PROJECT SUMMARY

Data Informed Crowd Management

17 October 2019

Background: Crowd management has been a long-standing life safety challenge for both fire-related and non-fire emergencies in assembly occupancies. The lack of data-informed situational awareness to identify rapid changes in crowd density, movement, and other behaviors presents challenges to crowd managers. Although crowd crushes and other disasters lead to civilian deaths every year, modern technologies can enhance existing crowd management strategies. This presentation will present a proof-of-concept framework for data-informed crowd management and decision support, highlighting the collection, analysis, visualization, and reporting of crowd movement to inform near-real time crowd management strategies and evacuation modelling. A demonstration of how video image recognition and state-of-the art data science techniques for crowd counting can be used to improve life safety and crowd manager's situational awareness during highly dynamic assembly events will be presented.

Research Goal: The goal of this project is to develop a proof-of-concept tool for the collection, analysis, visualization, and reporting of crowd movement to inform near-real-time crowd management strategies and evacuation modelling, to improve overall life safety of occupant crowd movement in assembly occupancies, such as during emergency evacuation.

Project Tasks: All project tasks will be guided by a project technical panel of qualified experts in accordance with the Research Foundation Policies.

Task 1: Literature Review and Information Analysis.

a) **Code Requirements**. Summarize and provide a comparative analysis of relevant and applicable code requirements (NFPA 1, NFPA 101, NFPA 130, IFC, others) on crowd management, egress of assembly occupancies, occupant load requirements, etc.

b) **Case Study Scenarios**. Identify and summarize five case study scenarios with diverse key variables (to be identified with assistance of the Project Panel), with available video records that will support subsequent proof-of-concept demonstrations of the data-informed technologies based on code analysis of the locations. Available video records could be existing or able to be readily captured for this project.

c) **Video Image Recognition Techniques**. Summarize and provide an overview of deep learning computer vision and video image recognition techniques (using artificial intelligence, AI), including software and hardware requirements, and how it can be applied to counting crowds.

d) **Application Summary Analysis**. Using the case study scenarios (Task 2b), provide a summary analysis of how the application of video image techniques can be used to inform near-real-time crowd management strategies and fire evacuation modelling. The summary analysis should:

   i. Identify and compare the data elements and metrics that need to be captured and processed to inform crowd management in near-real-time; and

   ii. Identify and compare the variables and input parameters to inform and enhance evacuation models.

Task 2: Establish an Extensible Proof-of-Concept Implementation Plan.

a) **Implementation Plan.** Establish an implementation plan to be used to conduct the proof-of-concept effort that is the core of this project, utilizing the five case study scenarios. The framework should at least include the following considerations: Data Collection Approach; Targeted Datasets; Algorithms; Software and Hardware Requirements; and Tool Inputs/Outputs.

b) **Data Collection Approach**. Identify existing documentation or collect live streaming data (via video or still images, at quick intervals) for the five case study scenarios.

c) **Targeted Datasets**. Identify the targeted datasets to be used in the implementation plan and identify and prioritize how they will be collected (e.g., high density crowd, sparsely populated crowd).

d) **Algorithms**. Identify AI-based (deep learning) algorithms to apply in the back end to the streaming data to count crowds (with reasonable accuracy). For example, consider converting head annotations to density maps. Explain how the algorithms will be applied to live streaming data.

e) **Software and Hardware Requirements**. Identify and assess available software and hardware solutions to display the crowd analytics on a dashboard for use by appropriate personnel in near-real-time, and to support evacuation modelling. Details for these requirements should include:

    i. Identify the software and hardware required to collect desired datasets (e.g. COTS webcams, etc.); and

    ii. Identify infrastructure (local or cloud based) needed to capture and properly store the streaming data.

f) **Tool Input/Outputs**. Consolidate all aspects of the implementation plan to support a useable tool that will enable data-informed crowd management. A key output of the tool should be the comparison of the occupant density at any given time with the occupant loading requirements (i.e., from the applicable code) to clarify relevant concerns.

Task 3: Pilot Test the Proof-of-Concept Tool.

a) **Tool Launch**. Launch the implementation plan to demonstrate proof-of-concept, using the five case study scenarios.

b) **Data Collection**. Collect and provide an analysis of live streaming data using AI-based algorithms.

c) **Summary Documentation**. Report the data analytics and provide data visualization on a near-real-time dashboard with a simplified graphic-user-interface coordinating with the Project Panel.

Task 4: Evaluation of the Feasibility of Full-Scale Implementation of Tool.

a) **SWOT Analysis**. Conduct a SWOT analysis that identifies, prioritizes and summarizes the perceived strength, weakness, opportunities and threats of the wide-scale implementation of data-informed crowd management, considering factors such as: computational power demands; assessment time; value of reporting; privacy & anonymity, and other applicable factors.

b) **Summary of Evaluation**. Summarize the overall project results, including discussion on the implementation of the proof-of-concept pilot tests of the tool.

Deliverables:

- Final report documenting the findings of all tasks.
- Demonstration of a proof-of-concept tool for data-informed crowd management.

Implementation and schedule: This research project is led by the Fire Protection Research Foundation and the National Fire Protection Association. Funding for this project is through a NIST Fire Grant with a targeted project completion within one year starting from October 2019. This one-year research program will be conducted under the auspices of the Research Foundation in accordance with Foundation Policies and will be guided by a Project Technical Panel who will provide input to the project, review periodic reports of progress and research results, and review the final project report.