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Simulating The Building Evacuation By Using Agents

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ABSTRACT: *The concept of an agent first appeared in the seventies in the previous century. The popularity of agent based system has increased swiftly because agent has intelligence, ability to reason and autonomy in simple terms we can say an agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors. Intelligent agents have mind which are capable of choice they can mentally figure out the problem how to solve it and what actions are to be taken in order to maximize its chances of success they are autonomous entities they can decide by themselves and have ability to act according to situation without any direct intervention of humans. In this work, agent-based simulation is proposed as a method to help in the evaluation of security in buildings by simulating their evacuation. These types of simulations allow us to measure evacuation time from the building and test their performance in the building security, which can be useful during its design. In these simulations, people are represented by means of agents.*

Keywords: *Agents, Multi agents, Pathfinder, Intelligent agents, UML.*

I. INTRODUCTION

An agent is a type of computer system that is competent of exhibiting intelligence and autonomous action on behalf of its user or owner they are capable of flexible self-directed action in dynamic, volatile and in multi-agent domains [1].

An agent is a hardware or software system that is:

- Situated

Surrounded in some environment which may be the physical world, software environment or a community of agents which they can sense (through physical sensors or message receipt and respond to environment via effectors, messages.

- Reactive

They respond to the present state of the environment they do not take history into account they are capable of reacting quickly to events without complex reasoning.

- Autonomous

Operates without the direct intervention of humans or other agents, they have their own control over their actions.

- Social

It can interact with other agents and possibly humans using messages or actions that change the shared environment.

- Pro-active

Have multiple goals which they try to achieve by communicating with other agents or acting on its environment.

- Has a centralistic model

Agent has an internal architecture such as beliefs, desires, intentions and obligations

- Sensors

Eyes (vision camera), ears (hearing), skin (touch), tongue (taste), nose (smell).

- Percept

A percept is the input that an agent perceives at any given moment [1] [3] [9].

***1.1 Intelligent agents*:** These are those entities that carry out some set of operations on behalf of a user or another program they are called autonomous entities means they are independent they are capable to decide their own. In computer science, an intelligent agent (IA) is a software agent that exhibits some kind of intelligence that assists the user and act on their behalf, in performing computer-related tasks. It is capable of flexible autonomous action. Intelligent agents are capable of interacting with other agents (and possibly humans) in order to satisfy their objectives [3]. It observes and acts upon an environment and directs its activity towards achieving goals [3] [4

***1.2 Multiagent system*:** A multi-agent system is composed of multiple interacting intelligent agents within an environment they consist of multiple autonomous entities having different information. A Multiagent system consists of number of agents which interact and collaborate with each other. Different agent's acts on behalf of

users with different goals in order to interact successfully they should have the ability to cooperate, negotiate and coordinate with each other. Multi Agent technology is used in distributed system to solve the complex problem which can not be solved by the individual agent. A multi-agent system is composed of multiple interacting software components known as agents, which are typically capable of co-operating to solve problems that are beyond the abilities of any individual [2]. Each agent has a incomplete information or capabilities for solving a problem within an environment no system has global control and data is decentralized. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent to solve. They are collection of distributed autonomous artifacts capable of accomplishing complex tasks through interaction, coordination, collective intelligence and emergence of patterns of behavior. Communication protocols enable agents to exchange and understand messages. Interaction protocols enable agents to have conversations. The following types of messages can be exchanged between two agents: Propose a course of action, accept a course of action, reject a course of action and retract a course of action [6] [8].

In this work a simulation has been performed in order to calculate the time taken by agent to escape from the building which is on fire and simulation has been performed by using agents that how much time the agent can take to escape from the building. Simulator Path Finder has been used as simulator. Earlier we proposed a UML model for building evacuation [5] which shows how agents can use various available resources in case of occurrence of any natural disaster. We have proposed the simulation in this paper by taking some parameters of our proposed model in which we have only shown the simulation of agents from building exclusive of how they interact and responsibilities of various emergency services [5].

The UML class diagram has been used to model the system which is a type of static structure diagram that describes the structure of a system by showing the system's classes here is an evacuation class diagram of moving agent which has a Sensor (View) and Effectors (React). The agents can sense doors, walls and other agents through its sensors and have the ability such as they can open or close doors, press alarm and act according to the situation with the help of effectors. They can use various options for exit such as stairs, lift and emergency exit. Agent's capabilities are specified in agent class box sense and act different exit options are shown on floor such as it is having lift, stairs, emergency exit and room. While attributes of room is shown which is having wall, alarm and door. On the right hand side of diagram emergency rescue team is modeled along with their duties and abilities [5].

UML (Unified Modeling Language) is a pictorial language used to make software blue prints. In 1997 OMG (object management group) develop UML as a common architectural framework for modeling systems and applications .It is an industry-standard graphical language for specifying, visualizing, constructing, and documenting the artifacts of software systems. The UML uses mostly graphical notations to express analysis and design of software projects. It helps to acquire an overall view of a system. UML is not dependent on any one language or technology. It provides several types of diagrams which provide the ease of understanding an application. The UML is used for specifying what is required for the system and how a system can be implemented. It takes into concern the entire important requirement, analysis, design and implementation decisions that are needed during system development life cycle. A Model is an abstract representation of a specification, a design or a system from a particular point of view. It is often represented visually by one or more diagrams. It aims at expressing the abstracts without going into the details. Modeling is an essential part of complex and large software projects. A model plays the equivalent role in software development that blueprints and other plans (site maps, elevations, physical models) play. UML is a graphical language for {Visualizing, specifying, constructing, documenting} the artifacts for a software intensive system. Every development process aims to produce an implemented system in a proper manner. The design and the architecture represent the important decision about how the system is built [11][13][15].

II. FIGURES AND TABLES

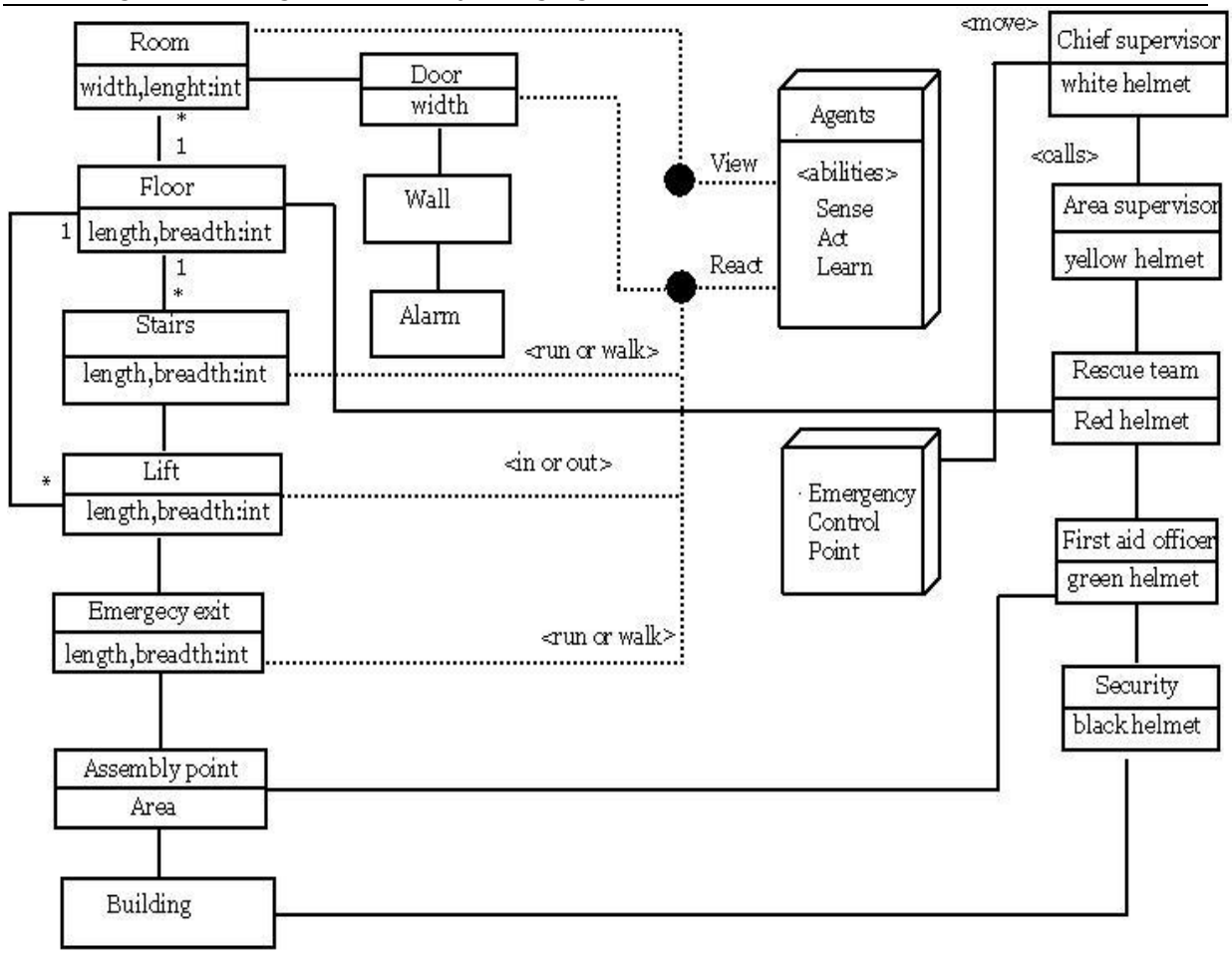

Figure 1: Evacuation class diagram [5].

In our simulation the floor is having two doors on one side of it width of two doors is 32inches. each which are linked with two stairs namely Left stair and Right stair. Area of each stair is 208.333 ft², Length of each stair is 50feet long, width of stair is 50inches. Riser 7inch. and Tread 11inch which ends and connected to Assembly point having an area of 300 ft² and Exit of width 360in. assuming that stair entrance is not blocked by any obstacle. Room which is having an Area of 6000.0 ft² and Top Floor of room is at 30feet of height from the ground which occupied by 350 Agents on top of room with density (0.583 per/ ft²) which are trying to escape from building during emergency and moving speed of agent is: 3.9 ft/sec, size of agent: 17.9449 inches.

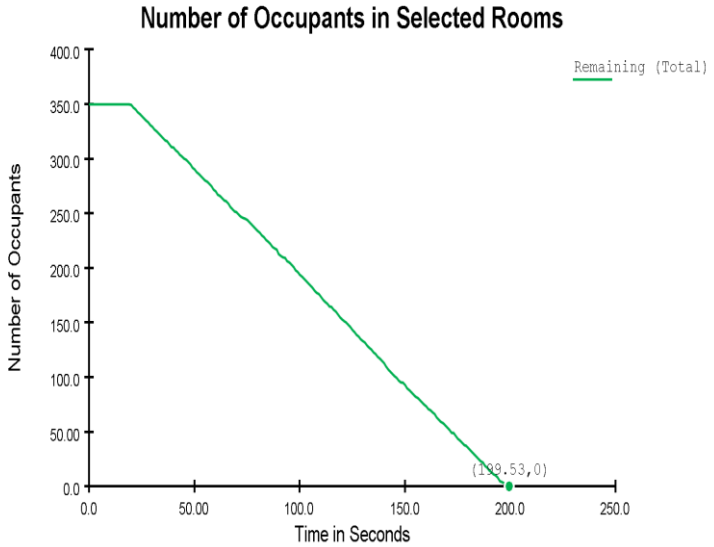

Figure2: Indicates the start of simulation.

In this simulation there are total 350 agents which are trying to escape from floor of the room in the building which is 30 feet at height from the ground. This graph indicates the start of simulation and when the first agent escape from the building after few seconds we can see the downward movement in the graph line which indicates the decline in the number of agents one by one finally all the agents escape from the building in 199.53 seconds.

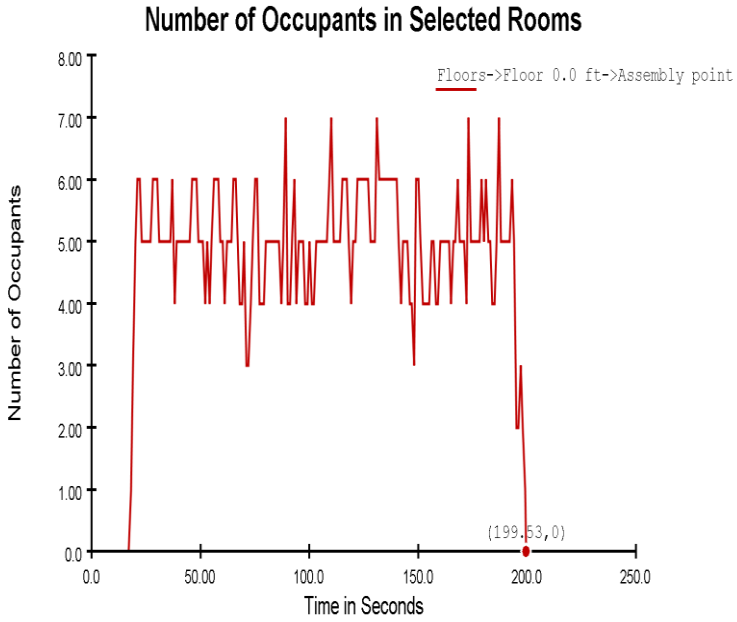

Figure3: Time taken by agents in moving from ground floor to assembly point

The graph above indicates the time taken by agents in moving from ground floor to assembly point

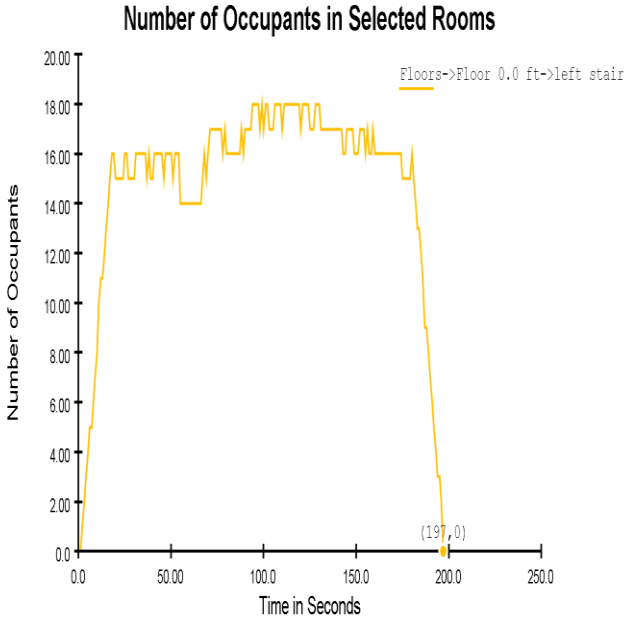

Figure4: Agents while moving through left stair

The graph above indicates the total time taken by agents in moving out from left stair

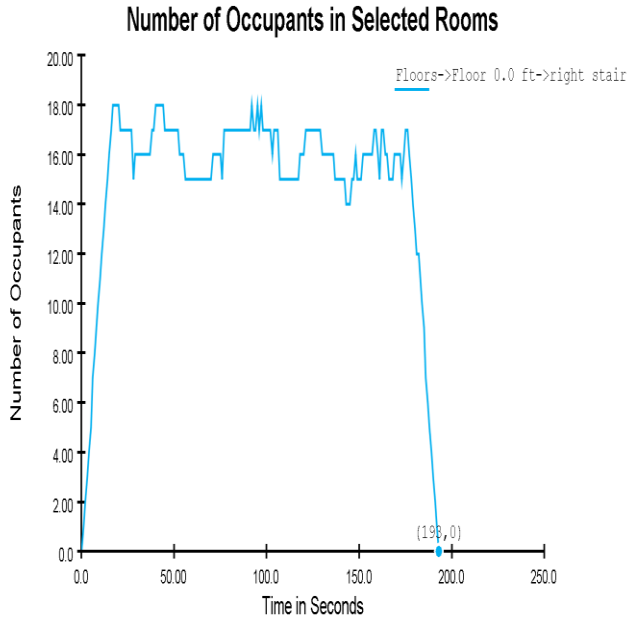

Figure 5: Agents while moving through right stair.

The graph above indicates the total time taken by agents in moving out from right stair

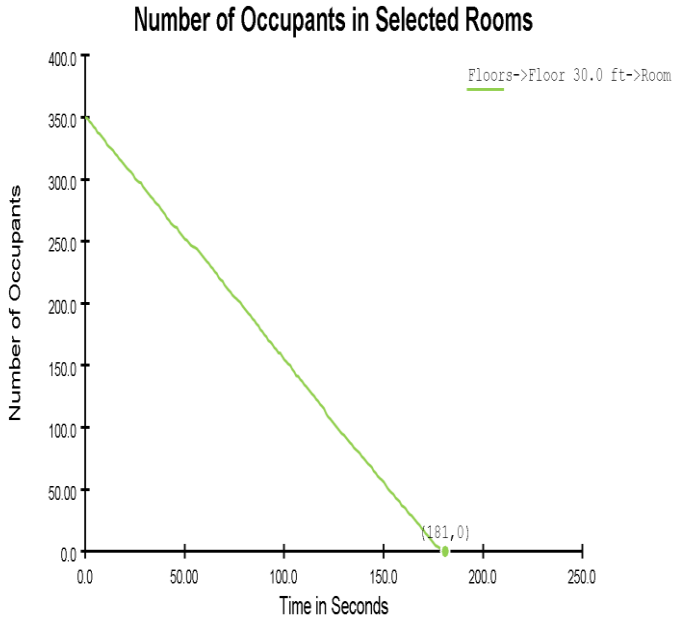

Figure 6: Indicates time taken by agents to escape from top floor.

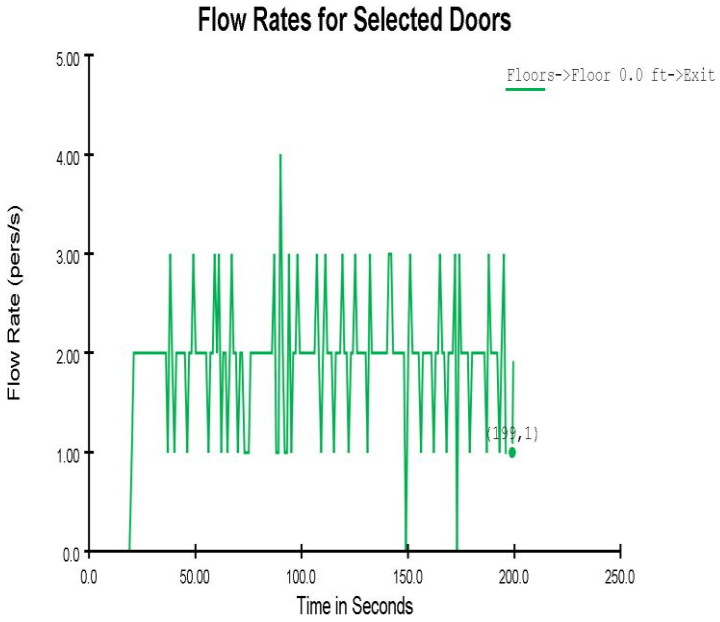

Figure 7: The average flow rate of persons from ground floor to Exit door to outside the building

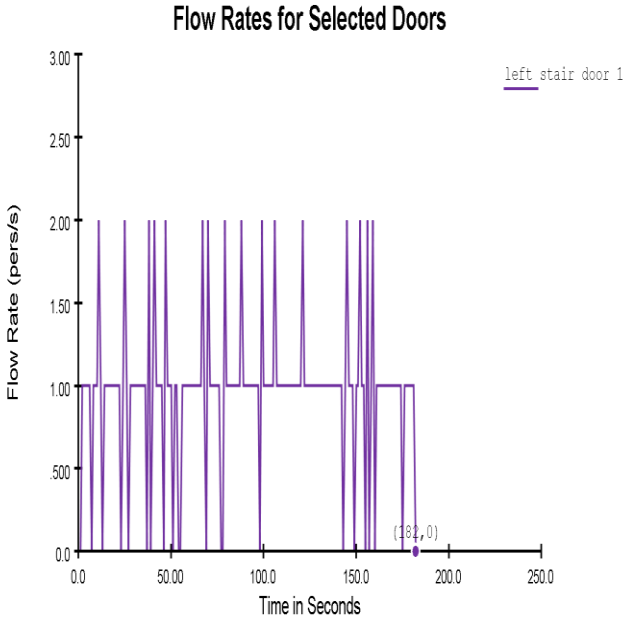

Figure 8: Indicates the flow rate of agents from left stair door1

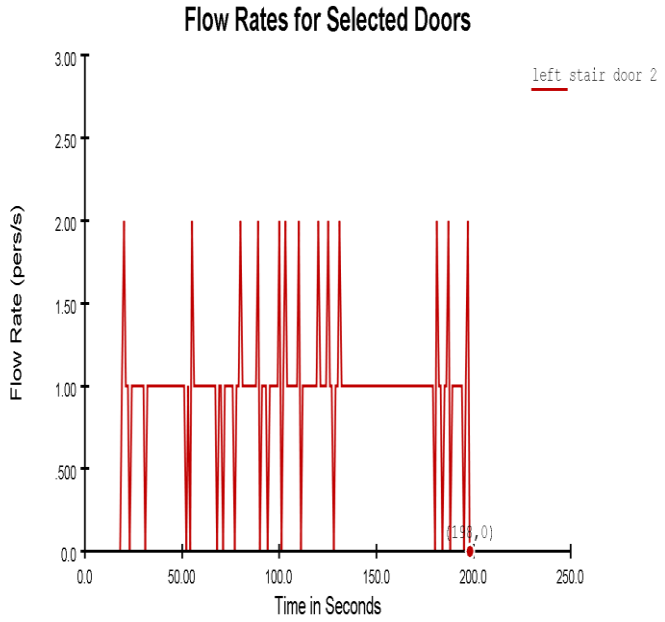

Figure 9: Indicates the flow rate of agents from left stair door2

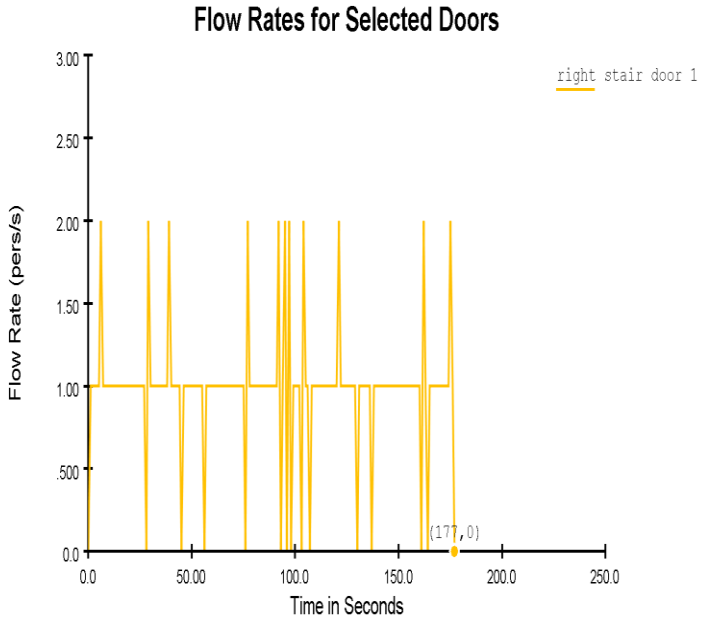

Figure 10: Indicates the flow rate of agents from right stair door 1

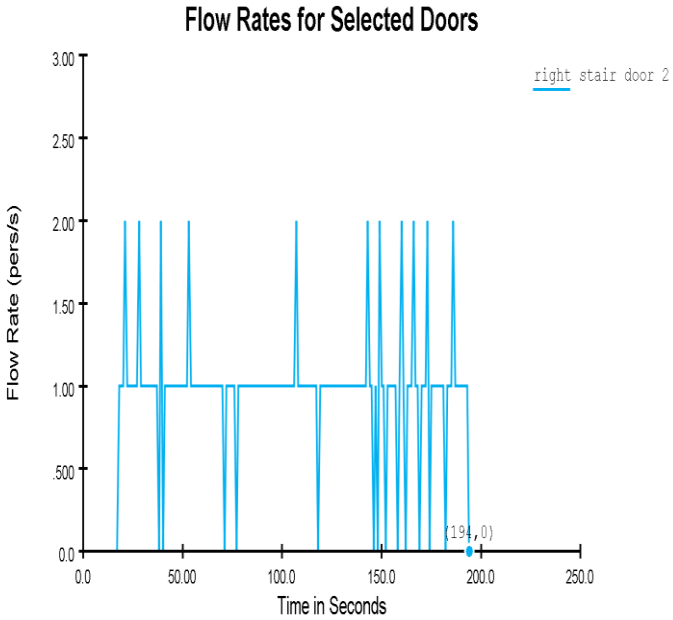

Figure 11: Indicates the flow rate of agents from right stair door 2

TABLE: 1

Room/ Door	First In (s)	Last out (s)	Total use (person)	Flow average
Floor 0.0 ft->Assembly point	17.20	199.33	350	
Floor 0.0 ft-> left Stair	1.78	196.73	176	
Floor 0.0 ft->right stair	0.65	192.23	174	
Floor 30.0 ft->room	0.00	180.18	350	
Floor 0.0 ft->Exit	19.80	199.33	350	1.95
left stair door 1	1.78	180.18	176	0.99
left stair door 2	18.30	196.73	176	0.99
right stair door 1	0.65	175.68	174	0.99
Right stair door2	17.20	192.23	174	0.99
Summary	0.00	199.33	350	

Table1: Parameters values for multiple stair exits.

III. CONCLUSION

In this paper we suggest an agent based modeling technique for the simulation of a building evacuation (in case the building is on fire). Simulation has been performed on the basis of model while this simulation can be helpful in many ways such as while designing the building this model and simulation can help in various architectural decisions which may affect evacuation of building when some emergency occurs, such as placement of regular and emergency doors, location of stair case such as its width and foot steps of stairs. As in real life experiment cannot be performed by humans, So by performing the simulation one can have an idea about how

much time it will take in real life to evacuate from this type of building moreover this can help in architectural decisions while constructing any new building, we can further make our evacuation system better and moreover we can enhance our building securities also with this model and simulation. This type of simulation can be further helpful in evaluating the building security and architecture of buildings.

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