Estimation of Bicycle Front Wheel Steering Angle and Cyclist Orientation Based on LiDAR Data

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April 16, 2025

Abstract

Autonomous driving technology is rapidly evolving, and safety remains a core issue—particularly when it comes to vulnerable road users such as pedestrians and cyclists, and the cyclists typically move faster than pedestrians, so predicting the cyclist orientation is a significant challenge for autonomous vehicle systems.

This research plan proposes a new approach to estimate cyclist orientation based on LiDAR data by focusing on the steering angle of the bicycle's front wheel, as a supplement to the research on cyclist orientation with rider's body, rather than the rider's body or head, which are occluded sometimes (e.g., by helmets or raincoats), the steering angle of the front wheel directly influences the direction of riders and is less affected by rider variations such as age, gender or riding status.

Proposed Method

Since this research plan focuses on the front wheel steering angle of the bicycle body, we choose 3D point cloud data with reflectivity as the primary input for model training. To improve the generalization ability of the model, one idea is to classify the data based on bicycle type or material. This allows the model to learn type-specific features through targeted training.

The LiDAR sensor data is first converted into Point Cloud Data (PCD) format, then input to ResNet50 model, which is useful in overcoming the "vanishing gradient" problem, enabling the training of deeper and effective networks.[1] To train the model for steering angle prediction, we define the loss function in the fully connected layer as Mean Squared Error, which measures the difference between the predicted and truth steering angles.

Furthermore, many existing studies on bicycle kinematic models provide methods to relate the front wheel steering angle with the cyclist's orientation, which can be referenced for further analysis.

Discussion

The core of this research plan is to process the data and training a CNN model to estimate the bicycle's front wheel steering angle. To further evaluate the feasibility of this plan, I will systematically study deep learning with relevant courses.

Reference

1. Hyoungwon Chang, Yanlei Gu, Igor Goncharenko, Li-Ta Hsu, Chinthaka Premachandra, "Cyclist Orientation Estimation Using LiDAR Data", Sensors, Vol. 23, No. 6, pp. 1-15, 2023.
2. Yanlei Gu, Yun Song, Igor Goncharenko, “Cyclist Intention Estimation at Signalized Intersections Using Deep Neural Networks”, 2023 IEEE 12th Global Conference on Consumer Electronics (GCCE2023), Nara, Japan, October 9-13, 2023.