Agent-based crowd simulation for building plan

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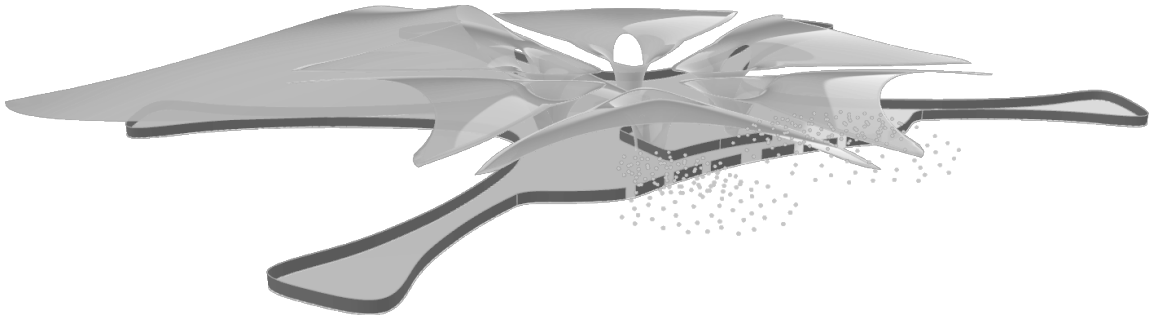

Fig. 1. Crowd dynamics in Daxing Airport

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 indecents 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 crow 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 investiaged 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 Entity-based Simulation: 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 time steps 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.

4 SIMULATION

The current simulation is still in its infancy and is only comprised of the the core components. The simulation can leverage basic logic to do high level representation of crowed activity.

5 DISCUSSION

Any feedback on the current progress is welcome.

5.1 Circulation evaluation

5.2 Limitations and future work

In the future, we will implement simulation in 3D. We are still working on smoothing out the rough-edges and integrating the core parts into a simulation together into a full efficient pipeline that adequately models crowed activity. Future work includes but is not limited to improving models, smoothing out animation, adding more complex logic, and possibly adding other features like 3d movement.

6 CONCLUSION

Currently we have the core concepts, tools, and components needed to build out a functional representation of crowed activity through the use of key graphics concepts and other important topics. The current implementation is a solid foundation for us to build off and we are actively moving towards improving almost every aspect of the simulation. Any feedback is welcome as this is a work in progress.

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