



**NANYANG  
TECHNOLOGICAL  
UNIVERSITY**  
SINGAPORE



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## ANNEX E: NTU TELEOPERATION SYSTEM FACTSHEET

Singapore, 19 October 2021

### NTU Singapore develops high-fidelity teleoperation for heavy-duty vehicles

Scientists at **Nanyang Technological University, Singapore (NTU Singapore)**, have developed a high-fidelity teleoperation system which enables drivers to operate heavy-duty vehicles remotely (from an off-site location) in a simple and realistic manner.



#### Features

- 1) **No motion sickness:** The platform simulates and synchronises with the actual vehicle, offering motion, visual and auditory force feedback (simulation technique to provide the driver a true-to-life feeling) so users feel no different from sitting in a real vehicle.
- 2) **Situation awareness:** The large monitors screen video of the road situation in real-time, providing the teleoperator a wide field of view with little distortion.

- 3) **Fleet management:** An individual teleoperation user can control multiple vehicles at once, by engaging the function on the platform whenever required.
- 4) **Flexibility in control:** Whenever necessary, the teleoperation user can take over control of the vehicle remotely, like the role played by the onboard safety driver - a requirement for autonomous vehicle (AV) tests currently. Hence, this feature supports the eventual rollout of autonomous vehicles (AVs) and AV systems on the roads in future.
- 5) **Low risk:** Teleoperation users can control the vehicle remotely, allowing the heavy-duty vehicle to operate at hazardous worksites.
- 6) **Diverse application:** The teleoperation system can be used to manage a variety of heavy-duty AVs, such as trucks, buses, ships, excavators, underground machine operations.

### High-fidelity teleoperation specifications

- 5 axes platform motion to simulate vehicle motion
- Haptic feedback to steering wheel reaction forces
- Seamless video streaming with 180° field of view for teleoperation operator
- Efficient bandwidth usage compatible with 4G, 5G and wifi networks
- Low latency in transmission
- Multiple layer fail-safe functions

### About the NTU high-fidelity teleoperation project

Principal Investigator **Professor Wang Danwei** from NTU's School of Electrical and Electronic Engineering leads the research team which developed the high-fidelity teleoperation system for heavy-duty vehicles, including the development of novel technologies to remotely operate autonomous systems. Prof Wang is an expert on multi-modal sensing, perception, and autonomy of unmanned systems in unstructured environments.

The development of the high-fidelity teleoperation system reflects the **NTU Smart Campus** vision, where the University harnesses the power of digital technology and tech-enabled solutions to support better learning and living experiences, the



discovery of new knowledge, and the sustainability of resources. The teleoperation system was developed as part of the Autonomous Environmental Service Vehicle R&D project under the National Environment Agency's Environmental Robotics Programme.<sup>1</sup>

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<sup>1</sup> The Environmental Robotics Programme was launched by NEA in December 2017 as part of the National Robotics R&D Programme. It focuses on the development of robotics solutions to: (i) Enable productivity gains; (ii) Enable sustainable manpower stream, and (iii) Enhance current capabilities and enable new ones.