



Environment-sensitive crowd behavior modeling method based on reinforcement learning

Chen Pang¹ · Lei Lyu^{1,2} · Qinglin Zhou¹ · Limei Zhou¹

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Abstract

Most existing crowd evacuation methods focus on internal factors and do not consider the influence of the external environment factors, producing unrealistic global behavior occurs when individuals are moving through the crowded space. As an essential part of a building, safety indication signs (SISs) are a form of environmental information and perceptual access that play an important role in promoting wayfinding by virtue of their guiding role in movement direction and route selection by providing guidance, warning and mandatory message to people. In this paper, we propose an innovative crowd simulation method guided by SISs with reinforcement learning strategy for use in emergencies. To illustrate the guiding function of the SISs, we establish a guidance field for each SIS and add the attractive force to the guidance field. Besides, we formulate the multi-agent (crowd) navigation problem as an action-selection problem and design a novel reinforcement learning strategy for driving individuals to accomplish collision-free movement more efficiently. Particularly, we define a state transition strategy between the SIS area and the non-SIS area to achieve continuity of guidance. We use extensive simulations to highlight the potential of our method in different scenarios and evaluate the results in terms of evacuation efficiency and the reasonableness of SIS placement. In practice, our system runs at interactive rates and can solve complex planning problems involving one or more groups.

Keywords Crowd behavior modeling · Safety indication signs · Reinforcement learning · Crowd evacuation

1 Introduction

With rapid urbanization and population growth, security incidents in crowded areas occur frequently. The main cause of this phenomenon is unexpected emergency evacuation. In such cases, large numbers of people must complete an

emergency evacuation from limited number of exits. As a result, it is critical to assist people in evacuating from the dangerous places as quickly as possible by using reasonable path planning and efficient evacuation strategies.

Crowd evacuation is a complicated process that involves a variety of human behaviors such as evacuation actions and behavioral responses. At present, the most common method of preventing emergencies is large-scale live drills, but they require the large-scale dispatch of people and materials and present a certain amount of danger. By simulating the crowd evacuation process through computer simulation technology, it is possible to break the limits of time and space and simulate a variety of common emergencies. In addition, the effectiveness and soundness of current crowd evacuation methods can be tested in a safe and controlled environment. During the simulation, it is important to simulate the real crowd situation as much as possible. The performance of group behavior is influenced not only by internal factors, such as size, density, age, or gender but also by external environmental factors, such as safety indication signs (SISs), noise, smoke, or odor. Existing approaches to crowd behavior modeling primarily focus on the influence

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