Software and Hardware Systems for Autonomous Smart Parking Accommodating both Traditional and Autonomous Vehicles

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Project Objective

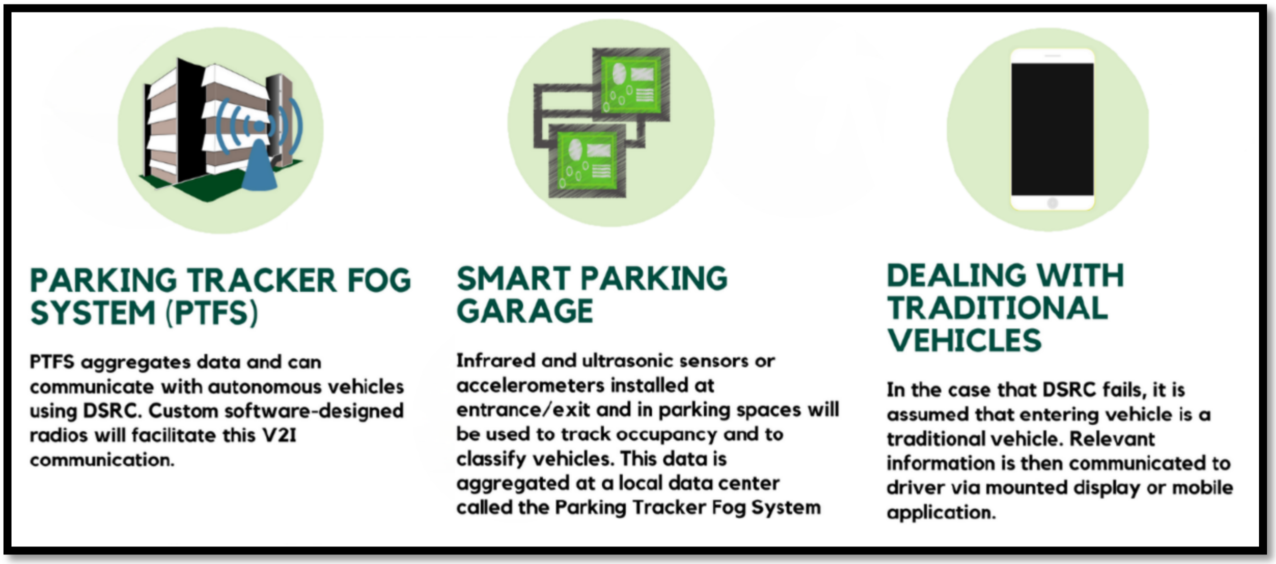

Figure 1: Parking Tracker Fog System

Parking infrastructure is suffering from congestion as the number of vehicles circulating in urban areas is growing and expansion is not a cost-effective solution. In parallel, developments in autonomous vehicle technology mean that driverless vehicles are predicted to be in circulation by the 2020s and makeup 40% of vehicle travel by the 2040s. Expected benefits of autonomous vehicle travel include reduced congestion through vehicle sharing and reduced walking distance for passengers who can be dropped off chauffeur-style by autonomous vehicles. However, empty vehicle cruising, or the case in which autonomous vehicles cannot efficiently locate parking and circle instead, can potentially increase congestion. Given that this new technology has the potential to exacerbate existing congestion issues, it is necessary to develop a solution for parking congestion integrated with autonomous vehicles. Our project addresses this issue by providing a full-stack solution including sensors to monitor occupancy, Fog systems to perform local data pre-processing, and SDR radios to communicate with autonomous vehicles, refer to Figure 1.

Problem Statement

Current infrastructure supports parking guidance information and a parking reservation system for traditional vehicles with smartphone-equipped users. DSRC has also been successfully employed in V2V and V2I communications. As such, the research challenge is integrating autonomous vehicles into existing smart parking platform options. This entails not only securing DSRC connections between smart parking systems and autonomous vehicles, but also ensuring that the system provides sufficient information for successful parking services in real time.

Research Methodology

The challenge of integration is addressed by developing a full stack system that will accomplish the following: monitor a parking garage's occupancy, classify vehicles within the parking garage, aggregate location data for available spaces and associated mapping data, and assign them to the respective vehicles to be routed to it.

Results

The work throughout this project showcased hardware and software implementation of a smart parking system that can communicate with both traditional and connected vehicles alike. This comes as a step towards evolving the existing parking infrastructures to accommodate the estimated wide-scale adoption of autonomous vehicles and connected vehicles, which would require real-time information about available parking services. In this regard, we developed a Parking Tracker Fog System (PTFS) that can establish communication through traditional wireless communication and DSRC which is the expected communication technology for connected vehicles, refer to Figure 3. We conducted several experiments through simulations and Hardware setup demos, as shown in Figure 2, to assess the reliability of the parking information exchange in real-time for both traditional and DSRC-based communications. Finally, we foresee our work being scalable to multiple parking spaces, each represented through its own PTFS, and all PTFSs are managed through a central cloud that can alleviate the smart parking services to a city-wide level and complement it with parking occupancy predictions.

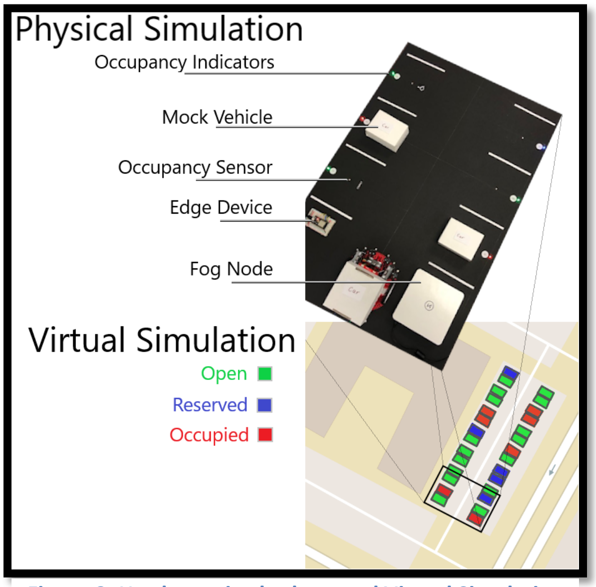

Figure 2: Hardware-in-the-loop and Virtual Simulation

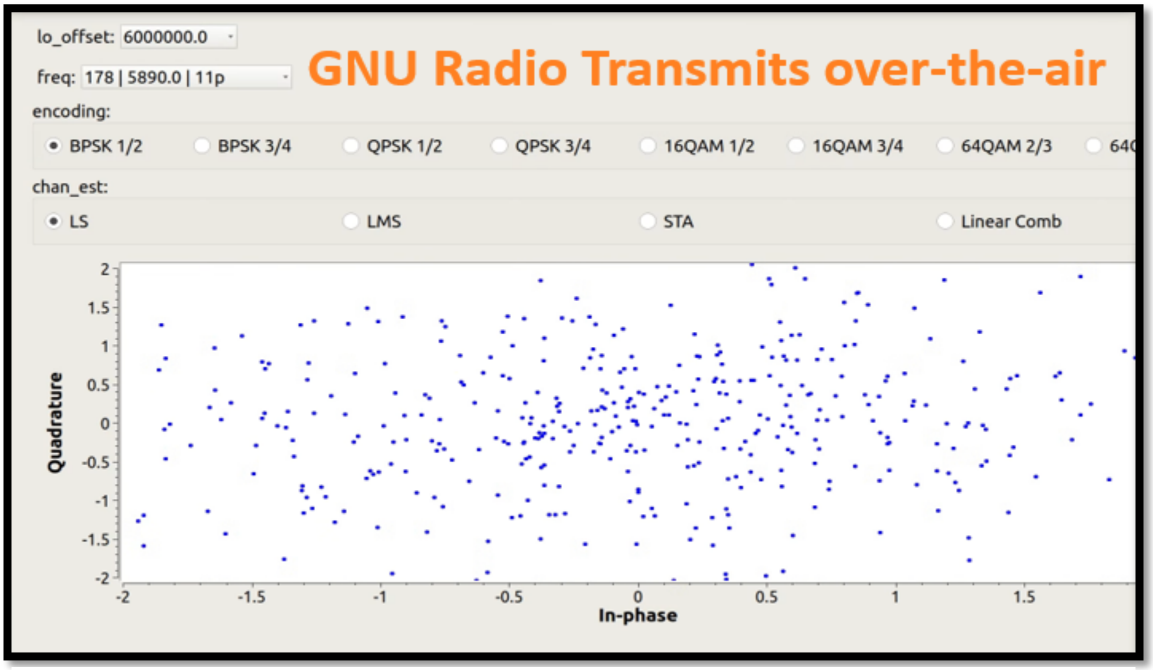

Figure 3: DSRC Communication