Active Park Assist

Requirements Definition

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General Purpose and Scope

The Active Park Assist (APA) system is designed to make parking easier and safer for the driver. It only requires a few inputs from the user via the Human Machine Interface, or HMI, to begin the process. The HMI is the interface through which the operator of the vehicle will be able to access the features of the Active Park Assist system. These features include selecting and verifying valid parking spots, authorizing the APA system to proceed, and viewing the front or rear camera feeds. Once all valid inputs are received, the HMI will proceed to scan the environment for any available parking spots with ultrasonic sensors in conjunction with the front and rear-facing cameras. Ultrasonic sensors are sensors that use sound waves above the maximum frequency audible to humans to detect objects. Upon identifying a potential parking slot, the HMI will prompt the user for verification of its selection. Upon user verification, the APA will proceed to automatically park the vehicle. During the automated parking process, the system continuously monitors the environment to avoid any potential accidents. During the process any input from the driver such as braking, accelerating, or steering, will instantly stop the automated process and restore full control of the vehicle back to the driver. The system will keep the driver up to date on the current conditions through the use of notifications displayed on the HMI.

Related Systems

The Active Park Assist system will consist of two subsystems: the detection system and the interaction system. It will also interface with the steering, powertrain and braking components of the vehicle. The detection system has two main components: the ultrasonic sensors mounted along the side of the vehicle and the front/rear cameras. The detection system is responsible for identifying that a given parking space is viable for the vehicle to park in, as well as detecting objects in the path of the parking maneuver. The system must have a detection range of at least 15 feet in order to appropriately identify parking slots. The detection system will also be responsible for processing user input and interpreting sensor data to identify vehicle location and trajectory. The interaction system's singular component is the Human Machine Interface. As a point of interaction for the user, the HMI provides a basic interface to initiate APA functionality. APA can only be initiated through the HMI.

The APA will need to interface with the steering, powertrain, and braking components of the vehicle. When the system is active, the APA will need to provide input to the power steering in order to appropriately direct the vehicle into the selected parking slot. It will also need to listen for user steering input, upon detection of which the system must return control of the vehicle back to the driver. The powertrain component consists of two main subcomponents: the engine and the transmission. Active Park Assist will utilize the powertrain components to move the vehicle into the designated slot, as well as changing from drive/reverse to park. It will also need to enable to active the brakes in order to halt the vehicle when the procedure is completed or otherwise interrupted.

Because the APA is composed of and will interface with multiple systems, it is paramount that appropriate security measures be implemented. No components besides the HMI and the APA's assorted sensors should be able to enter any input data into the system. All allowed input data, especially that from the HMI, should be appropriately filtered and sanitized to ensure no malicious entry can occur. Extra care should be taken to isolate the APA system from any internet connected components, as they could be used by a malicious third party to try to take over the APA system, or control of the vehicle.

Terms & Abbreviations

1. APA : Active Park Assist
2. Powertrain : consists of the engine, transmission, differential, and other aspects involved in vehicle propulsion
3. HMI : Human Machine Interface; the interface through which the vehicle operator will interact with the Active Park Assist
4. AAA : American Automobile Association
5. Ultrasonic : term referring to a sound wave that is of a frequency above the threshold of human hearing (greater than 20 kHz)

Background and Rationale

The general rationale for the Active Park Assist system is simple: automated systems have been shown to perform better than humans in tests performing various parking maneuvers. In a 2015 American Automobile Association test, “five [automated] systems tested performed better in four key areas than human drivers” [1]. One results of the test found that “compared to … AAA engineers who manually parked with the aid of a backup camera, autonomous parking systems experienced 81 percent fewer curb strikes and used 47 percent fewer maneuvers” [1]. However, most parking assist systems currently advertised are not fully automated. Instead, these systems primarily use sensors and rear view cameras to assist drivers in parking manually, and are not directly in control of the car. As a result, it is still up to the driver to complete the maneuver, in addition to stopping the vehicle should there be any objects, human or otherwise, that enter into the car’s path of travel.

In existing current driver-assisted systems, usually the only interaction between the driver and the system is in the form of the rear view camera feed onto a dashboard screen. Auditory signals may also be present to indicate the distance between a moving car and the objects behind it. Parking is a very intensive and stressful procedure for a driver of a vehicle. In parallel parking maneuvers, for example, it can be difficult to see the front bumper of the car behind the one parking. Parking lots are also potentially busy areas with people getting in and out of cars and perhaps trying to park themselves. Due to the high level of activity surrounding them, drivers may be distracted while parking, which only adds to the risk involved. An automated system has the ability to be safer than a human driver in that the automated system is able to avoid distracted driving entirely. An automated system would also be able to detect objects like people walking in the vehicle's blind slots, and be able to react to stop the vehicle quicker than a human would. Additionally, as shown by the the tests conducted by AAA, the procedure can be accomplished with a lower accident rate when done by an automated system.

Essential Characteristics

The use cases of this system will be taking place in potentially crowded environments, it is essential that the Active Park Assist meet several criteria to be an acceptable implementation of an automated parking solution. The system must be accurate, timely, secure, and safe. When the Active Park Assist is activated next to a parking spot, regardless of whether the slot is perpendicular or parallel, the system must correctly identify the parking space and correctly determine if the car has sufficient room to

adequately park while leaving enough space for the driver to safely leave the vehicle. If a car engages the Active Park Assist solution, the flow of normal traffic should not be disrupted, which is to say the APA system must park the vehicle within the timeframe it would take for a human to perform the same parking maneuvers.

The Active Park Assist solution must also be secure and safe. The safety of the car, and more importantly the passenger is critical for an acceptable solution. This means that the system must only be engaged when the driver permits, and it must be able to be halted as a result of either user input or external events including unexpected external interference from the parking space or the car itself. Additionally, for the Active Park Assist system to be safe, the system must be aware of software and hardware failures that may prevent the process from operating as intended. Upon successful completion of the maneuver, the APA will put the vehicle in park and notify the user that the operation is complete. The system is then deactivated, and control is relinquished to the user.

Environment

The APA system will be installed on a computer inside of the vehicle. This computer will host the software of the system and will be connected to other physical components of the vehicle, so that the computer can interpret and analyze sensor data and indicate the desired instructions to the physical components of the car. This system will only be installed on vehicles with automatic transmission and an interface with which the system can accept human input, such as a touch screen control panel found in many modern cars. Given these hardware constraints, the system will be best suited for newer vehicles. The system will take the distance inputs from the ultrasonic sensors and recognize where the vehicle is in a three dimensional space in relation to any other objects within the 15 foot range of the sensors. The system must also select the appropriate gear (park or reverse or drive), and apply the brakes if necessary. Thus, the APA system must be able to interface securely and non-trivially with both of those systems.

The system will be run in real-world situations wherein motorists would be parking their vehicle in potentially crowded and congested areas Thus, it will need to be functional both in streets and parking structures/areas, where there are parking spaces in a variety of different configurations. The APA will be able to support parking spaces that are parallel, perpendicular, or diagonal. Cameras will be used to identify available parking spaces. Ideally, the parking spaces will be indicated by line markings; however, the aforementioned ultrasonic sensors will also be able to assist in determining feasible parking slots in case the line markings are not visible, like when there is snow on the ground. The system must be able to function in all kinds of weather. These sensors will also be useful in safely performing the maneuver, since in a real-world setting there could be various obstacles such as other cars, people, or other objects.

References:

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