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RFES: a real-time fire evacuation system for Mobile Web3D

Key words: Fire evacuation drill; Building information modeling (BIM) building space; Mobile Web3D; Real-time fire evacuation system based on ant colony optimization (RFES-ACO) algorithm

Corresponding author: Jin-yuan JIA
E-mail: yanfengting2008@163.com

 ORCID: <https://orcid.org/0000-0002-0163-3016>

Motivation

There are many bottlenecks that limit the computing power of Mobile Web3D and they need to be solved before implementing a public fire evacuation system on this platform. In this study, we focus on three key problems:

- The scene data for large-scale building information modeling (BIM) is huge, so it is difficult to transmit the data via the Internet and visualize it on the Web;
- The raw fire dynamic simulator (FDS) smoke diffusion data is also very large and extremely difficult to transmit via the Internet and visualize on the Web;
- A smart artificial intelligence fire evacuation app for the public should be accurate and real time.

Main idea

To address these problems, the following solutions are proposed:

- The large-scale scene model is made lightweight;
- The amount of dynamic smoke is also made lightweight;
- The dynamic obstacle maps established from the scene model and smoke data are used for optimal path planning using a heuristic method.

Method

We propose a real-time fire evacuation system based on the ant colony optimization (RFES-ACO) algorithm with reused dynamic pheromones. The simulation results show that the public could use Mobile Web3D devices to interact and experience fire evacuation drills in real time and smoothly by progressive transmission technology on the network, and progressive loading and rendering technologies based on the frustum movement of Mobile Web3D terminals. The real-time fire evacuation system (RFES) is efficient and the evacuation rate is better than those of the other two algorithms, i.e., the leader-follower fire evacuation algorithm and the random fire evacuation algorithm.

Major results

- Results of reducing the size of the scene model based on our lightweight method

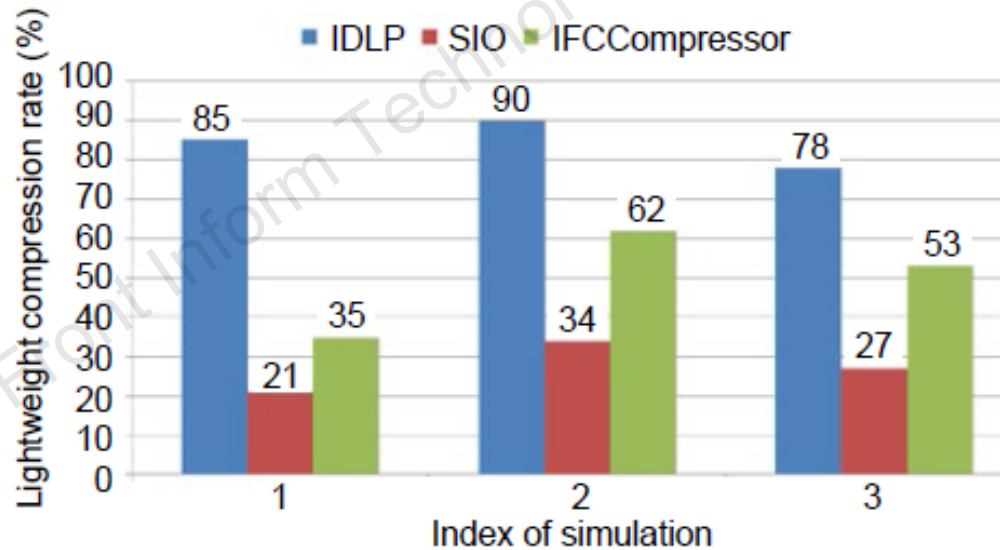


Fig. 13 Results of reducing the size of the scene model

Major results

- The RFES-ACO algorithm can be used for optimal path planning.

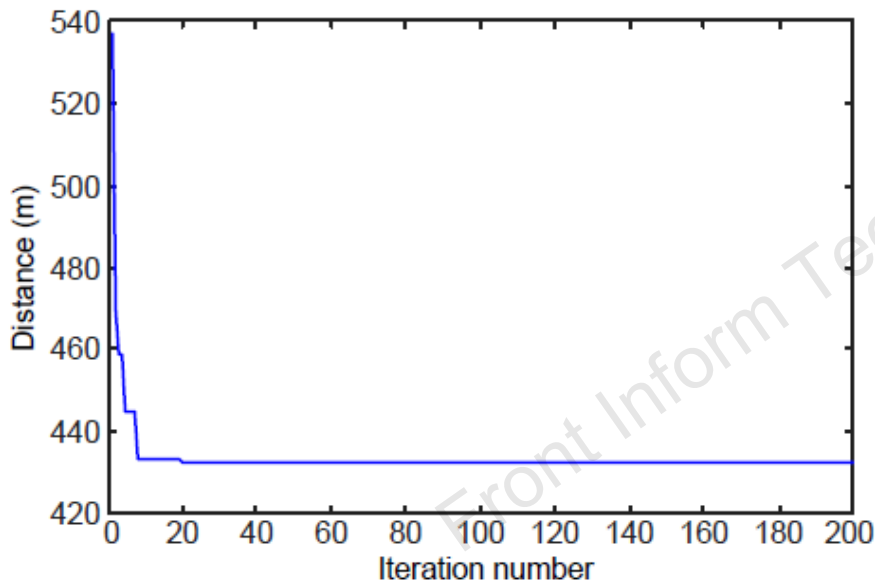


Fig. 15 Best solution for the RFES-ACO algorithm

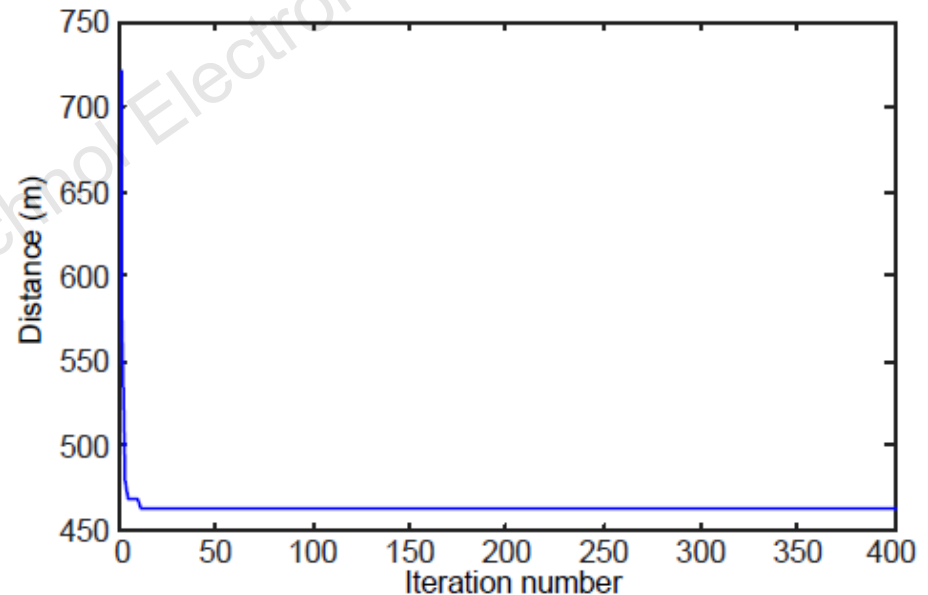


Fig. 16 Worst solution for the RFES-ACO algorithm

Major results

The RFES-ACO algorithm can be used for optimal path planning.

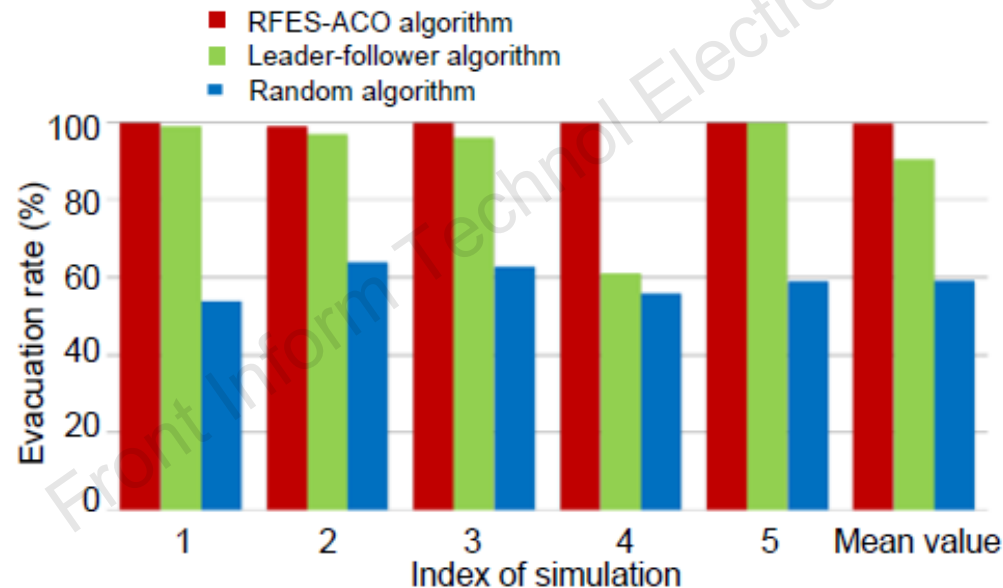


Fig. 25 Evacuation success rates of the three algorithms

Conclusions

We proposed a series of lightweight solutions: (1) The large-scale scene model has been made lightweight; (2) The amount of dynamic smoke has been made lightweight; (3) RFES-ACO is created which is effective with fast convergence.

Mobile Web3D devices can be used to experience fire evacuation drills in real time and smoothly by progressive transmission technology on the network, and progressive loading and rendering technologies based on frustum movement of Mobile Web3D terminals.

RFES is efficient and the evacuation rate is better than those of the leader-follower fire evacuation algorithm and random fire evacuation algorithm.