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APPLICATION OF AGENT-BASED SIMULATION IN EMERGENCY EVACUATION AND CASUALTY PREDICTION OF INDOOR SCENARIOS

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Simulation of crowd emergency evacuation is a complex part in which the objectives are improving the safety of the crowd by assessing geometrical structure of the escape area to decrease evacuation time and optimize architectural design and rescue operations. Usually, in public infrastructures, casualties can increase by inappropriate design of the architectural elements and intensify when hazardous high density crowd movements arise. In these cases, evacuation encounters a problem which can lead to injury or death of people. It is obvious that evacuation behaviors of the occupants will affect the casualty number in earthquakes. Furthermore, the structural failure patterns during an earthquake can influence occupants casualties. Besides, investigating how people behave in the event of a disaster (like earthquake) can lead to a more accurate prediction of the occupants casualty of the building.

Microscopic modeling approaches are recognized as a valuable basis to study occupant dynamics under emergency conditions. In this paper, evacuation models that mostly used or presented in last years such as cellular automata, social force, and agent-based models are presented. Besides, the studies related to the agent-based modeling that mostly used in indoor scenarios are reviewed. Then, Netlogo software presented as a tool for agent-based modeling and used for the simulation of a case study. Results have been analyzed by the Netlogo software under different failure scenarios of the building caused by an earthquake excitation. The case study is a classroom of a one-story high school building in China that studied by Li et al. (2018). Simulating the behavior of occupants need adequate information that can be obtained from a real-life video recording.

For verification of the model, the data of the video recording such as speed and path finding patterns are applied. The evacuation process is shown in Figure 1 at different time intervals. Dark circles present students evacuate from the classroom and red circle is a random selected student for showing each position during time instants.

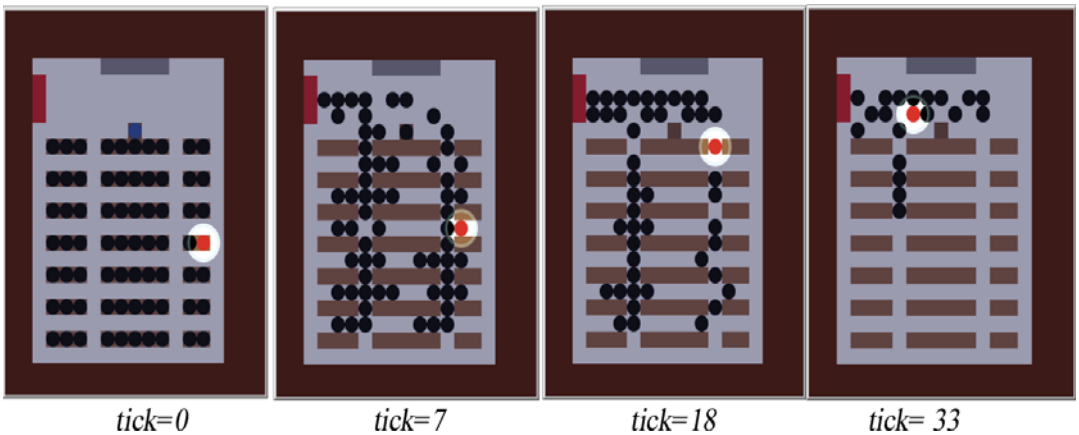

Figure 1. Four time instants in the evacuation process of Netlogo model.

Total evacuation time for the case study in Netlogo model is 43.0 s that is 7.0 s more than the real-life recorded evacuation process. Figure 2 shows the comparison between recorded and simulation results of the previous work (Li et al., 2018) and Netlogo model for the evacuation time vs. evacuated number of occupants, which illustrates that the simulation has an acceptable accuracy.

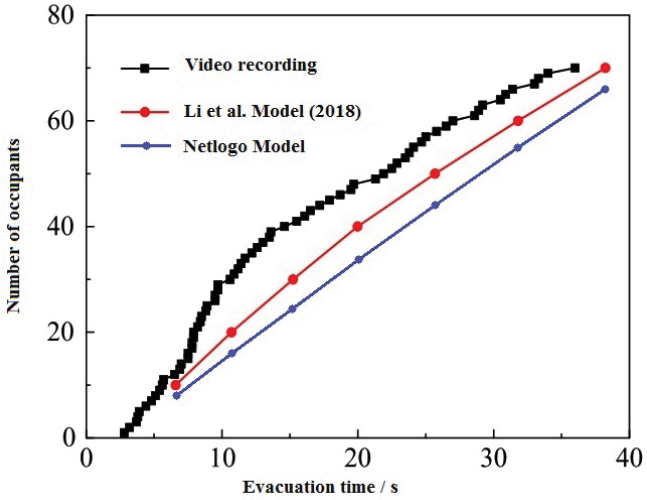

Figure 2. Evacuation time vs. evacuated number of occupants in previous and present study.

After modeling of the evacuation process, different failure scenarios were used to perform casualty estimation of the classroom. In this study, only casualties caused by structural components are considered. Failure scenarios are defined by the output of the finite element simulation. The Opensees software used to model the building under the earthquake excitation. Synchronization procedure of evacuation simulation and finite element simulation was used to determine the casualties in each time and space in the building.

The objective of this study is to provide a method for casualty prediction considering occupant evacuation in the building. The proposed method can give more accurate results in comparison with the existing statistical casualty prediction methods and the fragility curve method for some types of buildings. Moreover, combining simulation of human behavior and structural response can show the locations where casualties occurred, which is helpful for optimal designing of structures. Hence, the architectural and structural requirements of the building are re-examined and then, the escape area of the building occupants during emergency evacuation will be safer and less time-consuming. It can reduce casualty number and effect on economic loss estimation of the building.

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