Master's thesis in Mechanics and Maritime Sciences (MMSX30)
Mobility Engineering, MSc (MPMOB)

Master Thesis: Road-User Interaction Analysis by Combining Camera and LiDAR Data for Automatic Video Reduction

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Background

Road user interactions are a crucial aspect of transportation safety, and the ability to accurately analyze these interactions is essential for developing effective transportation policies and safety measures. To this end, researchers have turned to naturalistic video data as a source of information for analyzing road user interactions[1].

However, analyzing naturalistic video data poses several challenges, one of which is the need to manually reduce the amount of data collected[2] This process is often time-consuming and labor-intensive, making it difficult to scale up data collection and analysis. Additionally, analyzing video data manually is prone to errors and subjectivity.

To address these challenges, researchers have begun to explore the use of environment perception technologies such as computer vision for automatic video reduction[3]. However, the extraction of the kinematics of other road users is not obvious using video footage only.

LIDAR can provide accurate 3D data on the position and movement of road users, while cameras can capture detailed visual information that can aid in identifying road users and their behavior. Using LIDAR as ground truth, one could develop a machine-learning model that uses video footage to estimate the speed and distance of surrounding road users. These machine learning models together can help to automate the process of reducing video data by automatically identifying and tracking road users and their kinematics. This can significantly reduce the amount of manual labor required and improve the accuracy of the data collected.

In this thesis, I propose to explore the use of environment perception technologies such as LIDAR and Computer Vision for automatic video reduction in analyzing road user interaction behavior. Specifically, I aim to develop algorithms for extracting road user kinematics from video data. These algorithms will enable the automatic extraction of positions and speed from naturalistic video data, providing a more accurate and comprehensive understanding of road user interactions.

This research might help in transportation safety and policy development after due and careful analysis of road user interaction.

Objective
Calibration of Camera using LIDAR and development of an algorithm for automatically extracting speed and distance of selected road users. Further, using the algorithm on naturalistic data to analyse road user behavior.

Methodology
The methodology to solve this problem can be described in the following steps:
1. Literature Review: reviewing and planning the scope of the problem and defining the objective. It involves benchmarking methodologies already published.
2. Data collection: Collecting the training and validation dataset essential for the development of the machine learning models. This would involve understanding the system
3. Algorithm design: For identifying and segmenting road users and extracting the distance and speed. This could use CNN and be applied using an appropriate programming language.
4. Verification: The algorithm would then be tested against the output of LIDAR which could be considered as ground truth.
5. Data Analysis: The algorithm is applied to naturalistic data available to understand road user interaction perhaps involving an e-scooter.

References

1. Background on the importance of analyzing road user interactions: National Highway Traffic Safety Administration. (2019). National motor vehicle crash causation survey: Report to congress. Retrieved from https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812630
2. Challenges of manual video data reduction: Drew, T., Starner, T., & Saponas, T. S. (2016). Roadside computing: Moving beyond manual video analysis. IEEE Pervasive Computing, 15(2), 30-39.
3. Advantages of LIDAR and camera-based perception technologies: Wang, Y., Xiong, H., Gou, L., Zhao, X., & Zhang, L. (2019). Visual and LiDAR-based perception for intelligent vehicles: A review. Journal of Advanced Transportation, 2019.

Here is the Gantt chart proposing the schedule: