Abstract

Over the past years, many high-rise building fire incidents have highlighted the significance of evacuation strategies for such structures. In many of such incidents a clear failure of pre-planned evacuation strategy could be found. The failure of these strategies can be attributed to their dependence on multiple factors, including human behaviour, building dimensions and construction materials, and most importantly, the fire dynamics. Pre-planning an evacuation strategy that considers these complex factors poses a considerable challenge. It is equally challenging for the firefighters responding such fires. In the interviews conducted with the fire incident controllers, Klein reported the unavailability of any standard procedure to fight a high-rise building fire, because of that critical decisions are made relying on the previous experiences and the limited visual information from the building’s exterior. Gauging the extent of fire from outside the building is firstly inappropriate and increases the chance of human error.

One of the most effective way to evacuate a high-rise building is utilizing the phased evacuation strategy. A case study is performed to compare two commonly used evacuation strategies (simultaneous & phased evacuation) using the Pathfinder program. The results clearly depict that using phased evacuation algorithm proposed by Gravit prioritize those who were immediate risk of fire. This significantly reduces the evacuation time for those occupants & the overall density in the evacuation pathways also remains less. This will ensure their safety and an overall streamline evacuation without any congestion. However, the main problem lies in the implementation of strategy and static nature of the algorithm.

The advancement in the technology and development of AI and machine learning has resulted in installation of sensors in the modern-day buildings. Till now, the sensors data is used majorly for comfort, energy management and security applications as pointed out by Hamins. The same data could be utilized for the fire safety applications & specifically for strategizing an evacuation in this case. A framework for a smart phased evacuation system is therefore provided in this thesis.

The proposed smart phased evacuation system will take its input from the sensors to detect a fire and to analyse the number of occupants present in real time. The system will run the algorithm using these inputs and will formulate an evacuation strategy. The implementation of the strategy would be done by using an evacuation fire alarm for the floors which need to evacuate immediately, and voice alarms will be used to instruct the remaining floor occupants. With that, the system will continue the monitoring of the building and will update the strategy in case the fire spread is detected in a manner different from what is described in the proposed algorithm. In this way the system will provide a real-time and dynamic evacuation strategy.

For the future scope, the major task would be developing a system based on the proposed framework and its implementation in a real building. When implemented, the system would be another big step towards the overall smart firefighting framework proposed by Hamins.