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Title: Lifting the Veil: Fusing RaDAR and Sound to Provide Enhanced Perception in Obscured Environments

Organization: Colorado School of Mines

Principal Investigators: Andrew Petruska

Topic: Mine Escape, Rescue, and Training

Priority Area: Rescue Strategies and Technologies

SYNOPSIS

Problem Statement: First responders face a myriad of challenges when searching for personnel in a disaster scenario. Possibly the most acute challenge is the complete lack of visibility owing to a combination of dust, smoke and pitch-black conditions. Not only does the opacity of the air limit the responder's ability to navigate efficiently, it also prevents responders from identifying a hazardous condition until in close proximity. Moreover, the complex environment compounds the difficulty of navigating and searching the area. Enhanced perception and localization technologies that enable rapid and safe disaster response, could mitigate the mine rescue team's risk and reduce response times.

Research Approach: We propose to provide these responders with situation awareness by lifting the veil of the conditions and provide them with an augmented reality display of the surrounding environment. By leveraging miniaturized mm-wave RaDAR developed for the self-driving car industry, machine- learning enabled acoustic imaging, and state-of-the-art data-fusion and simultaneous localization and mapping techniques, we will reconstruct a 3D representation of the space. This will be visualized on a light-weight wearable display, e.g. a HoloLens, allowing the responders see around their environment as if it were well-lit and smoke-free (Figure 1). We will also leverage the inherent mapping capability of the approach to provide a level-plan view of the traversed environment to the user. This map can further provide details that delineate between explored/cleared areas and the remaining passages as well as information about the locations of rescue-shelters, call boxes and escape routes.

Impact of the Research: The technology will enable faster, safer, and more effective disaster response for mine rescue operations. Not only will it allow the responders to search the environment more rapidly, but it will also enable them to detect unexpected hazards before they become imminent threats. More- over, the utility of the developed system is far-reaching, for example for first responders searching smoke-filed burning structures. One day it may also enable autonomous systems to navigate these occluded environments effectively and enable disaster response to focus on the rescue in search-and-rescue.



Figure 1: (left) Rendering of a smoke-filled adit. Situational awareness is all but lost even though significantly more than 1-3 feet of visibility is apparent. (right) Smoke filled adit with tessellated Augmented Reality overlay simulating the projects output. Significantly more situational awareness is available in spite of the poor visibility of the conditions.