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Active Park Assist

Motivation

As high quality camera, radar and “by-wire “technology becomes available to automotive manufacturers, more autonomous driving functions can be developed. In theory, autonomous driving eliminates driver error and ensures that the vehicle desired maneuvers can be carried out in an accurate and safe manner.

Parking a vehicle can be a stressful situation for any driver. By taking advantage of technology already available on the vehicle to support other active safety functions, we can develop a system that will allow a driver to automatically park their car with minimal interaction.

Active Park Assist Description

The Active Park Assist feature allows a vehicle to automatically park itself in either a parallel or perpendicular parking space. The interaction with the customer is through the HMI (Human Machine Interface) only. The vehicle will 1) identify the parking spot, 2) accelerate/brake the vehicle 3) choose forward or reverse as required and 3) steer the vehicle into the parking spot.

The customer must first activate the feature through the HMI, and choose the type of parking (parallel or perpendicular). The HMI will then proceed to identify the available parking spots. Both front and rear cameras are available to be used to identify the parking spot. Ultrasonic sensors, mounted on the side of the vehicle, can be used to measure the available spaces between vehicles in a parallel parking situation, to identify spots that are large enough to fit into. Once a spot has been identified, the HMI will look for the customer to verify the selection.

Once the spot is verified, the Active Park Assist feature takes over the driving of the vehicle. The system will shift the automatic transmission into the appropriate range (reverse or drive) and will accelerate, brake, and steer the vehicle into the parking spot.

During the maneuver, radar/camera system will continue to monitor vehicle position to ensure that vehicle does not bump into any of the other parked vehicles.

At the end of the maneuver, the Active Park Assist feature will put the automatic transmission into the Park position, and indicate to the customer that the parking process has completed. At that point, the feature is inactive and the customer takes over the control of the vehicle.

While customer interaction is not necessary, it may happen during the parking maneuver. If the customer steps on the brake (for example) the system will abort, and normal driving mode will resume. The customer is notified through the HMI that Active Park Assist has been aborted.

The system should be able to identify obstacles that have moved into the path of the vehicle after a parking maneuver has started, and take action (i.e. stop the vehicle).

Security Constraints

The system must have a means of verifying that the driver has initiated the request, and the request was not a result of a fault in the HMI system, or a malicious 3rd party attack.

Safety Constraints

- The system shall prevent the vehicle from hitting obstacles that move into its path during the parking maneuver
- Once a parking event is initiated, it shall be complete in a reasonable period of time.
- A single point failure of any sensor input shall be detectable.

Subsystems involved in the Active Park Assist System:

- 1) Park Control Subsystem: masters the Active Park Assist feature. It accepts the customer input from the HMI subsystem, calculates the vehicle trajectory based on information from the Vehicle Position Subsystem, and issues commands to the other subsystems.
- 2) Powertrain Management Subsystem: accepts inputs from the Park Control Subsystem to accelerate the vehicle and select the gear lever position in order to meet the required trajectory.
- 3) HMI Subsystem: accepts customer inputs, displays camera information, and handles telltales / warnings.
- 4) Brake Control Subsystem: accepts inputs from the Park Control Subsystem to brake the vehicle in order to meet the required trajectory.
- 5) Steering Control Subsystem: accepts inputs from the Park Control Subsystem to steer the vehicle in order to meet the required trajectory.
- 6) Vehicle Position Subsystem: processes data from the vehicle's cameras / radar in order to identify parking spots and verify vehicle position throughout the duration of a parking event.

Scenarios

Scenario One: Fully working system as described above. Demonstrate a normal parallel parking scenario. Assume that the length of the parking spot must be $> 1.2x$ the length of the vehicle. The vehicle speed should be limited to < 5 mph.

Scenario Two: Consider at least one system failure mode. For example, the Brake Control System indicates a fault, or the Radar/Camera system indicates a fault. Can a parking maneuver complete if the failure is detected during a parking maneuver? What is the fail safe state the system should revert to?

Scenario Three: Consider the security of the system. The Park Control Subsystem effectively takes over the “role” of the driver. What if this system is hacked? What measures can the supporting subsystems take to ensure that it is the Park Control Subsystem issuing the driving commands and not a hacker?