EXTENDED REALITY AND HUMANOID ROBOTICS: NEXTGEN ASSETS FOR REMOTE CB RESPONSE AND OPERATION

An Autonomous System For CBRN Critical Missions

Eva Lee The Data and Analytics Innovation Institute **Taylor Leonard** U.S. Air Force

Drones have become ubiquitous in modern warfare. And robots have deeply in-grain and designed for large-scale disaster rescue missions. Since COVID-19, disinfection robots have been widely used to sterilize and disinfect airports and public transits for public safety. In January 2022, a Covid-stricken Australian aid ship headed for virus-free Tonga in response to a volcano disaster was refused entry, showcasing the importance of an unmanned rescue system amid CBRN incidents.

During large-scale CBRN events, rescue and emergency response operations and logistics, medical countermeasure dispensing, as well as supply and resupply of essential materials that sustain and save lives are often carried out under strained conditions and with limited resources. Damaged roads and dangerous terrain, with potentially hazardous contamination (chemical, biological, radiation plumes) greatly complicate response capabilities.

Unmanned systems hold unique promise in transforming emergency response logistics, detecting threats, decontamination and disinfection, and mass dispensing. UAVs can identify affected areas, examine terrain and blocked paths, scout usable facility sites, explore transportation paths, surveil on-site human situation, and transmit critical on-the-ground information back to Central Command; while UGVs can traverse affected areas, perform critical on-the-ground logistics and carry out supply and resupply missions. Equipped with robots and detection devices, they can surveil and detect, disinfect, and decontaminate sites and humans, and deliver supplies and medical countermeasures to a much broader scope of demographics and landscapes more readily and safely than traditional human labor. They can facilitate on-site video-tele-medicine that connects the displaced / injured population to outside experts.

The crux of running such a system involves determining the optimal deployment of fleets of unmanned vehicles (both aerial and ground) or a mixed of manned ones, and central system communication for effective response operations, mass dispensing logistics, and supply and resupply.

We describe a computational Command-and-Control platform that can model unmanned aerial and ground fleets for effective CBRN and emergency operations and supply/resupply in the face of uncertain road networks, conditions, and biological / radiological / chemical or hazardous conditions. The computational platform incorporates visualization, spatial networks, user-input location layout, mapping tools and crowd-sourcing data. It enables users to explore a mix of autonomous, semi-autonomous, and interactive mode operations. The model will return optimal fleets, associated paths, communication protocols, and dynamic resource allocation plans. Recommendations can be re-computed on-the-fly to adapt to evolving situations. Most importantly, the system allows exploration of the scalability of fleets to determine requirements to effectively protect the affected population within a given time horizon. For a sustained operation, deep learning and machine learning are applied to uncover patterns of on-the-ground events to predict evolving affected populations, associated demand, and required response resources. Beyond response missions, such a system can be used for exploration of terrain to detect and defeat adversaries. The Command-and-Control system can be used for planning, training, and operational purposes.

This work was partially supported by the Centers for Disease Control and Prevention, and the Department of Homeland Security.