

# Abstract

This thesis addresses the topic of dynamic evacuation route guidance in the intelligent building. Current building evacuation systems are static and are based on emergency exit signs and escape route plans which are unable to respond to dynamic events. If the danger is in the static escape route, the signs lead to the fire. Consequently, this work includes the development of a novel framework for dynamic building evacuation and guidance in emergency situations. The framework consists of three main components: the simulation environment, the evacuation strategies, and the guidance user interfaces.

The simulation environment provides the ability to create and configure building models. These include the placement of hazards, the distribution of agents, compliance with legal requirements regarding the capacity of escape routes capacity. Based on this simulation environment, four evacuation strategies were established. The static evacuation algorithm (SEA) was developed with the objective of imitating the functioning of static systems, thereby providing a basis for the evaluation of new dynamic evacuation algorithms. The development of the dynamic escape route algorithm (DEA) involves identifying temporary events and rerouting designated escape routes within the building. The comparative analysis between SEA and DEA showed that DEA improved evacuation performance. An algorithm for fire dynamics (FDA) has been developed that considers the dynamic spread of fire in route planning. The comparative study showed that the FDA escape routes are safer than those of SEA and DEA. Furthermore, an approach based on deep reinforcement learning (DRL) was developed and evaluated as an alternative to classical routing algorithms. Experimental evaluations confirmed that using DRL within the framework is a possible method to calculate escape route strategies. Two Guidance Interfaces (GIs) complete the framework, a mobile application and a mixed reality guidance application. The GIs facilitate the examination of the algorithms in a real-world setting. The mobile user interface is more conducive to emergency evacuation procedures, while the mixed reality approach is better suited for training in the presence of virtual hazards, such as smoke or fire, in a realistic setting.

The combination of partial results has provided a framework that enables the comprehensive process of simulating, controlling, guiding, and evaluating dynamic evacuation of intelligent buildings. This thesis presents a new framework for improving escape route systems that increases safety and efficiency in emergency situations through dynamic strategies and modern guidance approaches.