Evacuation Plan Simulation Project for FFR120

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————ABSTRACT————

BACKGROUND

Yerkes-Dodson Law (YDL) (optimal stress level)
faster is slower effect

The safety and efficiency of building evacuations are critical aspects of emergency preparedness, and understanding how stress influences evacuation times is crucial for optimizing evacuation strategies. The sound of a fire alarm produces a sense of urgency within individuals inside an evacuating building. The urgency creates an increase of stress that could potentially cause irrational decision making and congestion at bottleneck sites such as doorways and hallways [1].

In this research project, we aim to comprehensively analyze the evacuation dynamics of a building during emergency scenarios, specifically focusing on the interplay between evacuation time, individual stress levels, and the total number of occupants. We propose to conduct simulations that aim to replicate real-world evacuation scenarios, taking into account varying stress levels experienced by individuals during emergency situations. By utilizing simulations in python we intend to quantify the impact poor decision-making and movement patterns during evacuation. Additionally, we will investigate the correlation between evacuation time and the total number of individuals present in the building. The outcomes of this research will not only contribute to the improvement of building safety protocols but also provide valuable insights for designing interventions that can mitigate stress and enhance the overall effectiveness of emergency evacuations.

Questions

- How does stress and the number of individuals affect evacuation time?
- How can a simulation model be used to predict evacuation time for different stress levels and number of individuals?
- What factors should be included in the simulation model to accurately represent real-world scenarios?

METHOD

Simulation model

Simulated individuals will move towards the closest exit in order to try to escape. Individuals will also be influenced by the crowd as well as their stress levels. The Vicsek model will be used to simulate crowd behavior [2]. In this model, the individuals' orientation of movement is influenced by other individuals close to them. This is implemented as a flocking radius where the movement direction is the average of the directions of individuals in the sphere. Add element of noise to model stressed individuals who act irrationally. In order to simulate bottlenecks and congestion occurring only a cap will be put on the maximum number of individuals who can pass through an exit per second.

Simulation architecture

The simulation is implemented in Python and uses the Vicsek model to simulate crowd behavior. The Vicsek model is a type of self-propelled particle model where the direction of movement of individuals is influenced by other individuals close to them. This is implemented as a visibility sphere where the direction of movement is the average of the directions of the individuals within the sphere.

The simulation begins by initializing the state of the individuals. Each individual is represented by three values: an angle θ, and two coordinates (x, y). The initial angle is randomly assigned between 04 and 2, and the initial coordinates are randomly assigned within a square domain of size D.

The simulation then proceeds in discrete time steps. At each time step, the state of each individual is updated according to a rule that takes into account the current state, the location of the exit, whether an alarm is on, and several other parameters. If the alarm is on, the individual's direction of movement is influenced by the direction towards the exit. The individual's angle is updated with a combination of its current direction and the direction towards the exit, with some added noise to model the effect of stress. The individual's position is then updated based on this new angle and a fixed speed.

The simulation also includes a graphical representation of the evacuation process. The individuals are represented as points in a plot, and their positions are up-

dated at each time step. The plot also includes a counter for the number of individuals that have reached the exit, and a visual indication of whether the alarm is on

The simulation runs for a fixed number of time steps, and the state of the individuals at each time step is stored in a trajectory array. This array can then be used to analyze the evacuation process.

RESULTS

DISCUSSION

REFERENCES

[1] Walden University. (n.d.). *How Stress Impacts Decision Making.* https://www.waldenu.edu/online-masters-programs/ms-in-clinical-mental-health-counseling/resource/how-stress-impacts-decision-making

[2] Argun A, Agnese Callegari and Giovanni Volpe

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