Scalable Cruise Control Project (SCC)
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Software Requirement Specification Document

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1. Introduction

This document contains the detailed specification and requirements essential to design the Scalable Cruise Control by Ford Motor Company. This current section contains of the purpose of this document, description of the application domain, and definitions for any abbreviations used throughout this document. The software requirements of the system is described in detail using textual descriptions as well as model including use case diagrams, class diagrams, and state diagrams. Finally, a complete prototype of the system will is introduced with detailed instructions regarding its usage and sample scenarios representative of the system. References and contact information can be found at the last section of this document.

1.1 Purpose

The purpose of the Software Requirements Specification (SRS) is to define and specify in detail the requirements needed to create the software for the Ford Motor Company. The document also helps to complete the agreement between the developer and customer so that the specified requirements are being implemented to the customer’s satisfaction. Intended audience is developers and management that will use the document to validate that the system is being build according to the client requirements.

1.2 Scope

The software system being developed is the Scalable Cruise Control (SCC) system. This system is implemented as an entrenched system for automobiles. Users will benefit from the aversion of accidents otherwise caused by hackers, driver error or other compromised vehicle system. The main goal of the system would be to decrees number of accidents caused by cruise control.
Subsystem of the system would be simple cruise, following distance management, and automatic emergency brake. All would be implemented in the system as a final product. The SCC software system will provide a user with an automated response to possible safety threats while driving. It will do this through the prioritization of commands inputted by the user such as a set max speed, as well as following distance to other vehicles and through the use of the automatic emergency brake. The system will be extensible such that it will take in to account additional future features that can make use of the same base functionality, curve speed assist, etc. The SCC will not ensure the safety of all occupants in case an accident does occur, it is only a software system added on to a vehicle to prevent such accidents from occurring.

1.3 Definitions, Acronyms, and Abbreviations

The following definitions and acronyms will appear throughout the course of the documents. Each acronyms have a short description reference to the SCC system.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scalable Cruise Control (SCC)</td>
<td>The Scalable Cruise Control system being designed and implemented.</td>
</tr>
<tr>
<td>Simple Cruise (SC)</td>
<td>The Simple Cruise Control functionality that is enabled by the driver and allows a maximum speed to be set and maintained. The set speed must be greater than 25mph.</td>
</tr>
<tr>
<td>Throttle Control System (TCS)</td>
<td>The vehicle maintains the set speed through throttle control that manages the power of the engine and uses the vehicle speed feedback.</td>
</tr>
<tr>
<td>Lead Vehicle (LV)</td>
<td>The vehicle directly in front of the user’s vehicle. This is the vehicle that will be tracked by the camera and radar systems to maintain a safe following distance.</td>
</tr>
<tr>
<td>Rear Vehicle (RV)</td>
<td>The vehicle directly behind the user’s vehicle.</td>
</tr>
<tr>
<td>Automatic Emergency Brake (AEB)</td>
<td>The safety system that functions with or without the SCC in an active state. Inputs come from vehicle speed and camera/radar object tracking to alert the vehicle to brake if an object ahead is too close to the vehicle.</td>
</tr>
<tr>
<td>MPH</td>
<td>Miles per hour.</td>
</tr>
<tr>
<td>Following Distance</td>
<td>The system that tracks Lead and Rear vehicle data to maintain a set distance from the user’s vehicle. This setting is provided by the user via a simple button controls system inside the vehicle with presets such as small or large</td>
</tr>
</tbody>
</table>
Management System (FDM) | to set the distance. The vehicle also maintains a maximum possible safe speed by coordinating with the Simple Cruise system.
---|---
CSA | Curve Speed Assist.

1.4 Organization

The remaining document will describe more about the system itself starting from overall description of the system. Section 2 will describe the system inducing product perspective, product functions and user characteristics. In this section, it will give the overall idea of the system. In section 3, it will describe the specific requirements for the SCC. In this it will include all the requirements that’s necessary to develop the system. Section 4 will give detail information about the system design using UML diagram as well use case diagram. In this section, user scenario will be used to help describing the system design in detail. Following section will be used to describe the prototype of SCC system. In this section, it will be detailed information of how the system will look like and what user needs to do to test the system. In the last section, it shows all the references as well as the website for team contact.

2. Overall Description

This section will cover the definition of the SCC system including context for its creation and a complete description of the system. It will provide a sufficient background to understand the specific requirements described in section 3. The major functions of the SCC will be provided along with user characteristics, project constraints, assumptions, dependencies, and requirements outside the scope of the development project.

2.1 Product Perspective

The SCC system will operate as part of an embedded vehicle system. It will receive information about current speed and detected objects from the vehicle sensors and remote systems. It will then use this information along with user settings for set speed and follow distance to provide throttle and brake commands as appropriate to match the user settings.

The following block diagram (Figure 2.1) shows how the SCC system fits within the embedded vehicle system. The SCC system is connected to the Vehicle Controller so it can receive commands from the UI and send alerts to the driver. The SCC system will receive data inputs from the Sensor System, send brake commands to the Brake Control System, and send throttle commands to the Throttle Control System.
The SCC system itself is made up of three subsystems. The Simple Cruise subsystem is always present and can be enabled or disabled by the user. The Following Distance Management subsystem is an optional system that extends the functionality of the simple cruise system. Following Distance Management is enabled and disabled along with the simple cruise system. The Automatic Emergency Brake subsystem is another optional system that operates independently of the Simple Cruise and Following Distance Management systems. The AEB system cannot be disabled.

### 2.2 Product Functions

**Simple Cruise**

- Driver enables the feature and sets a maximum speed to be maintained. Set speed must be greater than 25 mph.
- Vehicle maintains the set speed through throttle control and vehicle speed sensor feedback.
- Driver may exceed the set speed through direct throttle inputs.
- Driver may suspend the feature through a button press or by depressing the brake pedal.
- Drive may resume the previously set speed by a button press, and the vehicle must accelerate or decelerate at a safe rate to the set speed.
- Driver may increase/decrease the set speed while active, through button presses.
- Drive may turn the feature off, which clears the previous set speed.

**Following Distance Management**

- Driver may set a following distance from a leading vehicle through button controls. Distance is represented to the driver in 4 relative steps (i.e. small up to large) without units, and is maintained internally by the cruise
controller as a measurement of minimum time to intercept, based on the position and relative speed of the leading vehicle.

- Vehicle maintains maximum possible safe speed through throttle and brake control, with real-time inputs from vehicle speed and lead vehicle tracking information from camera and radar, within the constraints of set speed, minimum following distance/time, and driver throttle input.
- Alerts the driver in case of emergency.

Automatic Emergency Brake
- Applies maximum braking pressure to minimize stopping distance, if the driver cannot react in time or with sufficient force.

2.3 User Characteristics

The user of this system will be a driver of a wide range of vehicles. Users can range greatly in experience from those just learning to drive to professional drivers. Many users may be inexperienced with complex software systems. Some users may be unable to read the language that the vehicle is produced in. Users will not be visually impaired and should be physically able to actuate buttons. Users of this system will consider their use of the system a secondary activity, where the primary activity is driving, and will not give all of their attention to the use of the system.

2.4 Constraints

The Simple Cruise and Following Distance Management functions will only operate above 25 mph. The AEB system will always be operational. In order to ensure the safety of the driver, the system needs to properly prioritize throttle commands between the AEB system, user input, and the cruise system. As well, the system will need to continue to function in the event of wireless network disruption. The system must not allow remote throttle and brake commands.

Development of the system must follow all automotive regulatory policies. The development of the system must also produce a product that is externally testable, easily debuggable, and extensible for future product additions.

2.5 Assumptions and Dependencies

This document assumes that the SCC system will have access to vehicle speed and object detection sensors. It also assumes that the embedded vehicle system will provide throttle and brake control systems that the SCC system can provide commands to. The SCC system depends upon the vehicle system controller to provide inputs from the user.
2.6 Apportioning of Requirements

There are currently no requirements outside the scope of the initial development project.

3. Specific Requirements

The following are some of the major specific requirements of the SCC system. The requirements listed reflect the behavior of the system.

1. The SCC system will maintain and monitor the user’s vehicle speed set by the user and adjust the speed based on vehicles ahead.
2. There will be a default following distance set as soon as the user enables/activates the system. The user will be able to change the set default following distance for the SCC system, but the factory default will be set to a following distance of time length 3.0 seconds.
3. The following distance in the SCC system will be computer in seconds behind the Lead Vehicle.
4. The driver will have access to buttons located on the steering wheel to enable/activate the SCC system and control the set max speed while the SCC system is active.
5. The driver will have access to buttons located on the steering wheel to set and change the following distance when the SCC system is active.
6. If the Lead Vehicle decreases speed, the SCC system will reduce the user vehicle’s speed to maintain the set following distance unless otherwise changed by the user.
7. If the Lead Vehicle increases speed, the SCC system will increase the user vehicle’s speed if the set max speed permits it. If the Lead Vehicle continues to speed up and passes the set max speed by the user, the user’s vehicle will keep its speed at the set max.
8. The SCC system will not allow a set max speed greater than 85 miles per hours while it is active.
9. The SCC system will maintain the following distance without exceeding the maximum speed set by the user whenever a front vehicle is detected.
10. The system will have set following distances available to the user that allows the vehicle to reduce speed and come to a halt if the Lead Vehicle does so, as well.
11. The SCC system will support a cruise speed range of 20 to 85 miles per hours.
12. The system’s automatic emergency braking system will work whenever the system senses a Lead Vehicle getting too close to the user vehicle at a set speed range.
13. The system will work alongside and not interfere with other systems present in the vehicle.
14. The system will use camera and radar technology to identify and target the Lead and Rear vehicles as well as estimate the Lead Vehicle’s distance and relative speed.
15. The driver has the ability to override or disable the SCC system at any time. If the driver pressed the brake in the vehicle, the SCC system will disable and begin to slow down the vehicle unless the user presses the gas pedal. The driver can press the gas pedal to increase the speed while the SCC system is active, but if the speed is not set again, once the driver stops pressing the gas pedal the vehicle will slow down to the speed that was originally set by the user.

16. Any component of the system that becomes dysfunctional or fails will alert the user that the system should be checked and will not continue working until checked and repaired. If the user attempts to activate the system while is damaged, it will alert the driver on the dashboard that

17. The user will be notified that the system is activated/deactivated by a light on the dashboard. The set speed and set distance will also be displayed.

4. Modeling Requirements

In this section of the document further represents how the system will behave in real world. Different visual diagram will show different view of the system and putting all the things together will give user a clear visual of the system. This section also talks about how the system will react on different stages in some of the given scenarios.

Use Case diagram, is a behavioral diagram that shows the services and actions that can be performed by actor interacting with the system. The following use case diagram (Figure 4.1) describes the user’s interactions with the system as well as additional external systems that are required for the operation of the SCC system. The driver is the primary actor and will initiate all functions related to cruise control and following distance management. The throttle control system and brake control system are secondary actors that receive speed up or slow down commands from the SCC system. The driver is able to enable and disable the system, set a cruise speed, increase or decrease the set speed, suspend and resume cruise, set follow distance, and override the set speed with the throttle.
The next diagram, Figure 4.2, is a high-level class diagram also known as UML diagram. This diagram gives a detail description of the classes that are going to be used in the system. This will give a developer an idea of how to design the software and what classes to use. Additionally, it also gives an over look of the classes and function structure of the system. From this, it is very easy to see how many functions are going to be used throughout the process of development of SCC system.
The State Diagram, Figure 4.3, for the SCC system that uses AEB involves the main states of Off, Activated/Suspended, and SC Enabled. The intermediate states of AEB Engaged, Throttle Accelerated, and Brake Pedal are methods of changing the vehicle’s acceleration. Once the vehicle achieves a speed the driver wishes to maintain the speed can be set, moving the state back to the SC Enabled state. The AEB and cameras are constantly activated to monitor the surroundings/follow distance, in case AEB needs to be fully enabled and activate the breaks for safety reasons. If the button enable button is pressed again after being activated, the cruise control system is turned off.
5. Prototype

The prototype provides a user interface panel for the operation of the SCC systems and a separate display panel that shows the user vehicle driving on a road. The user can interact with the UI panel to perform SCC functions as well as introduce other vehicles or objects to the scene in the display panel. The prototype uses information in the scene to simulate SCC functions for Simple Cruise, Following Distance Management, and Automatic Emergency Braking. Speed readings and system status will be displayed in the UI panel.

5.1 How to Run Prototype

The prototype is a browser-based javascript implementation that requires no additional plugins. The prototype can be run by simply accessing the prototype page on the development website.

The following is a direct link to the prototype:

http://www.cse.msu.edu/~maliklau/prototype.html
5.2 Sample Scenarios

The prototype is currently in development, so there is currently no sample scenario that can be shown.

6. Reference

Project website: http://www.cse.msu.edu/~maliklau/index.html