

# Crawler Robots for Inaccessible Areas in Precision Agriculture

Richard Voyles, Yuanmeng Huang, Yubing Han, **Engineering Technology, Purdue**; Shawn Donkin, **Animal Science**; Tim Filley, **EAPS**;  
Rammohan Sriramadas, Shashank Priya, **Penn State**

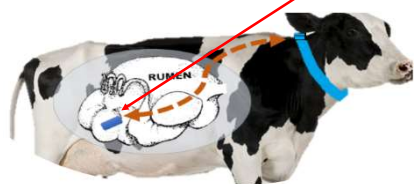
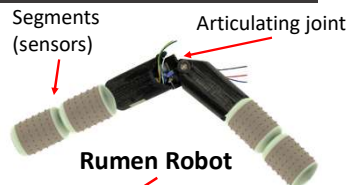
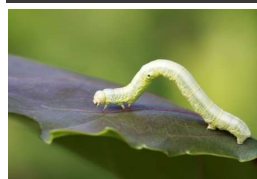
## RUMEN ROBOT

### Background of Ag Rumen Robot



- A cannula is usually inserted to the rumen of cows to collect samples extracorporeally.
- Limitations: disturbance to the rumen environment by introducing oxygen and mixing rumen contents.

### Mechanism of Animal Ag - Robotics



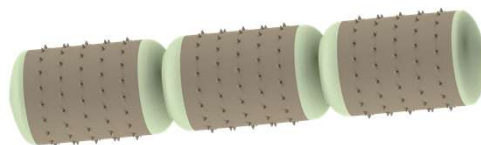
- A Rumen robot was built to be placed inside the cow rumen to collect data rather than inserting a cannula.
- Based on inchworm locomotory mechanism, the rumen robot was designed with 3 degree of freedoms.
- Articulating joint is placed in-between the segments so that the robot can change direction.
- The robot can be controlled and communicated wirelessly from the outside controlling unit.

### Project Support

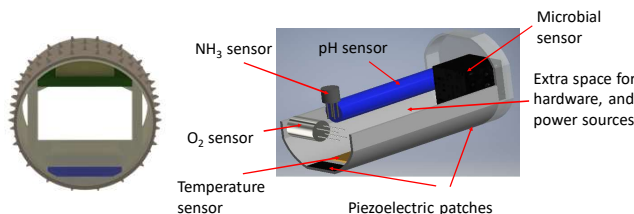
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- The Soils component is funded by a Peru/NEXUS grant.
- The Robotic RUMENS sensor is proposed to the National Science Foundation.

## ARTICULATING ROBOT JOINT

### Segments of Rumen Robot demonstration

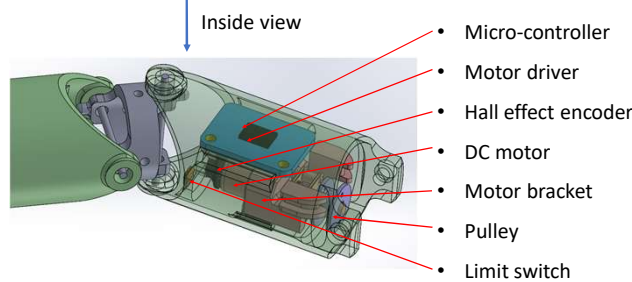
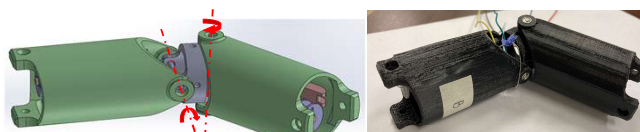


- Sensors, power source and actuators that enable longitudinal movement are placed inside these segments.
- Since the robot works inside the rumen, the robot will be covered with a water-proof layer.



Sensors in the robot (figure above) collect different data from cows for more accurate models of ruminant health and well-being and, in turn, populate those models for each individual cow.

### Articulating joint demonstration



- The articulating joint has two degree of freedoms.
- The cable driven system are controlled by two DC motors that can lead the robot to turn into different directions.
- The gearbox ensures enough torque to drive the robot in the rumens.
- The encoder records the exact rotation position of the joint.
- The limit switch protects the joint from overturning.

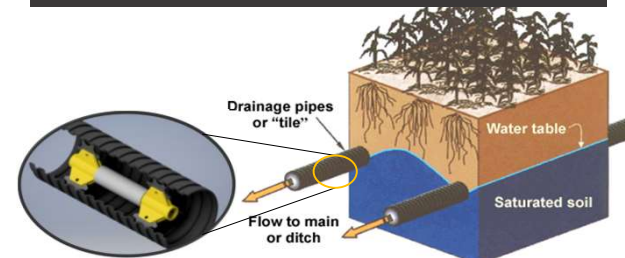
## SUBTERRANEAN CRAWLER

### Precision Sub-Surface Ag - the Soil Microbiome



Much of the land used for farming in the Midwest today would be wetland without human intervention. Wetlands are drained by systems of buried pipe known as drain tile – but this introduces oxygen into a normally anaerobic process.

### Potentially Negative Effects of Drainage Systems is Under-studied



- Nitrates, potassium, and phosphates are nutrients lost from the soil through agricultural runoff.
- Drain tile also allows oxygen to permeate the soil at depths far deeper than would be possible naturally.

### Robotic Solution to Facilitate Study



- Currently the CRL has developed a prototype to gather data to facilitate the study of soil.
- This subterranean crawler will use similar articulating joint to turn into different direction in pipes.