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

Digital Battlefield CB Threat Mapping And Augmented Reality Display

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Operations involving contamination detection of Chemical and Biological threats are moving towards modalities where soldiers are expected to directly assess mission risk and react accordingly. It is imperative that they can get faster, more digestible, and higher fidelity actionable intel about CBRN threats. As part of a DTRA CBI funded effort, we are developing an integrated suite of technologies surrounding the generation and dissemination of digital twin data for contaminated assets.

Current contamination detection of chemical warfare nerve agents currently leverages CIDAS spray's colorimetric response. In contrast to specific hardware detectors this wet chemistry response is faster and can extend into minute trace quantities. Digitization of this data is paramount to better situational awareness, record keeping, and inclusion in a larger data fusion framework.

To effectively digitize this wet-chemistry threat response, Teledyne FLIR has developed custom deep learning computer vision algorithms. The purpose of this ongoing work is to better leverage digital twins of contaminated assets at both training time and during inference. Video sequences of simulated contaminated vehicles are captured with COTS stereo RGBD depth cameras. Successive RGBD frames are stitched together with SOTA high performance SLAM algorithms. Then expert ground truth labels from a subset of keyframes of this data are projected onto the digital twin and fused into a labelled 3D point cloud. Then in-between frames are given synthetic labels from projecting the 3D digital twin back into the camera frame. Initial results have proved promising with data volume potentially increasing 100x.
For inference, multiple queries to the ML model from different angles can be fused to increase robustness to glare, shadows, and irreducible error in the model. Bearing similarity to widely used "bagging" in machine learning literature we expect this aggregation technique to further improve contamination mapping accuracy and precision.

Both techniques have been enabled by transition from LIDAR + Photogrammetry based approaches to more robust optical stereo depth cameras and monocular photogrammetry. By shifting away from LIDAR our approach lowers cost and swap of the system thus increasing ease of use and scale of deployment.

To better disseminate fused 3D contamination maps we also present the ROS-TAK bridge, a framework for taking generic sensor information from the Robotics Operating System (ROS) and integrating it with the Tactical Assault Kit (TAK). With support for several native datatypes, operators can be presented with at-a-glance information about where various sensors are deployed and what information is available. Our goal with this software is to provide a common framework for establishing on-the-fly data fusion algorithms at the tactical edge. This common framework allows not only for dissemination but for display and management on Android based end user devices (EUD) as well as commercial off the shelf extended reality headsets like the HoloLens 2.

The suite of technologies under development will allow for faster development of machine learning model and sensor fusion models and to provide a robust framework for better dissemination and presentation of 3D data to users via both EUD and HUD modalities.

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