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MODELING WITH FUZZY LOGIC THE DYNAMIC OF PEOPLE FLOW DURING THE EVACUATION OF CONSTRUCTED ENVIRONMENTS DIMENSIONED ACCORDING TO THE BRAZILIAN LEGISLATION

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The flow of people is an important field whose knowledge and implications directly influence the quality of life of everybody. In many ways, the movement of people can be linked to the flow behavior of particles, or even, especially in situations of very high population density, to a behavior similar to that found in fluid dynamics. Thus, the modeling of the movement can benefit from the knowledge already established for the flow of particles and fluids. However, in addition to the dynamic aspects already established, there are, concurrently in moving people, human factors, such as cognitive and social phenomena [1]. Thus, the modeling of the movement of people needs to incorporate all these aspects, mechanical and mental, as well as quantitative and qualitative.

There are several studies already developed to model the evacuation of environments [2, 3]. In this work, the computer program used in the simulations was the FUGA. v. 0.6 [4], whose model incorporates elements of artificial intelligence to determine the flow dynamics as well as fuzzy logic for the inclusion of the human aspects in the model. The incorporation of these paradigms within the FUGA is made based on ergonomics.

The planning of the built environment is performed according to specific laws. In Brazil, there is no single national law. Each state, or even each city, can have its own legislation or code. However, in general the current laws in Brazil are all prescriptive. This work uses as a reference the code of Fire Department of the State of Minas Gerais – CBMMG [5] (Minas Gerais is the Brazil's second largest state in population, has an important GDP and approximate the area of Spain and Portugal together). The CBMMG code has many similarities with the codes employed in various other regions of Brazil and also internationally. However, despite the existing rigid codes, serious accidents continue to occur. Recently, Brazil was the scene of a great tragedy in a night club, killing 242 people, most of them young university students [6].

In this work, the modeling of evacuation in small and midsize environments, like night clubs (regarded as especially critical in terms of safety), is performed. Dynamic aspects related to mechanical flow is presented. The FUGA program is briefly explained, as well as aspects of artificial intelligence and the fuzzy logic employed.

The simulated environments are single floors with area of 200 m^2 (these limits are values whose legislation introduces changes in the criteria). The population density adopted is always of 2 persons/m^2 (maximum population considered for this kind of environment) and the exits (minimum of 2 in each simulation) have a total width of 2.2 m (value calculated according to the legislation). The environments are square (1:1) and rectangular (1:3). The doors have multiple placements, from contiguous to each other until opposites in the environment. The dynamics of the people flow is evaluated by checking the flow capacity of the exits, the time and flow profile and the possibility of the occurrence of internal collisions.

The study and the modeling of the dynamics of people flow incorporating elements of artificial intelligence (as the Fuzzy Logic) is of fundamental importance for the understanding of the overall phenomena involved. It has been demonstrated that even if the requirements of Brazilian codes are thoroughly followed, serious accidents can potentially still occur in certain situations, demonstrating the need for greater discussion of the codes applied to these types of environments.

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