Researchers develop autonomous robot to kill SARS-CoV-2

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The Grainger College of Engineering at University of Illinois Urbana-Champaign's Health Care Engineering Systems Center has developed the UVBot: a robot that can be built out of easily accessible objects and programmed to clean spaces using UV light, which kills COVID-19. Credit: University of Illinois Urbana-Champaign

Ultraviolet light is a form of radiation that can be used for sterilization

and disinfection. With schools and offices beginning to meet in-person again despite little change in the rate of COVID-19 infections, easy, low-cost sterilization strategies are necessary to curb the spread of the pandemic. To meet this lofty demand, The Grainger College of Engineering at University of Illinois Urbana-Champaign's Health Care Engineering Systems Center has developed the UVBot: a robot that can be built out of easily accessible objects and programmed to clean spaces using UV light, which kills COVID-19.

In May 2020, HCESC director T. Kesh Kesavadas had an idea to create a low-cost robot that could be used to sterilize common areas such as classrooms, offices, and public transportation. He reached out to Helen Nguyen, professor of civil and environmental engineering and leader of the Illinois PPE team in The Grainger College of Engineering at UIUC. Nguyen, who has an extensive background in sterilization and UV light, saw the value in this idea and proposed to add a UV light to the robot. "From several studies conducted by my lab over the year, we know that commonly used UV irradiation is effective in inactivating or neutralizing SARS-CoV-2, and virus inactivation depends not only on the UV intensive but also the exposure time," said Nguyen. "To control the exposure time precisely and to prevent humans from exposure to harmful UV light, we need something like a robot."

While these autonomous robots do exist, they can cost as much as $50,000. "It's a difficult position to be in," said Kesavadas. "Many companies and schools don't have the funds necessary to purchase a robot that can disinfect spaces, but it needs to happen if people are returning to on-site work or learning. Our robot serves as a low-cost alternative and can be made for under $1,000."

Kesavadas and Nguyen decided to move forward on the project and put together an interdisciplinary team of engineers from HCESC, Holonyak Micro & Nanotechnology Lab, Mechanical Engineering, and Veterinary

Biosciences: Yao Li, Harris Nisar, Fanxin Wang, Elbashir Araud, and Jump ARCHES summer intern Peter Chien. The result of their teamwork is the UVBot: made from a Roomba robot, UV lamp, and 3-D-printed parts, the UVBot can be controlled by a mobile app over Wi-Fi or Bluetooth and programmed to autonomously clean many different types of spaces. It even has the ability to record and create a library of rooms. Since UV light is dangerous to skin and eyes without protective equipment, this robot is ideal for safe cleaning since it can autonomously plan its path or be controlled remotely on a smartphone. Users would be exposed to neither UV light nor COVID-19.

The team had to navigate creating the robot through the challenges of a pandemic, where remote work and social distancing of utmost importance. Simulation engineer Harris Nisar lead the mechanical design and fabrication of the robot. "I had a great time planning the build. Of course, because of COVID, there were tremendous challenges in getting work done that required tools or facilities such as 3-D printers and laser cutters, but we worked through those and learned a lot along the way."

Intern Peter Chien, a rising junior in mechanical engineering at UIUC, was excited to work on a robotics project and learn new skills that align with his interest in health care technology. "The most fun part of this project for me was designing the hardware, where I was able to take everything I've learned in my coursework and apply it to something that will help in the real world," said Chien. Fabricating the hardware involved designing mounts for the UV lamp and making sure that they fit securely onto the Roomba. Chien was also involved in designing the mobile app to control the robot over Wi-Fi and Bluetooth with Li and Wang. "Designing the software has been a great learning experience; it was difficult to get started but this knowledge will definitely be useful in the future," said Chien. The robot is able to successfully navigate rooms autonomously by using advanced sensors or controlled by a smartphone.

The UVBot promises 99% virus inactivation. The required exposure time and distance for inactivation was systematically tested using an RNA virus similar to COVID-19: Tulane virus. The team successfully conducted a test inside the Health Care Engineering Systems Center facilities to demonstrate the prototype's feasibility as a solution for disinfection.

Kesavadas, Nguyen, and their team were passionate about creating a solution that could be created and implemented by anyone, so they are planning to publish the design, bill of material, software, and environment test data as an open access project on GitHub. Any organization with basic engineering capabilities will be able to download and reproduce the UVBot system. A provisional patent has been filed. To obtain the GitHub information for the UVBot, please contact the Health Care Engineering Systems Center here: https://forms.illinois.edu/sec/867704172.

The inventors acknowledge the support of the Jump Applied Research for Community Health through Engineering and Simulation (ARCHES) endowment, a partnership between Jump Simulation and Education Center at OSF HealthCare and the Health Care Engineering Systems Center in The Grainger College of Engineering.

While the UVBot has proven successful, the team is still eager to improve the design with better collision detection, autonomous detection to shut off UV light when a human is detected, and software to support multiple UVBots functioning in the same network.

"It is our hope that schools and organizations feel confident enough in our work to create and utilize the UVBot for themselves," said Kesavadas. "Reopening our country's schools and offices safely is a huge task, and we are proud to be a small part of it."