Highway Autonomous Vehicle System

Part 2
Requirements Document

for
CSE 7313(SE533-N)
Requirements Analysis and Design Engineering
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1 Introduction

1.1 Purpose
A new Highway Autonomous Vehicle (HAV) System is being developed by the SMU Company. This document describes the requirements of the system. It is the official statement of what the developer must build. It specifies the main components and behavior of the computer system and its operating environment. It also characterizes its responses to unexpected events, and imposes constraints on the implementation.

This document follows the general outline of the “Modern SRS Package Template” defined in reference 2. General information about the HAV System and its components are described in the Software Project Management Plan. This information is not repeated in this document, but hyperlinks are provided to the Management Plan as appropriate. Clicking on hyperlinks to the Management Plan will bring up that section of the plan, provided the plan is saved in the same directory as this file.

In addition, links to information-shared or referenced between various sections of this document are linked via field references or hyperlinks where appropriate. Clicking on any field reference or hyperlink for this document will bring up that portion of this document.

When accessing this document in Word, use the Back button on Word’s Web toolbar to return from any hyperlink to the original location in this document.

For future traceability, all requirements against the system are defined by the use of the word “shall” and are automatically numbered with a number preceded by the prefix “SR”. All design constraints against the system are defined by the use of the word “will” and are automatically numbered with a number preceded by the prefix “DC”.

Traceability to the source and/or rationale for a requirement is provided in parentheses at the end of the requirement statement.

1.2 Scope
Features, components, and constraints that apply to the system are defined in the HAV Software Management Plan Introduction.

Hardware and software resources that apply to the system are defined in the HAV Software Management Plan Table 3.

1.3 References
1. HAV Software Management Plan

1.4 Assumptions and Dependencies
This document assumes the HAV system will be limited to use on highways specially modified for the system. Special modifications related to use of cameras for autonomous guidance and safety considerations may include:

• Special pavement markings
• Special lanes with safety barriers
• A normal lane and a passing lane
Other modifications may be necessary to support the system not specified at this time.
2 System Evolution and Use Case Model Survey

As described in the Software Management Plan Work Breakdown Structure (WBS), an incremental and iterative approach to project management will be used. Table 1 describes and prioritizes the system level use cases based on the features described. Table 1 also shows which iterations each use case will be addressed in. Section 9 describes the Use Cases in more detail. Table 1 also shows the actors involved in each use case. These actors are described in Actor Survey below.

<table>
<thead>
<tr>
<th>Use Case Name</th>
<th>Description</th>
<th>Actors</th>
<th>Priority</th>
<th>Risk</th>
<th>Iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use Case 1 - Activate HAV System</td>
<td>Driver turns vehicle control over to HAV system.</td>
<td>Driver, Vehicle</td>
<td>HIGH</td>
<td>LOW</td>
<td>1</td>
</tr>
<tr>
<td>Use Case 2 – Drive Autonomously</td>
<td>Car drives autonomously until 100 feet from exit.</td>
<td>Vehicle, GPS Satellite, Highway, Other Vehicles</td>
<td>HIGH</td>
<td>HIGH</td>
<td>1</td>
</tr>
<tr>
<td>Use Case 3 - Manual Override</td>
<td>Manual override of controls by driver</td>
<td>Driver, Vehicle</td>
<td>HIGH</td>
<td>LOW</td>
<td>1</td>
</tr>
<tr>
<td>Use Case 4 - Autonomous Resume</td>
<td>Autonomous resume of controls by driver prior to reaching destination.</td>
<td>Driver, Vehicle, GPS Satellite</td>
<td>MED</td>
<td>MED</td>
<td>2</td>
</tr>
<tr>
<td>Use Case 5 - Select Speed and Exit Number</td>
<td>Driver selects speed and exit number from map.</td>
<td>Driver</td>
<td>MED</td>
<td>LOW</td>
<td>3</td>
</tr>
<tr>
<td>Use Case 6 – Pass Car</td>
<td>Automatic passing of a vehicle to maintain desired speed.</td>
<td>Vehicle, Highway, Other Vehicles</td>
<td>MED</td>
<td>HIGH</td>
<td>4</td>
</tr>
</tbody>
</table>

Iteration 1 will address the basic functionality without which the system would be of no use to the customer. Iteration 2 will address an important and fairly risky feature. Iteration 3 will address features which, although fairly important are of low risk. It also addresses the more complicated user interface features of the system. Iteration 4 will address a fairly important, but high-risk feature. Iteration 5 will address responses to exceptions and non-functional requirements such as performance.

Table 2 describes each iteration and shows traceability to the numbered functional requirements in the sections that follow.
<table>
<thead>
<tr>
<th>Iteration</th>
<th>Description</th>
<th>Use Cases</th>
<th>Actors</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Autonomous Control</td>
<td>Addresses issues of basic autonomous control of the vehicle without addressing GPS navigation issues. Features addressed include: *Activation/manual deactivation  *Speed/steering control of vehicle</td>
<td>Use Case 1 - Activate HAV System Use Case 2 – Drive Autonomously Use Case 3 - Manual Override</td>
<td>Driver, Vehicle, Highway</td>
<td>SR5.1.1.1, SR5.1.1.2, SR5.1.1.3, SR5.1.1.4, SR5.1.1.5, SR5.1.1.6, SR5.1.1.7, SR5.1.1.8, SR5.1.1.9, SR5.1.1.10, SR5.1.3.1, SR5.1.3.2, SR5.1.3.3</td>
</tr>
</tbody>
</table>
3 HAV System Context

Figure 1 shows the HAV System context diagram with actors that interact with the system and the hardware and software components of the system. Components are described in the hardware and software components section of the Software Management Plan. The Vehicle will interact with the HAV system to allow it to control the vehicle speed and direction. The driver will interact with the system using the user interface. The GPS Satellite will send signals to the system to allow it to determine its location. The system will monitor the highway and other cars using its various sensors. Actors are described in Actor Survey below.

![Figure 1 - HAV System Context](image-url)
4 Actor Survey

As shown in the context diagram above, several actors interact with the system. These actors and their interaction with the system are shown in Table 3.

<table>
<thead>
<tr>
<th>Actor Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle</td>
<td>Sends speed, steering direction, acceleration, and deceleration status to HAV system and responds to steering, acceleration, and deceleration commands from the HAV System.</td>
</tr>
<tr>
<td>Driver</td>
<td>Drives vehicle during manual operation, selects operations for HAV system to perform via the user interface.</td>
</tr>
<tr>
<td>Other Vehicles</td>
<td>Position and speed of these actors will be sensed via the radar-warning receiver and laser range finder.</td>
</tr>
<tr>
<td>Global Positioning System (GPS) Satellite</td>
<td>Sends signals to the GPS receiver to allow the system to determine its location.</td>
</tr>
<tr>
<td>Highway</td>
<td>Properties of this actor will be sensed via the cameras allowing the system to keep the vehicle on course.</td>
</tr>
</tbody>
</table>
5 Requirements

The following sections specify the behavior of the HAV system and its operating environment. Traceability to use cases is provided through links at the end of each requirement. The numbering of requirements is automatic and may be used for future traceability.

5.1 Functional Requirements

5.1.1 Activation and Deactivation Requirements
SR5.1.1.1 Upon application of power, the system shall verify vehicle and sensor communications (Use Case 1 - Activate HAV System).
SR5.1.1.2 Upon application of power, the system shall attempt to lock on to GPS satellite signals (Use Case 1 - Activate HAV System).
SR5.1.1.3 The system shall display a message indicating whether it is ready to be activated or not. (Use Case 1 - Activate HAV System).
SR5.1.1.4 When the GPS Unit is locked on and the Vehicle and Sensor Communications are established, the system shall display a screen for selecting speed and exit (Use Case 1 - Activate HAV System).
SR5.1.1.5 The system shall activate vehicle control only when commanded by the user after a valid destination and speed have been selected and the GPS location has been established (Use Case 1 - Activate HAV System).
SR5.1.1.6 The system shall notify the user when it is activated and has control of the vehicle. (Use Case 1 - Activate HAV System).
SR5.1.1.7 The system shall notify the user of an error if the user attempts to activate the system prior to selecting a valid destination and speed or prior to the GPS location being established. (Use Case 1 - Activate HAV System).
SR5.1.1.8 The system shall deactivate vehicle control when commanded by the user. (Use Case 3 - Manual Override).
SR5.1.1.9 The system shall deactivate vehicle control when it is within 100 feet of the selected destination. (Use Case 3 - Manual Override).
SR5.1.1.10 The system shall notify the user when it is deactivated and is not controlling the vehicle. (Use Case 3 - Manual Override)
SR5.1.1.11 The system shall notify the user to prepare to resume control when it is within 5 miles of the selected destination. (Use Case 4 - Autonomous Resume)

5.1.2 Malfunction Requirements
SR5.1.2.1 In the event of a system malfunction affecting vehicle control, the system shall release control of the vehicle. (Use Case 4 - Autonomous Resume, Use Case 2 - Drive Autonomously, Use Case 6 - Pass Car)
SR5.1.2.2 In the event of a system malfunction affecting the ability to sense the vehicle’s surroundings, the system shall release control of the vehicle. (Use Case 2 - Drive Autonomously, Use Case 6 - Pass Car)
SR5.1.2.3 In the event the GPS unit is unable to report accurate location within the estimated time of arrival to the destination, the system shall release control of the vehicle (Use Case 2 - Drive Autonomously, Use Case 6 - Pass Car)

5.1.3 Autonomous Driving Requirements
SR5.1.3.1 When activated, the system shall control the vehicle speed and direction via commands over the hardware communication interface as specified in section 7 - Interface. (Use Case 2 - Drive Autonomously).
SR5.1.3.2 The system shall control the vehicle speed to within ±1.0 mile per hour (mph) of the selected speed. (Use Case 2 - Drive Autonomously)
SR5.1.3.3 The system shall keep the vehicle within the highway boundaries. (Use Case 2 – Drive Autonomously)

SR5.1.3.4 The system shall move the vehicle in the direction of the selected destination using GPS navigation information. (Use Case 2 – Drive Autonomously)

SR5.1.3.5 When the vehicle is within 100 feet aft of another vehicle or obstacle and the passing lane is clear, the system shall move the vehicle into the passing lane (See Figure 2). (Use Case 6 – Pass Car)

SR5.1.3.6 When the vehicle is within 100 feet aft of another traveling vehicle or obstacle and the passing lane is NOT clear, the system shall maintain a distance of 100 feet aft of the other vehicle or obstacle. (See Figure 2). (Use Case 6 – Pass Car)

SR5.1.3.7 When in the passing lane, the system shall move the vehicle 100 feet past the vehicle or obstacle being passed (See Figure 2). (Use Case 6 – Pass Car)

SR5.1.3.8 When the vehicle is 100 feet past the other vehicle being passed and the normal lane is clear, the system shall move the vehicle into the normal lane. (Use Case 6 – Pass Car)

SR5.1.3.9 The system shall maintain a minimum of 10 feet per 10 mph of speed between the vehicle and other vehicles in front of it, as shown in Figure 3. (Derived Use Case 2 – Drive Autonomously, Use Case 6 – Pass Car)

SR5.1.3.10 The system shall maintain a minimum of 5 feet between the vehicle and other vehicles or obstacles to either side of it as shown in Figure 3. (Derived Use Case 2 – Drive Autonomously, Use Case 6 – Pass Car)

Figure 2 - Requirements for Passing

5.1.4 Speed and Destination Selection Requirements

SR5.1.4.1 The system shall provide a graphical user interface for selecting speed and destination as specified in section 7 - Interface. (Use Case 5 - Select Speed and Exit Number)

SR5.1.4.2 The system shall allow the user to select speeds between 1 and 75 mph. (Use Case 5 - Select Speed and Exit Number)
SR5.1.4.3 The system shall allow the user to select an exit destination from a map as specified in section 7 - Interface. (Use Case 5 - Select Speed and Exit Number)

SR5.1.4.4 The system shall notify the user of invalid speed or exit selections. (Use Case 5 - Select Speed and Exit Number)

SR5.1.4.5 The system shall require the user to confirm speed and exit selections. (Use Case 5 - Select Speed and Exit Number)

SR5.1.4.6 The system shall be capable of displaying information on potential exits for any interstate highway exits, including numbers/names and their latitude/longitude. (Use Case 5 - Select Speed and Exit Number)

SR5.1.4.7 The system shall be capable of updating information on potential exits for any interstate highway exits, including numbers/names and their latitude/longitude. (Use Case 5 - Select Speed and Exit Number)

Figure 3 - Minimum Safe Distances
5.2 Non-Functional Requirements

Non-functional requirements apply to the system as a whole. Except for performance requirements, which are addressed in iteration 5, no iteration addresses these requirements. Verification of non-functional requirements may be performed via demonstration of the required trait, detailed analysis or simulation of the system showing the probability of satisfying the requirement as appropriate.

5.2.1 Performance Requirements
SR5.2.1.1 The HAV system shall control vehicle position with an accuracy of ±1 foot. (Derived Use Case 2 – Drive Autonomously)
SR5.2.1.2 The HAV system shall control vehicle speed with an average accuracy of ±1 mile per hour once the desired speed is obtained. (Derived Use Case 2 – Drive Autonomously)
SR5.2.1.3 The HAV system shall limit the acceleration of the vehicle to TBD miles per hour per second. (Derived - Safety)
SR5.2.1.4 The HAV system shall limit the speed of the vehicle to a maximum of 75 miles per hour. (Derived – Safety)

5.2.2 Usability Requirements
SR5.2.2.1 The HAV system shall require training time of less than TBD hours for normal users experienced with computer devices and vehicle cruise controls. (Derived - Usability)
SR5.2.2.2 The HAV system display and input devices shall be designed to allow the driver to perform normal manual vehicle tasks. (Derived - Usability)

5.2.3 Reliability Requirements
SR5.2.3.1 The HAV system shall have a Mean Time Between Failure (MTBF) rate of TBD hours of operation. A failure is any event that requires manual intervention of the driver over expected system operation.

5.2.4 Maintenance Requirements
SR5.2.4.1 The HAV system shall have a Mean Time Between Service (MTBS) rate of TBD hours of operation.
SR5.2.4.2 The HAV system shall have a Mean Time to Restore Service (MTRS) rate of TBD hours.

5.2.5 Safety Requirements
SR5.2.5.1 The HAV system shall have a Mean Time Between Hazard (MTBH) rate of greater than TBD hours. A hazard is defined as HAV system initiated movement that is unsafe for HAV driver or equipment.

5.2.6 Legislative Requirements
SR5.2.6.1 The HAV system shall satisfy all state and local laws imposed on autonomous vehicles as defined in TBD legislative documents dated TBD.
SR5.2.6.2 The HAV system shall satisfy all state and local laws imposed on operation of radio frequency receivers as defined in TBD legislative documents dated TBD.
SR5.2.6.3 The HAV system shall satisfy all state and local laws imposed on operation of laser devices as defined in TBD legislative documents dated TBD.

5.2.7 Delivery Requirements
SR5.2.7.1 The HAV system shall be delivered as a package installable with modifications on standard sedan-size automobiles with cruise control installed as defined in TBD.
6 Design Constraints

To ensure portability and maintainability, and the ability to operate with standard and special equipment the System Control Software will meet the following criteria.

DC1. The HAV system will be written in the Java programming language using a Commercial Off The Shelf (COTS) development system.

DC2. The HAV system will use Common Object Request Broker Architecture (CORBA) middleware services.

DC3. The HAV system will be designed for use on an industry standard computer operating system.

DC4. The HAV system will be designed for use on COTS computer hardware.

DC5. The HAV system will be designed for use with COTS communication devices.

DC6. The HAV system will be designed for use with industry standard communication protocols.

DC7. The HAV system will be developed using a software development process evaluated to be at least SEI CMM level 4.

DC8. The GPS Mapping Database will use a commercial database management system.

DC9. The HAV system will work with lane positioning modifications provided by special highways built for autonomous vehicle use.

DC10. The HAV system will work with standard automobiles with only modifications for feedback and control of the vehicle and containment of system and its components.
7 Interface Requirements

7.1 External Interface Requirements

7.1.1 User Interface Requirements
SR7.1.1.1 The system shall provide a display device positioned for viewing by the driver while still able to watch the road ahead. (Derived – Safety)
SR7.1.1.2 The system shall provide display navigation information when activated and moving towards the destination. (Derived – Usability)
SR7.1.1.3 The system shall provide a display device with a diagonal dimension of between TBD and TBD inches with a resolution of TBD by TBD pixels. The dimensions should be such that it is easily readable by the driver, but not be a distraction or interfere with driver operation of the vehicle. (Derived – Safety)
SR7.1.1.4 The system shall provide an input device the driver may use without releasing the steering wheel. (Derived – Usability)
SR7.1.1.5 The system shall provide menus and drop down boxes for selection of speed. (Derived – Usability)
SR7.1.1.6 The system shall provide a map display with a pointer for selection of exits. (Derived – Usability)
SR7.1.1.7 The system shall provide a method for updating the database of potential exits as exits are added or modified to the interstate highway system. (Derived - features).
SR7.1.1.8 The system shall provide a device for the driver to activate or deactivate the system while the driver still maintains control of the vehicle steering. (Derived – Safety)
SR7.1.1.9 The system shall provide a device for powering off and on the system while the driver still maintains control of the vehicle steering. (Derived – Safety)
SR7.1.1.10 The system shall provide both audible and visual notification of system malfunctions. (Derived - 5.1.2 Malfunctions)
SR7.1.1.11 The system shall provide both audible and visual notification of system status. (Derived – Multiple Use Case Notification Requirements)

7.1.2 Hardware Interface Requirements
SR7.1.2.1 The system shall communicate with vehicle steering, acceleration, braking, and speed status systems via a standard RS-422 bus. (Derived - ref3)

7.1.3 Software Interface Requirements
SR7.1.3.1 The system shall communicate with the vehicle steering, acceleration, braking, and speed status systems via a TBD standard messaging protocol. (Derived - ref3)

7.1.4 Communication Interface Requirements
SR7.1.4.1 The system shall communicate with GPS Satellites via standard NMEA (National Marine Electronics Association) Radio Communications. (Derived - ref4)
SR7.1.4.2 The system cameras shall be capable of recognizing special highway striping. (Derived - hwsa)
SR7.1.4.3 The system laser range finders shall be capable of detecting standard vehicles. (Derived - hwsa)
SR7.1.4.4 The system radar warning devices shall be capable of detecting standard vehicles. (Derived - hwsa)

7.2 Internal Interface Requirements

7.2.1 Hardware Interface Requirements
SR7.2.1.1 The control system shall communicate with Cameras, Laser range finders, GPS Unit, and Warning Radar via a standard RS-422 bus. (Derived - ref3)

7.2.2 Software Interface Requirements
SR7.2.2.1 The control system software shall communicate with Cameras, Laser range finders, GPS Unit, and Warning Radar via a TBD standard messaging protocol. (Derived - hwsa)
SR7.2.2.2 The HAV system shall use Common Object Request Broker Architecture (CORBA) middleware services for communication between software components. (Derived – Design Constraints)
8 Glossary

GPS - Global Positioning System
HAV - Highway Autonomous Vehicle
MTBS - Mean Time Between Service
MTRS - Mean Time to Restore Service
MTBH - Mean Time Between Hazard
NMEA - National Marine Electronics Association
TBD - To Be Determined
WBS - Work Breakdown Structure


9 Use Case Specification

Figure 4 shows the use case diagram for the systems with use cases and actors. The following pages describe the Use Cases in detail.

![Use Case Diagram](image)

Figure 4 - HAV System Use Case Diagram
### Use Case 1 - Activate HAV System

<table>
<thead>
<tr>
<th>Version:</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary:</td>
<td>Driver turns control over to HAV system.</td>
</tr>
<tr>
<td>Frequency:</td>
<td>One or more times per trip</td>
</tr>
<tr>
<td>Actors:</td>
<td>Driver, Vehicle, GPS Satellite</td>
</tr>
<tr>
<td>Preconditions:</td>
<td>Vehicle is operational.</td>
</tr>
<tr>
<td>Description:</td>
<td>The Driver powers up the HAV system. The system checks vehicle and sensor communications and attempts to lock on to the GPS signal. (Exception: Vehicle or Sensor Communication Error). The Driver performs Use Case 5 - Select Speed and Exit Number. The Driver commands the HAV system to activate using the user interface (Exception: Speed and exit not selected) (Exception: GPS not locked on). The HAV System indicates that it is activated and has control over vehicle.</td>
</tr>
<tr>
<td>Exceptions:</td>
<td>Vehicle or Sensor Communication Error: Message displayed by HAV system. Speed and exit not selected: Message displayed by HAV system. GPS not locked on: Message displayed by HAV system.</td>
</tr>
<tr>
<td>Illustrations:</td>
<td>N/A</td>
</tr>
<tr>
<td>Postconditions:</td>
<td>HAV system is controlling vehicle speed and direction. Driver has released control of the vehicle.</td>
</tr>
<tr>
<td><strong>Use Case 2 – Drive Autonomously</strong></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Version:</strong> 1.0</td>
<td></td>
</tr>
<tr>
<td><strong>Summary:</strong> Vehicle drives autonomously until 100 feet from exit.</td>
<td></td>
</tr>
<tr>
<td><strong>Frequency:</strong> 2 times per day</td>
<td></td>
</tr>
<tr>
<td><strong>Actors:</strong> Vehicle, GPS Satellite, Highway</td>
<td></td>
</tr>
<tr>
<td><strong>Preconditions:</strong> Activate HAV System use case has been performed.</td>
<td></td>
</tr>
</tbody>
</table>
| **Description:** The HAV system moves the vehicle along the highway towards the selected destination. (Exception: Vehicle or Sensor Communication Error) (Exception: GPS location error).
If another vehicle is being overtaken, the vehicle will be passed using Use Case 6 – Pass Car (Exception: Vehicle or Sensor Communication Error).
The Vehicle moves to within 100 feet of the selected destination (Exception: GPS location error) (Exception: Vehicle Control Error). |
| **Exceptions:** Vehicle or Sensor Communication Error: Message displayed by HAV system. GPS location error: Message displayed and HAV releases control of vehicle if GPS not reacquired within estimated time of arrival. |
| **Illustrations:** N/A               |
| **Postconditions:** Vehicle is within 100 feet of destination exit. HAV System has not released control of vehicle. |
# Use Case 3 - Manual Override

<table>
<thead>
<tr>
<th>Version:</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary:</strong></td>
<td>Manual override of controls by driver.</td>
</tr>
<tr>
<td><strong>Frequency:</strong></td>
<td>None to many times per trip</td>
</tr>
<tr>
<td><strong>Actors:</strong></td>
<td>Driver, Vehicle</td>
</tr>
<tr>
<td><strong>Preconditions:</strong></td>
<td>Activate HAV System use case has been performed.</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>The Driver commands the HAV system to deactivate using the user interface (Exception: HAV not activated). HAV System indicates that it is deactivated and releases control over vehicle. The driver takes control of vehicle.</td>
</tr>
<tr>
<td><strong>Exceptions:</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Illustrations:</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Postconditions:</strong></td>
<td>Driver has taken control of vehicle. HAV System has released control of vehicle.</td>
</tr>
</tbody>
</table>
## Use Case 4 - Autonomous Resume

<table>
<thead>
<tr>
<th>Version:</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary:</strong></td>
<td>Autonomous resume of controls by driver prior to reaching destination.</td>
</tr>
<tr>
<td><strong>Frequency:</strong></td>
<td>Once per trip</td>
</tr>
<tr>
<td><strong>Actors:</strong></td>
<td>Driver, Vehicle, GPS Satellite</td>
</tr>
<tr>
<td><strong>Preconditions:</strong></td>
<td>Drive Autonomously use case has been performed.</td>
</tr>
</tbody>
</table>

**Description:**
The vehicle is within 5 miles of the selected destination. HAV System indicates to the driver to get ready to resume control of the vehicle. The vehicle moves within 100 feet of the selected destination. HAV System indicates that it has been deactivated and releases control over vehicle (Exception: Vehicle goes past destination without releasing control). The driver takes control of vehicle.

**Exceptions:**
Vehicle goes past destination without releasing control: HAV releases control.

**Illustrations:**
N/A

**Postconditions:**
Driver has taken control of vehicle. HAV System has released control of vehicle.
## Use Case 5 - Select Speed and Exit Number

<table>
<thead>
<tr>
<th><strong>Version:</strong></th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary:</strong></td>
<td>Driver selects speed and exit number from map.</td>
</tr>
<tr>
<td><strong>Frequency:</strong></td>
<td>Once per trip</td>
</tr>
<tr>
<td><strong>Actors:</strong></td>
<td>Driver</td>
</tr>
<tr>
<td><strong>Preconditions:</strong></td>
<td>HAV System is powered.</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>The driver selects the speed and destination via the user interface. HAV System verifies speed and destination and displays confirmation to driver (Exception: Invalid speed or destination.). Driver confirms speed and destination.</td>
</tr>
<tr>
<td><strong>Exceptions:</strong></td>
<td>Invalid speed or destination: Message displayed.</td>
</tr>
<tr>
<td><strong>Illustrations:</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Postconditions:</strong></td>
<td>Driver and HAV system have confirmed speed and destination.</td>
</tr>
</tbody>
</table>
## Use Case 6 – Pass Car

<table>
<thead>
<tr>
<th>Version:</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary:</strong></td>
<td>Automatic passing of a vehicle to maintain desired speed.</td>
</tr>
<tr>
<td><strong>Frequency:</strong></td>
<td>Zero to many times per trip</td>
</tr>
<tr>
<td><strong>Actors:</strong></td>
<td>Vehicle, Highway, Other Vehicles</td>
</tr>
<tr>
<td><strong>Preconditions:</strong></td>
<td>Activate HAV System use case has been performed.</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>The Vehicle reaches a minimum distance behind the vehicle being overtaken (Exception: Vehicle or Sensor Communication Error). The vehicle will remain a minimum distance behind the Other Vehicle, until the passing lane is clear. Then the vehicle will move to the passing lane (Exception: Vehicle Control Error) (Exception: Sensing Error). The Vehicle moves a minimum distance past the Other Vehicle, and then moves back into the normal lane (Exception: Vehicle or Sensor Communication Error).</td>
</tr>
<tr>
<td><strong>Exceptions:</strong></td>
<td>Vehicle or Sensor Communication Error: Message displayed by HAV system.</td>
</tr>
<tr>
<td><strong>Illustrations:</strong></td>
<td>See Figure 2</td>
</tr>
<tr>
<td><strong>Postconditions:</strong></td>
<td>Vehicle has passed other vehicle. HAV has control of vehicle.</td>
</tr>
</tbody>
</table>