiments on the safety and resiliency of future habitat designs.

Mentor(s):

Davide Ziviani, College of Engineering, Herrick Lab

Amin Maghareh, Purdue University

Jaewon Park, Purdue University

Characterization of Drug Candidates as Lowe Syndrome Therapeutics

Author(s):

Lisette Skiba, College of Science

Abstract:

Lowe syndrome (LS) is an X-linked disorder with a poor prognosis. Most patients do not survive past late adolescence, usually due to progressive renal failure. LS is caused by mutations in the OCRL1 gene that lead to dysfunction of the encoded inositol-5-phosphatase, Ocr1. No cure exists at this time. Current therapeutics are intended manage the various resulting clinical manifestations, which include chronic issues with the eyes, brain, and kidneys. The purpose of this study was to characterize the action of selected drug candidates that target the defective enzyme, and to evaluate whether these candidates are capable of rescuing Golgi complex fragmentation and defects in ciliogenesis in cells expressing mutant Ocr1. We identified candidates LC9, LC10, and LC13 as effective in rescuing these phenotypes. Further studies are needed to confirm that phosphatase activity is rescued in addition to cellular phenotypes. Additionally, further analysis of mutant structures will be required to determine potential drug binding sites.

Mentor(s):

Claudio Aguilar, College of Science, Biological Sciences

Jennifer Lee, Purdue University

Temporal Categorization of Neural Responses in Larval Zebrafish

Author(s):

Thomas St. Pere, College of Science & Honors College

Abstract:

The purpose of the study is to characterize responses of pyramidal neurons in the Zebrafish optic tectum to temporal changes in visual stimuli using florescent imaging. Zebrafish (*Danio rerio*) are small freshwater fish that develop into larvae within a span of 72-96 hours after fertilization. Zebrafish have transparent skin while developing, and are genetically tractable which allows them to be genetically modified. The combination of these factors allows for the ability to label specific pyramidal neurons in the optic tectum with fluorescent proteins and conduct in vivo imaging to monitor neuron activity. The larval zebrafish are first sorted for high levels of fluorescent protein expression, they are then mounted in agarose one day before imaging, and then imaged while being presented with changing stimuli and using a small projector screen. The lab has previously shown that pyramidal neurons respond to gradual changes in luminance. We plan on expanding these previous studies by categorizing responses at shorter and longer time scales that would correlate to different stimuli the fish would experience in the wild. The data gathered so far indicate that the neurons respond similarly at very long intervals, but the shorter time intervals are yet to be analyzed. This categorization of the pyramidal neurons will contribute to our understanding of how zebrafish receive information from their environments and, more generally, how the vertebrate brain processes visual information.

Mentor(s):

Estuardo Robles, College of Science, Biological Sciences

Do early motor skills influence language development in infants at risk for autism spectrum disorder?

Author(s):

Jennifer Sun, College of Health & Human Science & Honors College

Abstract:

Previous studies of infant siblings of children with autism spectrum disorder (ASD) document elevated concerns in communication, social skills, and restricted/ repetitive behaviors. Recent studies suggest that early motor skills may be a key behavioral marker of later receptive and expressive communication concerns for children with ASD and their infant siblings. Recent evidence demonstrates concurrent associations between motor delays and language impairments; however, it is unclear if these motor delays precede language concerns in both elevated-risk and typical-risk populations. The current study aims to explore if early motor skills at 12 months of age are associated with language development at 30 months in two groups: infant siblings of children with ASD (SASD group, $n = 17$) and infant siblings of children who are typically developing (STYP group, $n = 18$). Infants were assessed with the Mullen Scales of Early Learning (MSEL) and Vineland Adaptive Behavioral Scales to index their expressive language, receptive language, and motor skills. A series of regression analyses with terms of maternal education were conducted and early motor skills were associated with later competence on both the MSEL expressive and receptive language scales in the SASD sample. However, the effect was attenuated when maternal education was removed. For infants developing at elevated risk for social communication and language concerns, the present study supports early developmental monitoring of motor skills to identify infants who may have an emerge communication concern.

Mentor(s):

AJ Schwichtenberg, College of Health & Human Science, Human Development & Family Studies

Pearlynn Chong, Graduate Student in Human Development and Family Studies

Initial evaluation of Pulsed Alternating Wavelength System (PAWS) on growth and physiological markers of stress in grow-out Pekin ducks.

Author(s):

Sara Tonissen, College of Agriculture & Honors College

Abstract:

Lighting can have profound effects on the health, production, and welfare of all poultry species, and the duck is no exception. Like all poultry species, ducks are seasonal breeders grown in curtain-sided barns, thus require artificial light in order to maintain long daylengths to maximize growth and fertility. However, there are no standards for lighting in commercial duck barns. Very few studies have evaluated the growth and welfare of ducks housed under different lighting systems. However, recent studies from several labs have reported that monochromatic light, particularly blue light, may not be appropriate for ducks, or waterfowl in general. A novel LED technology has recently been introduced referred to as Pulsed Alternating Wavelength System (PAWS) that provides a new approach to delivering multiple wavelengths of light to animals. PAWS delivers multiple rotating spectra of light in nanosecond pulses. The goal of this study was to determine the effects of PAWS on growth, FCR, and welfare of grow-out Pekin ducks.

We hypothesized that the PAWS lighting would have no adverse effects on production and welfare parameters.

In summary, there were no physical or physiological signs of acute or chronic stress; the most important outcome of this study is that the novel PAWS technology has no negative impact on production nor does PAWS elicit any physiological signs of stress. This was a small initial trial, but these data combined with the possibility that PAWS may impact brain biogenic amines warrants future larger studies.

Mentor(s):

Greg Fraley, College of Agriculture, Animal Sciences

Evaluation of intracardiac injections of tumor cells on cardiac function and metastasis formation in animal models

Author(s):

Aletea vanVeldhuisen, College of Engineering

Abstract:

A barrier in current treatment methods of brain metastases is the disruption of the blood-brain barrier[1]. We use mouse models to study the blood brain barrier and evaluate brain metastases. In studying the formation of brain metastasis in mice, ultrasound-guided intracardiac injections have a higher success rate than blind injections [2]. One unexplored concern with intracardiac injections is that it may impact cardiac function. In this study, we evaluated changes in cardiac function post-injection and success in forming brain metastases. Brain-seeking lung cancer cells were injected into nineteen athymic nude mice via ultrasound-guided intracardiac injection. Cardiac measurements were taken pre and post injection to measure cardiac changes and images were recorded during injection to measure consistency. Brain metastasis formation was then evaluated 24 hours post-injection using in vivo bioluminescence imaging. Consistent measurements were recorded between injections with higher variations in left ventricle volume between mice. Intracardiac injections had no significant effect on cardiac output and there was no significant correlation between post-injection cardiac output and metastases formation. Post-injection, there was a significant decrease in heart rate, correlating with a decrease in isoflurane exposure when transitioning the mouse to the ultrasound stage. Our injections had a 32% success rate with an average of 9 metastases per mouse and 95% survival rate compared to a 33% success rate of micrometastases and 52% survival rate with blind injections [2]. Treatment of these mice with a chemotherapeutic may have affected metastasis formation. In the future, we hope to evaluate metastasis formation without chemotherapeutic treatment.

[1] P. R. Lockman, R. K. Mittapalli, K. S. Taskar, V. Rudraraju, B. Gril, K. A. Bohn, C. E. Adkins, A. Roberts, H. R. Thorsheim, J. A. Gaasch, S. Huang, D. Palmieri, P. S. Steeg, and Q. R. Smith, "Heterogeneous blood-tumor barrier permeability determines drug efficacy in experimental brain metastases of breast cancer," *Clinical cancer research : an official journal of the American Association for Cancer Research*, Dec-2010. [Online]. Available: <https://pubmed.ncbi.nlm.nih.gov/20829328/>. [Accessed: 01-Feb-2021].

[2] L. Balathasan, J. S. Beech, and R. J. Muschel, "Ultrasonography-guided intracardiac injection: an improvement for quantitative brain colonization assays," *The American journal of pathology*, 08-May-2013. [Online]. Available: <https://pubmed.ncbi.nlm.nih.gov/23665347/>. [Accessed: 01-Feb-2021].

Mentor(s):

Tiffany Lyle, College of Veterinary Medicine, Comparative Pathobiology

Craig Goergen, Purdue University

Kimaya Bakhle, Purdue University

Elementary Students' Conceptions of Programming on A Sorting Task

Author(s):

Sirou Wang, College of Education

Abstract:

Understanding students' conceptions of programming is important for building on their knowledge in meaningful ways. In this study, 27 first graders and 26 third graders sorted pictures of objects, before and after a programming intervention, based on whether the pictures definitely involve programming, sort-of involve programming, or do not involve programming. Results indicate that the percent of students labeling pictures as definitely involving programming increased for the majority of items and this change was significant for girls on three of the five items of interest (two programming games and a robot). Students' changes aligned with programming applications they used and learned about during the intervention, suggesting helping students make direct connections to programming applications is important for their developing conceptions.

Mentor(s):

Laura Bofferding, College of Education, Curriculum & Instruction

Video Analytics for Understanding Human Behavior

Author(s):

Tong Wang, College of Engineering & Honors College

Apoorva Gupta, College of Science

Tim Diemer, College of Engineering

Elizabeth Thomas, College of Engineering

Abstract:

This research team is developing a camera-vision-based human identification system that tracks and analyzes human movement within a multi-camera system's field of view. The team works in two subteams: Re-Identification and 2D-mapping.

The Re-ID portion of the pipeline handles the detection of humans in the camera's field of vision. It creates bounding boxes around detected humans and assigns them a unique identifier based on their visual attributes. An image of this human is assigned a unique ID and stored in a dynamic gallery, allowing new IDs to be given to new people entering the frame.

The 2D-mapping pipeline converts coordinates from a multi-camera network to latitude and longitude and plots the position on a satellite image generated by Google Maps API. The pipeline first converts a point on the three-dimensional camera view to a point on the satellite image. Then it converts the mapped pixel coordinate on the image to latitude and longitude.

By testing the system with videos of various types of environments and analyzing the results, limitations and benchmarks can be identified. This allows for further developments which could extend re-identification and analysis of non-human entities, like vehicles, in different conditions. A functional system provides current and robust patterns of human behavior in the monitored space, which improves efficiencies in movement and flow in other open spaces.

Mentor(s):

Dave Barbarash, College of Agriculture, Horticulture & Landscape Architecture

Serial Communication Testing Mode Arduino & Jetson Endpoint

Author(s):

Christopher Wang, College of Engineering

Joshua Koshy, College of Engineering

Salim Al Salmi, College of Engineering

Prateek Sinha, College of Engineering

Abstract:

Cars, the mode of travel for most people in the world. In most of the world, but especially in the US, it is hard to live a normal life without having a car. Basic needs such as going to work, going grocery shopping and visiting family members would be hard without having a car. However, cars contribute to ten of thousands of deaths and a third of the total US greenhouse gas emissions. Autonomy would be the way to help fix this issue. The end goal of the AMP team is to develop an electric autonomous formula one car to capture solutions to challenging problems in the real world. For now, AMP is trying to reach that end goal in parts. This leads to our part in helping them reach their end goal which is our project. The idea of our project is to further develop the testing mode for communication to enhance logging the outputs and inputs in the autonomous kart to help the team. This project can log information on both terminals in a vehicle to help in multiple ways in the real world such as preventive safety, car health, autonomous models, sustainable dynamics and real world impact for autonomous cars. This fulfills our overlying goal, to present a safe future with autonomous electronics. Our team consists of four members of varying years. We hope to have an implementation that will benefit the AMP team in their quest for pure autonomy in racing and real world accessibility.

Mentor(s):

Aly El Gamal, College of Engineering, Electrical & Computer Engineering

Shreya Ghosh, Purdue University

Lessons Learned from the Academic Literature for Bt cotton Policy Development in India

Author(s):

Emilie Washer, College of Agriculture

Abstract:

Cotton is an important cash crop of India and provides a livelihood to more than 60 million people by way of support in agriculture, processing and use of cotton in textiles (1, 2). Past research has shown that Bt cotton plays a large economic role in local communities, especially in developing countries. For example, genetically modified cotton makes crops resistant to bollworm infestations and can decrease pesticide use and improve yields. Bt cotton was first introduced in India in 2002, and the increase in adoption of Bt cotton by farmers has led to increased government regulation and control of this genetically modified crop. Although a vast amount of research has been conducted on this crop in India, little work has been done to synthesize this research. From 2020 to 2021, a thorough investigation of peer-reviewed literature was performed to expand the understanding of the policy implications of Bt cotton and how those policies impact the local communities in India. Overall, a total of 45 peer-reviewed articles were synthesized and reviewed, and results indicated that while Bt cotton in India has several social, economic, agricultural, and environmental benefits, policies are needed to mitigate the potential downfalls that come from adopting Bt cotton such as price increases in cottonseed and decreases in pest resistance. Future policy recommendations include adopting policies that provide subsidies to farmers and setting seed quality standards to ensure that farmers have the potential to maintain consistent crop yields.

Mentor(s):

Rebecca Nixon, College of Agriculture, Forestry & Natural Resources

Zhao Ma, Purdue University

An Analysis of Student Teachers' Ideas of Classroom Libraries

Author(s):

Marissa White, College of Education & Honors College

Abstract:

The purpose of this research is to understand how two future teachers think about classroom libraries. It investigates their ideas about elementary classroom libraries and their understanding of these libraries' functionality and use. Their perceptions of text levels, organizational structures, and rules and procedures were explored. Classroom libraries can be the main access point to books for many elementary-aged children. The findings portray the perceptions and ideas of these two student teachers and how they hope to implement their future classroom libraries to best serve the needs of their students. Because the two student teachers were in their final semester, they have current and relevant experience in terms of pedagogical theory and implementing that theory in the classroom. Singular interviews were conducted with the student teachers, one placed in first grade and the other in third grade. The participants shared their beliefs that classroom libraries should be easily accessible and inviting and that consistent procedures are important to ensure appropriate use. They also felt that while leveling books has a place, this practice can hinder student development of a love of reading. This research's impact lies in highlighting the thoughts and goals of two pre-service teachers regarding their classroom libraries broadly and in terms of critical literacy. It also focuses on how classroom libraries' presentation can determine students' interaction with texts, how accessibility to quality texts across types, genres, lengths, and levels is an issue of equity, and how they connect to understandings of critical literacy.

Mentor(s):

Melanie Kuhn, College of Education, Curriculum & Instruction

Autonomus Cart Electrical system Wiring Optimization

Author(s):

Yue Yu, College of Engineering

Ming-chin Lee, College of Engineering

Joseph Freck, College of Engineering

Abstract:

The purpose of this VIP team is working on assisting the Black & Gold Autonomous Racing team of the Autonomous Motorsport Purdue (AMP) in competing in the Indy Autonomous Challenge (IAC). For High speed go-kart driving, it requires precise electrical control systems where our VIP sub-team is established to provide a solution for fully autonomous steering, throttle and braking functionality. In the need of the AMP team this semester, our electrical sub-team is mainly focusing on rewiring & testing of the sub-systems on the go-kart. In order to create a more efficient and clear workspace on the kart. To do this, we will start our work base on the prototype of our new wiring harness built from last semester. We will test and improve it to become a final product. We will also focus on the rewiring of the server motor and linear actuator group with the coordination from other electrical teams.

Mentor(s):

Aly El Gamal, College of Engineering, Electrical & Computer Engineering

Shreya Gosh

SoCET UVM Verification

Author(s):

Yueting Zhao, College of Engineering

Abstract:

System-on-Chip is an integrated circuit that contains many subcomponents. The failure or malfunction of one component can make costly damages to the entire chip or even the bigger system the chip belongs to. Therefore, testing and debugging are important steps in chip design before sending the chip for fabrication. The universal verification methodology (UVM) is a standardized method for verifying digital designs. Following UVM, we can create scalable and well-formatted test benches that can be reused for other components and projects. In the SoCET team, we are learning this methodology and applying it to verify RTL blocks of the system-on-chip we have designed. The focus of this particular project is to build a UVM testbench to rigorously validate the functionality of a recently developed SPI peripheral. We first analyze the code and determine what features should be tested. Then we come up with test cases with checkers and implement them into the testbench. We will examine the waveform for each test case and find out the possible sources of error if a certain test case fails. We aim to test as many corner cases as possible. Finally, we will send out the report to design teams and repeat the process until the block is thoroughly tested and passes all the tests.

Mentor(s):

Mark Johnson, College of Engineering, Electrical & Computer Engineering

Sarang Pramod, Purdue University

Water Resistance of Zein Adhesives

Author(s):

Irina Zhilinskaya, College of Science

Kylie Smith, College of Science

Abstract:

Adhesives based on zein protein derived from corn are biodegradable and nontoxic. A non-toxic adhesive that is water resistant but fails when soaked in water for a prolonged time may be useful for products like dentures and bandages. We are testing how adhesives made from different compositions of zein and tannic acid perform when soaked in tap and salt water for varying amounts of time. Cured zein-tannic acid adhesives are the high strength controls and zein-only adhesives are a second control. We are using aluminum substrates because of the versatility of this substrate in everyday applications. Previous experiments evaluated the performance of these adhesives on wood and even skin substrates under similar conditions and can be used for comparison. In the experiments, lap-shearing testing provided the maximum force at bond failure of the glue. This maximum force divided by the glued surface area gives the adhesion strength. Adhesion strengths are presented as a function of time underwater. Data shows that the adhesion strengths decrease, but do not disappear when the adherents are submerged in water for increasing periods of time. The adhesion strength of the zein-only control was very low; however, the addition of tannic acid greatly improved the performance of the glue by promoting cross-linking. The adhesion strength of the glue under tap water is weaker than the adhesion strength of the glue under salt water possibly due to ionic interactions in salt water that promote cross-linking. Future experiments will evaluate the adhesive's water resistance for dental applications.

Mentor(s):

Gudrun Schmidt, College of Science, Chemistry

Web Content Accessibility Guideline Comparison of the Average Number of Known Errors in Implementation Across Tradeshow Websites

(Previously, Research Talk 99)

Author(s):

Victoria Young, College of Health & Human Science

Abstract:

The Web Content Accessibility Guidelines (WCAG) have been created by the World Wide Web Consortium (W3C) Web Accessibility Initiative to assist in making content on the web more accessible to people with disabilities (PWDs). Web Contents Inclusion (WCI), the practice of making websites accessible to PWDs, is essential to create an inclusive business event. The purpose of this research is to analyze and compare web content accessibility among trade shows in various countries and compare them by the average number of known problems within their implementation. This study explores policies followed in different countries that supplement in understanding the findings.

2,178 websites of tradeshow websites were analyzed by using the content on their homepages to gather this data. Of those 2,178 tradeshow websites, 1,838 were used for this research paper. 18 countries holding more than 20 tradeshow websites were finally used for comparison and accessibility policies in the respective countries were explored. The countries included in the analysis are Australia, China, India, Japan, Russia, Ukraine, and the United States. AChecker was used to evaluate HTML content for web-accessibility problems based on WCAG 2.0.

Overall, the tradeshow websites showed higher numbers of known problems in WCAG guidelines categories, 1.1 Text Alternatives and 1.4 Distinguishable. Of the countries being analyzed Australia, China, India, Japan, Poland, and Spain (the European Union) follow or refer to the WCAG guidelines. The countries with a higher average number of known problems are China, Russia, Poland, India, and Spain, while Australia, Japan, and Ukraine have the least.

Mentor(s):

Shawn Jung, College of Health & Human Science, Hospitality & Tourism



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ugresearch@purdue.edu :: (765) 494-6503

