Software Requirements Specification (SRS)

Project TJA2

Authors: Evan Fioritto, Collin Massmann, Ashish Pasula, Sofia Perez Rodriguez, Amelia Smallfield

Customer: Mr. Bill Milam

Instructor: Dr. Betty Cheng

1 Introduction

Section 1 will introduce our system and what we will outline in this document. The Traffic Jam Assist (TJA) system is an advanced driver assistance feature which is designed to enhance vehicle control and comfort when in situations where traffic conditions are present. TJA builds upon existing Adaptive Cruise Control (ACC) technology through integration of steering, acceleration, and braking while at low speeds. Using a front-mounted radar, camera sensors, and lane detection modules, TJA can assist the driver in maintaining a safe following distance, center the vehicle within the lan, and smoothly start/stop movement as needed based on the flow of traffic. While this system reduces driver workload in heavy traffic scenarios, it is still semi-autonomous, meaning the driver's attention is required at times.

This document details the comprehensive overview of the software requirements, functionality, and the behavior of the TJA system. Throughout the document, we will be outlining the motivations and objectives of the system and identify the functional and no-functional requirements in order to define the operations in which the TJA operates. This document will also detail the system architecture, system interaction, dependencies, and any logic that would be considered necessary vehicle behavior in a situation of dense traffic.

1.1 Purpose

The purpose of this SRS document is to define any functional, non-functional, and performance requirements related to our TJA system. Through the detailed description of how this system will interact, operate, and integrate with existing systems, we can ensure that the TJA system will be developed according to the specifications that support safety, reliability, and comfort of the driver. The intended audience of this document would be mainly developers and engineers who would be the main people to design, implement, and integrate the software components. Other audiences would include testing and validation teams and regulatory and safety assessors.

1.2 Scope

The TJA system is a software product developed for the use within modern automotive vehicles that are already equipped with ADAS (Advanced Driver Assistance Systems). The primary objective is to enhance comfort and safety during low-speed traffic conditions through the automation of control functions such as acceleration, braking, and steering. Our system extends the capabilities of ACC by allowing the vehicle to automatically move, stop, idle, and resume with the traffic flow while maintaining a safe following distance when the speed is below 40 mph. The software runs on the vehicle's ECU (Electronic Control Unit) to interact with the various sensors and it is through these interfaces that the system can maintain stability, comfort, and safety.

The objective of the development of TJA is to reduce driver workload during dense traffic conditions while increasing safety through consistent spacing and lane positioning. The TJA software will essentially detect vehicles ahead using the radar and camera inputs when maintaining a user-specified following distance and speed limit. TJA will adapt to the acceleration and traffic flow to decide when it is necessary to brake or perform steering adjustments. The system will also alert the driver when manual intervention is necessary and deactivate under specific conditions. Some of the limitations TJA cannot accomplish is to operate as a fully autonomous driving system and function outside designated environments or speeds above 40 mph.

1.3 Definitions, acronyms, and abbreviations

ADAS (Advanced Driver Assistance System) : A group of systems that assist drivers via driving and parking functions busting automated technology.

TJA (Traffic Jam Assist) : A semi-autonomous assistance feature which automatically controls steering, braking, and acceleration in traffic conditions at low speeds.

ACC (Adaptive Cruise Control) : A system that automatically adjusts vehicle speed based on vehicles in front of the driver in order to maintain a safe distance.

ABS (Anti-lock Braking System) : Wheel lock prevention during the action of braking and is used by TJA for controlled deceleration.

Radar Sensor: A forward-facing sensor used to measure distance and speed of objects that are positioned in front of the vehicle.

Camera Sensor: An optical device used to detect lane markings, other vehicles, pedestrians, and other objects.

ECU (Electric Control Unit) : A microcontroller responsible for processing sensor data and managing vehicle control systems.

Target Vehicle: The vehicle that is directly ahead which TJA uses as a reference for calculating distance and speed.

Driver Override: A driver controlled action that temporarily disables TJA.

Closing Rate: The relative speed distance between driver vehicle and target vehicle and is used to determine whether to accelerate/brake.

GPS (Global Positioning System) : Used to confirm approved freeway operations.

OTA (Over-the-Air) : Remote software and map updates to the vehicle system.

1.4 Organization

After the detailed introduction in section 1, the remainder of this document is structured as follows. Section 2 introduces the reader to the product perspective, the main functions of the software, the characteristics of the users, and any possible constraints that could affect development of the system. Section 3 enumerates and categorizes all of the functional, non-functional, and security requirements required in our TJA system. Section 4 presents various diagrams and models that depict the structure and operation of our system. These include the use case diagram, domain model, sequence diagrams, and state diagrams. Section 5 describes how to access and run the prototype, outlines any configuration requirements necessary, and any sample scenarios for the vital use cases related to our system's core features. Section 6 lists all sources used throughout this document to describe the system design. Lastly, section 7 provides the project instructor's contact information for any further information related to this project.

2 Overall Description

The following sections will describe at a high level how the Traffic Jam Assist(TJA) works. Section 2.1 will contain the context and constraint of the system as well its connection to the bigger system. Section 2.2 will summarize the main functions that the software will perform.Section 2.3 will contain the expectations and assumptions of the user. Section 2.4 will dive deeper into the system constraints. In section 2.5, key assumptions and dependencies of the system will be addressed, and lastly in section 2.6 approportioning of requirements will be addressed.

2.1 Product Perspective

TJA system is based on the Adaptive Cruise Control (ACC) system present in most modern vehicles. It's ultimately a level 2 driver assistance that combines ACC and lane centering technologies to form a traffic jam " autopilot". TJA works by allowing, on a limited number of highways, the ability to adjust to traffic flow when the vehicle in front is slow or stops. If the vehicle in front starts again, the vehicle with TJA will also start up and follow, controlling the closing rate.

Regarding the interface of the system, TJA consists or interacts with many different subsystems that are used on different moments under different circumstances, including acceleration, braking and the existing ACC system which allows the vehicle to cruise at a set speed on a highway. It communicates with the braking system to apply controlled deceleration and overrides its system, which includes automatic braking, when a collision is imminent. TJA communicates with the steering wheel system to allow lane centering assist. The system is heavily integrated with different systems of the vehicle, on a high level TJA utilizes front facing radars,cameras and other lane detecting sensors. Front radar helps the vehicle computer determine the speed and distance of the vehicle ahead, while the camera sensors assist to identify any possible obstacles on the road as well the lane markings.[1] TJA system also requires a GPS sourced from server but that cashes data locally to determine whether the vehicle is on an acceptable road for TJA. Updates on the GPS are delivered through OTA.

Being more specific, TJA utilizes the inputs gathered for ACC and expands the use to allow more automation. While ACC allows high speeds, TJA is limited to 40mph[1] and when the driver brakes, it will shut off not only TJA but also ACC. Another system heavily used for TJA is the Lane Assist System, typically, the Lane Assist uses side mounted radar and/or camera sensors to identify the lane markings and warns and corrects the driver if the vehicle starts to drift.

From the user's perspective, all of the interactions and communication with the system are done through the steering wheel and the dashboard.The driver can engage the TJA system by pressing the ACC switch on the steering wheel, which is also used to set speed and, in some cases, the closing distance for TJA. All of the alerts from the system are shown in the dashboard, these include set speed, distance, and alerts when the system will disengage.

2.2 Product Functions

The high level goal of the TJA system is to assist the driver on highways to operate the vehicle at slow speeds during traffic jams. The system assists the driver by changing the speed according to the traffic flow and the vehicle in front

During typical use, the vehicle relies on GPS to determine whether it is traveling on an acceptable road, and if so, TJA becomes active. Once active, the system uses its sensors and cameras to detect lane markings and identify vehicles ahead. If the vehicle in front slows down, TJA will override the braking system and reduce speed to maintain the selected closing distance. When traffic begins moving again, the system will resume speed up to the maximum set limit as long as the traffic flow allows. To ensure the driver remains alert, the system will occasionally verify attention either through camera-based eye monitoring or through small, unexpected steering inputs. If the driver does not respond, the system will shut down after a short delay.When TJA is engaged, lane assist will keep the vehicle centered and will correct the steering wheel if the vehicle is drifting unless turning lights are on.

The system will for the most part maintain a closing rate of zero, but it is possible it will be positive if the closing distance grows and there is no action needed from the system. If, on the other hand, the closing rate is zero, the system will need to immediately slow down and maintain a safe distance from the vehicle in front. A negative closing rate means that the vehicle is too close to the target vehicle.

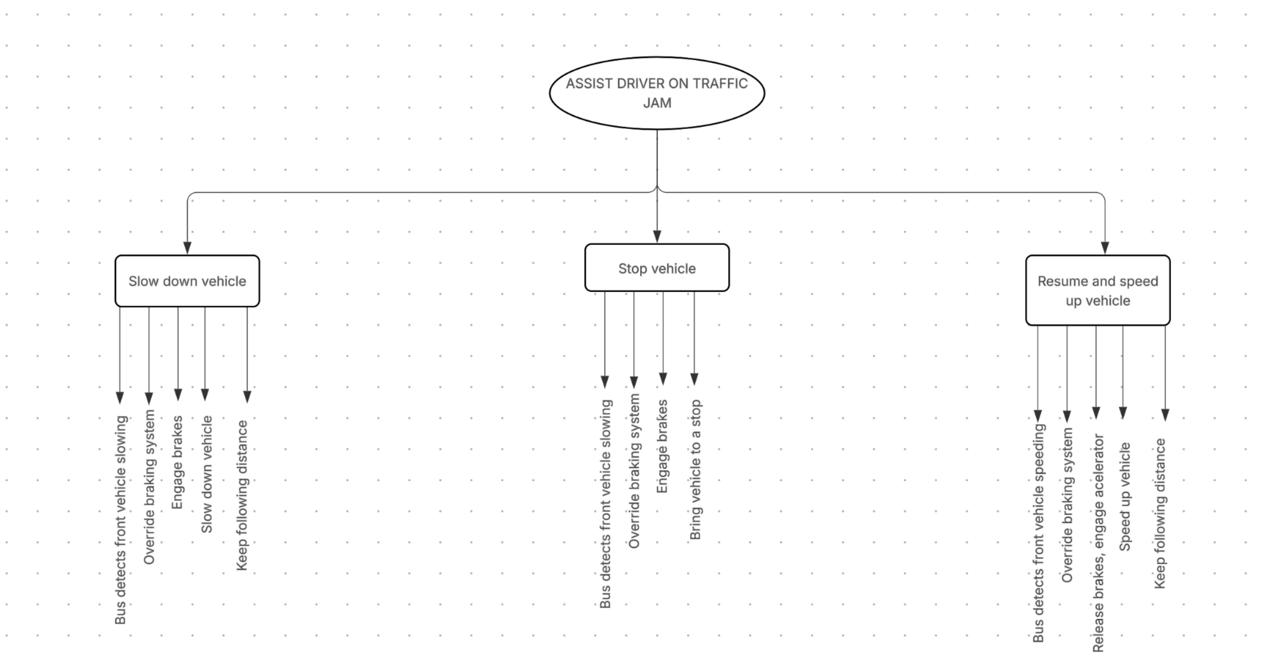

Figure 1: High level goal diagram: This diagram shows the main goal of the TJA system, assisting the driver during traffic jams, and how it is divided into 3 main tasks and events in each task. Slowing down the vehicle, stopping the vehicle and speeding up.

2.3 User Characteristics

The driver is the main user of the system and does not require extensive knowledge of it. Drivers should be licensed and should drive following laws and regulations. The user must be able to read street signs, if needed the driver can have aids like glasses. Is assumed the driver will respond to alerts thrown by the system(ie. Alarm and dashboard) and react accordingly. The user understands the system does not make the vehicle drive autonomously and is only an aid for the driver, therefore the driver is ready to take control of the vehicle if the system fails under any circumstances.

2.4 Constraints

Following are some general constraints that might get in the way of the development of the TJA system. Country regulations(ie NITSHA requirements for the United States), limitations for hardware dependencies such as radar and camera. The system must take into consideration possible limitations of the hardware, like visibility of camera and radar under tough weather conditions.

Other constraints for the TJA system involve ADAS calibration. The sensors for the vehicle must be properly calibrated to ensure accuracy of the TJA system. Failure in calibration of these means the system will not be able to operate correctly and might cause false positives and/or false negatives which can both lead to accidents.[1]

Regarding safety-critical properties for the system and the vehicle, the primary features are working airbags, a working anti lock braking system, electronic stability control system and a forward collision warning system as well as working sensors and camera.All of the properties mentioned above are crucial for the system to work properly, and if under any circumstances these properties are violated TJA will immediately deactivate and full control of the vehicle falls back onto the driver.

2.5 Assumptions and Dependencies

For the TJA system, the vehicle is assumed to have working analogue braking system and acceleration as well as the following sensors and hardware: Rear view camera, Lane dividing camera,throttle position sensor, as well as wheel speed sensor and Electric Control Unit(ECU) which processes speed sensor information and cycles brakes pression.[2] It is assumed that the GPS is up to date on the roads that allow TJA and assumed that system follows NITSHA Vehicle safety.

2.6 Apporportioning of Requirements

In the future, the TJA system may evolve to include requirements left out of this version in order to prevent the scope of this project/system from growing out of hand. Next versions may include AI integration into the system. Brief description of the feature is found below:

- If the vehicle is equipped with a front view camera, AI can be used to do target recognition and improved lane verification.

3 Specific Requirements

1. The Traffic Jam Assist system shall activate when the TJA ON button is pressed
   1.1. When the system is activated, the dashboard shall indicate to the driver that the system is on by displaying an TJA ON icon
2. The system shall by default set the maximum vehicle speed to be the current speed and set the maximum following distance to be the longest of the three options
   2.1. The vehicle shall not surpass the speed set by the driver at any time
3. The Traffic Jam Assist system shall be deactivated when a cancel/OK button on the steering wheel is pressed, or when the brake pedal is pressed.
   3.1. Upon deactivation, the driver must be aware of traffic ahead.
4. The maximum vehicle speed and the maximum following distance shall be able to be adjusted with buttons on the steering wheel
5. The driver must be engaged at all times when using the Traffic Jam Assist system. The Traffic Jam Assist system shall only work if contact is detected in the steering wheel at all times.
   5.1. If contact with the steering wheel is not detected, a visual alert shall be displayed on the console until contact with the steering wheel is detected.
   5.2. After contact with the steering wheel has not been detected for one minute, visual and audio alerts shall be given to the driver and then the Traffic Jam Assist system shall deactivate.
6. The Traffic Jam Assist system shall use the vehicle's front-facing camera to keep the vehicle centered in its lane.
   6.1. If the vehicle drifts away from the center line of the lane, a visual alert shall be displayed on the console and Traffic Jam Assist system shall recenter the vehicle by manipulating the steering wheel.
      6.1.1. The Traffic Jam Assist system shall never manipulate the steering wheel with more force than a human could reasonably overwhelm.
   6.2. The Traffic Jam Assist system shall not recenter the vehicle or manipulate the steering wheel if the turning blinker is activated.
7. If the target vehicle is within the set following distance and is not moving forward, the vehicle shall come to a stop.

    7.1. If an object is detected within the emergency braking zone, the Traffic Jam Assist system shall immediately activate the vehicle’s brakes.
8. If the target vehicle is moving slower than the vehicle, the vehicle shall slow only as much as is needed to maintain the set following distance from the target vehicle.
9. If the target vehicle is not moving forward and then begins moving forward, the vehicle shall accelerate as much as possible while maintaining the set following distance from the target vehicle.
10. A visual alert shall be displayed on the console if the Traffic Jam Assist system detects that lanes are not visible
11. The Traffic Jam Assist system shall only activate on approved highways.
    11.1. If the Traffic Jam Assist system is active when the vehicle enters a non-approved area, visual and audio alerts shall be given to the driver and then the Traffic Jam Assist system shall deactivate.
12. Provide status on the overhead dash and enable/disable alerts for vehicles when TJA is active.

3.1 Cybersecurity Requirements

13. Threat Vectors
    13.1. External data transmission
    13.2. Internal hardware tampering
14. Threat Actors
    14.1. Interruption
    14.2. Modification
    14.3. Fabrication
15. Vulnerabilities
    15.1. Remote updates to system software
        15.1.1. The system shall require a security key to accept a software update
    15.2. Updates to cached highway data
        15.2.1. All transmitted data shall be encrypted.
    15.3. Access to system hardware
        15.3.1. System hardware shall be securely contained within the car and as inaccessible as possible.

4 Modeling Requirements

This section outlines multiple models which describe the CACC++ system. This includes Use Case Diagrams, Object Oriented Models, Sequence Diagrams, and State Diagrams. Each diagram is described in detail and uses Unified Modeling Language notation.

4.1 Use Case Diagram

The use case diagram below describes all the major use cases in our system. The actors include driver, road, and the vehicle in front that are shown in the diagram as stick figures. The actors are placed outside of the blue system boundary. Each actor plays a role in the system and has use cases that interact with other actors. Use cases are connected using dotted arrows. Below the diagram is a series of tables which further describes each use case and their relationships.

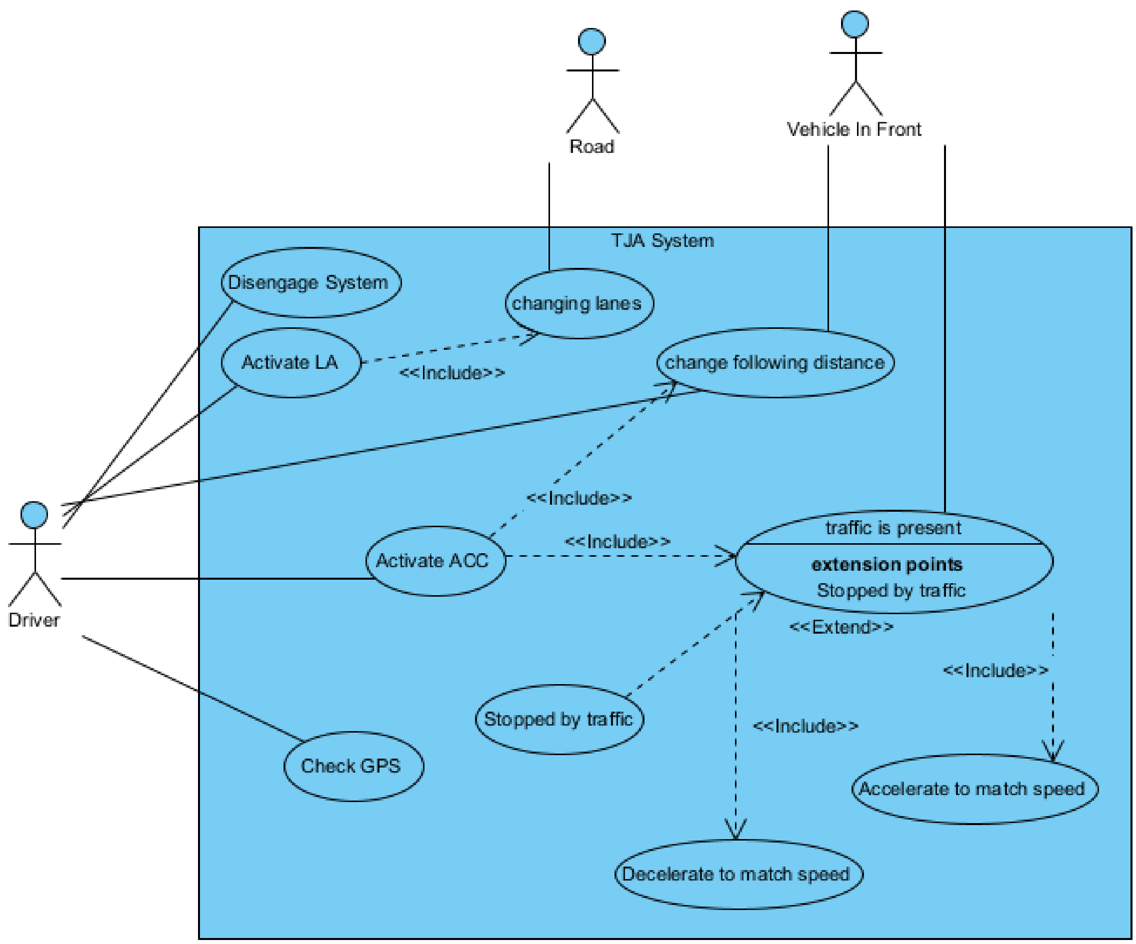

Figure 1: Use Case Diagram

Use Case:	Activate LA
Actors:	Driver
Description	The driver turns on TJA and the lane assist turns on. The system then keeps the vehicle centered in the lane
Type:	Primary (essential)
Includes:	Changing lanes
Extends:	
Cross-refs:	6, 6.1, 6.1.1, 6.2
Use cases:	Changing lanes

Use Case:	Disengage system
Actors:	Driver
Description	When the driver signals the system to shut off, the system will turn off and defer control back to the driver
Type:	Primary (essential)
Includes:	
Extends:	
Cross-refs:	3
Use cases:	

Use Case:	Changing Lanes
Actors:	Driver, Road
Description	Changes the lane when turn signal is activated

Type:	Primary (essential)
Includes:	
Extends:	
Cross-refs:	6.1, 6.2
Use cases:	Changing lanes

Use Case:	Activate ACC
Actors:	Driver
Description	When the driver activates the TJA system the ACC will engage and the speed will be set to the current speed and the distance is set to the max
Type:	Primary (essential)
Includes:	Change following distance, traffic is present
Extends:	
Cross-refs:	2, 2.1
Use cases:	Vehicle Slowing Down Due to Traffic, changing speed

Use Case:	Check GPS
Actors:	Driver
Description	When the driver activates the TJA system the GPS will ensure the vehicle is on an accepted freeway.
Type:	Primary (essential)
Includes:	

Extends:	
Cross-refs:	11, 11.1
Use cases:	Driving off approved freeway

Use Case:	Change following distance
Actors:	Driver, vehicle in front
Description	When the driver activates the TJA system the ACC will engage and the speed will be set to the current speed and the distance is set to the max. The driver can press one of the different following distance buttons changing how far away the vehicle is from the vehicle in front
Type:	Primary (essential)
Includes:	
Extends:	
Cross-refs:	2, 4
Use cases:	Changing speed

Use Case:	Traffic is present
Actors:	Vehicle in front
Description	The vehicle in front slows down due to traffic
Type:	Primary (essential)
Includes:	Decelerate to match speed, Accelerate to match speed
Extends:	Stopped by traffic

Cross-refs:	7, 7.1, 8, 9
Use cases:	Vehicle Slowing Down Due to Traffic

Use Case:	Stopped by traffic
Actors:	System
Description	The vehicle stops due to traffic stopping
Type:	Primary (essential)
Includes:	N/A*
Extends:	N/A*
Cross-refs:	7, 7.1
Use cases:	Vehicle Slowing Down Due to Traffic

Use Case:	Accelerate to match speed
Actors:	System
Description	Engage the engine to match a speed faster than the speed the car is currently moving
Type:	Primary (essential)
Includes:	
Extends:	
Cross-refs:	9
Use cases:	Vehicle Slowing Down Due to Traffic, changing speed

Use Case:	Decelerate to match speed
Actors:	System
Description	Engage the braking system to match a speed slower than the speed the car is currently moving
Type:	Primary (essential)
Includes:	
Extends:	
Cross-refs:	8
Use cases:	Vehicle Slowing Down Due to Traffic

4.2 Domain Model

Figure 2 below shows an object-oriented model, or domain model, for our Traffic Jam Assist system. It uses UML class diagram notation for operations and attributes. For example, the ACC class has attributes such as engaged and operations such as closingRate(). The diagram shows various relationships between classes. Lines with hollow diamonds indicate aggregation relationships, where one class contains others as parts. For instance, the TJA system aggregates components like the ACC, LA, and On/Off Button. Simple lines between classes represent associations, indicating communication and interaction between components. The Camera associates with LA to keep the vehicle centered in the lane, while the ACC associates with both the Accelerator and ABS for vehicle control. Each class in the diagram is detailed in the accompanying data dictionary, which comprehensively describes the class's purpose, attributes, operations, and relationships.

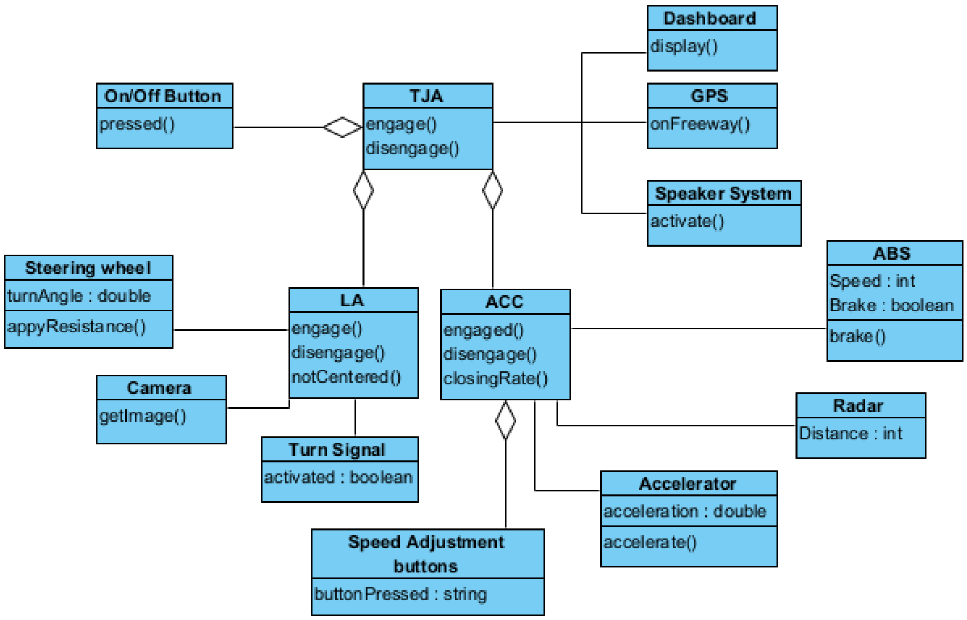

Figure 2: Domain Model for TJA System

CLASS			
	Description (responsibilities)	Assist drivers in traffic jams by utilizing LA and ACC	
	Export control (public: yes/no)	yes	
	Relationships	**Associations**	Dashboard, GPS, Speaker System
		Aggregations	LA, ACC, On/Off Button
		Generalization	
	List of attributes and their primitive types		

TJA

	List of operations (include parameters and results)	engage() disengage()	

CLASS			
On/Off Button	**Description (responsibilities)**	Engage and disengage TJA	
	Export control (public: yes/no)	yes	
	Relationships	**Associations**	
		Aggregations	TJA
		Generalization	
	List of attributes and their primitive types		
	List of operations (include parameters and results)	pressed(): notify TJA button has been pressed	

CLASS			
Dashboard	**Description (responsibilities)**	Display message to driver	
	Export control (public: yes/no)	yes	
	Relationships	**Associations**	TJA
		Aggregations	
		Generalization	
	List of attributes and their primitive types		

	List of operations (include parameters and results)	display(): display given message	

CLASS			
	Description (responsibilities)	Tracks vehicle location	
	Export control (public: yes/no)	yes	
		Associations	TJA
		Aggregations	
	Relationships	**Generalization**	
	List of attributes and their primitive types		
GPS	**List of operations (include parameters and results)**	onFreeway(): return true if vehicle is on freeway	

CLASS			
	Description (responsibilities)	Keeps vehicle centered in lane	
	Export control (public: yes/no)	yes	
		Associations	Steering wheel, Camera, Turn Signal
		Aggregations	TJA
	Relationships	**Generalization**	
LA	**List of attributes and**		

	their primitive types		
	List of operations (include parameters and results)	engage() disengage() notCentered(): returns true if vehicle is not centered using the image from the Camera	

CLASS			
	Description (responsibilities)	Controls the direction of the vehicle	
	Export control (public: yes/no)	yes	
		Associations	LA
		Aggregations	
	Relationships	**Generalization**	
	List of attributes and their primitive types	turnAngle: double	
Steering Wheel	**List of operations (include parameters and results)**	applyResistance(): applies resistance to the steering wheel to keep the vehicle centered	

CLASS			
	Description (responsibilities)	Takes pictures of the view in front of the vehicle	
	Export control (public: yes/no)	yes	
		Associations	LA
		Aggregations	
Camera	**Relationships**		

		Generalization	
	List of attributes and their primitive types		
	List of operations (include parameters and results)	getImage(): returns the image from the camera	

CLASS			
	Description (responsibilities)	Indicates the vehicle is turning or changing lanes	
	Export control (public: yes/no)	yes	
		Associations	LA
		Aggregations	
	Relationships	**Generalization**	
	List of attributes and their primitive types	Activated: boolean	
Turn Signal	**List of operations (include parameters and results)**		

CLASS			
	Description (responsibilities)	Sets a constant speed for the vehicle and can change it based upon the vehicle in front	
	Export control (public: yes/no)	yes	
ACC	**Relationships**	**Associations**	ABS, Radar,

			Accelerator
		Aggregations	TJA, Speed Adjustment Buttons
		Generalization	
	List of attributes and their primitive types		
	List of operations (include parameters and results)	engage() disengage() closingRate(): obtains the rate at which the vehicle is closing in on the vehicle in front and accelerates or brakes based off the closing rate	

CLASS			
	Description (responsibilities)	Changes the following distance from the vehicle in front	
	Export control (public: yes/no)	yes	
		Associations	
		Aggregations	LA
	Relationships	**Generalization**	
	List of attributes and their primitive types	buttonPressed: string	
Speed Adjustment buttons	**List of operations (include parameters and results)**		

CLASS			
	Description (responsibilities)	Increases the speed of the vehicle	
	Export control (public: yes/no)	yes	
		Associations	ACC
		Aggregations	
	Relationships	**Generalization**	
	List of attributes and their primitive types	Acceleration: double	
Accelerator	**List of operations (include parameters and results)**	accelerate(): increases the speed of the vehicle	

CLASS			
	Description (responsibilities)	Senses a vehicle in front	
	Export control (public: yes/no)	yes	
		Associations	ACC
Radar	**Relationships**		

		Aggregations	
		Generalization	
	List of attributes and their primitive types	Distance: int	
	List of operations (include parameters and results)		

CLASS			
	Description (responsibilities)	Stops the vehicle, or slows it down	
	Export control (public: yes/no)	yes	
		Associations	ACC
		Aggregations	
	Relationships	**Generalization**	
	List of attributes and their primitive types	Speed: int Brake: boolean	
Brakes	**List of operations (include parameters and results)**	brake(): engages the brakes	

4.4 Sequence Diagrams

In this section, many sequence diagrams will be presented to further describe how certain scenarios are handled within our system. The large blue boxes with dotted lines are objects in our system and their life lines. The arrows between the dotted lines represent messages between objects in order in which they occur, most recently being the highest on the diagram. Loops are shown by boxes around messages and messages may have guards, shown in brackets, which are conditions which must be checked before continuing.

Figure 3 describes a scenario where the driver adjusts the speed of the vehicle causing the ACC to accelerate or decelerate.

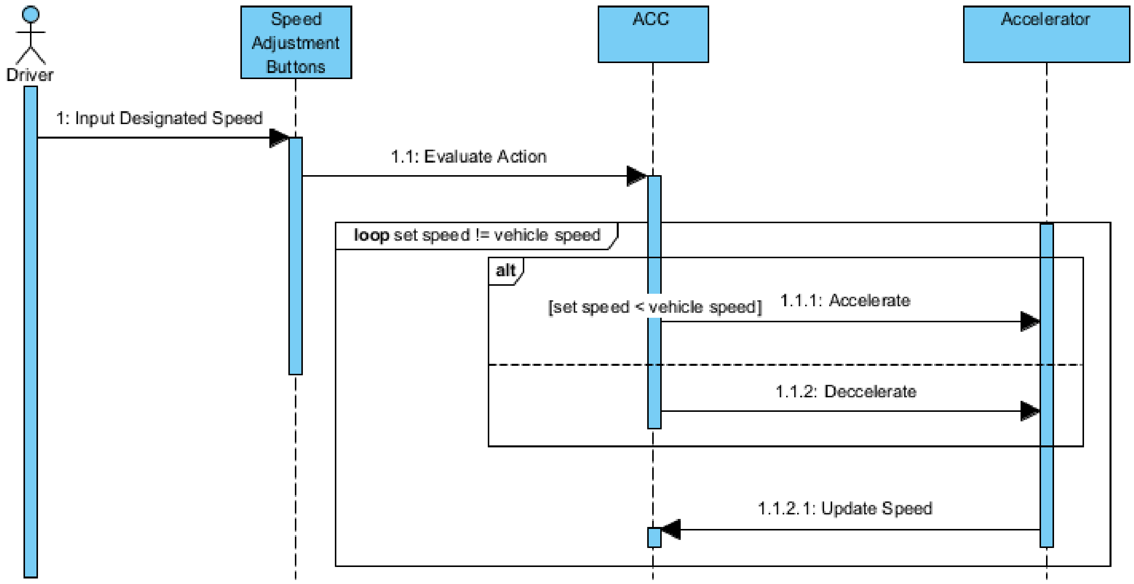

Figure 3: Sequence Diagram for speed adjustment

Figure 4 describes a scenario where there is an imminent crash. When the radar detects that the target vehicle is closing rapidly, it will read the speed and distance and cut the throttle and engage the emergency brakes. The vehicle will gradually slow down while TJA is disabled for driver control until vehicle speed is updated.

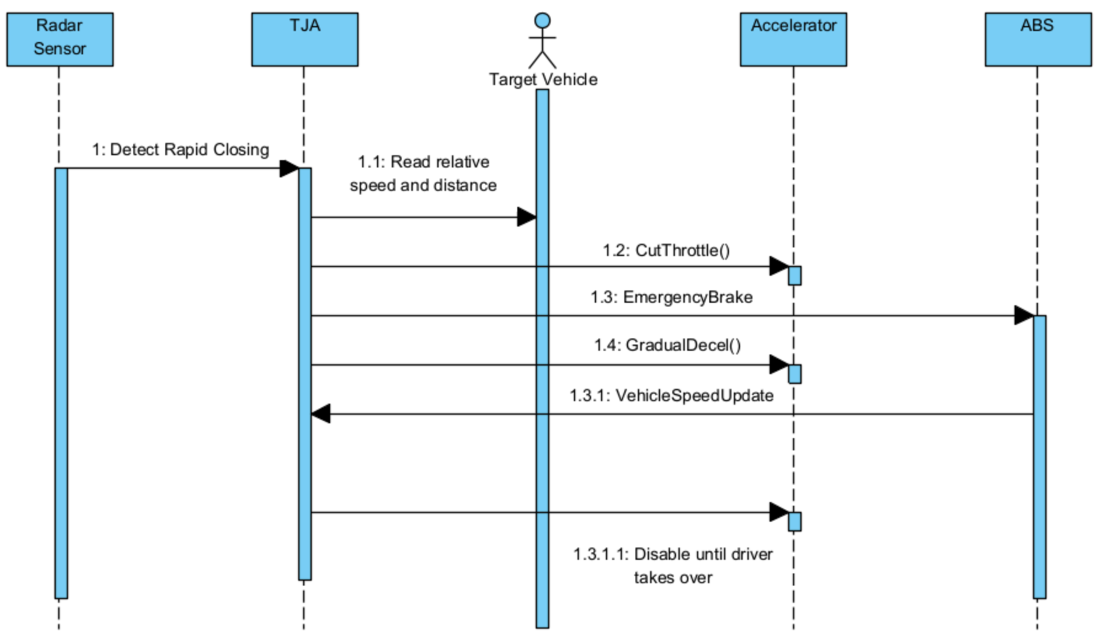

Figure 4: Sequence Diagram for an Imminent Crash

Figure 5 describes how the system would act when the vehicle changes lanes. When the driver changes lanes, the camera notifies Lane Assist. Lane Assist checks if turning lights are on. If they are on, the steering wheel will have no resistance. If turning lights are off the steering wheel will have resistance.

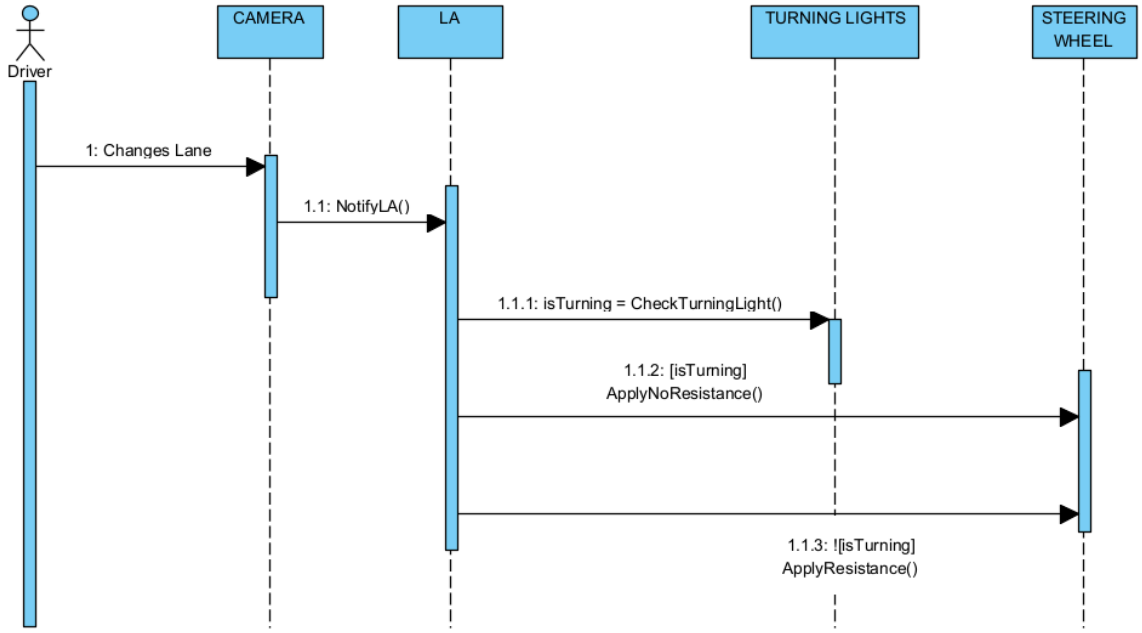

Figure 5: Sequence Diagram for Changing Lanes

Figure 6 describes a scenario where TJA is activated and there is a vehicle in front. The system calculates the closing rate and slows down due to the vehicle in front speed being slower than the vehicle's speed.

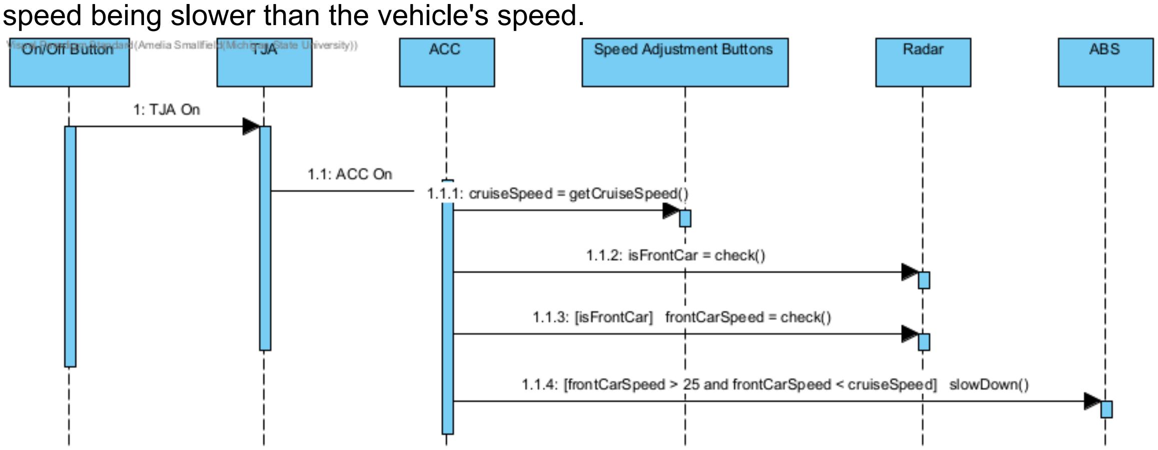

Figure 6: Sequence Diagram for Vehicle Slowing Down Due to Traffic

Figure 7 describes a scenario where the driver activates the TJA and drives off the highway disengaging the system. The scenarios include the display and sound notification for engaging and disengaging the system.

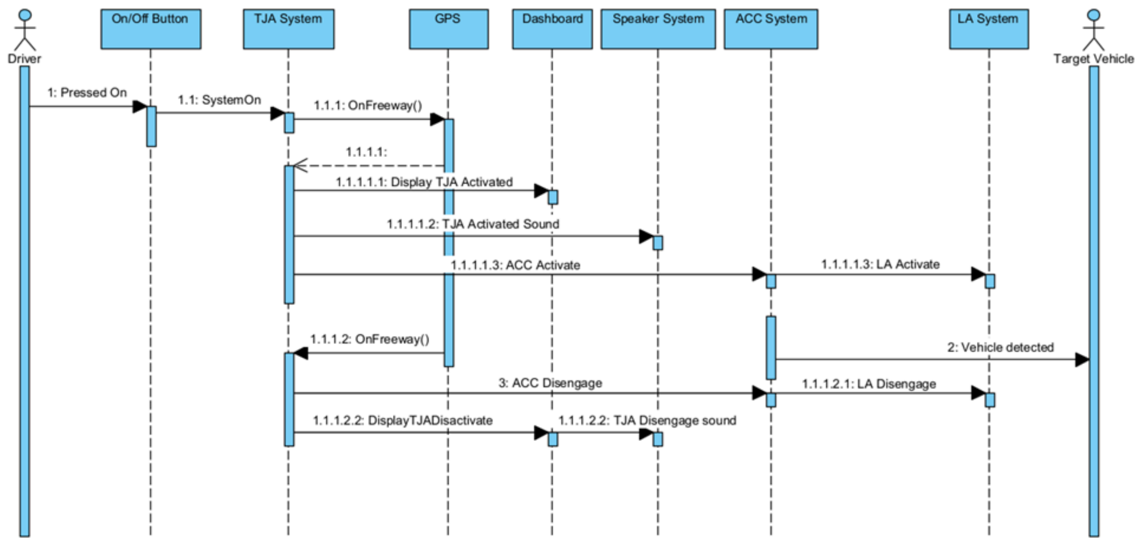

Figure 7: Sequence Diagram for TJA disengage due to leaving approved freeway

4.4 State Diagram

This section will contain state diagrams which describe how different components of our system move from state to state. In the following state diagrams, states are represented by the blue rectangles and transitions between states are denoted by arrows. The text on the arrows is the trigger that causes states to change.

In figure 8, the GPS system notifies the TJA system that the vehicle has left an approved freeway causing the TJA system to shut down.

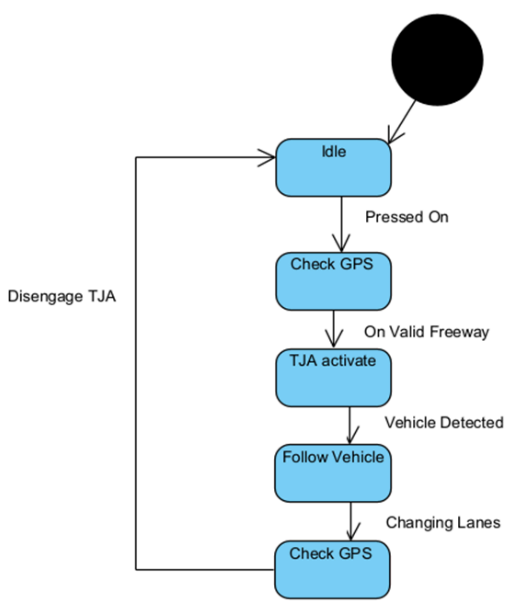

Figure 8: State Diagram for TJA disengage due to leaving approved freeway

In figure 9, it describes how the braking system works when there is an imminent crash.

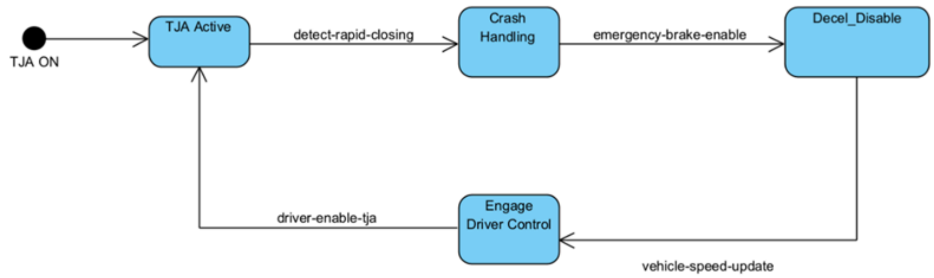

Figure 9: Sequence Diagram for an imminent crash

In figure 10, it describes how the system reacts to speed changes. After the target speed is set the system determines if the speed is at the target speed, if not the vehicle will accelerate or decelerate. When the target speed is reached the end state is achieved.

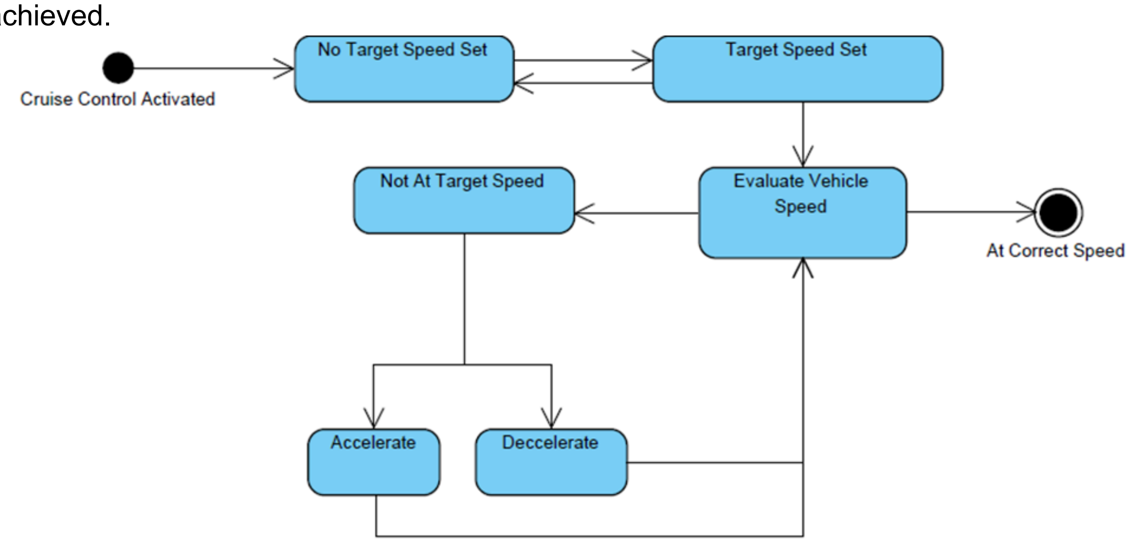

Figure 10: State Diagram for speed changes

In figure 11, it describes lane changing using the LA system. Once the driver starts changing lanes, if the driver activates the turn signal the system will allow the lane change, but if the turn signal is not activated the system will apply an opposing force onto the steering wheel.

Template based on IEEE Std 830-1998 for SRS. Modifications (content and ordering of information) have been made by Betty H.C. Cheng, Michigan State University (chengb at msu.edu)

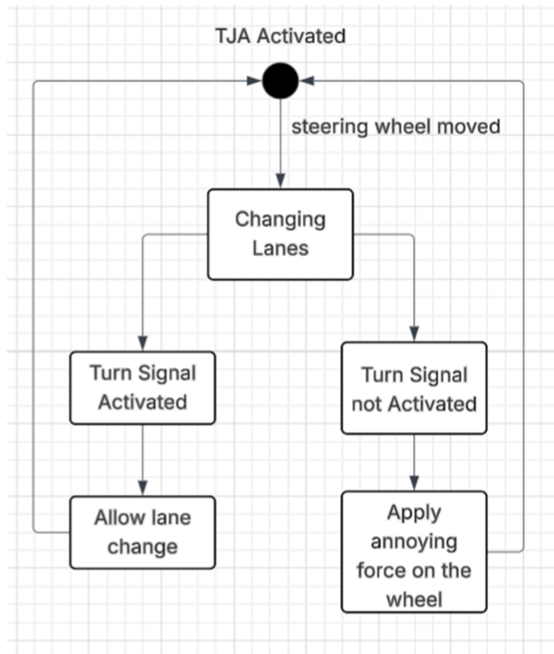

Figure 11: State diagram for changing lanes

5 PrototypeA

Our prototype will be a WebGL build of a Unity application that will allow users to control a vehicle in third person and travel along multi-lane road scenes that showcase several use cases of the TJA2 system. Users will be able to signal lane changes and toggle lane assist, as well as toggle and adjust cruise control. In addition, following three distances for the ACC subsystem will be able to be set. These will all be visible on a mock dashboard UI.

5.1 How to Run Prototype

The prototype will be hosted and embedded in our TJA2 website, and must be accessed on a recent desktop version of Firefox, Chrome, Edge, or Safari. Prototype v1 is available at the following URL: https://www.egr.msu.edu/cse435/tja2/prototype/. It may take longer to load on devices with lower amounts of RAM, showing a black screen until properly loaded.

5.2 Sample Scenarios

The sample scenarios shown by the prototype will show the vital use cases of the TJA2 software. These consist of getting stopped in traffic, driving through normal traffic, and reacting to an imminent crash. They will include the implementation of established systems like ACC and lane assist.

6 References

[1] H. Milam, “Traffic Jam Assist (TJA) ADAS Guide | Calibration & Repair Insights,” *Revvhq.com*, Oct. 05, 2025. https://www.revvhq.com/blog/traffic-jam-assist-tja-adas-feature-calibration (accessed Nov. 09, 2025).

[2] Hawley, Dustin. “What Is a Front Wheel Speed Sensor?” *Jdpower.com*, J.D. Power, 2023, www.jdpower.com/cars/shopping-guides/what-is-a-front-wheel-speed-sensor.

[3] "IEEE Guide for Software Requirements Specifications," in IEEE Std 830-1984 , vol., no., pp.1-26, 10 Feb. 1984, doi: 10.1109/IEEESTD.1984.119205. keywords: {Software engineering;System analysis and design;software;requirements;specifications},

[4]

[5]

7 Point of Contact

For further information regarding this document and project, please contact **Prof. Betty H.C. Cheng** at Michigan State University (chengb at msu.edu). All materials in this document have been sanitized for proprietary data. The students and the instructor gratefully acknowledge the participation of our industrial collaborators.