Development of a Computer-Vision Based Real-Time Pedestrian Comfort Estimation System

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1. Introduction

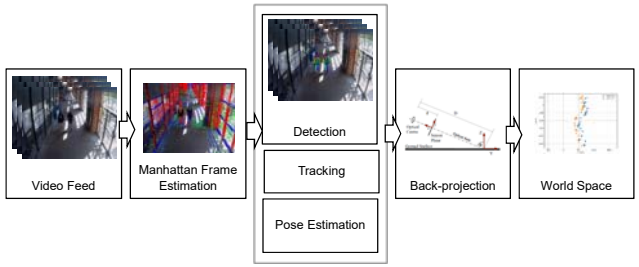
❑ Problem Statements

- Pedestrian comfort is often represented by pedestrian level of service (PLOS). PLOS usually measured using aggregated level of pedestrian volume, speed, and/or density.
- Very few studies have considered individual pedestrians' specific gait characteristics to present pedestrian comfort. However, they did not measure individual pedestrians' comfort real-time basis.

❑ Study Goal

- Develop a novel method that can measure individual pedestrians' comfort real-time basis using pedestrians' gait characteristics.

2. Methodology

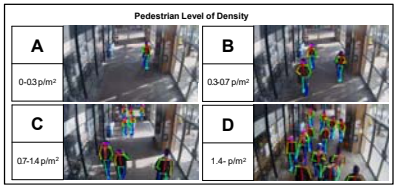


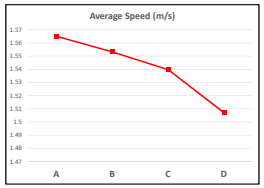
- We automate the extraction of 2D pedestrian gait characteristics from CCTV camera and transform it into 3D representation real-time basis.
- Multi-pedestrians' walking poses were detected using OpenPose and Kalman filter is applied to track individual pedestrians' different walking poses for each and every frame.
- Homography transformation technique is used and 2D walking poses are back-projected into ground plane and obtained world space of walking poses.
- Savitzky-Golay filter is applied to reduce redundant jumpy samples that was stored in five frames per second original data.

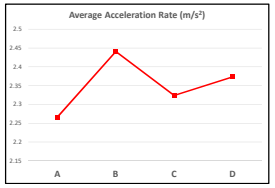
3. Analysis Results

❑ Speed and Acceleration Rate per Pedestrian Level of Density

- Average pedestrian speed is decreased from 1.565 to 1.507 as pedestrian density increases.
- Average pedestrian acceleration rate is fluctuated within the range from 2.270 to 2.440 as pedestrian density increases.





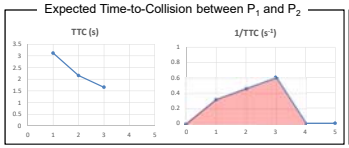


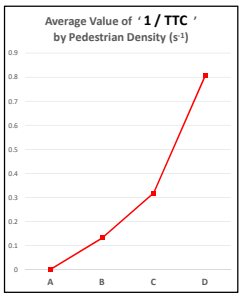
❑ Time-to-Collision (TTC) among Pedestrians

- Each circle (with r = 0.2 m) represents a person. We estimated the expected time when two moving circles may collide each other.

$$(O_{Ax} + V_{Ax}t - O_{Bx} + V_{Bx}t)^2 + (O_{Ay} + V_{Ay}t - O_{By} + V_{By}t)^2 = (r_A + r_B)^2$$

- O_A and O_B present position of pedestrian A and B; V_A and V_B present speed of pedestrian A and B; t present each measurement time.
- We searched t if it exists.





4. Findings & Future Works

❑ Findings

- As pedestrian density increases, average speed based on individual pedestrian speed is decreased, whilst average acceleration rate based on individual pedestrian acceleration rate is fluctuated.
- As pedestrian density increases, the inverse of TTC is increased from zero to 0.8. The inverse of TTC can be viewed as a type of pedestrian comfort.

❑ Future Works

- Add additional gait characteristics such as trajectory of pedestrians to present tailored pedestrian comfort for each pedestrian.
- Consider pedestrians' different moving direction in estimating individual pedestrian comfort.
- Develop a more comprehensive index of pedestrian comfort using an advanced methodology such as artificial intelligent technique.
- Apply the developed method to more complex walking environments such as subway platforms.
- Search a way to improve pedestrian walking environment using developed index of pedestrian comfort.

5. Acknowledgement

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