Space Design Simulation for a Crowd Accident: case study of the 2014 Shanghai Bund Accident

雑踏事故とスペースデザインに関するシミュレーション
ー2014 年上海外灘を事例としてー

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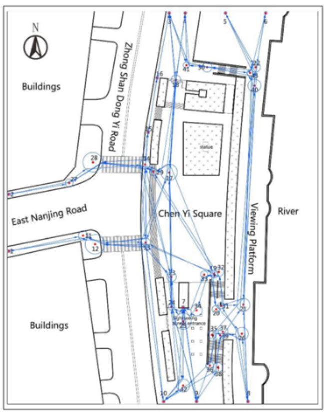
1. Introduction

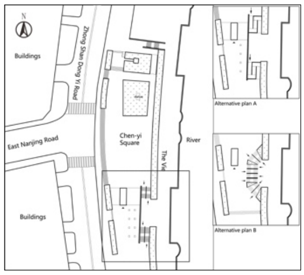
Along with the growing city density and large gathering happening all over the world every year, crowd management has become a new science. Contrast with the rapid development of multiple computational technologies is the fact that most city planners and managers still base their work on traditional empiricist methods. In this paper, we try to use agent-based simulation model as a tool to diagnose crowd safety in different space designs. First, we analyzed the original space design in Shanghai Bund accident in 2014 for fact-finding. Then we tested the performances of two alternative space designs and compared the results with the original plan.

2. Methodology of model development



We developed an agent-based pedestrian movement simulation model following ASPF (Agent Simulator of Pedestrian Flows) rules developed by Kaneda and others. ASPFver4.0 has a total 36 behavior rules，including: 6 basic behavior rules, 8 slow-down rules, 4 avoidance rules, 3 high density flow rules, 1 pattern cognition rule and 14 wall avoidance rules. In the route choice, agents move to the destination exits following shortest path rule. When the destination is not directly visible, a waypoint was set as a temporary destination. Each waypoint was surrounded by a choice-making circle whose radius was decided by real observation. When agent moves into the sphere of the circle, it updates its destination.

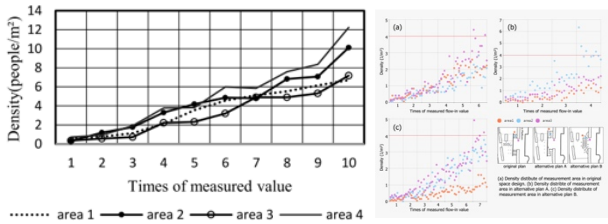
3. Simulation setting



A survey was conducted on a September afternoon to count the flow-in-value of each entry. We conducted experiment as below:

- Experiment 1: In original space design, we timed up the measured flow-in-value from 1 to 10 times to observe the feature of density changes.
- Experiment 2: In original space design, 10 times flow-in-value (closest to the actual accident), we imitated the density distribution in only the upwards flow case, only the downwards flow case and counter flow case.
- Experiment 3: In original space design and two alternative space designs, we timed up flow-in-value to observe how many times the surveyed flow-in-value will make the areas around the stairs reach the risk density (4people/m^2). Measurement areas were set at the bottom, above and on each space design's stairs.

4. Simulation analysis and results



From the results, we: (1) Roughly analyzed the causes of a crowd accident. (2) Concluded the features of density change to facilitate crowd management. (3) Tested the performance of alternative space designs.

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