System Identification for Designing a Crowd Danger Controller in a Metro Station During Large Passenger Flow

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Abstract Large passenger flows in metro stations may lead to potential safety issues. However, existing studies have primarily focused on service-oriented passenger flow control strategies [1]. To fill this gap, we investigate the potential for managing crowd risk by delaying the service time of the entrance ticket gates. We use crowd danger [2], the state-of-the-art definition of pedestrian dynamics, as an indicator for assessing crowd safety. Specifically, we develop a comprehensive microscopic pedestrian simulation model tailored to metro station scenarios, this model generates input-output data for the predictive model. The simulation scenario is shown in Figure 1, where the sensing area for crowd danger detection includes the paid area of the station hall, as well as the stairs and escalators. It is observed that high crowd danger values are primarily distributed near stairs and escalators, in reality, these areas experience the highest number of accidents [3]. Next, we develop a predictive model to capture the system dynamics, specifically the relationship between ticket gate delay time and crowd danger in the sensing area. This predictive model plays a crucial role in understanding the underlying mechanics of the system and enabling precise control. It serves as an accurate mathematical representation of the system, derived from input-output data generated by the simulation. The results indicate that entrance ticket gate delay time is highly sensitive to crowd danger in the sensing area. Moreover, the use of a linear state-space model effectively captures system dynamics and provides accurate multi-step predictions, demonstrating the potential of our proposed crowd management solution.

Keywords Metro station pedestrian regulation, Pedestrian microscopic simulation, Pedestrian dynamics, System identification, Crowd danger

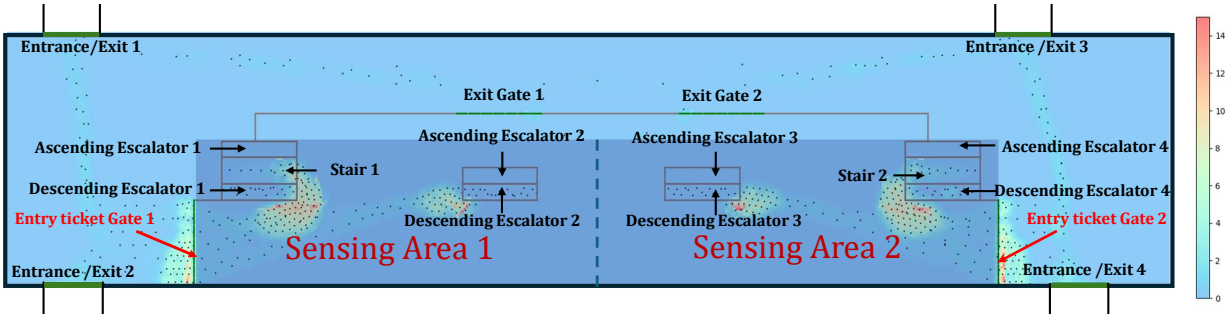

Figure 1: Metro station simulation scenario and pedestrian regulation solution.

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