

# Agent-based crowd simulation for building plan

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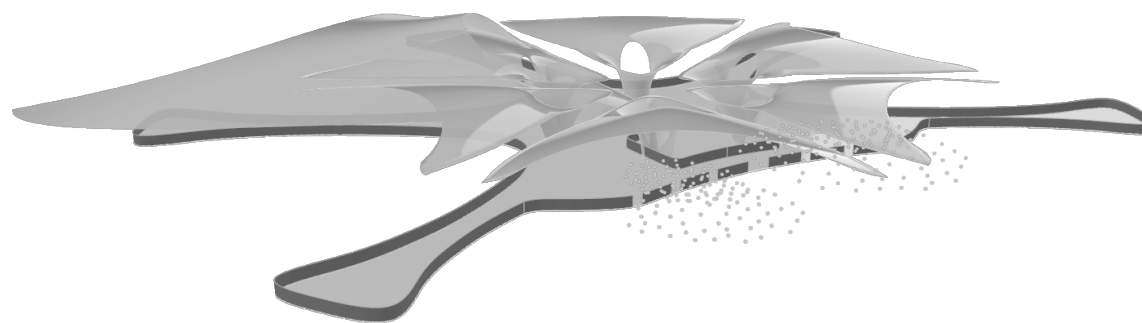


Fig. 1. Crowd dynamics in Daxing Airport

Circulation simulation is critical for both architecture design and urban planning, which has a great impact on the efficiency of the common daily life as well as emergencies such as fire incidents and terrorism. We propose an agent-based circulation simulation with personalized characters to visualize, evaluate, analyse and optimize the building plan. We use ray tracing to detect the furthest direction one agent can reach, and use Russian Roulette for probability of turning into a specific direction. We introduce swarm algorithm to the crowd, but for each agent we introduce randomness by parameterizing different behaviours. Then for each building plan, we provide goals, for the crowd to reach a specified destination, and use the converge time as evaluation of the effectiveness of the building plan. Our hypothesis is that the building plans with curvature walls will have a better performance regarding the circulation efficiency.

Additional Key Words and Phrases: Crowd simulation, Crowd dynamics, Agent based modelling, Collision Avoidance, Rock dynamics

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## 1 INTRODUCTION

It is crucial when architects make the design decisions for choosing the best circulation plan, especially for large activities. Failure in circulation design can cause problems ranging from making it confusing to find ways and locating to Stampede, and can be critical when unexpected indecens happens [4]. This study provides a evaluation tool for

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circulation in complex building settings by stimulating behaviors of crowds. We use particle simulation with swarm algorithm to generate the crowd simulation, we also incorporate randomness by setting different behavior within the group, including the preference of turning at a crossroad, the distance to the majority of people, etc., to perform circulation simulation within a building, and use the simulation to evaluate the design of the building plan. We aim to simulate how people behave in crowds with different environments, and more to accurately model and simulate crowd behavior and inform design and planning decision.

## 2 RELATED WORK

Many studies investigated how to accurately model the crowd behaviour with real time simulations [2][3][5][6]. Including Flow-based Approach, Entity-based Approach, and Agent-based Approach.

Recently, Li et al. [1] (2022) investigated the influence of geometric layout of exit on escape mechanism of crowd.

## 3 METHODOLOGY

We implemented basic collision detection for each of the people in the simulation by ray casting to check for objects in the persons trajectory. We cast rays out in a fan centered on the persons current velocity. The rays were given some maximum distance, and if they collided with any object before that distance, then agent would know there is an obstacle in its path.

### 3.1 Crowd dynamics

The crowd are spawned at a specific segment (a stand in for doors at peak traffic) and begin moving in 2D space according to a preset rules: Movement is based on current position with a random movement factor included; Individual agent aims to maintain course for a noticeable subset of timesteps to complete a goal; Individual agent has a innate repulsion factor to avoid collision but it is affected by randomness(the crowd tend to stay apart but not at the same distances), but also finds a fast path to their destination

### 3.2 Entity-based Simulation

## 4 SIMULATION

## 5 DISCUSSION

### 5.1 Circulation evaluation

### 5.2 Limitations and future work

Our current implementation is in 2D space, which does not represent the majority of the real case. In the future, we will implement simulation in 3D.

## 6 CONCLUSION

## ACKNOWLEDGMENTS

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