Simulating the Spread of a Virus Spread in a Modern Building Environment
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Abstract

This project explores the development and use of a real-time simulation to simulate the spread of a virus through the hallways and confined walking areas in a modern building environment, such as schools and other enclosed public places. In addition, the project explores the use and creation of various pathing algorithms used in real-time simulations.

Keywords: real-time simulation, hallway simulation, pathing algorithms, virus spread

1 Introduction

New and modern buildings today are generally designed to be large and open. The hallways are wide and tall, creating vast open spaces for people to walk in, as in Figure 1. Larger hallways are generally more appealing and easier to walk though, but they also serve an even greater purpose of reducing the spread of airborne diseases. In addition, larger hallways can reduce the spread of diseases spread by physical touch due to a decrease in the general density of people in the hallway or building space. The impact of having a larger hallway on the spread of a virus, compared to a narrower hallway of a older building, can be simulated by computers. The focus of this project is to develop is to develop software to simulate the spread of a virus in the hallways of a building.

2 Background

A virus let loose in a building can be a major problem today, especially in today's schools where the average infection rate is greatly increased compared to other public places [6]. In addition to the large amount of contact between children, most schools do not take into account the fact that building design can af-

Figure 1: A large modern hallway [1]

fect the spread of a disease or virus. One of the easiest factors to control in a design decision for a new school building is hall width. In theory, this factor can have an effect on the rate of a virus or disease spreading through a building from person to person. Making a building wider would decrease the population density per area, which one would assume to decrease the rate of the virus. These aspects of a hallway become very important to decrease the number of infections for airborne viruses, such as chicken pox, tuberculosis, and more recently, swine flu[2].

A subsection of this project is to explore pathing algorithms and AIs for real-time simulations. There are various pathing systems, each with its own advantages and disadvantages. The first system is a Potential Field AI.[3] Potential field AIs are developed for RTS games, or Real Time Strategy games, which as the name says, are real-time and need to be consistently very fast. However, they are most useful in large open areas and maps, where the terrain is generally static and non-changing. Another choice for a pathing system is to develop a system of avoidance by using "probe points" to scout ahead and beside a person.[5] A unit will also check in front of itself in a larger area for any units that may get in its way.

3 The Project

The main language for this project is be Java. I have chosen Java over languages due to its simplicity of use and ability to easily create a graphical display for many different things. Every piece of the software is written by scratch, with ideas taken from open source projects such as Open Steer [4].

3.1 Simulation

The simulation portion of the project is to create a real-time simulation of virtual people walking through a given building layout from location A to location B. Throughout his, her, or its journey, they may come across another person randomly infected with a virus. This virus then has the ability to spread to spread to the healthy person, depending partly on chance and partly on how the virus spreads. The simulation can keep track of where a new infection takes place and display these infections to see where the most infections took place.

The environments the virtual people walk through are very adjustable and customizable; almost any building can be created. One example map is shown in Figure 2.

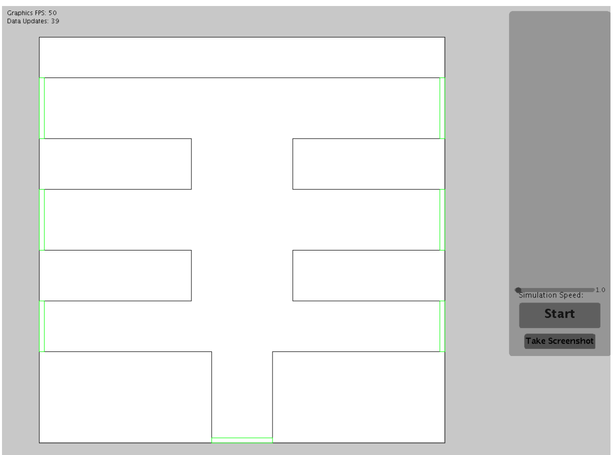

Figure 2: An example layout of a simple building

3.2 Pathing

After experimenting with various pathing systems for the people in the simulation, some systems have been deemed not applicable to this project and some seem possible. By itself, a potential field AI is not the best choice for a simulation of people in a building with tight areas. Potential field AIs work best in open spaces and not the tight hallways of a school or building. However, when used to get the general direction of movement and combined with another pathing system, it can be very useful. In this case of this project, I implemented the "probe point" system for pathing as the main pathing system, while the potential field will provide directional assistance. The probe points can be seen in Figure 3, where a group of virtual people are avoiding the walls.

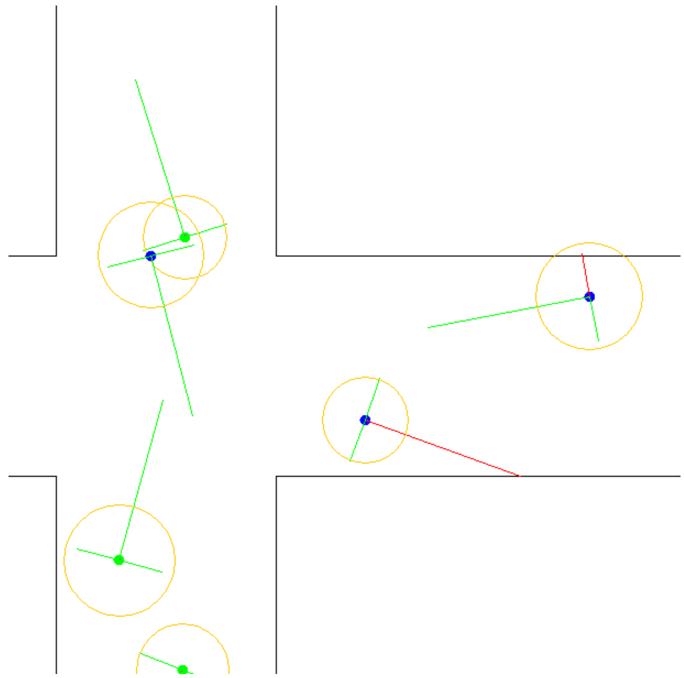

Figure 3: The simulation running showing the "probe points"

3.3 Virus Spread

The virus type used in this simulation is a basic airborne virus with an infection chance from a person to another person dependent on the distance from the infected person to the non-infected person. There is, however, a randomness to the infection of another person. Many aspects of the virus spread are controllable by the user of the simulation software, including variables such as maximum distance for infection, infection rate, and others.

4 Testing Results

So far, the simulation has shown some correlation between hallway width and the rate of infections when using an airborne-only virus. Hallways with smaller widths seem to increase the rate of infection, while hallways with larger widths generally decrease the rate of infection between people.

5 Conclusion

The results from this project show that there is indeed a correlation between hallway size and the rate of infection between people. The simulation itself is somewhat accurate at real human movement through hallways, but there are areas that could use some improvement, such as better wall avoidance, a better system to avoid other people, and a straighter movement down a straight hallway, instead of a more crooked movement.

One application of this project is to aid in the design of the new TJ building, the hallways of which could be designed with the results of this project in mind to help reduce the spread a virus or disease during the school day.

References

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