Software Requirements Specification (SRS)

APA2

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1 Introduction

This document will identify the description of the APA (active park assist) system and the software requirements that are required to build it. It will also provide visual diagrams, prototypes, assumptions and dependencies, user characteristics, and sample scenarios.

1.1 Purpose

Identify the functionality of active park assist; What the software will do and how it will be expected to perform. It also describes the service the active park assists needs to fulfill all stakeholders. Insight on the system requirements and an understanding of how the design will be implemented to achieve those requirements. It is also intended to help developers understand the system that will be developed before implementation.

1.2 Scope

The name of this project is APA, or active park assist. APA is a high tech feature installed in newer vehicles. APA allows the driver to select and park in a space (only when the driver selects). The system will not run if it has not been activated, and will be embedded in the computer of the vehicle. While the system is active the driver will not have to control the steering. Perpendicular and parallel parking will become much easier, in turn reducing the amount of collisions from parking.

There are three software products that will be developed for this project. The first is the APA system’s backend. This will be responsible for detecting and recognizing other vehicles, pedestrians/obstacles, and possible parking spaces. It will also be responsible for navigating the vehicle into a parking space by accelerating and turning the vehicle. It will be dependent on the other two software products that will be produced for input. The second product is the Human Machine Interface (HMI), which acts as the primary method for receiving input from the driver. The driver will interface with this software through the vehicle’s screens and other controls.
1.3 Definitions, acronyms, and abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Term/Definition</th>
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<tbody>
<tr>
<td>APA</td>
<td>Active Park Assist: The system that we are building</td>
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<tr>
<td>HMI</td>
<td>Human Machine Interface: The control panel that the driver interacts with</td>
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<tr>
<td>SW</td>
<td>Software</td>
</tr>
<tr>
<td>HW</td>
<td>Hardware</td>
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Definitions:

- **APA Backend** - The system which handles APA functions that don’t require human input.

1.4 Organization

This document is laid out in sections that specify the APA system and its functionality.

*Section 1:* Introduces the APA system.

*Section 2:* Identifies the product perspective, product functions, user characteristics, constraints, assumptions/dependencies, and appropriating of requirements.

*Section 3:* Identifies the specific requirements.

*Section 4:* Identifies the modeling requirements.

*Section 5:* Introduces the 2D prototype.

*Section 6:* Lists the references.

*Section 7:* Point of contact.

2 Overall Description
2.1 Product Perspective

The Active Park Assist (APA) is a system that enables a vehicle to automatically park itself in available parking spots with minimal control from the driver. The APA performs three major functions:

1. Identify parking spots.
2. Notify the driver of available parking spots.
3. Steer the vehicle into a selected parking spot.

2.2 Product Functions

The active park assist is functioning to provide the vehicle with automatic parking. There is an option to choose parallel or perpendicular parking. The system automatically parks itself into an available parking spot. The driver activates the system through the HMI.

The system utilities:

- Cameras to identify parking spots
- Ultrasonic sensors to be used on the chosen spot.

When the system is activated the system is in full control of the vehicle. While activated the system will continue searching for obstacles. If an obstacle is detected the system shuts off and the driver becomes fully in control of the vehicle. When a spot is selected and the system has successfully parked the system switches to automatic transmission in the park position and will then exit.

2.3 User Characteristics

The driver of this system must be an individual who satisfies the basic requirements for drivers, such as possession of a driving license. They should also be able to operate an interactive display and use a touch screen interface.

2.4 Constraints

The constraints impact the execution of the systems performance

1. Weather
2. Obstacles
2.5 Assumptions and Dependencies

The assumptions and dependencies ensure the functionality of the system:

1. The sensors have been tested and are in good condition
2. The cameras are in good condition and handle aggressive weather conditions
3. The vehicle is fully stopped before activation
4. The system is only activated when the driver interacts with the HMI
5. If an obstacle is detected the sensors will detect them
6. After completion the system shuts off and gives full control back to the driver

2.6 Apportioning of Requirements

3 Specific Requirements

1. The system must be initially activated, and shall then further interact with the customer through the HMI (Human Machine Interface)
   a. The HMI is an interactable touch screen that is mounted on the infotainment system
   b. The system shall turn on only when the customer activates it through the HMI
   c. The HMI shall notify the passenger when a spot has been identified. The HMI shall request verification from the passenger to proceed with parking.
   d. The HMI shall allow the passenger to stop the maneuver at any point in time.
   e. When the driver activates the parking assist, the system comes on in \( x \) seconds.
2. The system shall identify available parking spots when it is activated
   a. The system will utilize cameras to collect visual information about the surrounding environment.
   b. The system will utilize ultrasonic sensors mounted on the side of the vehicle to measure available spaces between vehicles in a parallel parking situation, to identify spots that are large enough to fit into.
   c. The ultrasonic/camera system shall be actively monitoring the vehicle position throughout the maneuver to ensure the vehicle does not bump into other objects or vehicles.
      i. If an object or vehicle is detected within 0.5m of the vehicle, the system shall stop the vehicle and notify the passenger.
3. The Active Park Assist (APA) feature shall take over driving of the vehicle once the request has been verified.
   a. When appropriate, the APA shall shift automatic transmission into the appropriate gear (reverse or drive).
   b. The APA will then accelerate, brake and steer the vehicle into the parking spot.
c. The passenger shall be involved in the maneuver by maintaining speed control with the brake pedal. The vehicle shall have a maximum speed which can be reduced by the passenger.

d. At the end of the maneuver, the APA feature will put the transmission into the park position.

e. The system shall disable the APA feature and the passenger can regain control of the vehicle.

4 Modeling Requirements

Use Case diagram for our system.

A visual of potential scenarios that the driver and system may encounter.

Use Case descriptions below:

<p>| Driver turns on the APA system | When the driver turns on the APA system the driver is no longer in control of the vehicle. |</p>
<table>
<thead>
<tr>
<th><strong>HMI display</strong></th>
<th>The driver interacts with the HMI to activate the system</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parking spot</strong></td>
<td>The system uses the HMI to select the parking spot. Sensors and cameras to indicate if parking is possible</td>
</tr>
<tr>
<td><strong>Parking type</strong></td>
<td>The driver selects the parking type (parallel or perpendicular). The system steers the vehicle into the spot.</td>
</tr>
<tr>
<td><strong>Driver stops vehicle completely</strong></td>
<td>The driver must stop the vehicle completely in order for the APA to successfully execute</td>
</tr>
<tr>
<td><strong>Obstacle moves into trajectory of vehicle</strong></td>
<td>If an obstacle were to move into the trajectory of the vehicle then the system would shut down</td>
</tr>
<tr>
<td><strong>Collision with other vehicles</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Invariants:**
- Camera and ultrasonic sensors must be active for as long as the APA is active.
- Driver should be able to control speed with the brake throughout the maneuver.
- The driver must be able to stop the procedure through the HMI at any point during the maneuver

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**Domain Model** for our system

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**Data Dictionary** for our system

To describe each class, its attributes, its operations, and relationships between classes.
1. **APA system**: The system that handles the parking of the vehicle. This class collects information about the vehicle's position and potential obstacles. APA system parks the vehicle
   a. Attributes: gathering measurements of the vehicle.
   b. Operations: **parking** the vehicle
   c. Relationship between classes: APA system has an association with the Sensor and Controls class.

2. **Controls**: The controls takes information from the APA system class to get the direction of the vehicle.
   a. Attributes: direction
   b. Operations: **breaking** when necessary, **moving the car** in the right direction
   c. Relationship between classes: Speed, Steering Wheel, Brakes, HMI, APA system

3. **Speed**: The speed takes information from the controls class to get the direction of the vehicle in order to get the speed of motion
   a. Operations: **Getting the speed** of motion
   b. Relationship between classes: controls

4. **Steering Wheel**: The steering wheel class takes information from the Controls class to get the correct direction
   a. Operations: when activated the system will **steer** the vehicle into the parking spot
   b. Relationship between classes: controls

5. **Brakes**: The breaks class takes information from the Controls class to get the correct direction
   a. Operations: **break** the vehicle
   b. Relationship between classes: controls

6. **HMI**: The HMI takes information from controls to active the apa system in order to select a spot.
   a. Operations: **activate the APA**, **selecting spot**
   b. Relationship between classes: controls

7. **Sensor**: The sensor takes information from the controls so finding a parking spot and detecting obstacles are possible.
   a. Operations: **find spots to park**, **detect an obstacle** (boolean)
   b. Relationship between classes: controls

8. **Camera**: the camera takes information from the sensor class in order to detect parking spots as well as obstacles.
   a. Operations: detection
   b. Relationship between classes: Sensor

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**Sequence Diagrams** for our system
1. Sequence diagram for when driver interacts with the HMI to activate the system, later turn off the system

2. Sequence diagram for when the system works properly

3. Sequence diagram for when an obstacle is detected
5 Prototype

To visualize the APA system we designed, we created a 2D prototype to simulate the different scenarios that may arise when using the system. This section includes instructions on how to run the prototype.

5.1 How to Run Prototype

The prototype is available at http://cse.msu.edu/~alqarnil/prototype1/index.html. It was created using the Unity Game Engine and can be run directly on a Google Chrome or Firefox web browser by clicking on the play button at the given link. An executable version of the prototype can also be downloaded and run a Windows or Mac computer.

When the prototype is first run, the user is greeted with a Main Menu screen, from which they can select any of the available scenarios to view. Once they are done viewing the scenario, they can return to the main menu by clicking on the “Main Menu” button.
5.2 Sample Scenarios

Scenario 1 (Perpendicular Parking with no Obstacles) - In this scenario, the driver activates APA, and then drives past cars parked in a perpendicular setting. Once the system identifies an available parking spot, the driver is notified through the HMI. The driver agrees to park in the given spot, and APA proceeds to park the vehicle.

Scenario 2 (Parallel Parking with no Obstacles) - In this scenario, the driver activates APA, and then drives past cars parked in a parallel setting. Once the system identifies an available parking spot, the driver is notified through the HMI. The driver agrees to park in the given spot, and APA proceeds to park the vehicle.
6 References

http://www.cse.msu.edu/~cse435/Projects/Deliverables/Templates/requirements-doc-template.pdf

7 Point of Contact

For further contact and information please contact Prof. Betty Cheng via email chengb@msu.edu