**Crowd Simulation Background** (Why do crowd simulation):

The increasing urbanization of the world population presents new challenges for decision makers. Real-time crowd simulation is crucial in addressing these challenges, including determining evacuation times in complex buildings, avoiding overcrowded areas during mass events, and improving the crowd flow in cities. We are developing a simulation framework with unique features that aim at realism, speed and accuracy. Our software is available for research and commercial use.

(Reference: <https://www.uu.nl/en/research/algorithms/computational-geometry/research-themes/crowd-simulation>)

Crowd and multi-agent simulation is the process of simulating large numbers of people, creatures, or other characters, each interacting in one environment. These actors are expected to move to their goals, interact with their environment, and respond to each other. Crowd simulations have many uses, including improving architectural planning, enhancing training environments and virtual realties, and driving artificially intelligent (AI) characters in games and movies. Our group has worked on many problems in crowd simulation, including fast, guaranteed, collision avoidance, real-time path and motion planning, crowd flows, and directed behaviors. See also our related work in ([motion and path planning](http://gamma.cs.unc.edu/research/robotics/)) for single and multiple robots or agents.

(Reference: <http://gamma.cs.unc.edu/research/crowds/>)

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**Existing approaches (others’ works)**:

[May or may not have features in common]

Walk Along steering for navigating a couple of agents to reach a certain place together. The results of a believability study with 26 human subjects who compared the new steering to the known Leader Following steering in eight different scenarios suggest the superiority of the Walk Along steering in social situations. (from Abstract Malostranské nám)

< ***When a Couple Goes Together: Walk along Steering*** >

The algorithm is composed of three phases:

1) perception of agents and obstacles through the peripheral vision of the agent setting up a list of neighbors and time contacts;

2) building ranges of available speeds and orientations;

3) discretization of ranges, finding the best combination considering a heuristic function about energy consumption, deviation angle and risk of collision.

< ***Prediction in Social Path Following*** >

Problem Descriptions:

The main objective of this work is to introduce online learning techniques in multi-agent navigation so that the agents can exhibit a more intelligent collision avoidance behavior. In a typical multi-agent navigation problem, we are given a virtual environment containing static obstacles and n heterogeneous agents Ai (1 ≤ i ≤ n) with specified start and goal positions. The task is then to steer each of these agents to its goal without colliding with the other agents and the obstacles present in the environment. We also require that the agents navigate independently without explicitly communicating with each other.

< ***Online Learning of Mutil-Agent Local Navigation*** >

What this paper do:

This paper presents a novel technique to design the agents to with following modules 1) Path planning behavior for collision avoidance 2) Situation awareness during herding behavior and turbulent flow in high density crowds. 3) Personal Reaction bubble (PRB) based response and perceptions. The evaluation with real life situations is performed to validate the RBAS model.

< ***Realistic Modeling of Agents in Crowd Simulations*** >

**Question**:

What unique feature(s) our project have?

How I verify my result?

Speed up 🡪 acceleration

**PAPER**

**Abstract**

Current crowd simulation research could achieve path planning for collision avoidance, researchers are more focus on develop walking behavior of single or pair agents. Unfortunately, their crowd simulation approach is lack of realism and flexibility because it does not involve complex behavior such as allowing agents to move in and out of different lines based on agent’s desire. In order to create realistic and trustworthy crowd simulation result, we proposed new, sophisticated crowd simulation algorithm that allow agents to achieve complex features. In the simulation, agents not only queue up to form waiting lines in the scene to pass through gates, but also switch between lines if agents think there has a shorter line to queue up. These crowd features are collected from various observations of real-life crowd videos recorded among different events.

**Introduction**

[**Previous work**] The increasing proportion of people living in urban areas brings new challenges to urban planning and architecture. Bringing a large amount of people to perform the crowd experiment is unmanageable and dangerous. Thus, crowd simulation plays an important role in addressing these challenges. With the help of crowd simulation techniques, urban designers and architects could determine the evacuation time of a massive crowd, detect the behavior of crowd flow inside of a building or prevent overcrowding during certain events.

[**Our contribution**] A large crowd of people is a complicated system. Technique such as agent based modeling which model the situation comprised of individual agent into simulations and making decision based on the situation agent dealing with could successfully allow agents behave as pedestrians in the simulation.For example, agent based simulated approach [Baig, Mirza Waqar] designs agent as ellipses that have a sense of the environment and plan their own path ahead of time to avoid agent collisions. Unfortunately, the output of simulation lacks realism and flexibility. Since it does not involve complex behaviors such as allowing agents to move in and out of different group or queues based on agent’s desire, agents who have planned a path ahead of time might end up in the longest waiting line without. However, in reality, people do not just stay in their waiting line once they choose it, they might need to change waiting lines if there is a better option.

[Realistic Modeling of Agents in Crowd Simulation: …*Path planning for collision avoidance…* do I need to mention about the lower level approach?]

**Related Work**

**Approach**

Before we dive into our approach, we need to finish our simulation setup: various agents in the scene could achieve features such as interaction, navigation, perception and optimization; agents walk in the virtual two-dimensional plane which is represented as the environment; time is counting, for each time a new velocity vector is calculated, each agent’s next position is updated for each frame. Our approach is based upon the work of an Open Source Application [##*open source app link*##]; summarizing the Open source application’s algorithm, which consists of the following main steps in which are agents could avoid static obstacle collision, retrieves other agents’ collisions and navigate to the desired destination. We expand these three stages by increasing social behavior and complex queue up behavior patterns.

**Reference**:

[Baig, Mirza Waqar] Baig, Mirza Waqar, et al. "Realistic modeling of agents in crowd simulations." 2014 5th International Conference on Intelligent Systems, Modelling and Simulation. IEEE, 2014.