Automotive Emergency Stopping System
Software Requirements Specification

COMP225 – Sec 404 (Group 12)

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1.0 Introduction

1.1 Purpose

The Automotive Emergency Stopping System will address the issue of the incapacitated driver by performing an escalating warning process, warning external road users, and executing an emergency stopping maneuver when required. The Automotive Emergency Stopping System is a single sub-system to the vehicle's pre-existing longitudinal controller, an add on module any vehicle with pre-existing longitudinal controllers.

1.2 Document Conventions

Acronyms	Description
AESS	Automotive Emergency Stopping System
C	Computer programming language
STKH	Stakeholder
FR	Functional Requirement
NFR	Nonfunctional Requirement
ACC	Adaptive Cruise Control
AEB	Autonomous Emergency Braking
DMC	Driver Monitoring Camera

1.3 Intended Audience and Reading Suggestions

This document is for the AESS software developers, project managers, marketing team, validation team, and documentation writers.

1.4 Project Scope

A large contributor to automotive crashes is when the drivers become incapacitated. This situation can arise in several ways: a driver can fall asleep at the wheel or have a sudden illness, such as a heart attack. In such cases, the crash's severity worsens because surrounding drivers and pedestrians are unaware of the incapacitated driver.

Many vehicles today are equipped with advanced driving assistance features, including autonomous emergency braking and adaptive cruise control; however, this will not prevent collision with pedestrians or static objects (light pole). These existing advanced driving assistance features also will not prevent the host vehicles from drifting off the road.

The pre-existing longitudinal controller on vehicles, capable of advanced driving assistance, can be leveraged with a driver-facing camera to track the driver's status. This will ensure that the driver can perform the driving task, and AESS will execute an emergency stopping maneuver when required.

1.4.1 AESS Escalation Process

	State 1	State 2	State 3	State 4	State 5	No State
State Entry Condition	Duration of Eyes Closed/ Eyes off Road 3 Sec	Duration of Eyes Closed/ Eyes off Road 6 Sec	Duration of Eyes Closed/ Eyes off Road 9 Sec	Duration of Eyes Closed/ Eyes off Road 12 Sec	Vehicle Standstill Achieved	Eyes on Road + Brake Pedal Pressed or Accel Pedal Pressed
Door Lock	N/A	N/A	N/A	N/A	Unlock Doors	N/A
Vehicle Horn	N/A	N/A	N/A	N/A	Constant Horn	N/A
Hazard Light	N/A	N/A	N/A	Hazard Light Activated	Hazard Light Activated	N/A
Brakes	N/A	N/A	3 Light Taps	Begin Braking	Engage Brake Hold	N/A
Panel Display	Yellow Warning: "Return Gaze to Road"	Orange Warning: "Return Gaze to Road"	Red Warning: "Return Gaze to Road"	Red Warning: "Emergency Stopping Maneuver Activated"	White Warning: "Place Eyes on Road, and Retake Control of Vehicle with Accel Pedal"	N/A
Radio	1 Soft Beep	3 Loud Beep	Continuous Loud Beep	Continuous Loud Beep	1 Soft Beep Every 30 Sec	N/A

1.5 References

Reference 1: https://westvalley.mastermuffler.net/the-9-general-vehicle-systems/

Reference 2: https://imotions.com/products/hardware/smart-eye-pro/#product-specifications

Reference 3: https://imotions.com/products/imotions-lab/

Reference 4: https://tests.ca/driving-statistics/

2.0 Overall Description

2.1 Product Perspective

The AESS can be retrofitted to any vehicle with pre-existing longitudinal controllers.

2.1.1 Business Benefits

160,000 car accidents happen every year in Canada.[4]

30% of these accidents are caused by heart attacks, strokes, illness, etc.

Rental agency:

Assuming these crashes result in the vehicle needing replacement / full insurance claim, and a rental agency has Z crashes, this means they will prevent P vehicle replacements.

A typical vehicle costs $50,000.

Price of driver camera module + installation = $500

Therefore, rental agencies will save ____ on average.

Dealerships:

Automotive dealerships selling vehicles with ACC or AEB will already have a longitudinal controller that is capable of being used with AESS system.

Vehicles sold with ACC systems can be upsold to include driver camera module + installation, can upcharge $750 ($250 profit per unit sold)

Insurance Data Logging:

All units sold will have disclaimers that data will be collected by our company via cloud connected services, and we can download logs of # of AESS events that occurred, and sell this info to insurance agencies, automotive companies, and government agencies (regulators) sorted by demographics. 1000 projected new users per month = 12,000 unique data points in the first year for information that was previously unavailable to the market. Can charge $1000 per monthly report as a subscription package.

2.2 Product Features (Functions)

The AESS will provide the following functionalities:

- The driver monitoring camera can detect closed eyes.
- The driver monitoring camera can begin a timer and starts the escalation process when the driver's eyes are closed.
- The driver monitoring camera can actuate hazard lamps.
- The driver monitoring camera can actuate vehicle horns.
- The driver monitoring camera can actuate in-vehicle audible alerts.
- The driver monitoring camera can actuate pre-existing longitudinal controller.
- The user can set the custom response time for the timer within the allowed response time.
- The driver monitoring camera can actuate the door locks at the end of the escalation process to allow emergency responders to enter the vehicle.

When the driver is determined to be incapacitated, an escalating warning process will be introduced and ultimately command the vehicle to come to a full stop. During this process, the vehicle will additionally warn external road users and pedestrians that the host vehicle is performing an emergency maneuver.

2.3 User Classes and Characteristics

Potential customers: Consumers: elderly, parents with teenage drivers, insurance providers, automotive retailers, dealerships.

1. Automotive dealerships: will use AESS to make vehicles more appealing to the intended buyers.
2. Elderly drivers: will use AESS for additional safety measures.
3. Drivers with Medical Condition: Drivers in poor health or medical condition, who might be incapacitated during the drive, will use AESS to prevent collisions.
4. Rental car services: will use AESS to reduce insurance claims by taking extra precautions with their vehicles.

2.4 Operating Environment

AESS will:

- interfere with the braking system.
- interfere with signaling devices - in-vehicle audible alert.
- interfere with signaling devices - brake light.
- interfere with signaling devices - hazard warning light.
- interfere with signaling devices -car horn.
- be developed using C.
- display AESS user settings on the in-car infotainment system.

2.5 Assumptions and Dependencies

- AESS can autonomously command the longitudinal vehicle controller.
- AESS can command infotainment system to display messages, audible alerts, and customer settings.
- AESS can command external vehicle devices (hazard lamps, vehicle horn)
- AESS can use vehicle radar systems and vehicle speed information to safely control braking trajectory during emergency braking maneuver.
- AESS uses the eye tracking software stack from iMotions.
- AESS uses driver-facing infrared camera capable of machine vision.
- AESS must reject false positives for eyes off road or eyes closed.
- AESS uses onboard diagnostics port to interface with the vehicle communications bus.

2.5.1 Design Constraints

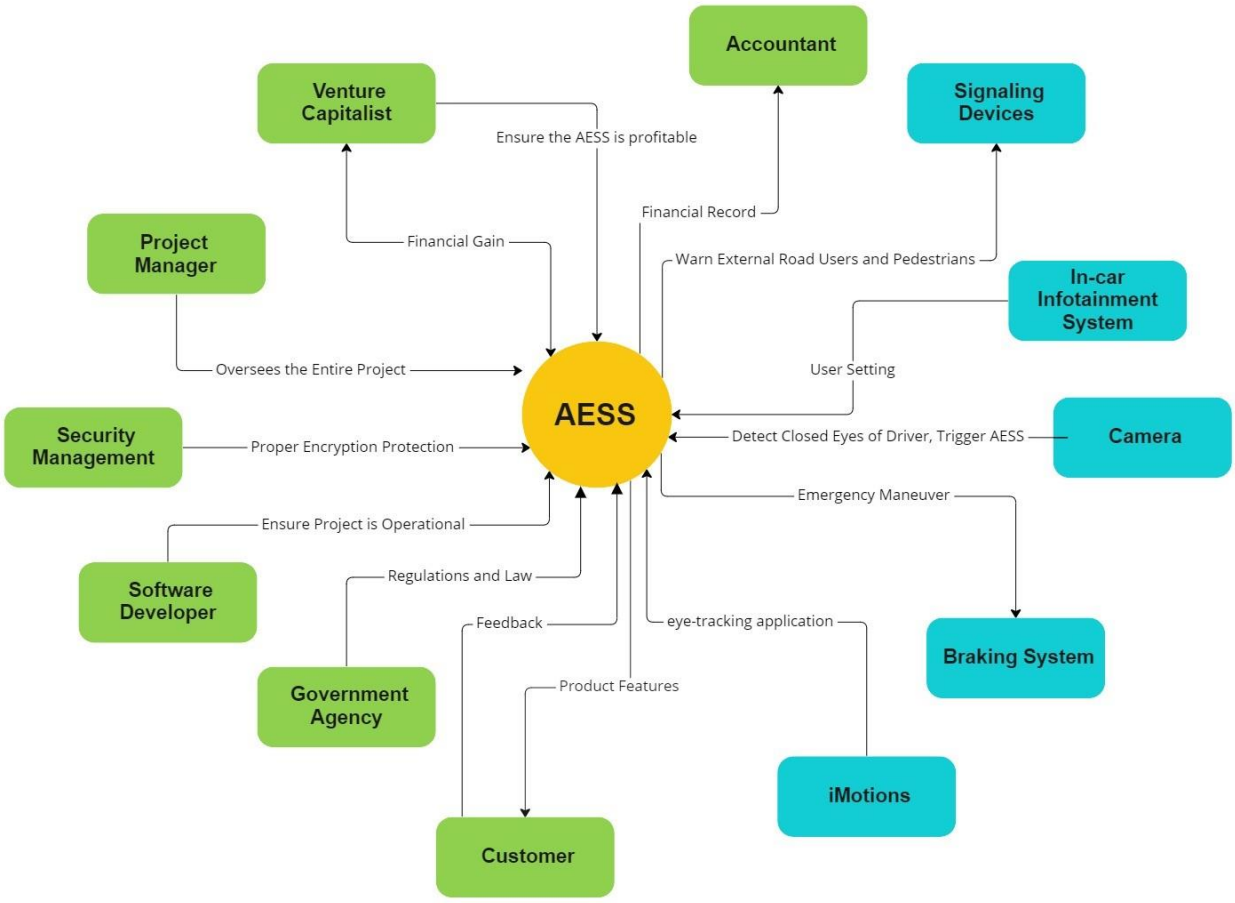
Driver monitoring camera is constrained by machine vision technology for eye tracking and must be accurate for 95th percentile facial recognition. System must have clear view of the driver's eyes and will be unable to track eye position through polarizes glasses, obstructions (hat brims), or thick plastic sunglasses.

3.0 External Interface Requirements

3.1 User Interfaces

Users will use an in-car infotainment system to set the custom response time for the timer within the allowed response time. AESS user interface is based on the already built in-car infotainment system, and do not require internet access. The setting can be made on AESS user setting system is limited, custom response time for the timer within the allowed response time is the only feature that can be changed by users.

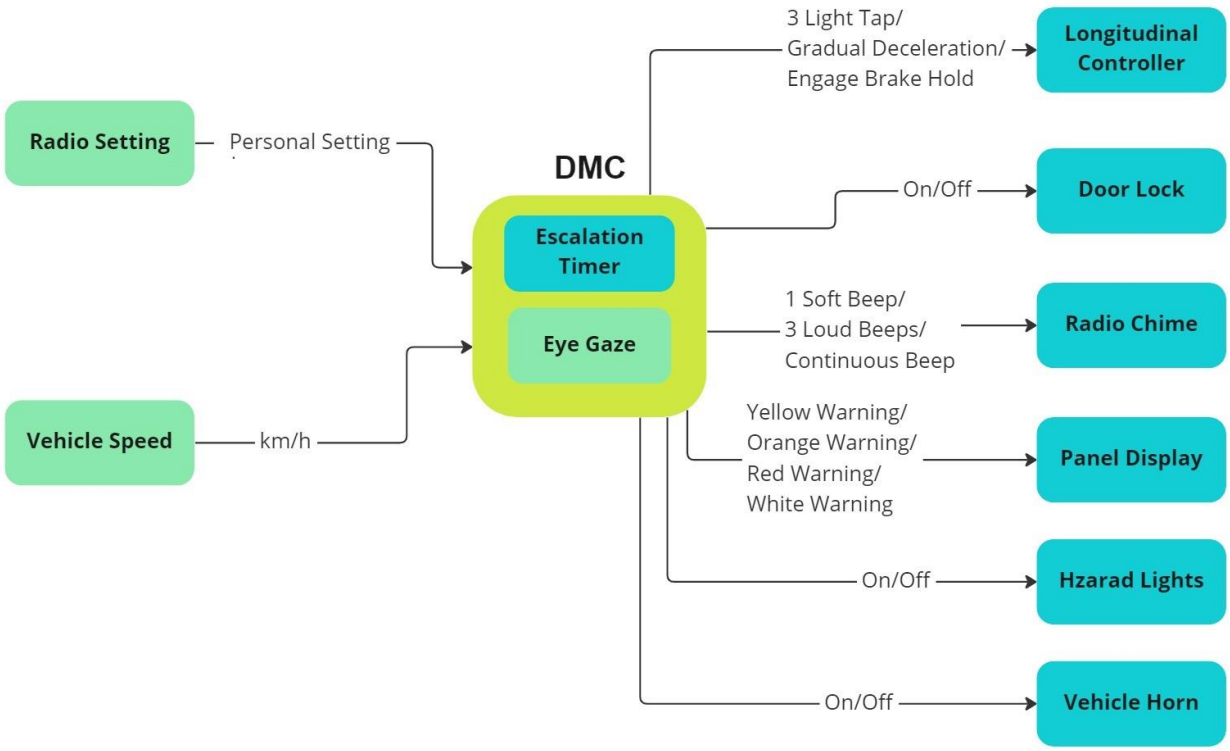
3.1.1 AESS System Context Diagram



3.2 Hardware Interfaces

- A driver monitoring camera to detect closed eyes of host driver.
- Vehicle longitudinal controller to control braking.
- Electronically commanded door locks
- Audio amplifier and tonal generator for Radio to create warning chimes.
- Wiring harness connected to vehicle communication bus through onboard diagnostics port.
- Display panel behind steering wheel, to display warning messages.
- Hazard lamps actuator
- Vehicle horn actuator

3.2.1 AESS Hardware Architecture



3.3 Software Interfaces

- An eye-tracking application software, iMotions 9.3.10.
- Vehicle infotainment system software
- Vehicle communications embedded software.

4.0 Functional Requirements

4.1 Functional / Subsystems Requirement List

Functional Requirement List				
Requirement ID	**Requirement title**	**Description**	**Priority**	**Requester**
FR1.1	Driver Monitor Camera - Outputs	The Driver Monitoring Camera shall command the following subsystems to perform AESS functionality: Door Lock, Longitudinal Controller, Radio Chime, Hazard Lamps, Vehicle Horn, AESS Escalation Timer	High	DMC Software Engineer
FR1.1.1	Driver Monitor Camera – Outputs – Door Lock	The DMC shall command the door lock to unlock when escalation timer is in state 5.	High	DMC Software Engineer
FR1.1.2	Driver Monitor Camera – Outputs – Longitudinal Controller	The DMC shall command the longitudinal controller to perform the following action in different states of AESS: 3 light taps, begin to brake, and hold brake.	High	Brake Engineer
FR1.1.2.1	Driver Monitor Camera – Outputs – Longitudinal Controller (Sate 3)	The DMC shall command the longitudinal controller performs 3 light taps in state 3.	High	Brake Engineer
FR1.1.2.2	Driver Monitor Camera – Outputs – Longitudinal Controller (Sate 4)	The DMC shall command the longitudinal controller begin to brake the vehicle in state 4 until the vehicle comes to full stop.	High	Brake Engineer
FR1.1.2.3	Driver Monitor Camera – Outputs – Longitudinal Controller (Sate 5)	The DMC shall command the longitudinal controller to hold brake in state 5.	High	Brake Engineer

FR1.1.3	Driver Monitor Camera – Outputs – Radio Chime	The DMC shall command the radio to perform a unique chime per AESS escalation state.	High	Radio Engineer
FR1.1.3.1	Driver Monitor Camera – Outputs – Radio Chime (State 1)	The DMC shall command the radio to perform one soft chime when escalation timer enters state 1.	High	Radio Engineer
FR1.1.3.2	Driver Monitor Camera – Outputs – Radio Chime (State 2)	The DMC shall command the radio to perform three loud chimes when escalation timer enters state 2.	High	Radio Engineer
FR1.1.3.3	Driver Monitor Camera – Outputs – Radio Chime (State 3)	The DMC shall command the radio to perform continuous loud chimes when escalation timer enters state 3.	High	Radio Engineer
FR1.1.3.4	Driver Monitor Camera – Outputs – Radio Chime (State 4)	The DMC shall command the radio to perform continuous loud chimes when escalation timer enters state 4.	Med	Radio Engineer
FR1.1.3.5	Driver Monitor Camera – Outputs – Radio Chime (State 5)	The DMC shall command the radio to perform one soft chime every 30 seconds when escalation timer enters state 5.	Med	Radio Engineer
FR1.1.4	Driver Monitor Camera – Outputs – Hazard Lamps	The DMC shall command the hazard lamps only activates in state 4 and state 5.	High	Hazard Lights Engineer
FR1.1.5	Driver Monitor Camera – Outputs – Vehicle Horn	The DMC shall command the vehicle horn to perform constant horn in state 5.	High	Vehicle Horn Engineer
FR1.1.6	Driver Monitor Camera – Outputs – AESS Escalation Timer	AESS Escalation Timer activates unique state's functionality when driver's eyes closed/ off road for 3 seconds.	High	Escalation Timer Software Engineer

FR1.1.6.1	Driver Monitor Camera – Outputs – AESS Escalation Timer (State 1)	AESS Escalation Timer activates panel display to display the yellow warning, and radio for 1 soft beep in state 1.	High	Escalation Timer Software Engineer
FR1.1.6.2	Driver Monitor Camera – Outputs – AESS Escalation Timer (State 2)	AESS Escalation Timer activates panel display to display the orange warning, and radio for 3 loud beeps in state 2.	High	Escalation Timer Software Engineer
FR1.1.6.3	Driver Monitor Camera – Outputs – AESS Escalation Timer (State 3)	AESS Escalation Timer activates the panel display to display the red warning, radio for a continuous beep, 3 light taps on brakes in state 3.	High	Escalation Timer Software Engineer
FR1.1.6.4	Driver Monitor Camera – Outputs – AESS Escalation Timer (State 4)	AESS Escalation Timer activates the panel display to display the red warning, radio for a continuous beep, brake begins, and hazard lights in state 4.	High	Escalation Timer Software Engineer
FR1.1.6.5	Driver Monitor Camera – Outputs – AESS Escalation Timer (State 5)	AESS Escalation Timer activates the panel display to display the white warning, radio for one soft beep every second, brake holds, and hazard lights in state 5.	High	Escalation Timer Software Engineer
FR1.2	Driver Monitor Camera - Inputs	The DMC shall use the following information to control the AESS escalation timer events: Driver Eye Gaze Zone, Vehicle Speed, AESS Personalization Settings.	High	DMC Software Engineer
FR1.2.1	Driver Monitor Camera Eye Zone Determination	The DMC shall use iMotions 9.3.10 to determine if the driver eyes are: 1) on road or 2) closed / looking away from road	High	DMC Software Engineer
FR1.2.1.1	Eye Zone Determination-on Road	The DMC shall consider “on road” eye gaze to be driver gaze anywhere within the front windshield for a duration of 0.5 seconds	High	DMC Software Engineer

FR1.2.1.2	Eye Zone Determination - closed / looking away from road	The DMC shall consider eye gaze “closed / looking away from road” when driver eyes are closed for 0.5 seconds OR gaze anywhere outside of the front windshield for a duration of 0.5 seconds	High	DMC Software Engineer
FR1.2.2	AESS Escalation Timer	The DMC shall consider “closed / looking away from road” eye gaze to be driver eyes closed for 0.5 seconds OR gaze anywhere outside of the front windshield for a duration of 0.5 seconds	High	DMC Software Engineer
FR02	Retrofit Compatibility	The system shall be compatible with any vehicle that already has a pre-existing longitudinal controller. This will allow for the system to be installed on a wide range of vehicles.	Medium	Project Manager
FR03	Observation of Safety Regulation	The system shall follow all relevant automotive safety regulations to ensure it is safe to use on the road.	High	Government Agency

5.0 Nonfunctional Requirements

5.1 Nonfunctional Requirement List

Nonfunctional Requirement List				
Requirement ID	**Requirement title**	**Description**	**Priority**	**Requester**
NFR01	Closed Eye Detection Accuracy	The system should accurately detect the closed eyes of the driver with a high degree of reliability, with a minimum rate of 97%.	High	Project Manager
NFR02	Response Time	The system should respond within 5 seconds of detecting closed eyes, which activates the escalation process.	High	Project Manager

NFR03	Hazard Lamp Indication	The hazard lamps must turn on within 3 seconds of the escalation process being activated.	High	Software Developer
NFR04	Horn Actuation	The horn should sound within 3 seconds of the escalation process being activated.	High	Software Developer
NFR05	Driver Alert System	The in-vehicle audible alert should sound within 3 seconds of the escalation process being activated.	High	Software Developer
NFR06	Durability	The system should be to maintain functionality over a minimum of 5-7 years in all weather conditions.	Medium	Customer
NFR07	Full Stop Command	The longitudinal controller should bring the vehicle to a full stop within 10 seconds of the escalation process being activated.	High	Project Manager
NFR08	Ease of Retrofit	The retrofitting process should be simple and straightforward, in order for consumers to install the system to their vehicles, taking no more than 2 hours per vehicle.	Medium	Venture Capitalist
NFR09	Cost Effectiveness	The cost of the system should be reasonable and affordable for consumers and should not exceed over $600.	Low	Venture Capitalist
NFR10	Data Privacy	The system should not collect, store, or share any personal data. The system should also follow all relevant data privacy regulations.	Medium	Government Agency
NFR11	Updatable	The system should be easily updatable in order to add new features, enhance performance, and fix bugs.	Low	Software Developer

6.0 AESS Use Cases

6.1 Use Case Table

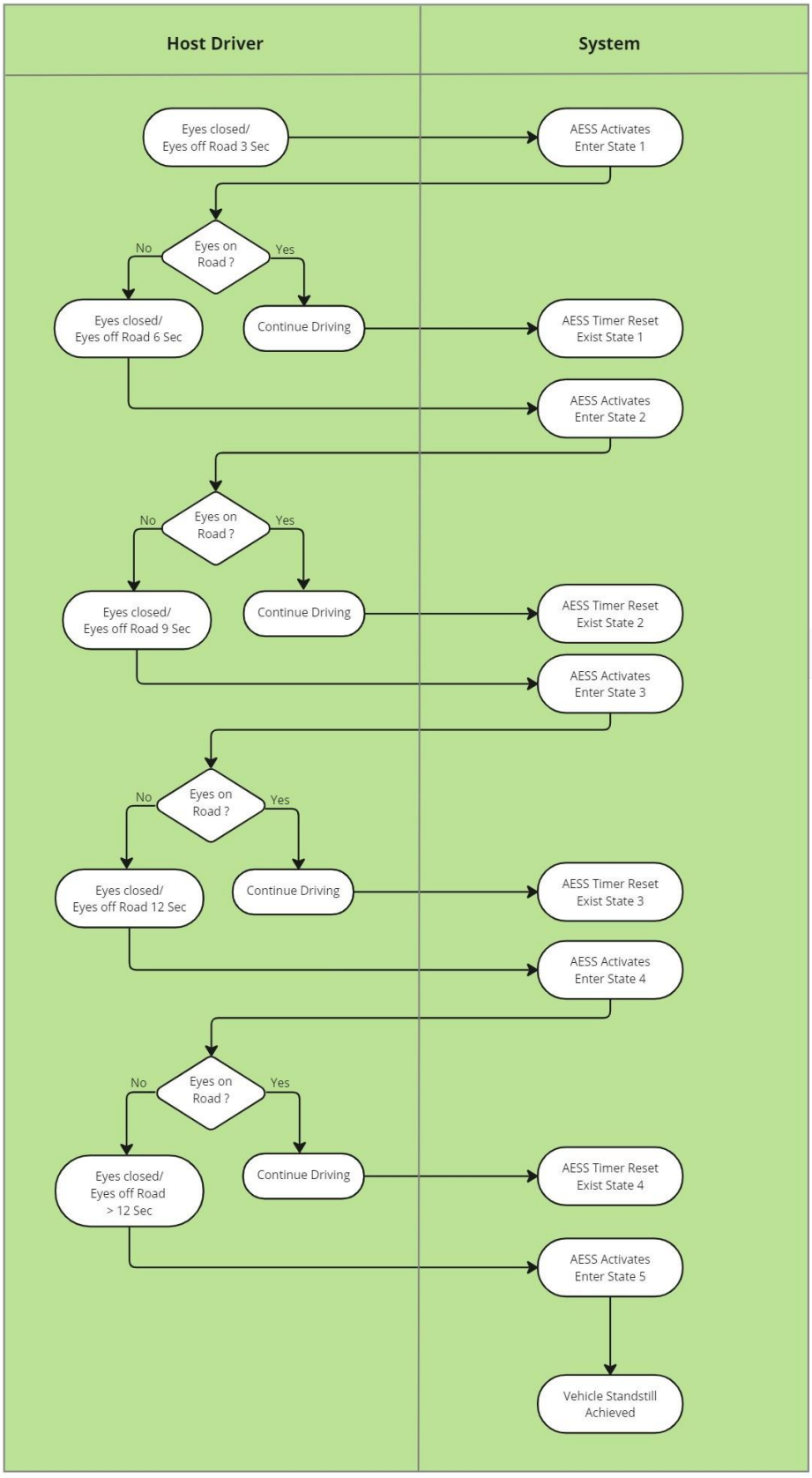
Use case name	Related FR ID	Actor(s)	Brief Description
Detects closed eyes	FR 1.1 FR 1.2	AESS Driver	The AESS system detects the actor's (driver) eyes are closed and initiates appropriate response based on the state that the system is in.
Displays panel warning	FR 1.1.6	AESS Driver	The AESS system will show a warning on the display panel based on the state that the system is in.
Warning chime on the radio	FR 1.1.3	AESS Driver	The AESS system will emit audible warning based on the state that the system is in.
Engages brakes	FR 1.1.2	AESS	The AESS systems will engage the car's brakes based on the state that the system is in.
Displays hazard lights	F.R 1.1.4	AESS	The AESS will display the hazard lights in State 4.
Initiates Vehicle Horn	F.R 1.1.5	AESS	The AESS system will initiate the vehicle's horn on a constant basis.
Activates Door locks	FR 1.1.1	AESS	The AESS system unlocks the doors while the system is in State 5.
Detects re-opened eyes	FR 1.1 FR 1.2	Driver AESS	The AESS system detects driver's eyes are open and return AESS to normal state and reset timer.

6.2 AESS Detailed Formal Use Case Description

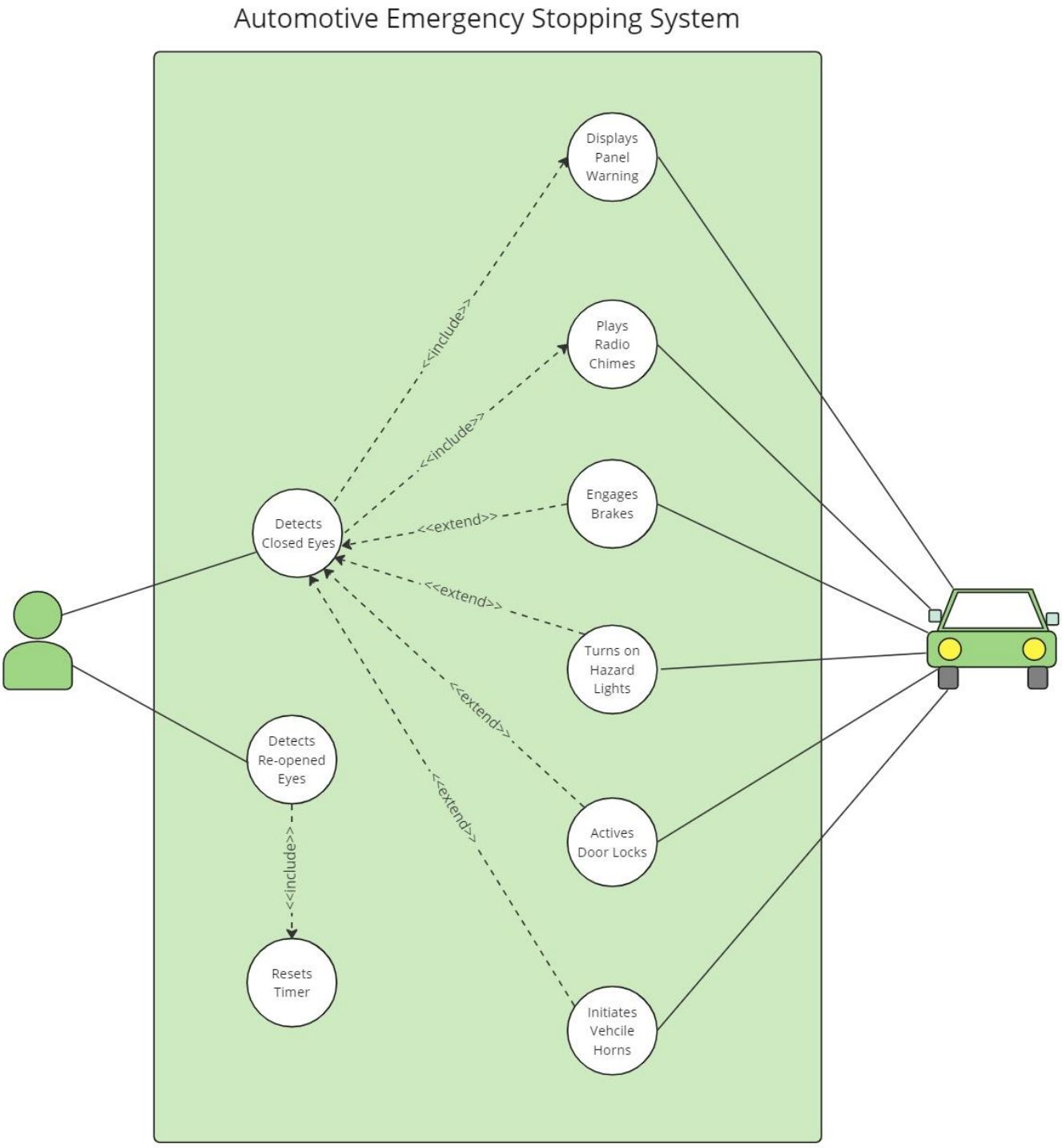
Use case name:	Detects closed eyes with AESS	
Scenario:	Detect when a driver's eyes are closed or off the road for 3 seconds while driving, then activate AESS and enter AESS State 1.	
Trigger Event:	The driver of the host vehicle has their eyes closed or off the road for 3 seconds during the act of driving.	
Brief Description:	When the driver's eyes are closed or off road for more than three seconds, the AESS system detects it and activates a suitable response depending on the system's current state.	
Actor(s):	AESS, the Host Driver	
Related Use Cases:	This use case may trigger both a warning on the Displays panel warning use case and Warning chime on the radio use case.	
Stakeholders:	Software Developer, Customers, Venture Capitalist	
Preconditions:	The host vehicle must be equipped with the longitudinal vehicle controller and AESS installation.	
Postconditions:	After three seconds of closed eyes or being off the road, the host driver must remain attentive when using the AESS State 1 functionality. When the host driver fails to return their eyes to the road within six seconds, AESS State 2 will be activated.	
Flow of Activities:	**Actor:**	**System:**

	1.The host driver has their eyes closed or off the road for 3 seconds during the act of driving. 2.The host driver returns their eyes back to the road within 6 seconds. 3.The host driver fails to return their eyes to the road within 6 seconds.	1.1 AESS triggers, enter State 1. 1.2 Yellow Warning on Panel Display: “Return Gaze to Road” 1.3 The radio performs one soft chime when escalation timer enters state 1. 2.1 AESS reset timer, exist State 1. 3.1 AESS continuous actives, enter State 2. 3.2 Orange Warning on Panel Display: “Return Gaze to Road” 3.3 The radio performs three loud chimes when escalation timer enters state 2.
Exception Conditions:	1.1 The DMC fails to detect closed eyes. 2.1 The AESS timer fails to reset. 3.1 The AESS fails to enter State 2.	

6.3 AESS Swimlane Activity Diagram



6.4 AESS Use Case Diagram



7.0 Party Analysis pattern

The Party Analysis pattern is a valuable tool for understanding the interactions of several stakeholders in a system or project. In the context of the Automotive Emergency Stopping System (AESS), the Party Analysis pattern can assist in identifying the many parties involved in the system's development, deployment, and use. Parties involved could include, for example, the vehicle manufacturer, the AESS development team, regulatory bodies, and end-users. (drivers and passengers). The AESS development team can construct a system that satisfies the needs of all stakeholders by understanding each party's interests and concerns.The manufacturer's goal, for example, could be to ensure that the AESS meets safety regulations and is simple to install. The motorist may want a system that does not interfere with their driving experience, while the government may want to ensure that the AESS is effective in reducing accidents.

To begin, the system's end users are the vehicle's drivers and passengers. They will be the key benefactors of the system because it will increase their safety and lower the likelihood of accidents. They may, however, have reservations about the system's impact on the driving experience, such as the possibility of false positives or the system being unduly obtrusive. As a result, it is critical to ensure that the system is built to strike a balance between safety and use.

Second, automotive manufacturers and suppliers will be project participants. They will be in charge of building and implementing the system, and they must examine the system's cost and practicality, as well as any potential legal or regulatory requirements. Furthermore, they may be concerned about the potential influence on the vehicle's warranty or the system's reliability.

Ultimately, regulatory agencies and governments will be involved in this initiative. They will be in charge of establishing and enforcing vehicle safety standards, as well as ensuring that the system meets these requirements. They may be concerned about the effect on traffic flow or the possibility of unforeseen effects.

Subsequently other road users, such as pedestrians and cyclists, may be participants in this project. They may be concerned about the system's possible impact on their safety or the system's ability to cause confusion or misconceptions.

However, there are limitations to the party analysis pattern in the context of the AESS project. For instance, there might be stakeholders who are not immediately apparent, such as insurance

companies or emergency response teams. Additionally, identifying the interests of each stakeholder can be challenging, and there might be conflicting interests that cannot be reconciled. For example, the government might be interested in reducing accidents, while the driver might be interested in maintaining their autonomy and control over the vehicle. In such cases, the AESS might need to balance conflicting interests and find a solution that satisfies all stakeholders to the extent possible.

All in all, the Party Analysis pattern is an effective method for identifying and analyzing the stakeholders in the Automotive Emergency Stopping System project. The project can be structured to balance safety, usability, and feasibility by considering the interests and concerns of all parties.

Appendix A: Stakeholder Register

Stakeholder Register

STKH Name	STKH Position	External /Internal	STKH Contacts	Operational /Executive	Interest*	STKH Information
Yang Q	Project manager	Internal	qy434667148@gmail.com	Operational	High	Ensure adherence to schedule, budget, and scope
Fan Y	Security Management	Internal	fanquerques@gmail.com	Operational	Medium	Ensure security system is in place, and proper encryption protection
Lammim	Software Developer	Internal	lamminm287@gmail.com	Executive	Medium	Ensure project is operational, and performance as per design
Cogie	Government Agency	Internal	cogiecruz@gmail.com	Executive	Medium	Ensures compliance with applicable regulations and laws
Tom	Teenage Customer	External	tom123@gmail.com	Operational	High	Provides feedback on UI, and general usage of product
Ami	Elderly Customer	External	ami123@gmail.com	Operational	High	Provides feedback on UI, and general usage of product
Edward	Venture Capitalist	External	edward456@gmail.com	Executive	High	Ensure product is unique and proprietary and has a market
Emma	Accountant	Internal	emma456@gmai. com	Operational	Low	Helps corporate record and report on financial information

*Interest Rating: High, Medium, Low

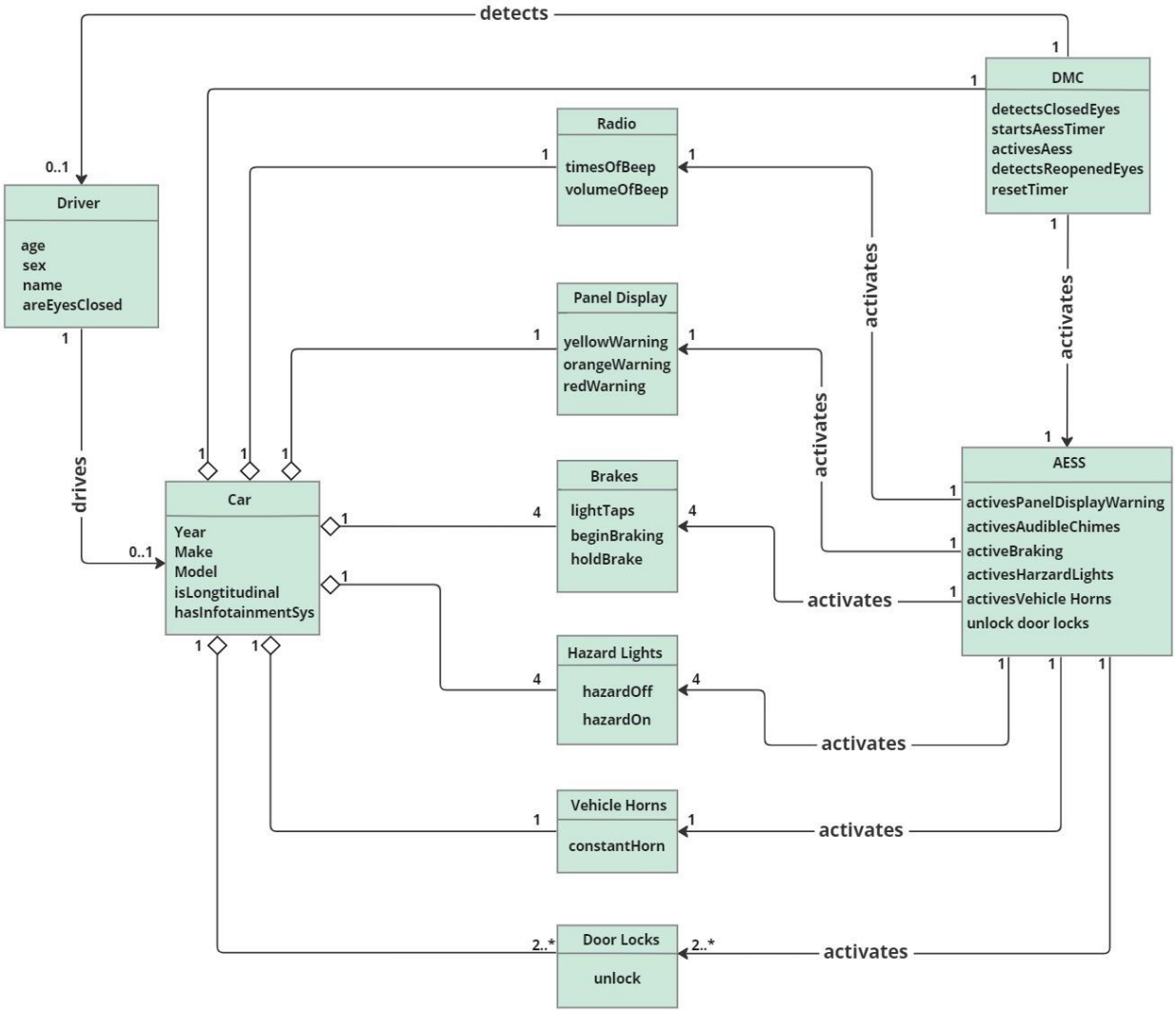
Appendix B: Interview Questions

Interview Questions		
Question	**Stakeholder Position**	**Answer**
1) What measures have been put in place to ensure that the AESS will be reliable and effective in emergency situations?	Project Manager	Extensive testing on AESS and the eye-tracking camera before the release ensures the quality of AESS. Additionally, we provide after-sale routine maintenance to all customers, which will ensure the reliability of AESS.
2) Can you describe the process for testing and certifying the AESS before it is deployed in vehicles?	Validation Engineer	We test AESS in various scenarios to see if AESS responds appropriately. Moreover, we ensure that AESS adheres to the government's safety standards.
3) How do you plan to market the AESS to potential customers and target audiences?	Marketing Manager	- Additional safety measurements: AESS can reduce the chance of collision. - Compatibility: AESS can be retrofitted to any vehicle. - Financial benefits: lower insurance rate, and lower
4) What inspired you to invest in the development of AESS?	Venture Capitalist	We invested in the development of AESS because we believe drivers, car rental businesses, and car dealerships will pay for AESS for extra safety measurements. This will generate profits.
5) Can you describe the market demand for the product and how it fits into the automotive industry?	Marketing Manager	If people care for safety, the AESS is in demand. To be specific, automotive dealerships, elderly drivers, Drivers with medical conditions, and rental car services are all our target audiences. The AESS will be a desired safety feature in automotive.
6) What is your long-term analysis of the potential return on investment for the AESS?	Venture Capitalist	Since the target audience is broad, the expected market demand is high. Currently, there is no similar technology to the AESS on the market. The AESS will continually develop more features to occupy a more significant market share.

7) What programming languages and tools have been used to develop the AESS?	Software Developer	The AESS was created using C programming languages and iMotions 9.3.10. eye-tracking technology.
8) What steps have been taken to make sure the software is scalable and maintained for upcoming updates and improvements?	Software Developer	The AESS software was organized and documented for future updates and improvements.
9) In order to make sure the software operates as planned, how did the development team test and debug it?	Software Developer	We've tested the AESS software thoroughly to make sure it works as it should. We also fixed any issues we found while testing to make sure it's as good as it can be.
10) How does the AESS make you feel safer and more secure while driving?	Customer	I will feel safer driving thanks to the AESS which can take over in case I'm unable to. I will be able to drive with peace of mind because of this.
11) What functions would you like to see upgraded or introduced in future AESS versions?	Customer	I would like to see the AESS cover fatigue driving issues in the future, along with incapacitated drivers.
12) How important is the AESS in your decision-making process when choosing a new vehicle?	Customer	I want to make sure the car I am buying is compatible with AESS, safety is something I take seriously.

Appendix C: Diagrams and CRC Cards

AESS Domain Class Diagram



Class Responsibilities and Collaboration Cards

Class: Driver		
Responsibilities	Collaborators	Attributes
• Operate the vehicle safely. • Respond appropriately to warnings from AESS. • Provide input to AESS system configuration (e.g., custom response time)	• Car • DMC	• age • sex • name • areEyesClosed

Class: Car		
Responsibilities	Collaborators	Attributes
• Respond to commands from the AESS. • Must have a longitudinal controller. • Must have an infotainment system.	• Driver • DMC • Radio • Panel Display • Brakes • Hazard Lights • Vehicle Horns • Door Locks	• year • make • model • isLongtitudinal • hasinfoainmentSys

Class: Driver Monitoring Camera (DMC)		
Responsibilities	Collaborators	Attributes
• Detect if the driver's eyes are closed using a camera. • Detect if the driver's eyes are closed using a camera. • Reset the timer when the driver's eyes are detected as open again. • Activate AESS if the driver is not responsive within the allowed response time.	• Driver • Car • AESS	• detectsClosedEyes • startsAessTimer • activesAess • detectsReopenedEyes • resetTimer

Class: AESS		
Responsibilities	Collaborators	Attributes
• Activate visual warning on Panel Display • Activate audible chimes. • Activate braking system. • Activate hazard lights. • Activate vehicle horns. • Unlock door locks.	• DMC • Car	• activesPanelDisplayWarning • activesAudibleChimes • activeBraking • activesHarzardLights • activesVehicleHorns • unlockDoorLocks

Class: Radio		
Responsibilities	Collaborators	Attributes
• Respond to commands from the AESS. • Play audible warnings. • Adjust the volume of the audible warnings.	• Car • AESS	• timesOfBeep • volumeOfBeep

Class: Panel Display		
Responsibilities	Collaborators	Attributes
Respond to commands from the AESS. • Display visual warning.	• Car • AESS	• yellowWarning • orangeWarning • redWarning

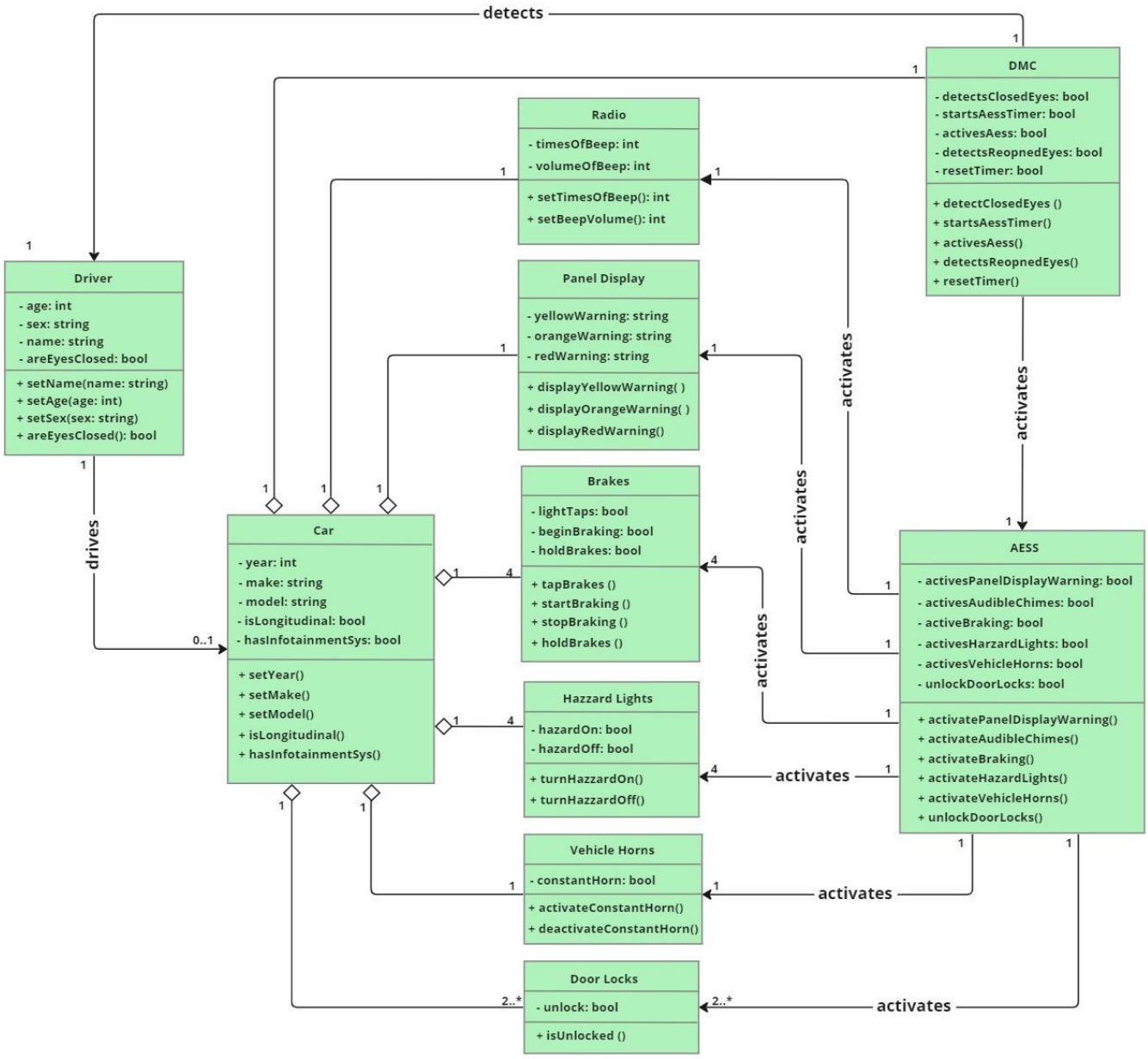
Class: Brakes		
Responsibilities	Collaborators	Attributes
• Respond to commands from the AESS. • Apply and release brakes based on signals from the AESS.	• Car • AESS	• lightTaps • beginBraking • holdBrakes

Class: Hazard Lights		
Responsibilities	Collaborators	Attributes
• Respond to commands from the AESS. • Activates hazard lights based on signals from the AESS. • Warn surrounding vehicles.	• Car • AESS	• hazardOn • hazardOff

Class: Vehicle Horns		
Responsibilities	Collaborators	Attributes
• Respond to commands from the AESS. • Activate vehicle horns based on signals from the AESS. • Produce sound to warn nearby road users.	• Car • AESS	• constantHorn

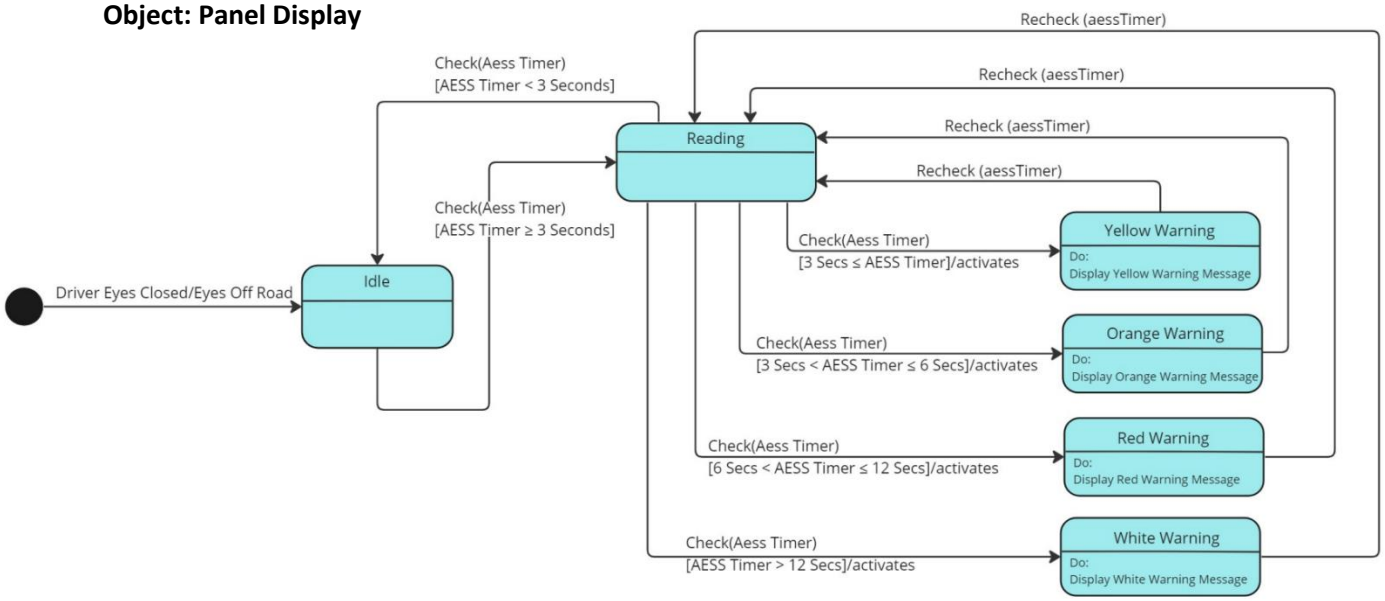
Class: Door locks		
Responsibilities	Collaborators	Attributes
• Respond to commands from the AESS. • Unlock the car doors based on signals from the AESS.	• Car • AESS	• unlock

AESS Class Diagram

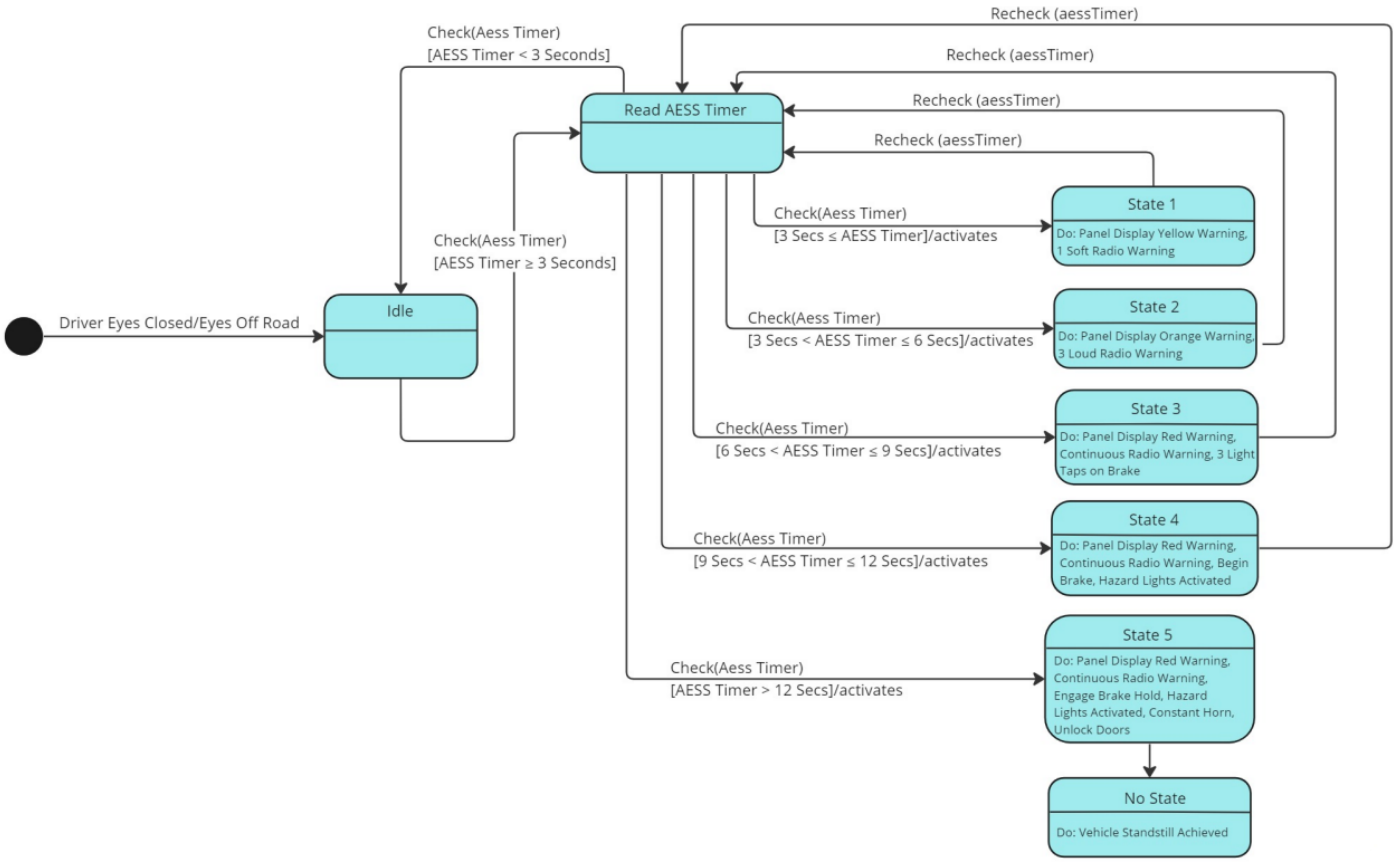


State Machine Diagrams

Object: Panel Display



Object: AESS



Sequence Diagram