VISOR: VIruS exterminatiOn Robot

University of Kent, University of Essex

This project will leverage the substantial expertise and track record of two research laboratories to rapidly develop a vehicle decontamination system which will speed decontamination and ease mobile deployment. It builds on mobile robotics expertise from the EPSRC National Centre for Nuclear Robotics, that has pioneered inspection in extreme environments, to deliver a solution consisting of an automated robotic system which simultaneously maps and methodically de-contaminates a vehicle or facility in both the longitudinal and vertical planes. This will be augmented by computer vision technology to analyse images recorded from multiple vantage points within the vehicle to ensure that all surfaces have been decontaminated, thus ensuring total coverage and providing appropriate feedback to a human operator.

The project will harness and build up on our existing infrastructure (robots, sesors) and software relevant to the perception-action-decision making loop available at the Universities of Essex and Kent. Given the diversity in the kind of vehicles to be accessed (buses, trains, ambulances, other natural living spaces) a configurable 'plug and play' multi-task approach will be deployed to ensure flexibility and incorporation of task specific constraints. The solution will be built on the existing tried and tested robotic technologies originally researched and developed for remote inspection of challenging and extreme environments as part of the EPSRC National Centre for Nuclear Robotics (NCNR) and European Healthcare Robotics projects.

The initial prototype platform will be the Beast robot platform at Essex (currently being deployed for Agricultural robotics/Soft Fruit harvesting) consists of Husky UGV (with over 100kg payload) carrying two industrial arms. Multiple stereo cameras, Velodyne Puck Lidar (100m range, 360 view with real time 3D data), multi fingered soft hand, customized gripper/cutter, onboard computing enable the platform to sense and interact intelligently and perform a range of manual tasks, which in addition to the core spraying task, include picking and cutting. Essex and Kent have a range of other mobile robotic platforms onto which the core technology can subsequently be mounted with actuators and sensors based on the nature of the vehicle to be assessed for decontamination. Both teams have been developing a range of software functionality 2D/3D sensing to object detection/localisation, goal directed navigation, dextrous manipulation applied already in several robotics sectors and assistive medical device mobile robotics. Standard industry ROS based middleware and hardware integration will be used to combine LIDAR, distance ranging, and camera sensors with robotic arm manipulators, drive motors, and spraying equipment using proven algorithms together with our novel detection pattern recognition to provide a robust control loop for decontaminating different scenarios enabling both quick start up and task specific flexibility.

The platform will support a tank containing disinfectant which is used to supply the spray heads located on the robotic arms alongside which will be mounted UV sterilisation lamps and/or other devices as later required, such as a manipulator for picking up items. This will enable thorough cleaning and sterilisation for COVID-19 or other highly infectious pathogens.

The mobile platform will consist of:

- A platform based upon a mobile base such as the Husky UGV, or where this is too large, a range of alternative platforms to access the specific spaces to be decontaminated.
- A number of mechanically extendable and retractable arms with piezo actuated/controlled nozzles and UV lamps attached.
- A disinfectant tank with constant pressure pump and regulator.
- Camera, 3D LIDAR, and other ranging sensors.

The system will function by:

- Systematically moving through the vehicle, train, bus, or around a building such as a hospital.
- Extending the robotic arms out and under/over seating/bedding and up above luggage racks and hand rails for standing passengers.
- Deploying disinfectant/and or UV sterilisation as specified by the operator from the extended robotic arm.
- Using optical feedback and pattern recognition software form a control loop for ensuring complete coverage.
- Provide remote feedback and control if required to a human operator via a tablet or laptop and recording some images for quality control verification.

Future extension and add on potential:

- UV detection for particular scenarios using specific biomarkers by updating the pattern recognition and feed back control.
- Additional tasks using end effectors mounted to robotic arms such as picking up litter or other specific objects.
- Detection and identification of specific or random objects using trained classifiers.
- Mechanical cleaning devices such as rotating brush heads for vigorous cleaning.

The potential for these future potential suggestions can be seen in similar developments we have undertaken such as the fruit identification and picking robot. In short, the team from Essex and Kent will be able to develop intelligent navigation and control algorithms for fast coverage of bus/train interior, and extend the existing functions of available robotic platforms to address the need to fast clean and sterilisation. The existing baseline technology equipment and expertise will enable rapid delivery of prototype systems as milestones are completed during the project workplan and is thus very suitable for showcasing of the capabilities and providing high TRL prototypes that facilitate rapid uptake in robotic systems and services industry.