Effective Disinfection

- On average, patients are quarantined for 12 days, considering the 3-day overlap period at opening and the 10-day minimum quarantine period. This results in a turnover rate of 18 days.

Autonomous Mobile System

- The base of the robot is an omnidirectional vehicle capable of payloads up to 200 kg.
- The base has integrated sensors such as LiDAR, 3D cameras, collision sensors, and IMUs to perform autonomous navigation through SLAM. The sensors also enable fail-safe operation and error correction.
- The UVC lamps on the robot are 254 nm tubes in a housing with antimicrobial coating.

SAFETY GUIDELINES

Because the COVID-19 virus (SARS-CoV-2) is so new, the scientific community doesn’t yet have a specific deactivation dosage. However, the dosage values for comparable viruses in the same SARS virus family are 10-20 mJ/cm² using direct UVC light at a wavelength of 254 nm; this dosage will achieve 99.9% disinfection (i.e., inactivation) under controlled lab conditions. In real-life, the virus is often hidden or shaded from direct UVC light, reducing UVC’s effectiveness.

- UV-C dosage from the tower used in this robot is shown in the figure above. According to CDC guidelines the dosage must be less 20 mJ/cm² and the wavelength of 280 nm. The operator must also wear proper PPE while operating.

PEOPLE RESPONSIBLE

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Efficient Disinfection

Autonomous Mobile Robots

Timeliness

Method of Disinfection

Safety Priority
Robots for COVID-19 Pandemics: Protecting Essential Workers in Different Phases

Evolving Pandemics, Changing Demands

<table>
<thead>
<tr>
<th>Onset Phase</th>
<th>Quarantine Phase</th>
<th>Reopening Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hospitals overflow facing a novel virus.</td>
<td>• General public stay at home while retail staffs remain at work.</td>
<td>• Schools and businesses reopen.</td>
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<tr>
<td>• Deficient PPE supplies. Medical workers come into direct contact with infected people.</td>
<td>• Prevent community spread at public indoor spaces.</td>
<td>• Prevent sporadic outbreak. Low risk of exposure in general but everyone is involved.</td>
</tr>
</tbody>
</table>

Who are at risk?

- Medical workers come into direct contact with infected people.
- Essential non-medical workers, especially retail staffs.
- They face lower risks but prolonged exposure time.
- Professors, students, and janitorial staffs.
- General public working in offices are involved.

How Robots can Help

- Medical robots acting as telepresence of physicians.
- Performs basic screening and diagnostic tasks:
  - Automatic temperature taking
  - Teleoperated ultrasound examination
  - Teleoperated stethoscope examination
  - Deployed for testing in Beijing and Wuhan in March.
  - Physical separation of physicians with pathogens yielded improved sense of safety.
- Disinfection robot that leans the air and surfaces of public indoor spaces
- Multimodal disinfection that are occupant-safe
  - Bernoulli air filtration + enclosed UVC disinfection
  - Combination of conventional spraying with electrostatic spraying for enhanced coverage
  - Robot PPE is a photocatalytic nano-coating on the robot surface, which prevents cross-infection from happening through the robot.
  - Combination of air filtration with a moving robot cleans the saliva plumes carrying the pathogen before they spread and finds the next victim.
- Modular payload design for quickly modifying the disinfection robot for multiple application scenarios.
  - By mounting a UVC light instead of the air filtration unit, it can be used for disinfecting isolation dorms during shift.
  - Unified control interface for quick adaptation
  - Back-seat driving which provides the robot with autonomy as well as fault identification ability.
  - Robot seeks help on the “robot call center” when it get stuck, and learns from the teleoperator for mitigating future problems.