Research Title:

Sensing for Autonomous Vehicles in Dense Urban Environments

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The performance of Advanced Driver Assistance Systems (ADAS) and Autonomous Vehicles (AVs) critically depends on the quality of their sensor suites, which typically combine cameras, LiDARs, and radars. Among these sensors, automotive radar plays a central role due to its ability to provide robust range and velocity measurements under adverse weather and lighting conditions. However, radar operation in dense urban environments is severely affected by multipath propagation, where signals reflect off surrounding structures and vehicles, producing spurious “ghost” detections that degrade perception accuracy.

This research addressed this challenge by developing an automated multipath annotation framework for automotive radar datasets. The framework was designed to compensate for the lack of accurately annotated data suitable for deep learning (DL) applications. It automatically detects and labels multipath reflections, distinguishing them from real targets and classifying them according to multipath type and order. This enrichment enables data-driven models to better learn the characteristics of multipath phenomena.

The developed annotation pipeline was applied to the NuScenes dataset, a large-scale multimodal collection containing approximately 1000 driving scenes and 1400 hours of recorded data. Through this process, the dataset was augmented with detailed annotations that associate each radar detection with its reflection properties.

Based on the enriched data, a Graph Neural Network (GNN) architecture was implemented and trained for fine-grained multipath classification. The GNN effectively modeled the geometric and spatial relationships between radar detections and reflectors, demonstrating the ability to identify multipath-induced artifacts and differentiate them from genuine targets.

The study delivered a comprehensive annotated radar dataset, a validated GNN-based classification model, and quantitative evaluations showing significant improvements in multipath recognition and suppression compared to baseline deep learning methods. These results contribute to improved radar perception reliability in complex urban environments, supporting safer and more accurate sensing for modern automotive systems.