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A swarm-based dynamic evacuation simulation model under the background of secondary disasters

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Abstract

Due to the occurrence of secondary disasters in disaster relief, a swarm-based dynamic disaster evacuation simulation model is established to settle the practical difficulties of reducing efficiency in evacuation. And much better simulation results have been achieved than static plans or disorganized autonomous escape scheme. Simulation results show that "to changing the status quo" dynamic evacuation plan is much better than "maintaining the status quo," the static and self-evacuation plan or autonomous escape behavior for emergency evacuation, especially those with secondary disasters.

Keywords: Secondary disasters; Dynamic evacuation plan; Evacuation efficiency; Successful ratio of evacuation; Agent; Swarm

1. Introduction

Recently, research on the process of people's evacuation under disasters has become the main focus in emergency management [1,2]. However, the secondary disaster caused by protogenetic disaster hasn't got comprehensive attention either in rushing to deal with the emergency or providing disaster relief or in theory research. In fact, it will usually induce a new serial of secondary disasters during the protogenetic disaster's occurrence. Sometimes damages of secondary disaster is more than protogenetic disaster, especially if people only pay attention to the protogenetic disaster instead of secondary disaster during the evacuation, which will lead to decline the efficiency dramatically, and even induce more hurt and death. For example, if we cannot change the evacuation plan, in other words, we continue to evacuate people to the "broken" exit. In this case, we not only cannot evacuate people from "broken" exit, but also may induce more death and hurt due to choosing the wrong path.

As we know, the rescue is impossible to predict in advanced in reality. However, computer simulation can take the obligation –"the result of rescue can be surely predicted in advanced". It can simulate the process of real evacuation, that is to say, to simulate the scenes appear over and over again such as disaster, rescue, disperse, then, it'll optimize the evacuation plan.

The simulation models of the evacuation have two kinds, one uses macroscopical method, the other uses microcosmic method[3]. The microcosmic model can set different parameters and regulations which can emulate the process of the person evacuation more clearly in reality.

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The goal of this paper is to establish a swarm-based dynamic evacuation simulation model under the background of secondary disasters based on the existing theory of person evacuation and the method of modeling. This model comes up with the plan of evacuation by changing the evacuation command dynamically, in other words, to adjust the scheme dynamically according to the secondary disaster, meanwhile, the dynamical scheme will carry out microcosmic simulation based on swam, and observe the advantages of the dynamical scheme.

2. Overview of the Swarm-based simulation model

Swarm is a simulated platform for complicated modeling system, which is invented by the Santa Fe Institute. Because the swarm does not have the restriction between the mode and the element of mode in the process of exchanging, so this kind of swarm can emulate any physical system and social system. From 1999, it provided support of java and was more available in smart body. Our work applies in three layers of swarm: Agent, ModeSwarm and ObserverSwarm. In addition to this, our work also uses the detector, timing sequence, action selector provided by the Swam. For example, we make use of detector to change the experimental data according to the experimental scheme.

3. Preparation of establishing the model of dynamical person evacuation

3.1. Description of the whole simulation environment

The simulation environment makes the evacuation arena into the virtual 2-D space of 160*120. In terms of that, every coordinate is entitled to the below value of property: wall, obstacle, the exit of evacuation, waited-evacuated person, and NULL. Every coordinate can be entitled to one property during every period and cannot have two or more property simultaneously. In addition to this, all the waited-evacuated person, obstacle and disaster should be simulated in this area.

3.2. Agent's regulation, strategy and behavior

Same with other researches, our work also cast the waited-evacuated person light onto the agent, so the feature of the waited-evacuated reflects into the state property and regulation of agent.

- Agent description

  An agent include below property：

xPos：	x coordinate at t moment
yPos：	y coordinate at t moment
Barrier _act	records whether random obstacle exists introduced by secondary disasters
Indicator_act	records whether the dispersed indicator has change
sight_length	field of view
study_length	scope of learning
Act_State	individual behavior
agentColor：	marks color of the behavior

- Learning strategy of agent

  During simulation process, we should considerably take the lead function of evacuation process, evacuation passageway obstacle, person obstacle into consideration, which will exert the effect on the people during the process of the evacuation. The learning behavior of between the two agents is that when an agent feels the evacuation passageway obstacle, and then the escape exit will notice the agent within the scope of horizon. So the agents will add their own experienced value through interaction. In such way we can achieve the adaptability between the agents.

Simulation environment totally considered the function of evacuation indicator during the process of evacuation, secondary damages and the congestion of waited-evacuated people. When an agent feels that case's happening, it'll notice the other agent within the horizon in order to imitate evacuation process and consider the relative proportion