Developing a Pedestrian Agent Model for Analyzing an Overpass accident

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Recent softwares have enabled us to apply pedestrian dynamics models into analyses on pedestrian accidents. The author had already developed a pedestrian dynamics model, called ASPF, based on the cell space model, that is evolved from Cellular-Automata (CA). After a couple of years’ efforts for continuous revision, we analyze the causes on an accident of Asagiri Pedestrian Overpass in 2001 even though retrospectively. In this paper, the typical existing models for pedestrian dynamics are reviewed, especially explaining on the class of cell space models. Next, ASPF (Agent Simulator of Pedestrian Flows) are explained, in that each pedestrian moves according to several behavioural rules on the cell-grid space of 40 cm side each. Based on not only the fundamental findings from the existing spatial researches but also these from the accident report, ASPF ver.2 is ‘tuned up’ carefully. ASPF ver.2 is to assess measures for managing pedestrian flows by focusing on the domino risk (density 3 to 5) that shows a symptom for the accident rather than a reconstruction of the real accident itself that had occurred at extremely high density (more than 10). The simulation results show that a two-way flow, combined with standing spectators (stoppers) can trigger an accident even on an overpass that satisfies present design standards. Moreover, we have confirmed that even simple traffic regulations such as partitions can be an effective measure to prevent a pedestrian accident.

1. Introduction

Recent softwares have enabled us to apply pedestrian dynamics models into analyses of pedestrian accidents. The author had already developed a pedestrian dynamics model, called ASPF, based on the cell space model, that is evolved from Cellular-Automata (CA). After a couple of years’ efforts for continuous revision, we analyze the causes on an accident of Asagiri Pedestrian Overpass in 2001, even though retrospectively. This paper addresses our development project of a pedestrian agent simulation model, ASPF. In section 2, after a bottom-up approach is described, the cell space models on which our pedestrian model is based and which belong to a class of the models are reviewed with typical existing models for pedestrian dynamics. ASPF (Agent Simulator of Pedestrian Flows) is also explained, in that each pedestrian moves according to behavioural rules on the cell-grid space of 40 cm side each. In section 3, the development circumstances, the outline of ASPF ver.2 that tried an accident analysis, the results of the simulation analysis and consideration are described in due order. Based on not only the fundamental findings from the existing spatial researches but also these from the accident report, the rule configuration of ASPF ver.2 has been ‘tuned up’ carefully. ASPF ver.2 is to assess measures for managing pedestrian flows by focusing on the domino risk (density 3 to 5) that shows a symptom for the accident rather than a reconstruction of the real accident situation itself that had occurred at extremely high density (more

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than 10). The simulation results show that a two-way flow, combined with standing spectators can trigger an accident even on an overpass that satisfies present design standards. Moreover, we have confirmed that even simple traffic regulations such as partitions can be an effective measure to prevent a pedestrian accident. Instead of conclusion, our recent revise works of ASPF and future works are to be stated.

2. Existing Researches and Our Approach

2.1. Bottom-up approach

Pedestrian agent modelling appears to be under developed when compared to vehicle modelling, partly because the micro behaviours of pedestrians are so richly varied. The author, who has an interest in the practical application of modelling from the viewpoint of urban planning, can perceive a bottom-up modelling approach – loading higher-order functions for a pedestrian agent on the cell space in order – as this process is developed, it would be cross checked against survey data and observation gained through research.

Firstly, to explain this bottom-up approach, the broad body of existing research has been divided into four categories (Fig. 1). The first category is the actual survey, observation and measurement of pedestrian behaviour and pedestrian flow\(^1\text{-}\text{7}\). In this category, a wide variety of case studies have been accumulated; taking fundamental data through to practical application, from micro to macro, from the every day’s behaviours to panic behaviours.

The second category is research on models of pedestrian dynamics demonstrating the emergence of macro phenomena in pedestrian flow from the accumulation of micro-motives of pedestrians’ behaviours\(^9\text{-}\text{21}\). This category includes the physical phenomenon analogy model, the CA model and the cell space model evolved from CA. However, in many cases, pedestrians just make straightforward movements and avoid others.

The bottom-up approach means the development of a model that loads such higher-order functions as route selection, trip planning and the scheduling of a visiting order into this second category of pedestrian model; all of which must be checked against data taken from survey research.

The third category is research on elemental models of these functions\(^22\text{-}\text{25}\). Much of this research has been studied in OR, transportation planning or the artificial intelligence fields.

The fourth and final category is research to study integrated models for application incorporating all these models by using platforms such as GIS\(^26\text{-}\text{29}\).