Behavioral Models of the Interaction Between Non-Motorized and Motorized Road Users – Focus on Automated Vehicles

Master‘s Thesis of Chenxin Zhu

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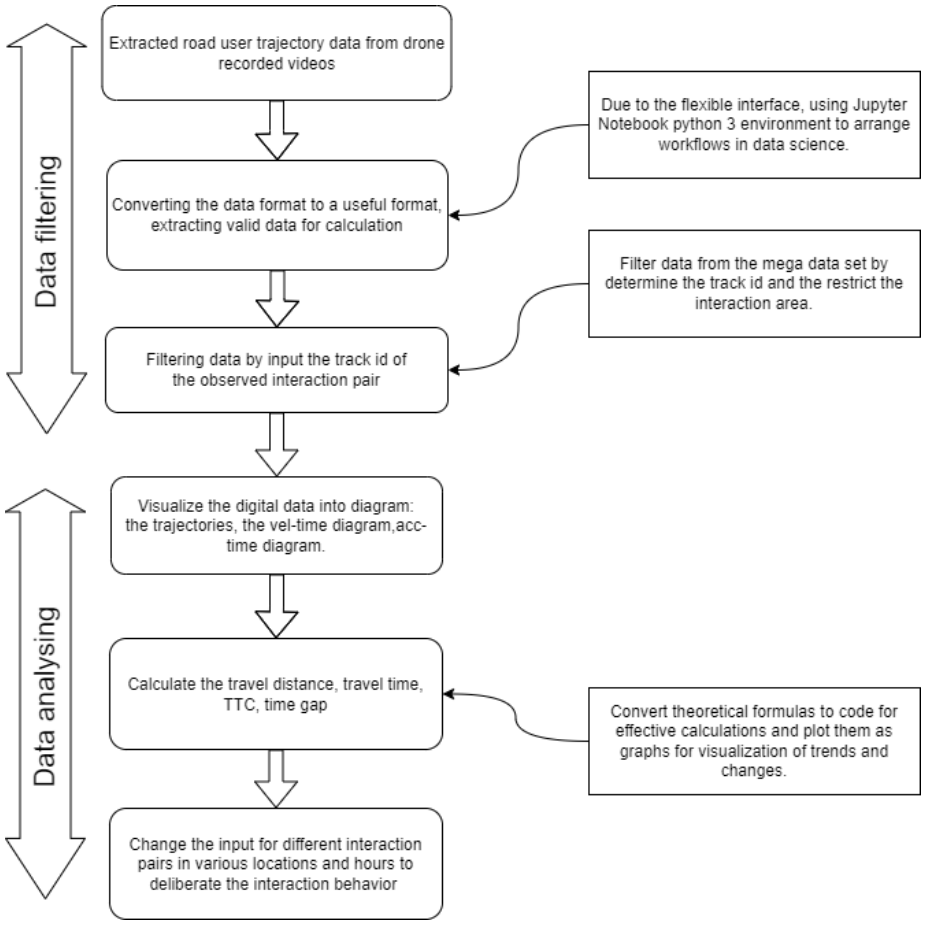

Figure 1: Proposed methodology of the model

Data Analysis and Model Description

The raw data consists of mega files evaluated from each individual video recorded by drones that includes seven parameters to describe the current condition of the objects in observed area. These extracted data are in JSON form which is an interchange format that uses human-readable text to store and transmit data objects. Transforming the JSON files into CSV files and Python Pickle files could efficiently process the useful data and describe the data buildup. The proposed methodology of the model is visually depicted as a flowchart in Figure 1. By employing a behavior model to process the data, crucial parameters such as velocity, acceleration, time-to-collision (TTC), and post encroachment time (PET) can be retrieved to provide a systematic approach to assess the temporal and spatial aspects of VRU-vehicle interactions, furthermore to quantitatively analyze and classify various urban traffic scenarios. The model is built in Jupyter Notebook python 3 enviroment to arrange workflows in data science.

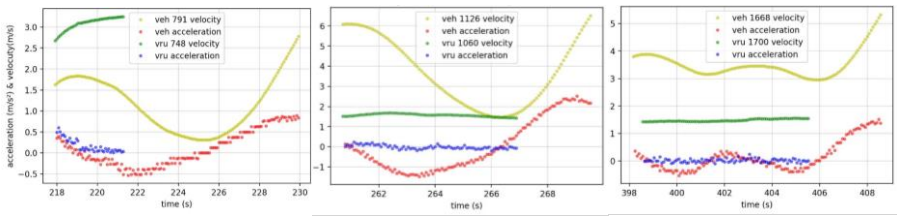

Figure 3: Velocity and acceleration profile of both veh and VRU sample pairs in interaction area 1-A, 2-B, 3-C

Introduction

In traffic situations that involve vulnerable road users (VRU), accidents occur relatively frequently due to the complexity of interactions and behavior patterns among traffic participants. To simulate interactions between vehicles and VRUs in shared areas, detecting them in videos or images to explore their behaviors is an important but challenging solution. The motivation of this thesis is to optimize the dynamic interaction condition in traffic flow data and could highly benefit from the drone-video-based road user data evaluation of interaction. The generated behaviour model can be used to better understand road users' behavior based on analyzing the video data and visualize the interactions.

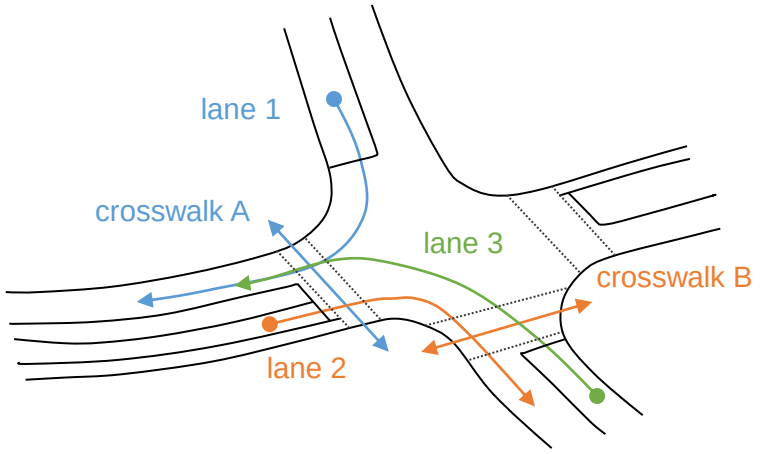

Figure 2: Simplified observed intersection

Results

The various comparisons were explored in different aspects using the control variable method. The estimation of the impact of the change of daytime, different VRU types, such as pedestrians and bicyclists, different interaction turning performanceon calculated metrics and road safety dynamics were reached from the analysis of video annotated data and modeling of interaction areas.

Figure 2 shows the distinct interaction types of left- and right-turning vehicles from the three interaction areas 1-A, 2-B, and 3-A in a X-intersection. The model calculated velocity and acceleration of the participants from selected interaction pairs in each area is visualized as trending profile in Figure 3 to determine the behavoir of VRUs and vehicle while interacting with each other in different situations. The vehicle's behavior is similar in all three areas, characterized by initial deceleration until the VRUs pass, with the acceleration from positive to negative. The VRUs' velocity remains stable, exhibiting only minimal variations, resulting in nearly parallel lines to the x-axis.

As for different type of VRUs, TTC of bic-veh is slightly smaller than ped-veh, pedestrians tend to maintain a consistent walking speed, resulting in a smoother trajectory during the interaction with vehicles; when interacting with vehicles, VRUs may adjust their paths slightly to maintain a safe distance from the vehicle; TTC tends to rise, while traffic volume increases during peak hours from 5.2 seconds to 7.78 seconds, indicates higher safety margins and reduced risk levels for vulnerable road users.