

Radar on Bike: Coarse Classification based on Multi-Level Clustering for Cyclist Safety Enhancement

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Abstract : Cycling, a popular mode of transportation, can also be perilous due to cyclists' vulnerability to collisions with vehicles and obstacles. This paper presents an innovative cyclist safety system based on radar technology designed to offer real-time collision risk warnings to cyclists. The system incorporates a low-power radar sensor affixed to the bicycle and connected to a microcontroller. It leverages radar point cloud detections, a clustering algorithm, and a supervised classifier. These algorithms are optimized for efficiency to run on the TI's AWR 1843 BOOST radar, utilizing a coarse classification approach distinguishing between cars, trucks, two-wheeled vehicles, and other objects. To enhance the performance of clustering techniques, we propose a 2-Level clustering approach. This approach builds on the state-of-the-art Density-based spatial clustering of applications with noise (DBSCAN). The objective is to first cluster objects based on their velocity, then refine the analysis by clustering based on position. The initial level identifies groups of objects with similar velocities and movement patterns. The subsequent level refines the analysis by considering the spatial distribution of these objects. The clusters obtained from the first level serve as input for the second level of clustering. Our proposed technique surpasses the classical DBSCAN algorithm in terms of geometrical metrics, including homogeneity, completeness, and V-score. Relevant cluster features are extracted and utilized to classify objects using an SVM classifier. Potential obstacles are identified based on their velocity and proximity to the cyclist. To optimize the system, we used the View of Delft dataset for hyperparameter selection and SVM classifier training. The system's performance was assessed using our collected dataset of radar point clouds synchronized with a camera on an Nvidia Jetson Nano board. The radar-based cyclist safety system is a practical solution that can be easily installed on any bicycle and connected to smartphones or other devices, offering real-time feedback and navigation assistance to cyclists. We conducted experiments to validate the system's feasibility, achieving an impressive 85% accuracy in the classification task. This system has the potential to significantly reduce the number of accidents involving cyclists and enhance their safety on the road.

Keywords : 2-level clustering, coarse classification, cyclist safety, warning system based on radar technology

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