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Agent-Based Modelling and Simulation for evacuation of people from a building in case of fire

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Abstract

The evacuation of people from a building on fire is a task which can prove to be very difficult, in particular because of the influence of human behavior, but also of the type of people or the evacuation place configuration. Thus, it is crucial to think on how to organize the evacuation upstream for a situation of emergency can give rise disorganization, on one hand because of panic which grips evacuees, and on the other end because of the large quantity of evacuees in dangerous conditions. These recent years, several fire evacuation models have been proposed. Unfortunately, most of these models do not clearly define the parameters to be considered for their effective evaluations. These models consider, more generally, the number of survivors as a key parameter of evaluation. The purpose of this paper is to propose an intelligent Agent-Based Model enabling the modelling and simulation of evacuation of people from a building on fire. Our proposed model is based on four parameters that allow her practical evaluation. A case study of simulation is carried out in a building having the general configuration of Kinshasa supermarkets. This model is general enough for it to be implemented in several types of commercial buildings without major changes.

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Keywords: Modelling; Simulation; Fire; Evacuation; Intelligent Agents; Evaluation parameters.

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1. Introduction

More and more, fire is the cause of human losses in the world. In[1] authors present several examples: in December 2001, 291 people killed during the burning of the commercial center of Mesa Redonda in Lima (Peru). The burning of the hospital in Moscow (Russia) killed 46 people on December, 9 2006. The burning of Santika Club in Bangkok (Thailand) killed 66 people on January, 12 2009. The burning of the day-care center of ABC killed 47 people in Hermosillo (Mexico) on June, 5 2009. At least, 117 people were killed during the burning in the town of Dhaka (Bangladesh) on June, 3 2010. In California, 36 dead people in the burning of a building occupied by a group of artists in December 2016 and recently, in June 2017, the burning of a tower in London caused the death of 17 people and brought about numerous missing people. And that list keeps on growing in an exponential way. Considering these catastrophes, and the human losses, there are grounds to ask questions on the reliability of the evacuation systems applied. When a building is in fire, the evacuation of people raises a certain number of problems. When people get panic, it can even cause numerous victims. Thus, it is important to think about the prevention of risks. In a real life situation, it takes a lot of means, in terms of equipment and even of people, to simulate a building evacuation. The modelling of this situation with intelligent agents and the simulation with a computer program is an interesting thing to do which will help to understand and predict a case of fire without altering the environment.

2. Definition of key concepts

2.1. Intelligent agents

Several definitions relating to agents have been presented by different authors. In[2,3], an agent is defined as a computer system located in an environment and able to accomplish autonomous actions in order to reach its aims in that environment. In[4,5,6], the agent perceives its environment, acts autonomously, interacts to share the aims, constraints, etc., anticipates and reacts with flexibility with its environment and learns from its experiences and adapts to its environment. According to[3,7,8,9,10,11], an agent is a physical or virtual entity able to act in an environment. This agent can communicate directly with other agents; which is driven by a set of tendencies; which possesses its own resources; that is able to perceive (but to a limited degree) its environment; which has only a partial representation of that environment (and eventually none); that possesses competences and offers services.

2.2. Model

A model is a mathematical, graphic and computerized representation of the objects and the relations between them in a confined zone of the real world[2,3]. A model can also be viewed as a simplified representation of a complex reality. To be useful, models must be adapted to theirs objects and be conveniently studied and validated[5,7,12].

2.3. Modelling and simulation

Systems composed by a large number of individuals submitted to several environmental variations, which interact between them and with their environment, like the evacuation of a building in case of fire, where the people evacuated must make decisions quickly, avoid obstacles, choose a nearest exit door, get panic, etc.: these are complex and dynamic systems[9,13,14,15,16,17]. As a whole, modelling and simulation first of all consist in the designing of a model. It is a way of making explicit the complexity of a system in order to better understand its functioning and to make good decisions. It brings the complex system to experiment without altering it too much, often difficult in real life situations[9,18,19]. It enables the system to be accessible at the level of its structure (description) and of its functioning; it tests the hypotheses put up (validation), to have new hypotheses (discovery), and predict its functioning if its structure is changed (prediction).