ABSTRACT

LiDAR Placement Optimization Using a Multi-Criteria Approach

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Most road fatalities are caused by human error. To help mitigate this issue and enhance safety, companies are turning to Advanced Driver Assistance Systems (ADAS) and Autonomous Vehicle (AV) development. A key module, Light Detection and Ranging (LiDAR) sensor, facilitates obstacle detection and environment mapping. In spite of extensive research on LiDAR for autonomous driving, further exploration into LiDAR placement remains vital. This thesis begins with a comprehensive review of different sensor technologies, exploring their specific strengths and weaknesses, including Camera, Radio Detection and Ranging (RADAR), Global Positioning System (GPS), and Inertial Measurement Unit (IMU). Subsequently, a methodological framework is established and implemented for LiDAR Placement Optimization, leveraging Multi-Criteria Decision Analysis (MCDA). While MCDA has been widely employed in various aspects of AV development and adoption, its application in LiDAR placement optimization remains relatively unexplored. Given the numerous criteria and placement alternatives, MCDA emerges as an effective tool for optimizing LiDAR placement. The evaluation of LiDAR placement alternatives involves diverse criteria, including point density, blind spot regions, sensor cost, power consumption, percentage of detection, sensor redundancy, ease of installation, and aesthetics. Data collection methods comprised the utilization of the CARLA simulator, sensor datasheets, and questionnaires. To standardize measurement units, scaling was implemented through value functions derived from respondent data. The data was analyzed by employing weighting techniques, including equal weighting serving as a baseline, sensitivity analysis with randomly generated weights, and weighting from respondents. Finally, the weighted and scaled criteria measures were amalgamated to derive the overall performance scores of each alternative LiDAR placement design, thereby ranking them to identify top performing and worse performing placements. Therefore, the optimization method used is enumeration. The findings in this study results serve as a reference to determining optimal LiDAR placements based on select criteria and can contribute to a better understanding of LiDAR placement's impact on AVs, enabling cost-effective design of their placement and ultimately, improving traffic safety.