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Cell-based discrete event and discrete time simulation for advanced evacuation analysis considering human behavior in a passenger ship (Conference Paper)

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Abstract

Advanced evacuation analysis of passenger ships is a stochastic method in which the total evacuation time is calculated via computer-based simulations, by considering each passenger's characteristics (e.g., age, gender, etc.) and the detailed layout of the ship. This paper presents simulations of advanced evacuation analysis using a cell-based simulation model for human behavior in a passenger ship. The cell-based simulation model divides the space in a uniform grid, called a "cell." Each passenger is located in a cell and moves to another cell according to a set of local rules that are assumed to be associated with the individual, crowd, and counterflow-avoiding behavior of the passengers. Individual behavior pertains to the basic walking direction that a passenger will take during the evacuation. The direction is determined based on the shortest-distance route to a destination calculated with a visibility graph. The change in the direction and speed of a passenger based on his/her interaction with the other passengers is expressed by the crowd behavior, which has three basic rules: separation, alignment, and cohesion. The passenger's behavior to avoid other passengers moving in the opposite direction is referred to as "counterflow-avoiding behavior," because such a counterflow is included in the evacuation scenario. These behavior patterns are implemented as the local rules and are assigned to each cell. Each cell was implemented using a discrete event and discrete time simulation model that represents different variables of the local rules. Each cell has three basic states: empty, occupied, and obstacle. In terms of performance, the speed and direction of only the occupied cells are simultaneously updated by those of the neighboring cells in the previous time step. The passenger moves depending on the value of each cell at each discrete time step. To verify the usefulness of the proposed simulation model, 11 tests, all of which are specified in the International Maritime Organization Maritime Safety Committee/Circulation 1238 (IMO /MSC/Circ. 1238), were implemented, and it was confirmed that all the requirements of these tests had been met. © 2011: The Royal Institution of Naval Architects.

Indexed Keywords

Behavior patterns; Cell-based; Computer based simulation; Counterflow; Crowd behavior; Discrete events; Discrete time; Discrete-time simulation; Evacuation analysis; Evacuation time; Human behaviors; Individual behavior; International maritime organizations; Local rules; Maritime safety; Passenger ships; Simulation model; Stochastic methods; Time step; Uniform grids; Visibility

graphs; Walking direction

Engineering controlled terms: Behavioral research; Cells; Computer aided analysis; Discrete event simulation; Shipbuilding; Ships; Shipyards; Social sciences

Engineering main heading: Cytology

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