AB065. Pedestrian modeling using the least-action principle

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Background: In this work, we present a theoretical and experimental study of the natural movement of pedestrians when passing through a limited and known area of a shopping center. The modeling problem for the motion of a single pedestrian is complex and extensive; therefore, we focus on the need to design models taking into account mechanistic aspects of human locomotion. The theoretical study used mean values of pedestrian characteristics, e.g., density, velocity, and many obstacles. We propose a human pedestrian trajectory model by using the least-action principle, and we compared it against experimental results. The experimental study is conducted in a Living Lab inside a shopping center using infrared cameras. For this experiment, we collected highly accurate trajectories allowing us to quantify pedestrian crowd dynamics. The tests included 20 runs distributed over five days with up to 25 test persons. Additionally, to gain a better understanding of subjects' trajectories, we simulated a background of different pathway scenarios and compared it with real trajectories. Our theoretical framework takes the minimum error between previously simulated and real point pathways to predict future points on the subject trajectory.

Methods: This paper explores paths of 25 pedestrians along a known area. After obtaining the trajectory and their points of origin, we evaluated the speed with the objective to calculate the kinetic force of the pedestrian. In the present model, we assume that the principle of least action holds and using this concept we can obtain the potential force. Once all the forces of pedestrian movement are known, then we calculate the adjustment of the parameters employed in the equations of the social force model.

Results: It is possible to reproduce observed results for real pedestrian movement by using the Principle of Least Action. In the first scenario, we focused on a pedestrian walking without obstacles. Using the actual trajectories of the experiment we obtained the necessary information and applied it to the Social Force Model. Our simulations were clearly able to reproduce the actual observed average trajectories for the free obstacle walking conditions.

Conclusions: When a scenario does not represent free walking (obstacles, constraints), the potential energy and the kinetic energy are modified. Note that when the trajectory is real, the action is assumed to equal zero. That is the value of the potential energy changes in each interaction with a new obstacle. However, the value of the action remains. It is shown here that we can clearly reproduce some scenarios and calibrate the model according to different situations. Using different values of potential energy, we can obtain the values of the actual pathway. Nevertheless, as a significant extension concerning this model, it would be desirable to simulate cellular automata that could learn the situation and improve the approximation model to predict the real trajectories with more accuracy.

Keywords: Crowd dynamics; least-action principle; pedestrian simulation

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