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Next Generation Smart and Connected Fire Fighter System

Despite significant advances in various areas of science and technology, the profession of firefighting is inherently dangerous. Advances in technology and its application are important in making the role of fire fighters safer and more effective. Firefighting systems that are currently used do not involve any automated detection and characterization of the fire ground. The detection of objects of interest and the estimation of the condition of the firefighters or other persons in the fire ground might be slowed down and obscured due to a number of factors that include smoke, fire or other elements or anxiety level or exhaustion of the active firefighters. It is critical that the decisions pertaining to the firefighting and rescue operation are able to be made based on accurate environmental condition information. This research aimed at proposing a situational awareness system that uses the information available from the firefighter gear to extract the necessary knowledge about the fire fighter environment and transmit it to the command.

Project Goal & Approach

The objective of this project was to address enhancements to firefighting through the application of next generation cyber technology. The goal of this project was to make fundamental technical and algorithmic advances within the context of connected and smart cyber firefighting. This goal was part of an overall effort to investigate a new and smart infrastructure that allows the development of next-generation first responder coordination protocols, in conjunction with the electronic safety equipment (ESE) that is part of a fire fighter's personal protective equipment (PPE).

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Research by:

THE UNIVERSITY OF NEW MEXICO

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Summary Observations: Conceptually, the proposed system aims to augment existing systems used by first responders, with an initiative aimed at coupling hardware and software components to the firefighters' existing equipment. These proposed systems provide a predictive modeling capability that supports incident command evaluation of possible alternative actions for selection of the best approach based on experience and available resources. Overall, the communications backbone, in addition to the voice channel, have been enhanced and extended to enable increased data flow from various sensors collected locally but not yet fully integrated into the command infrastructure. The project focused on five main topic areas:

1) Fireground Personal-Area-Network (PAN)/Local-Area-Network LAN Data Communication System: A practical Personal-Area-Network (PAN) using a PPE Sensor Network, and a Local-Area-Network (LAN) involving a Fireground Local Area Data Communication System has been established. This consists of a mesh structure for communications that, based on the experimental approach, is based on Wi-Fi communications, and is extended to other communication methods. This is important because it provides a baseline structure that supports the other topic areas.
2) Fireground Sound Discrimination: Critical fireground sounds (e.g., PASS device or "Mayday") have been captured and identified with discrimination and filtering of these sound from other fireground noise. This data is then addressed by algorithms supported by machine learning to implement specific pre-assigned fireground actions.
3) Prediction of Fire Fighter Exhaustion: Speech features have been captured and identified, which were then processed through the central computer in order to determine the level of stress and exhaustion of the target fire fighter. This has been further combined with respiration estimation procedures, in order to be used for actionable measures, such as estimation of remaining quantities of available SCBA air or as a supplement to other physiological indicators.
4) Human/Object/Event Recognition with Thermal Imaging: Algorithms have been used to identify specific target entities using thermal imagining. With support from machine learning these have been transformed into knowledge-based actions for fire fighters.
5) Navigational Image Search Techniques: Algorithms that utilize imagining techniques and are supported by machine learning have been adapted to support fire fighter locator navigation, to ultimately benefit key fireground activities dependent on locator technology such as search and rescue or RIT (rapid intervention teams).