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Agent-Based Prediction Model from a Burning Building

Emergency Evacuation Prediction Model From A Burning Building

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***Abstract* - If the evacuation preparations are not tested and evaluated, a crowd evacuation during an emergency may result in fatalities. In recent years, the age of emergency evacuation plans has evolved as a solid, economical option that may be more precise. The most effective type of simulation for evacuation scenarios is an agent-based simulation (ABS), which can simulate both societal and individual behavior. The agent-based approach incorporates agents moving on floors, choosing an exit and staircase, and simulating people's natural movement in stairs in the event of an emergency evacuation. Iterative simulations are used to research and test the factors that influence a person's personality. To show the impact of different agent parameters, simulations are also run. Interesting findings included the notion that "faster means slower" and the lack of awareness of alternative exits.**

Keywords – Agent-based modeling, simulation, evacuation.

I. INTRODUCTION

Emergency evacuation is the hasty removal of individuals from a hazardous area as a result of the impending or actual occurrence of a catastrophic event. Examples include the evacuation of a structure due to fire or a district due to flooding. Natural catastrophes may need evacuations before, during, or after. Whether brought on by a natural disaster or a terrorist assault, emergency evacuation ion can be the difference between life and death. Many people will die during an emergency evacuation as they are frequently crushed or trampled to death by other people. The ability to evacuate hundreds of thousands of people in a very short amount of time can save lives. Planning for incidents that could endanger life is crucial and includes emergency management. Creating an emergency evacuation plan is the first stage in disaster management, which includes identifying potential emergency scenarios. Planning for incidents that could endanger life is crucial and includes emergency management. Creating an emergency evacuation plan is the first stage in disaster management, which includes identifying potential emergency scenarios. To conquer these challenges, several types of crowd simulation systems have been developed, such as flow dynamics- based simulations; cellular automata-based simulations and agent-based simulations. The results of the simulation can be used to draw conclusions about the practical means of reducing the negative effects and the existence of an ideal escape plan. It is a common belief that those who experience panic are driven by impermanent personal interests or psychological drives that are unrestrained by societal or cultural norms. As a result, many choices, such as side exits, are mostly disregarded. These bizarre phenomena can be the outcome of intense terror. Additionally, a single person's panic will spread to those around him, causing a mass panic that frequently has negative effects such as dangerous crowding and slower escape. The precise design of an evacuation model must take these psychological considerations into account. Two unique issues, the evacuation of buildings and the evacuation of vast areas, such as entire cities or coastal plains, have received the majority of study attention.

Our proposed model is based on four parameters that allow for practical evaluation: fire, smoke (carbon monoxide content), bottleneck and agent behaviors.

II. BUILDING ARCHITECTURE

A. Floor plan

A floor plan is modelled as a 2D modeled cell is surrounded by four additional cells (top, bottom, left, right). There are characteristics for each cell, including normal (N), wall (W), bottleneck (B), fire (F), safe zone (S), and people (P). The objective is for as many individuals to reach the safe areas, where danger cannot reach them. We employ a 2D network with nodes and edges connecting them to address this problem (neighbors). Moving between adjacent nodes is possible.

B. Entry and exit points

One aspect in this study that affects the agents' choice of exit and staircase is familiarity level. Each agent was given one of the following three values:(i) P = 1 denotes that the agent is aware of only one exit, namely the entrance/exit it used to enter the building, as well as one stairway, if it did so;(ii) P = 2 denotes that the agent is aware of both the number of the agent's known exits and staircases as well as the number of exits and staircases in this particular building;(iii) P = 3 denotes that the agent is aware of every staircase and exit. Agents can be given access to a variety of well-known staircases and exits thanks to these definitions of familiarity level.

III. AGENT

A. Agents characteristics

The physical characteristic (e.g., stamina, disability), the mental state (e.g., stressed, tired), the knowledge and experience, the personality traits (e.g., risk-taking), and the motivation (e.g., control, relationship) are all factors that are considered relevant to the evacuation when taking into account sociological and psychological factors at the individual level. In the study characteristics, crowd dynamics, and group behavior are significant phenomena. The psychological components of an individual inside a group are related to group behavior This covers leadership, pro-active behavior kinship ties, and other associations.

B. Types of agents

The types may include humans, animals, birds, etc with their respective characteristics such as age, intuition, energy level, and so on.

C. Agent movements

The "stride" notion, which was first put forth in the Optimal Steps Paradigm, serves as the foundation for agent movement in this model. The depth of a stair step limits the length of a stride on staircases. Most of the time, people only use one stair step at a time and never use the same stair step twice. Furthermore, it has been noticed that when there were other pedestrians around, people didn't stray far from the path. As a result, before moving its maximum stride—which may be two stair steps—downstairs or upstairs in the model described in this work, an agent must first determine if the space in front of it is completely or partially occupied by other agents.

IV. BEHAVIOR

The intricacy of modelling people is a crucial component. Human traits and behaviour have a significant impact on the evacuation process, making them a crucial component of more accurate simulations. Real-world pedestrians have varied physiological needs and psychological needs. Therefore, modelling evacuation crowds as heterogeneous individuals rather than homogeneous ones has advantages. Numerous research modelled heterogeneous agents by giving each set of agents varied characteristics as age, gender, knowledge, stamina, average speed, and psychology. These traits have an impact on the decision-making and mobility of the agent during an evacuation.

The integration of a wide range of variables is necessary for modelling human behaviour during evacuation.
However, in evacuation scenarios, this isn't always obvious.
The complexity of modelling agents makes it challenging to scale them to bigger populations. With modern computers performing better, this problem might be solved. The challenge of choosing the appropriate variables to replicate human behaviour in emergency situations occurs in addition to computational and empirical limitations. Numerous physical, cognitive, motivational, and social elements are considered to be human factors.

The simulation could be divided into multiple models, including movement models, partial behaviour models, and behavioural models. Behavioural models include both the movement toward an exit and the actions taken by pedestrians.
These models also take into account how people make decisions. Without taking into account human behaviour, movement models guide pedestrians from one spot inside the building to an exit or a safe area. These models are helpful for identifying regions of building congestion, line-ups, or bottlenecks. In addition to implicitly depicted behaviours like pre-evacuation time distributions among persons, distinctive individual traits, and smoke impacts on individuals, partial behaviour models also include occupant movement. The physical characteristic (i.e., stamina, disability), the mental state (i.e., stressed, tired), the knowledge and experience, the personality traits (i.e., risk taking), and the motivation (i.e., control, relationship) are all factors that are considered relevant to the evacuation when taking into account sociological and psychological factors at the individual's level. Additionally, population dynamics and group behaviour are significant phenomena in the study of evacuations. The psychological components of an individual inside a group are related to group behaviour. This covers leadership, pro-active behaviour, kinship ties, and other associations.
Crowd dynamics, on the other hand, describes how people move and interact in crowds, including their speed, density, navigation, avoidance of barriers and collisions, as well as their physical and social contact and imitation.

A. Individual Behavior

Many personal traits have an impact on how well a person performs during an evacuation in terms of decision-making and movement. Gender, age, speed, reaction time, familiarity and knowledge level, leadership qualities, and level of panic are a few examples of these features. Age and gender are crucial considerations when it comes to evacuees' migration. Adults typically move more quickly than young children and the elderly. Consider, for instance, classifying the individuals into various categories with various speed ranges (adults, females, males, children, elderly). On the other side, when we use two categories: children and seniors, which includes people with lesser mobility, and adults, which includes both females and males from 15 to 65 years old. Additionally, it is thought to be crucial to accurately depict the physical traits and impairments of evacuees because these things affect their pace and speed. They have an effect on decision-making as well. A youthful, healthy agent, for instance, might consider the physical demands of a particular action to be light compared to an aged agent. Individuals' stamina varies depending on their age and gender.

Aside from that, after an emergency, people's capacities for endurance may vary, and injuries may result. Due to their slower speed or greater space requirements, people with disabilities, such as those who have trouble moving around or who have hearing or visual issues, may not only need assistance during an evacuation but also obstruct the evacuation of other pedestrians. Shoulder breadth, clothing, and luggage are additional physical characteristics of the human body that are closely related to calculations of escape routes in structures. Additionally, the presence of toxic fumes brought on by fires can result in symptoms ranging from mild headaches, which slow down the evacuee's movement, to incapacitation, which prevents the evacuee from moving independently.

Some affiliated theories make the assumption that evacuees always take the shortest path. The affiliative argument contends that regardless of the existence of shortest routes, most evacuees opt to leave the same way they came in since it is known to them. Additionally, the affiliation theory postulates that people with good psychological ties will attempt to flee in groups of two or more. The panic model, on the other hand, presupposes that people are concerned with self-preservation and compete with one another to flee through constrained exits. According to studies, rather than the real disaster, panic and impulsive behaviour are the main reasons for casualties during emergency evacuation.

Other factors include waiting or response times since people frequently hold off before acting on an evacuation alarm. The behaviour sequence model states that after a signal of danger is received, people go through three stages: interpret, prepare, and act. Many actions are done by people before or in place of responding to alarms. There are a variety of factors that can contribute to this hesitation, including the need for information, commitment to other tasks, and uncertainty about the alarm's veracity.

Many of the publications analysed make the erroneous assumption that all pedestrians are equally knowledgeable about their surroundings, including where exits are. However, due to information asymmetry, which occurs when some people have access to more knowledge than others, this is not always the case in real-world situations. Information asymmetry has a direct impact on the evacuation process since people who don't know the area tend to follow the throng while those who do will pick their own path and be less susceptible to fear.

B. Group Behavior

Human relationships are taken into account during evacuation as a very essential factor. For instance, seeking behavior in which group members initially become separated and then attempt to reunite, or looking for a missing person who may be a friend or family member before evacuation.

The evacuees who are unfamiliar with the surroundings typically follow those who have a better understanding of the escape path in group behaviour. The process of evacuation is also influenced by this social connection and attachment. This is due to the fact that it speaks of the connections made via interactions with other people, such as family, friends, and coworkers, as well as with things, settings, and activities. A youthful, healthy agent, for instance, might consider the physical demands of a particular action to be light compared to an aged agent. The stamina of individuals varies with their age and gender. A youthful, healthy agent, for instance, might consider the physical demands of a particular action to be light compared to an aged agent. The stamina of individuals varies with their age and gender. Social influence theory and social proof theory have been used to explain how people influence one another during the initial stage of evacuation at the level of the crowd. Competitive, line-waiting, and herding behaviours are a few examples of simulated behaviours during evacuation.

People can collaborate and evacuate in a systematic way during an evacuation, demonstrating social collective behaviour. For instance, in a counter-flow scenario, two persons walking in different directions cross paths inside a constrained area. People must interact with strangers in order to escape safely, therefore queuing and collective movement are other forms of social collective behaviour. Even when their path is hindered, social force, a motivating force, causes agents to move faster in the direction of their goal. In order to prevent collisions and injuries, people also typically maintain a personal space from other agents or objects. In order to prevent physical interaction between simulation actors and other objects, simulations should model a repulsive social force.

CONCLUSION

Agent based modeling is being used for the simulation of a burning building because of its many advantages like being able to control individual and group behavior along with group dynamics**.** Our proposed model is based on four parameters that allow for practical evaluation: fire, smoke (carbon monoxide content), bottleneck and agent behaviors. Different agents will behave differently (i) some will know only one entry/exit which might decrease their chances of survival (ii) some agents might know more than one but not all exit points, which will help in a more efficient escape but not the best, (iii) and some agents can know all the exit points due to which they may have the best chance at survival. With this model, we aim to simulate a proper escape strategy and study how agents in the real world might react to emergency situations, which will help architects come up with better exit strategies.

REFERENCES

[1] Nur Siyam, Omar Alwaryouti, and Sherief Abdallah, “Research Issues in Agent-Based Simulation for Pedestrians Evacuation”, Digital Object Identifier 10.1109/ACCESS.2019.2956880.

[2] Xiaoyan Zhang, Graham Coates, Sarah Dunn, Jean Hall, “An Agent-based Model for Emergency Evacuation from a Multi-floor Building”, AAMAS 2022, May 9-13, 2022, Online.

[3] C.Beyaz, E.D. Ozgener, Y.G. Bagci, O. Akin, H. Demirel, “Integration of Building Information Modelling and Agent-Based Modelling for Evacuation Simulation”, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Services, Volume XLVI-4/W5-2021, The 6th International Conference on Smart City Applications, 27-29 October 2021, Karabuk University, Virtual Safranbolu, Turkey.