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

3-D Reconstruction, Visualization, And Modeling Of Buildings From Multiple Image Sources

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Extended reality (XR) has emerged as a crucial tool supporting the DTRA's mission to defend warfighters against chemical/biological (CB) threats. XR, including augmented, mixed, and virtual (VR) reality, coupled with accurate transport and dispersion (T&D) modeling of CB hazards, can provide critical situational awareness, enhanced live training, and immersive virtual training with fully realized hazard consequences. Generation of 3-D representations of buildings requires semantically labeled 3-D models of real-world buildings, along with terrain, devices, and weapons integrated from multiple data modalities acquired from a variety of sensor platforms.

To meet this need, we are developing the Semantic Understanding and Mapping of Environments (SUMOE) framework that enables stakeholders to rapidly, automatically, and accurately generate 3-D models of buildings by combining multimodal data sources and export the data in the necessary formats for XR applications and T&D modeling. SUMOE is a modular, extensible, plug-in-based framework that integrates best-in-class 3-D model generation, processing, and fusion algorithms and semantically labels the 3-D model data to provide T&D model geometry in CONTAM format. SUMOE uses an innovative iterative data fusion (IDF) approach to rapidly provide actionable models while iteratively improving the fidelity of the generated model as computation progresses. It does this by first generating models in standardized formats from minimally required datasets, and then iteratively fusing these datasets to produce the highest-fidelity model possible from all available input data. This approach enables a highly extensible, modular framework where new minimal-data pipelines can be developed and become immediately available in the general-purpose fusing process. Moreover, by combining foundational machine learning (ML) models, SUMOE semantically understands objects in the 3-D scene, enabling automatic generation of T&D simulation geometry. Finally, SUMOE exports models in open, industry-standard formats for easy integration in downstream tools such as CONTAM and building information model (BIM) applications.

This paper describes the design of our planned overall approach and the results of our initial feasibility demonstrations. Examples of these feasibility demonstrations include automated techniques for (1) 3-D building reconstruction from fused multi-model datasets, (2) inference of building interior floor plans from solely exterior images, (3) generation of photorealistic georeferenced models, (4) semantic understanding of a scene to support T&D model construction, and (5) generation of CONTAM input files for T&D model execution.

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