The simulation dataset of each model for the circle antipode experiment

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**A R T I C L E   I N F O**

Article history:
Received 8 August 2021
Revised 19 November 2021
Accepted 29 November 2021
Available online 2 December 2021

Keywords:
Double-layer decision model
Detour decision
Voronoi diagram
Pedestrian dynamic

**A B S T R A C T**

This dataset includes trajectory data and video data produced by different models (including the traditional social force model, the Voronoi-based detour social force model and double-layer detour decision model) simulating the circle antipode experiment. During the simulation process, the coordinates of each pedestrian in each simulation step are recorded to form trajectory data, and each frame is recorded to form simulation video data. This data can provide an intuitive gap in the description of pedestrian detour behaviour among these pedestrian simulation models, and can be used as the comparative data when modify model to better describe pedestrian detour behaviour in the circle antipode experiment.

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Specifications Table

| Subject | Mathematical Modelling |
|---------|------------------------|
| Specific subject area | Modelling and Simulation; Engineering, Applied and Computational Mathematics; |
| Type of data | Table |
| Video |
| How data were acquired | The dataset is acquired by runs of simulation powered by pedestrian simulation model, and several models include the traditional social force model, the Voronoi-based detour social force model and the double-layer detour decision model are chosen to compare the performance of the model with respect to the characteristic of trajectories. All simulation is runs on a computer with Intel(R) Core(TM) i5–4590 CPU @ 3.30 GHz, and its system is windows 10 professional. |
| Data format | Raw |
| Analyzed |
| Parameters for data collection | The trajectory data is collected by the program when running the simulator of each model, there is no consideration of the condition when collection except the parameter of the simulation. The simulation parameter including the parameter of the simulation scene, the pedestrian and the model, these parameters are all listed in the research article [1]. |
| Description of data collection | In the process of using different models to simulate the circle antipode experiment, the coordinate of pedestrians in each step are recorded to form the trajectories data. At the same time, the pedestrian and its Voronoi diagram are drawn in each step, and record each frame by Matlab to form a simulation video. |
| Data source location | Institution: School of Traffic and Transportation Engineering, Central South University. |
| City/Town/Region: 22 South Shaoshan Road, Tianxin District, Changsha City. |
| Country: China. |
| Data accessibility | With the article |
| Repository name: The simulation dataset of each model for the circle antipode experiment |
| Direct URL to data: http://dx.doi.org/10.17632/bpdg9tf6k7.1 |
| Related research article | Li, Maosheng, Panpan Shu, Yao Xiao, and Pu Wang. “Modeling Detour Decision Combined the Tactical and Operational Layer Based on Perceived Density.” Physica A: Statistical Mechanics and its Applications 574 (2021). |
| https://dx.doi.org/10.1016/j.physa.2021.126021. |

Value of the Data

- These data describe the trajectory data simulated by computer under three different pedestrian detour models (the traditional SFM, the Voronoi-based detour SFM and the double-layer detour decision model) in the circle antipode experiment.
- These data provide a new perspective for all researchers who study pedestrian behaviour, i.e., pedestrian must have detour tendency, predictive, and congestion perception ability when behave detour behaviour, which is different from avoidance behaviour.
- These data are useful for researchers studying pedestrian detour behaviour in normal scenes and evacuation scenes, as well as architectural designers.
- Scholars who study the pedestrian detour behaviour in this circle antipode experiment can use this dataset as a visual comparison of the trajectory, and at the same time, they can further analyse the characteristics of pedestrian trajectory data.

1. Data Description

Table 1 is the pedestrian trajectory data simulated by the traditional social force model, it is a Matlab matrix and it contains the position coordinate of all pedestrian at each time step, the column represents the time step of the simulation and every two rows represent the po-
sition of one pedestrian, which is the x-axis coordinate and the y-axis coordinate. See “Traditional_SFM_traj.mat” in http://dx.doi.org/10.17632/bpdgbtn6k7.1.

Table 2 is the pedestrian trajectory data simulated by the Voronoi-based detour social force model, it is a Matlab matrix and it contains the position coordinate of all pedestrian at each time step, the column represents the time step of the simulation and every two row represent the position of one pedestrian, which is the x-axis coordinate and the y-axis coordinate. See “Voronoi-based_detour_SFM_traj.mat” in http://dx.doi.org/10.17632/bpdgbtn6k7.1

Table 3 is the pedestrian trajectory data simulated by the double-layer detour decision social force model, it is a Matlab matrix and it contains the position coordinate of all pedestrian at each time step, the column represent the time step of the simulation and every two rows represent the position of one pedestrian, which is the x-axis coordinate and the y-axis coordinate. See “Double-layer_detour_decision_traj.mat” in http://dx.doi.org/10.17632/bpdgbtn6k7.1

And the video of the simulation process of each model is displayed respectively, in each time step of simulation, the pedestrians are represented as red circle, and the Voronoi diagram of current distribution of pedestrian is plotted.

Video 1 is the simulation process of the traditional social force model to simulate the third of 10m-64p circle antipode experiment. See “Simulation of the traditional social force model.mp4” in http://dx.doi.org/10.17632/bpdgbtn6k7.1

Video 2 is the simulation process of the Voronoi-based detour social force model to simulate the third of 10m-64p circle antipode experiment. See “Simulation of the Voronoi-based detour social force model.mp4” in http://dx.doi.org/10.17632/bpdgbtn6k7.1

Video 3 is the simulation process of the double layer (the combination of the tactical and operational level) decision model to simulate the third of 10m-64p circle antipode experiment. See “Simulation of the double-layer detour decision model.mp4” in http://dx.doi.org/10.17632/bpdgbtn6k7.1

2. Experimental Design, Materials and Methods

The dataset is produced by the simulation experiment, which is the pedestrian simulation model to simulate the circle antipode experiment. In the experiments, 64 pedestrians were uniformly distributed on the circle with a radius of 10 m at the very beginning, and they were required to leave for the antipode position of the circle at the same moment. The traditional social force model, the Voronoi-based detour social force model and the double-layer detour decision model are chosen as the simulation model.

In the traditional social force mode [2], the movement of pedestrians is affected by three hypothetical forces. The first force $F_i$ is the driving force of pedestrians walking at the desired speed and direction. The second force $F_{ij}$ is the repulsion force between pedestrians due to their close proximity. The third force $F_{iw}$ is the repulsion force among pedestrian and the walls, the interaction is treated analogously.

$$m_i a_i = F_i + F_{ij} + F_{iw}$$  \hspace{1cm} (1)

Here, $m_i$ is the mass of the pedestrian $i$; $a_i$ is the acceleration of the pedestrian $i$.

Based on the traditional social force model, the Voronoi-based detour social force model [3,4] uses Voronoi diagram to determine detour direction $e^{detour}$ and speed $v$.

$$e^{detour} = \frac{N_k - x_i}{\|N_k - x_i\|}$$  \hspace{1cm} (2)

Here, $N_k$ is the node of the Voronoi diagram; $x_i$ is the location of the pedestrian $i$.

$$v = \min\left(v_{max}, \frac{l_k}{\tau}\right)$$  \hspace{1cm} (3)

Here, $l_k$ is the distance between $x_i$ and the node $N_k$ of the Voronoi; $\tau$ is the reaction time of the pedestrian; $v_{max}$ is the maximum speed of the pedestrian walking.
In the double-layer detour decision model [1], the movement of pedestrian depends on the joint guidance of tactical layer and operation layer [5]. At the tactical layer, the pedestrian detour path is determined by the congestion degree prediction in the pedestrian’s visual field. At the tactical layer, the path direction is set as the target direction of the Voronoi-based detour social force model. Divide the visual sector area of pedestrians into 2M sector sub areas on average, and marked as $VR_i = \{A_{i1}, \ldots, A_{iM} \}$ ($i = 1, 2, \ldots, 2M$). If $n < M_0$, it is the straight point, otherwise it is the detour point. The pedestrian perception density of each sub-sector after $t_i$ moment can be calculated by Eq. (4).

$$D_{A_{in}}(t + t_i) = \begin{cases} \frac{p_{A_{in}}(x_i)}{|A_{in}|} \cdot |\vec{V}_i|; & \text{if } n < M_0 \\ \frac{p_{A_{in}}(x_i)}{|A_{in}|}; & \text{otherwise} \end{cases}$$  \hspace{1cm} (4)$$

Here, $p_{A_{in}}(x_i)$ is the density of pedestrians based on the Voronoi diagram. $|A_{in}|$ is the size of the area $A_{in}$; $|\vec{V}_i|$ is the current velocity value; $A_{in}$ is the desired velocity.

The corresponding path points $\{DP_{i1}, \ldots, DP_{iM}, \ldots, DP_{i2M} \}$ are distributed on the middle points of the sector-shaped arc. The travel cost of each path point can be calculated by Eq. (5).

$$E_{(in)} = k_1 \cdot \frac{\sum_{n=1}^{2M} ||DP_{in} - x_{i}^\text{dest}||}{\sum_{n=1}^{2M} ||DP_{in} - x_{i}^\text{dest}||} + k_2 \cdot \frac{D_{A_{in}}(t + t_i)}{\sum_{n=1}^{2M} D_{A_{in}}(t + t_i)}$$  \hspace{1cm} (5)$$

Here, $x_{i}^\text{dest}$ is the target position of the pedestrian; $k_1$ and $k_2$ is the weight parameter.

Therefore, the optimal path point $DP_{o}$ can be determined by Eq. (6).

$$DP_{o} = \arg\min(E_{in})$$  \hspace{1cm} (6)$$

Correspondingly, the detour direction can be determined by formula (7).

$$e^\text{detour} = (DP_{o} - x_i)/||DP_{o} - x_i||$$  \hspace{1cm} (7)$$

**Ethics Statement**

The authors declare that the work did not involve the use of human subjects, animal experiments, or social media data and that all authors have read and agreed to the final version of this article.

**Declaration of Competing Interest**

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

**CRediT Author Statement**

**Maosheng Li**: Conceptualization, Methodology, Writing – review & editing; **Qingyan Ning**: Writing – original draft; **Panpan Shu**: Methodology, Software, Writing – original draft.

**Acknowledgments**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
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