

Pedestrian Flow Estimation Using Sparse Observation from Autonomous Vehicles

Ranulfo Bezerra

Kazunori Ohno

Thomas Westfechtel

Satoshi Tadokoro

Tohoku University

BEZERRA.RANULFO@RM.IS.TOHOKU.AC.JP

KAZUNORI@RM.IS.TOHOKU.AC.JP

THOMAS@RM.IS.TOHOKU.AC.JP

TADOKORO@RM.IS.TOHOKU.AC.JP

1. Introduction

Autonomous driving vehicles have to understand their environment to a high degree in order to operate safely in highly dynamic environments. This includes not only the static scene, but more importantly the behaviour of other traffic participants, like other vehicles and pedestrian. One major difficulty for such systems is the unpredictability of pedestrian movement in traffic zones. Pedestrian often tend to ignore traffic sign and for example cross the street even when there is no designated crosswalks [Rasouli and Tsotsos \(2019\)](#). To overcome this problem we present a pedestrian flow estimation from sparse observation data for autonomous vehicles.

The goal of this proposal is to estimate the flow of pedestrians using sparse observation from autonomous vehicles. Traffic control, risk detection and autonomous safe driving systems are essential for the evolution of intelligent transportation systems. Moreover, the unpredictability of pedestrian movement in traffic zones makes it necessary the study and development of people flow analysis. However, pedestrian data acquired by autonomous driving cars have sparse observation, which means that from most of the data obtained by the car's sensors there are scarce regions of pedestrian data. In contract to surveillance cameras that continuously capture a single spot, the data captured by the car spans a large area, but each spot is only captured for a limited period of time as the car drives by.

In this work we propose a pedestrian flow estimation for sparse observation data. The main contributions of the work are the estimation of pedestrian flow using a sparse data gathered by autonomous electric vehicle, and the graph of the pedestrians where the nodes have information gathered by detecting and tracking pedestrians.

2. Methodology

We employ two main methods to predict the pedestrian flow in the surrounding. Firstly we detect, track and cluster pedestrian observed during our trial runs. As the data is gathered from a moving vehicle, there is only sparse pedestrian data for many places. To overcome this problem we employ our second main technique. The pedestrian clusters are employed

to build a pedestrian flow graph that connects the sparse pedestrian observations using the flow direction which lets us predict a more dense pedestrian flow map.

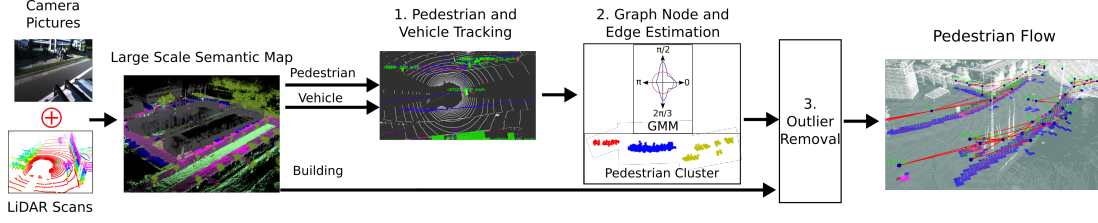


Figure 1: Flow graph-based model representation. The center of each node is represented by the blue sphere, and the red links between nodes show the flow of people.

3. Results

An autonomous electric vehicle (AEV) was used to gather data from an urban environment in Sendai, Japan. The AEV gathered LIDAR, camera, GPS and encoder data throughout the experiment. The AEV drove around 2 kilometers extracting LiDAR scan points and camera images used in this experiment. The outlier techniques described in this work successfully detected and removed 81% false positive edges from the graph. After analysing the the coverage of the area, the graph-based pedestrian flow shows an increase of 37% of coverage of pedestrian density.

4. Conclusion

This work shows how to create a pedestrian flow using sparse data from electric vehicle. A graph structure is used to represent the pedestrian flow, where each node represent a region of pedestrian observation, and each edge represent the flow between two clusters. Moreover, the link between two clusters is determined through a probabilistic approach, where the heading direction information extracted from the pedestrian data is used to generate a Gaussian mixture model of the pedestrians heading direction in each region.

In our future work, the flow graph will be used to infer context information, such as vehicle entrance, pedestrian entrance, bus stop, crosswalk and dangerous regions where pedestrians cross the street without crosswalk or traffic signs.

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References

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