Autonomous Parking System Development and Evaluation Using CARLA

Background: Autonomous parking significantly enhances convenience and safety in urban environments. Unlike traditional parking assistance systems, fully autonomous parking integrates perception, planning, and decision-making to detect parking spots, assess surroundings, and execute maneuvers without human intervention. The challenges include detecting dynamic obstacles, varying parking space shapes, and adapting to different lighting and weather conditions. These systems must handle real-time tracking of pedestrians and moving vehicles, requiring robust object detection and motion prediction algorithms.

Proposed Study: The failure of autonomous parking systems in challenging scenarios is a significant issue. Deep learning models often struggle with extreme lighting conditions, ambiguous parking spaces, and severe occlusions. This project aims to explore the performance of state-of-the-art deep learning algorithms for autonomous parking under various scenarios (night, rain, snow) using the CARLA simulator. CARLA supports research in autonomous vehicle development, model training, and algorithm validation.

The study will focus on several key tasks. First, it will involve detecting available parking spaces by employing computer vision and deep learning models to identify parking spaces from camera images and lidar data, handling occlusions and edge cases such as tight spaces or misaligned spots. Second, it will explore different types of parking maneuvers, including parallel, perpendicular, and angled parking, developing algorithms responsible for planning safe paths for the vehicle to park in these scenarios. Third, the system will be tested in dynamic environments with pedestrians, other vehicles, and moving obstacles, using object detection algorithms to track moving obstacles and adjust parking strategies accordingly. Finally, the system's performance will be evaluated under various environmental conditions, incorporating different weather conditions (e.g., rain, fog, or snow) and varying lighting scenarios (night, dawn, or bright sunlight). The evaluation will focus on accuracy, robustness, and the time required to park under these conditions.

This study will provide a comprehensive understanding of the current challenges in autonomous parking and inspire novel enhancements. By addressing these challenges, the project aims to enhance the safety and efficiency of autonomous parking systems, contributing to the overall advancement of autonomous driving technology.