Prince Mohammad Bin Fahd University
College of Engineering
Department of Electrical Engineering

Smart Driver Safety System

Team Members	
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Advisors:
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Mr. Saifullah Shafiq

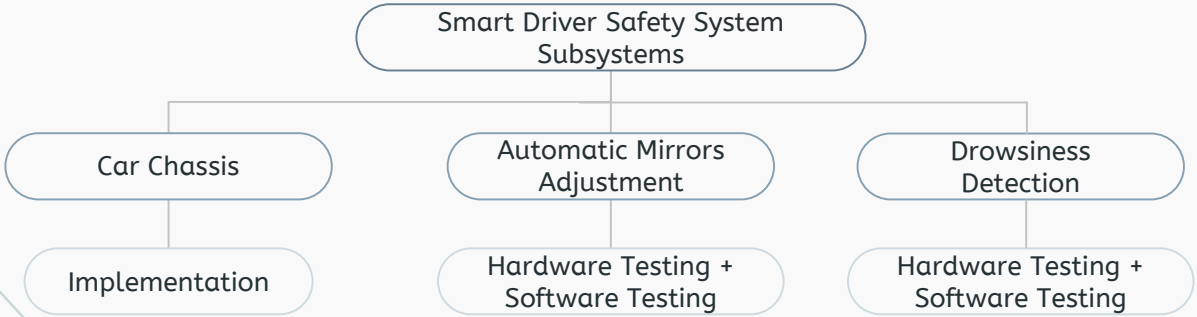
May 17, 2022

Outline

• Pproject Definition

- Design a smart driver safety system to adjust the car side-view mirrors automatically and detect the driver drowsiness to alert the driver by generating an audio alarm.

- Implementing the project by designing three subsystems.



Project Objectives

01 To improve the vehicle's safety.

02 To assist the driver in avoiding the blind spots.

03 To keep the driver engaged, alert and mentally active.

04 To reduce the risk of accidents caused by blind spots and drowsy driving.

Project Specifications

- Locates the driver’s upper body position using LiDAR sensors.
- Computes the mirrors angle values to minimize blind spots.
- Performs automatic adjustment of the mirror's angles with respect to upper body position.
- Tracks the driver’s eyes using an Infrared pi-camera to compute the eye aspect ratio (EAR).
- Generates an alarm once drowsiness is detected.
- Controls the system by a switch to turn it on/off.

Design Constraints & Standards

Social

Project meets needs and addresses a social issue.

01

Safety

Meets safety standards and doesn't cause harm.

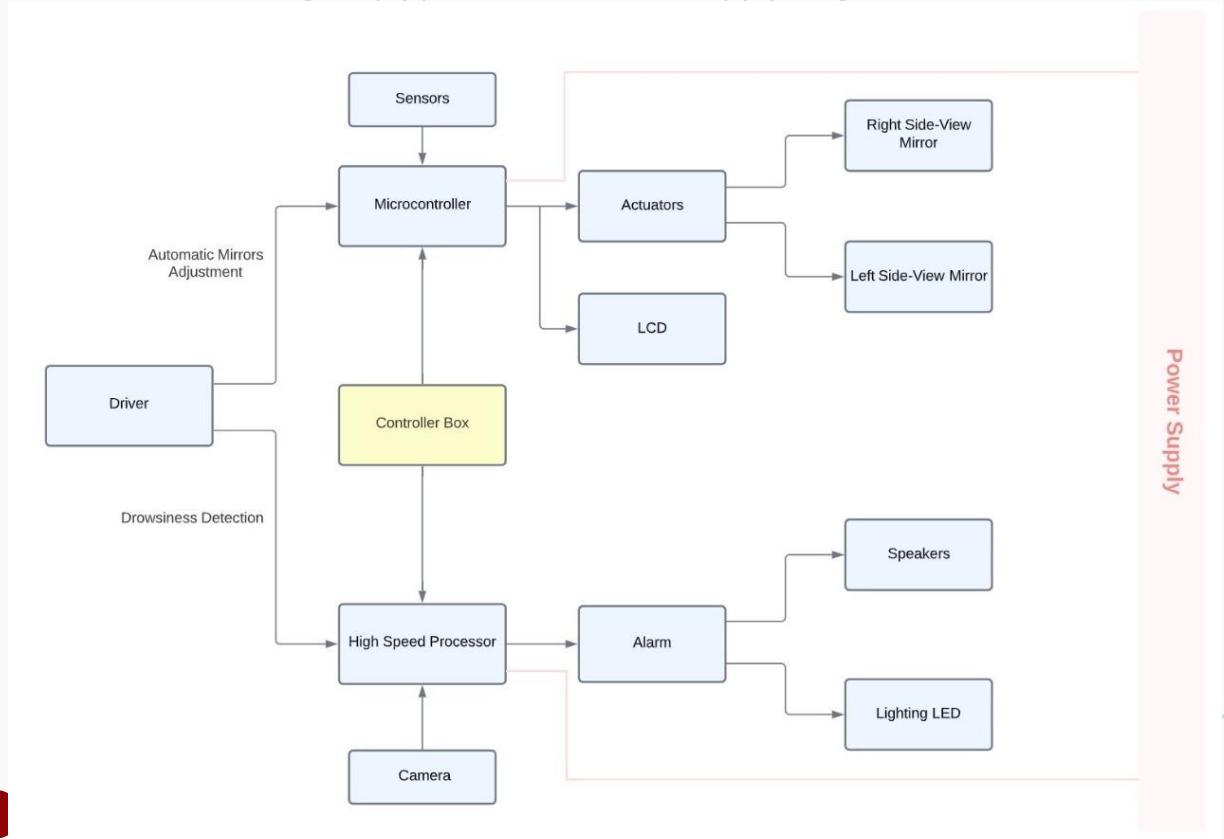
02

03

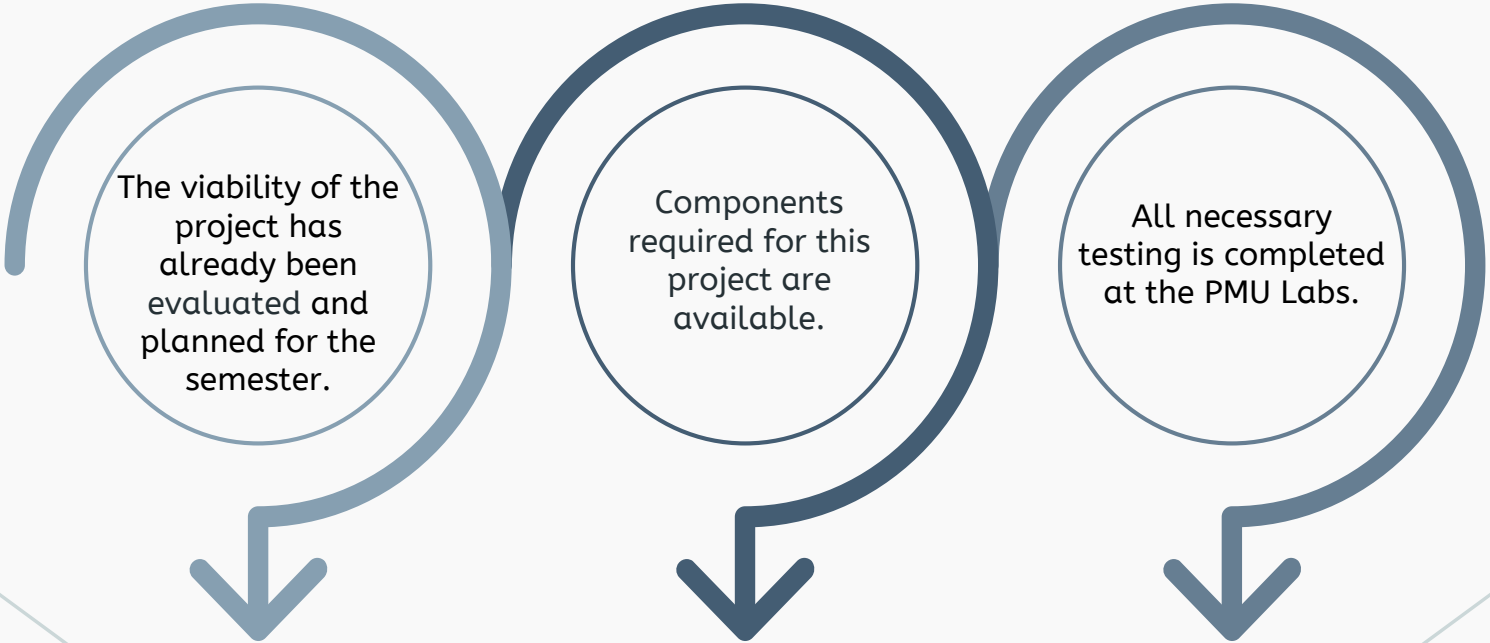
Manufacturbaility

Designing in a way that product can be manufactured.

Project Architecture

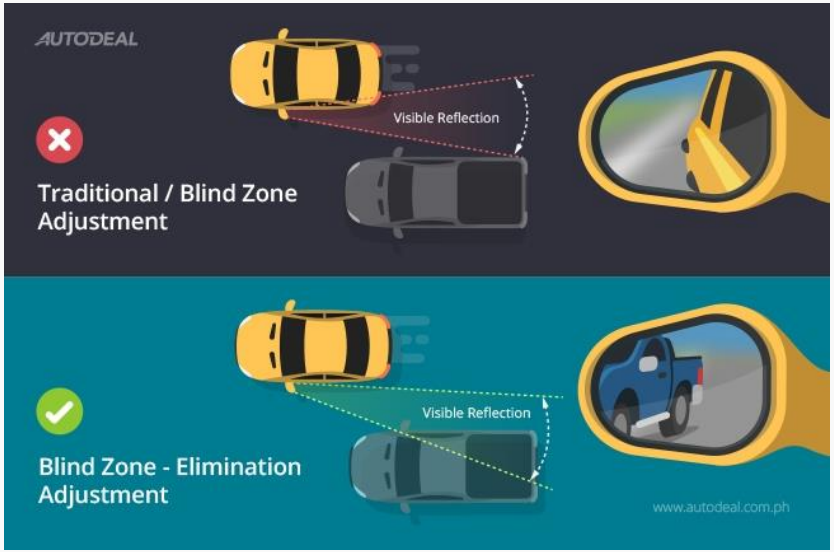


Planning


The viability of the project has already been evaluated and planned for the semester.
Components required for this project are available.
All necessary testing is completed at the PMU Labs.

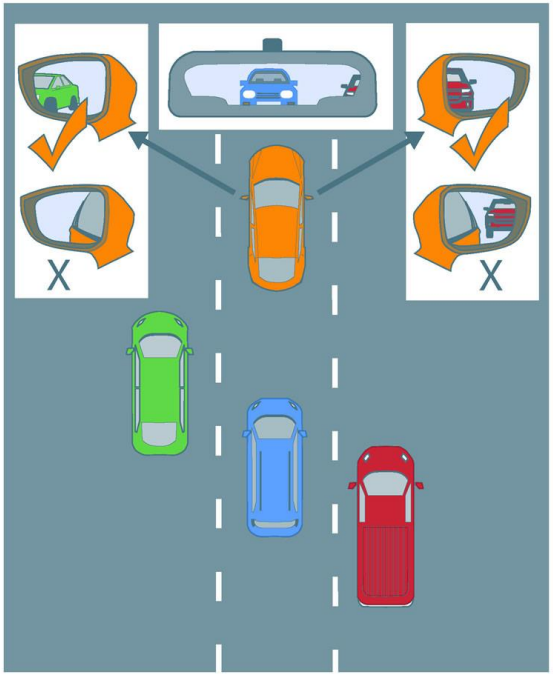
Background: First Problem

Common Mistake	Aligning the edge of the mirror with the side of your car.
Problem	This already shows what you can see in rearview mirror and causes a blind spot.



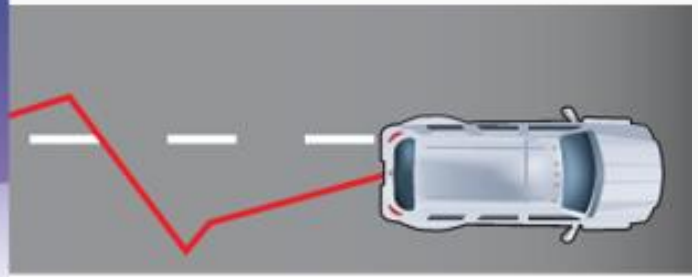
Background: Solution

- Adjusting the side mirrors manually to the correct position.



Background: Second Problem

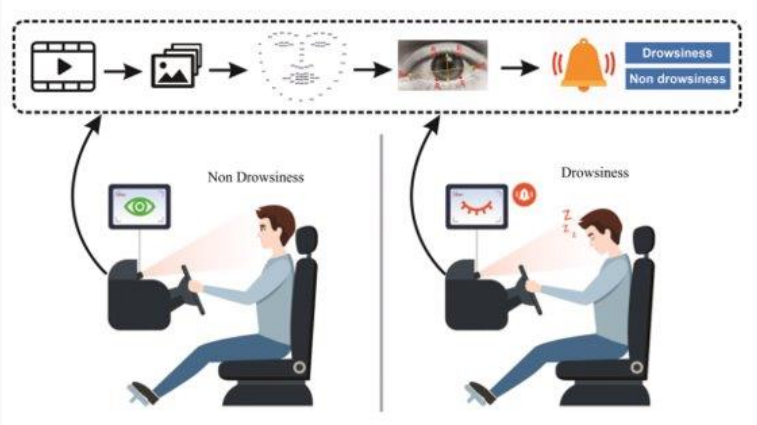
Problem: Drowsy driving is disturbing problem, as evidenced by various data indicating how dangerous it is and how it can result in major injuries or fatalities.



Background: Solution (Drowsiness Detection)

The Eye Aspect Ratio Equation:

$$\mathrm{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$



Design of Subsystem 1 (Car Chassis)

Car Chassis:

- Two side-view mirrors
- One rear-view mirror
- One driver seat
- Steering wheel
- Control box

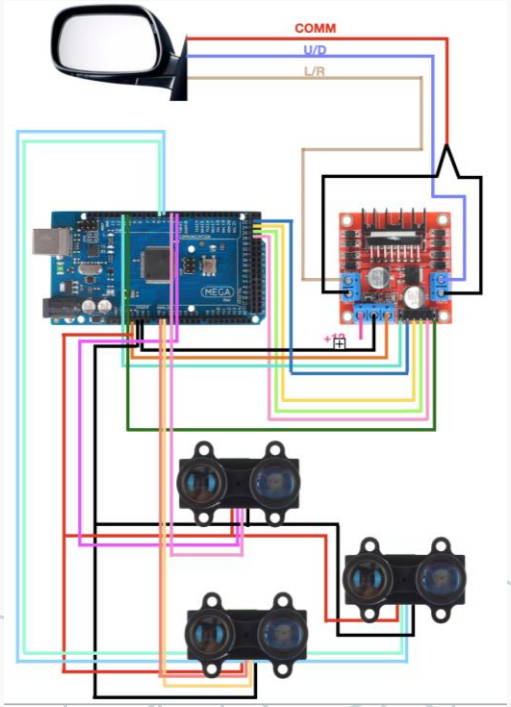
Design of Subsystem 1 (Car Chassis)

Sensors Placements

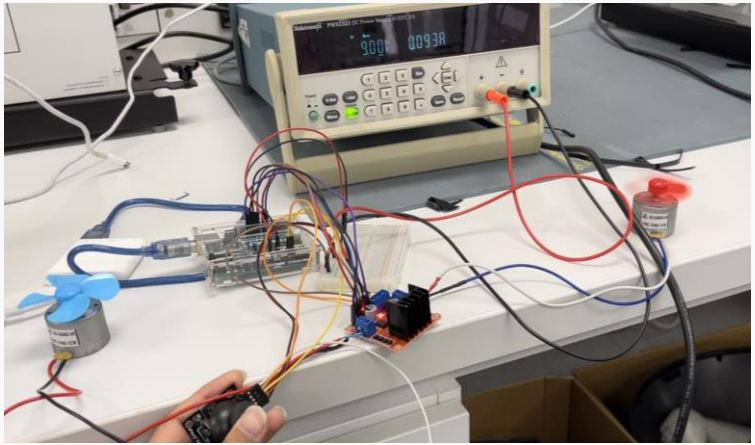
Design of Subsystem 2 (Automatic Mirrors Adjustment): Hardware *1st Design*

Component Selection:

- Understanding the mirror's wiring.
- Using an H-bridge to drive the motor in both directions.
- Using Lidar Sensors.



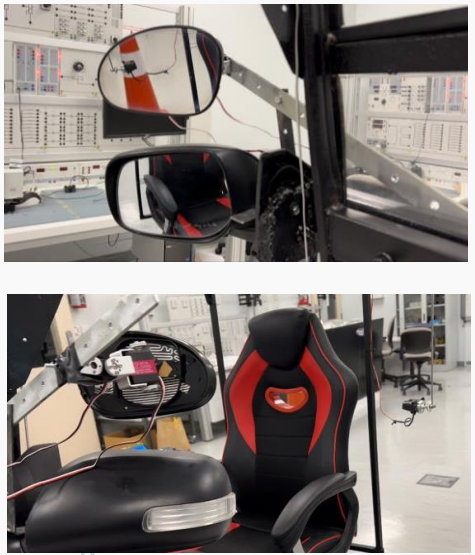
Design of Subsystem 2 (Automatic Mirrors Adjustment): Hardware *1st Design*



Design of Subsystem 2 (Automatic Mirrors Adjustment): Hardware *2nd Design*

Side-View Mirrors

Servo Motors

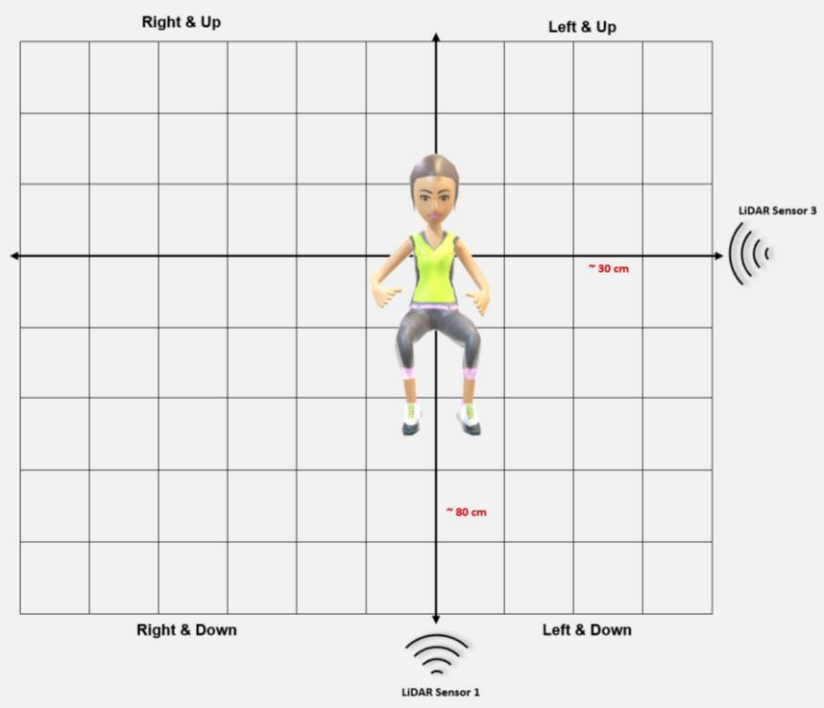


Side-View Mirrors
with Servo Motors

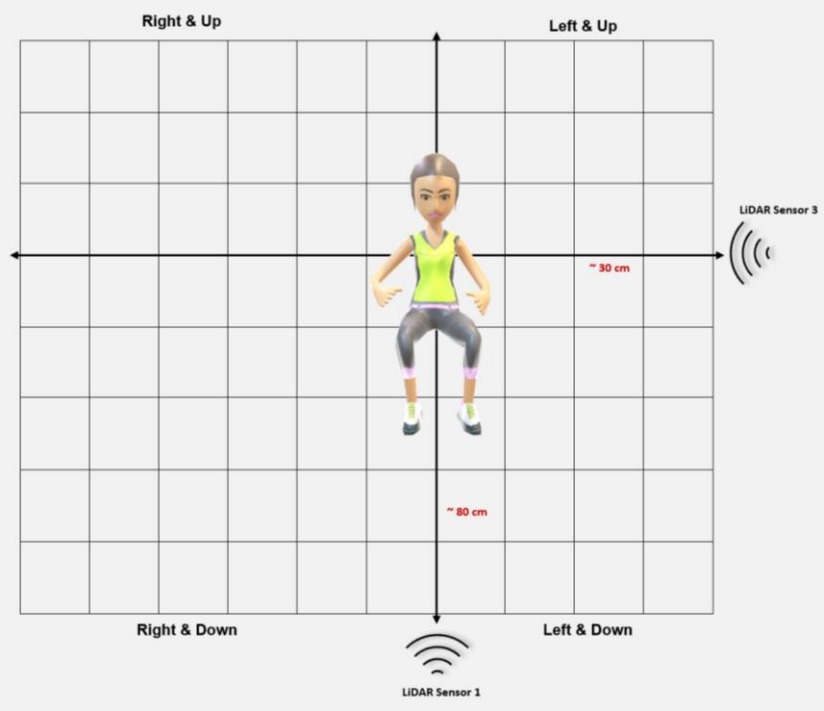
Design of Subsystem 2 (Automatic Mirrors Adjustment): Operation

- Automatic Mirrors Adjustments Subsystem Using LiDAR Sensors.
- Placement of the three LiDAR Sensors to the driver's head:

LiDAR Sensor #	Position
LiDAR Sensor 1	In front
LiDAR Sensor 2	Left



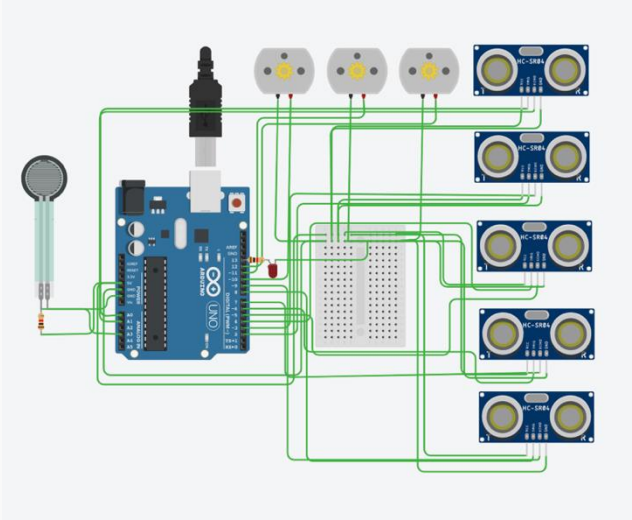
Design of Subsystem 2 (Automatic Mirrors Adjustment): *Operation*



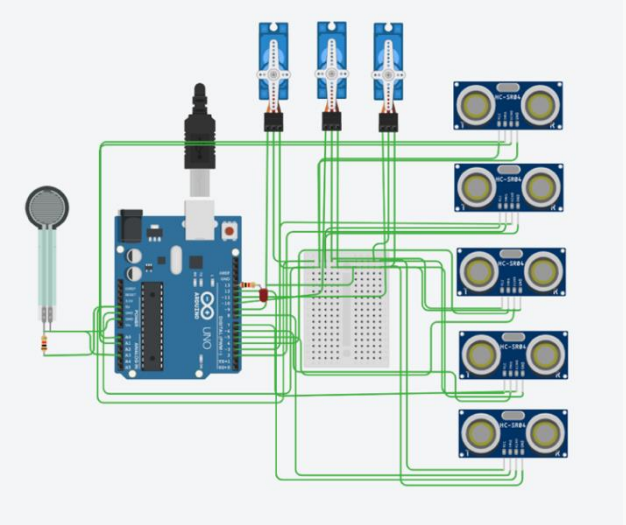
	Driver Action	Right Mirror	Left Mirror
1	To Left	To Left	To Right
2	To Right	To Right	To Right
3	To Front	To Left	To Right

ARDUINO™

Design: Motor Options

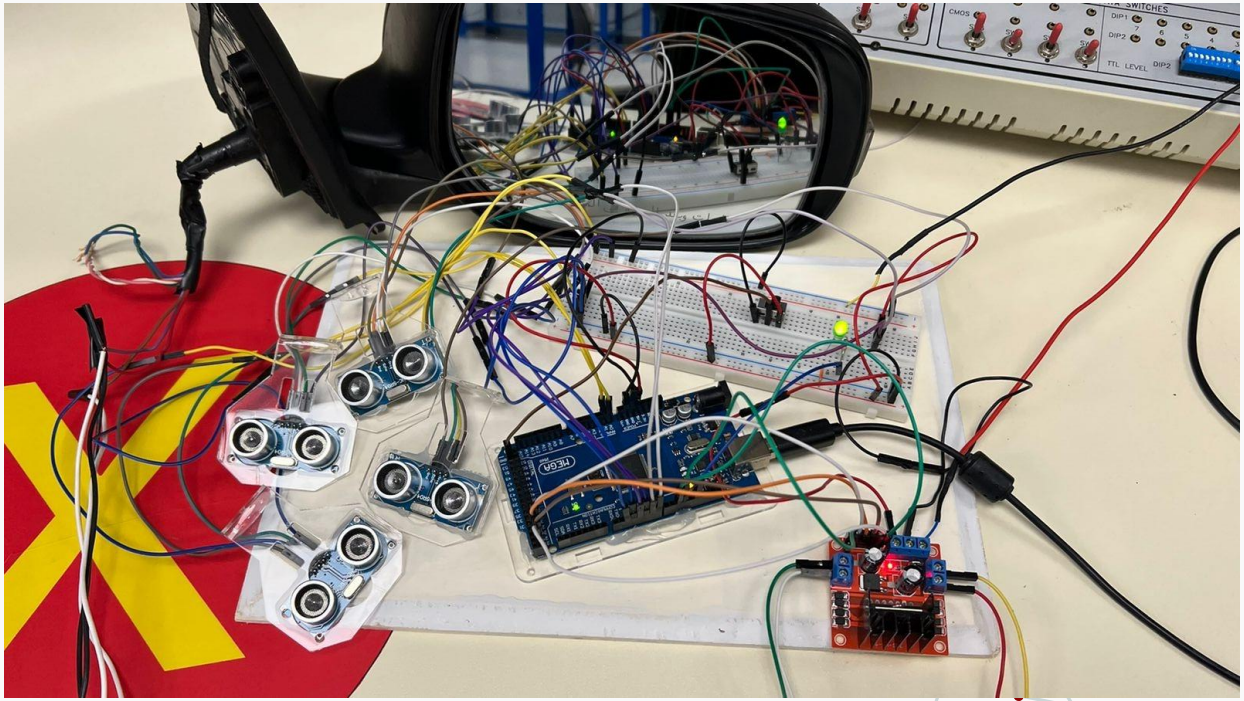


TinkerCad Simulation for DC Motors

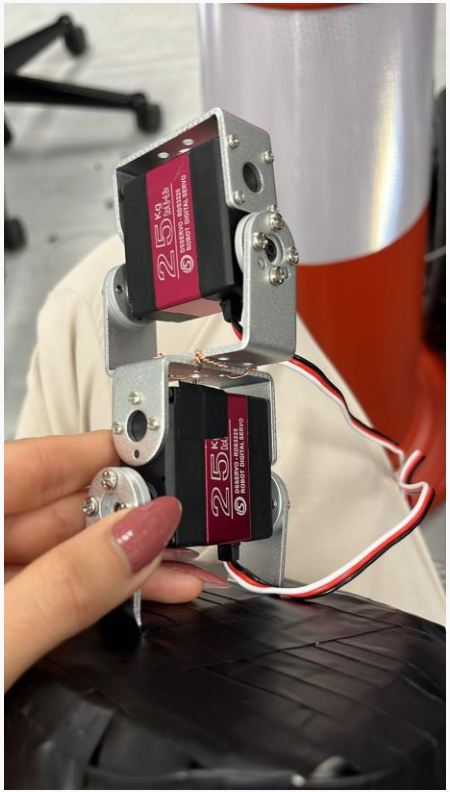


TinkerCad Simulation for Servo Motors

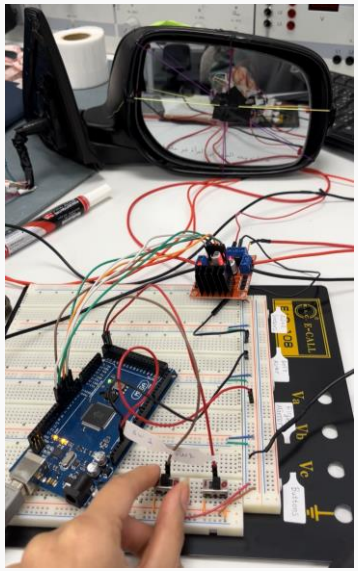
Design: Motor Testing (DC Motor)



Design: Motor Testing (Servo Motor)



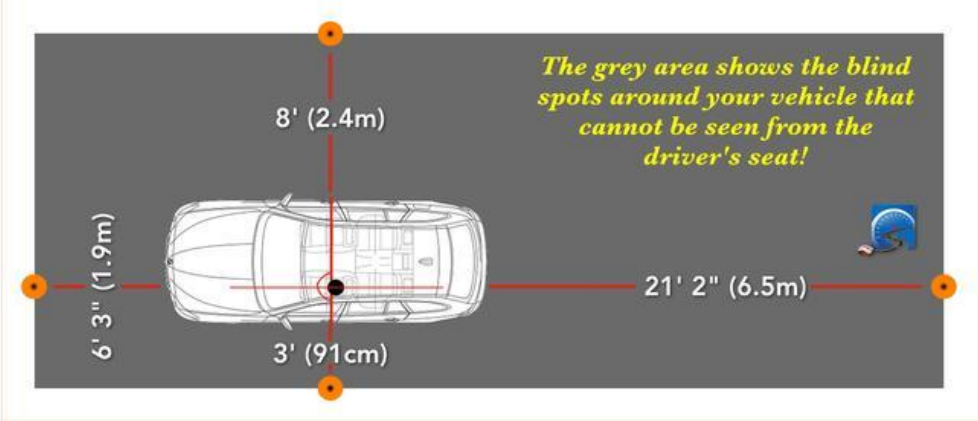
Design of Subsystem 2 (Automatic Mirror Adjustments): *Angle Measurements*



Method Used to Measure the Angles

Mirror Angles Testing

Design of (Automatic Mirrors Adjustment): *Operation & Logic Testing*



Design of Subsystem 2 (Automatic Mirrors Adjustment): *Operation & Logic Testing*

Left Side-View Mirror

Right Side-View Mirror

Design of Subsystem 2 (Automatic Mirrors Adjustment): *Operation & Logic Testing*

	Action	Which sensor will read?	Sensors and Distances	Right Mirror	Left Mirror
1	Driver at the Ideal Position	ALL SENSORS		Joystick	Joystick
2	Driver to Left	Sensor 3	S3 < ideal d S2 > ideal d S1 > ideal d	To Left, A2 High	To Right, A3 High
3	Driver to Right	Sensor 3	S3 > ideal d S2 > ideal d S1 > ideal d	To Right, A3 High	To Right, A3 High
4	Driver to Front	Sensor 1	S3 > ideal d S2 > ideal d S1 < ideal d	To Left, A2 High	To Right, A3
5	Driver to Back	Sensor 1	S3 < ideal d S2 < ideal d S1 > ideal d	To Right, A3	To Left, A2 High

Design of Subsystem 2 (Automatic Mirrors Adjustment): *Operation & Logic Testing*

	Driver Action	Right Mirror	Left Mirror
1	To Left	To Left	To Right
2	To Right	To Right	To Right
3	To Front	To Left	To Right

First Action

Second Action

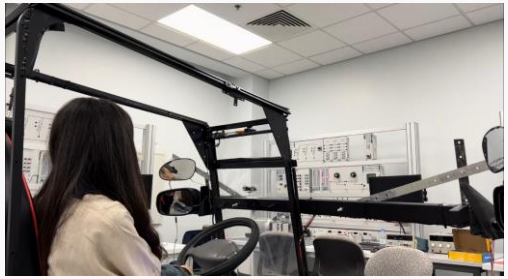
Third Action

Fourth Action

Design of Subsystem 2 (Automatic Mirrors Adjustment): *Operation & Logic Testing*

	Driver Action	Right Mirror	Left Mirror
1	To Left	To Left	To Right
2	To Right	To Right	To Right
3	To Front	To Left	To Right

First Action



Second Action

Third Action

Fourth Action

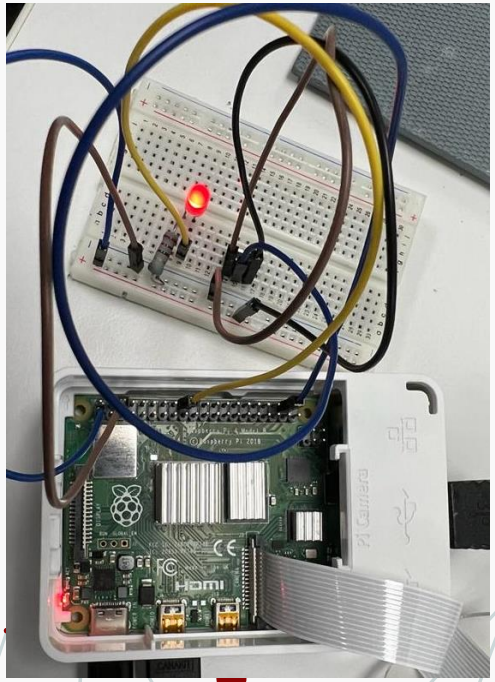
Design of Subsystem 2 (Automatic Mirrors Adjustment): *DC Motors Vs. Servo*

Side-View Mirrors (DC Motors)	Side-View Mirrors (Servo Motors)
No reference point	Reference known by degrees
Inaccurate saving memories	Accurate saving memory
Less accurate for automatic adjustment	Accurate automatic adjustment

Design of Subsystem 3 (Drowsiness Detection): *Hardware*

- Raspberry Pi.
- Raspberry Pi Infrared Camera .
- Speaker.
- A control Switch .

- Microcontroller, Image Processing, and Alarm Programming in Python and OpenCV.

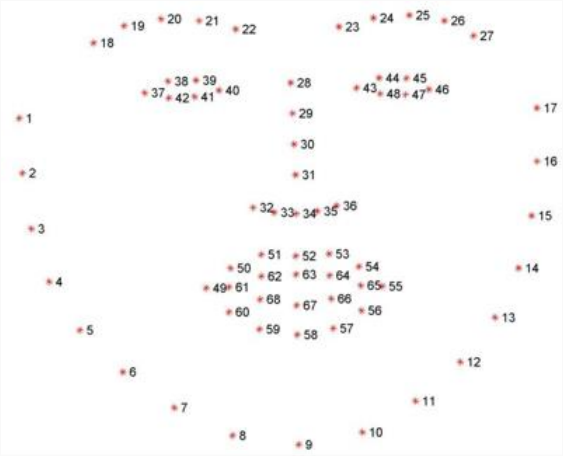


Design of Subsystem 3 (Drowsiness Detection): *Operation*

- Face Landmark Detection using dlib-Python OpenCV.

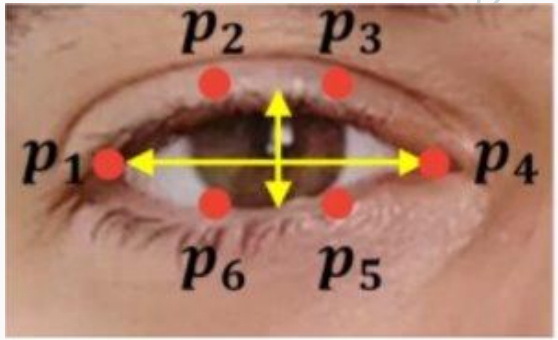
- It uses 68 points to recognize the:

1. Eyes.
2. Eyebrows.
3. Nose.
4. Mouth.
5. Jawline.
6. Locating the eye points from 37-46.



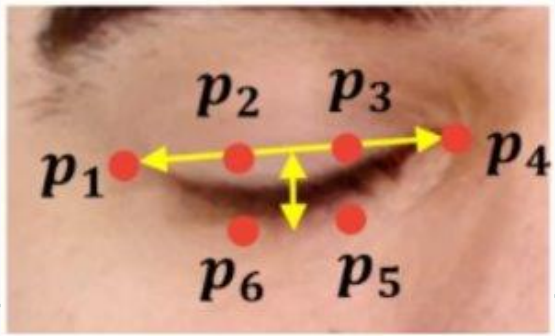
Design of Subsystem 3 (Drowsiness Detection): *Operation*

$$EAR = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

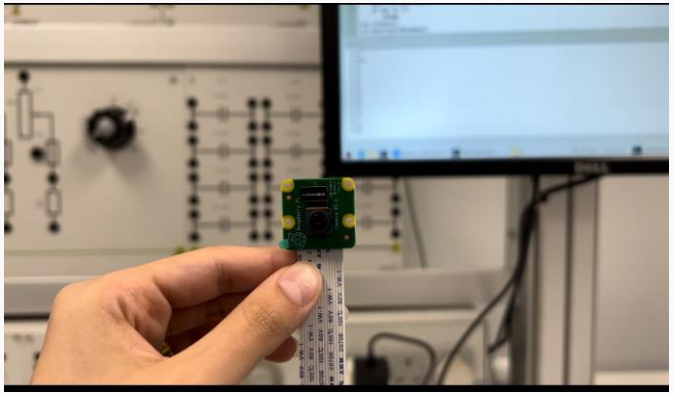


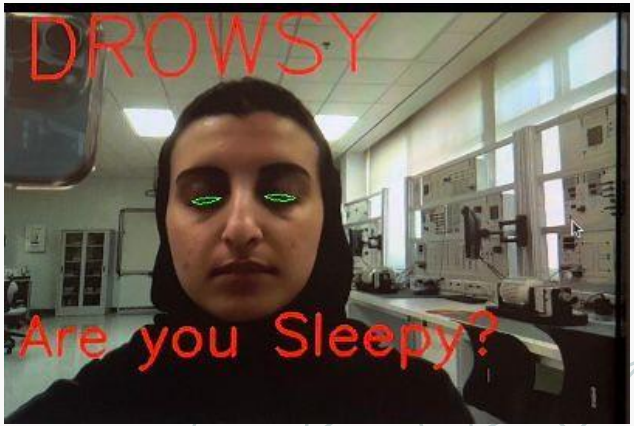
EAR: Eye Aspect Ratio .

When the eye is closed the vertical distance between p2&p6 and p3&p5 decreases which detects that the eye is closed.



Design of (Drowsiness Detection): *Operation & Logic Testing*





Design: Completed Work

- Used LiDAR sensors .
- Wrote a code for obtaining the angle each delay makes.
- Calculated the Eye Aspect Ratio.
- Drafted a code for detecting drowsiness using Open CV.
- Tested the Automatic mirrors adjustment subsystem.
- Drowsiness detection subsystem using OpenCV.
- Implemented the drowsiness detection system using Raspberry Pi IR camera.
- Implemented the drowsiness detection code with an alarm system.

Design: Remaining Work

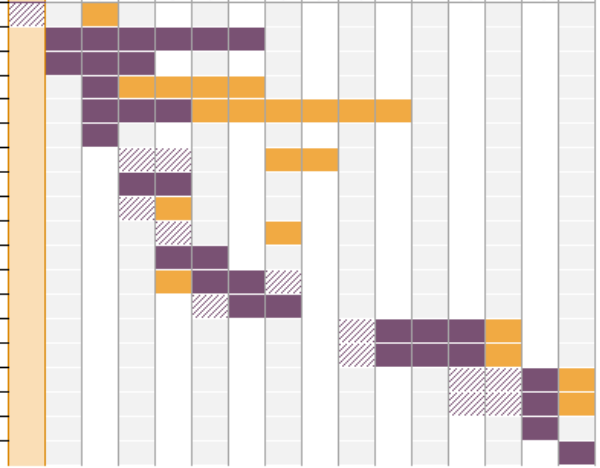
- The Team have Completed all assigned activities.

Project Management & Team Work

Title: Smart Driver Safety System	Advisor: Ahmed Abul Hussain, Saifullah Shafiq	Design II (ASSE 3)	Spring 2022
Lujain Alawami (LA) - 201701688		Project PLAN & Progress	
Tyma Al-Nasser (TN) - 201800435		ProgRpt No. 6	
Lama Al-Rimali (LR) - 201800785		Plan updated (Date): May 17, 2022	
Reem Al-Khater (RK) - 201800099		Instructor: Dr. Sadiq Alhuwaidi	

Period Highlight: 1 — Plan — Actual — Actual (beyond plan) — % Complete (beyond plan)

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Write a plan	1	1	LA & TN & LR	3	1	100%
Software and coding (Subsystem 2)	2	6	LA & TN	2	6	100%
Learning python language	2	3	LR & RK	2	3	100%
Redesign Car Chassis Subsystem	3	1	LA & LR	3	5	100%
Purchasing components	3	3	ALL	3	9	100%
Hardware connections	3	1	ALL	3	1	100%
Installing subsystems in the Car Chassis	4	2	LA & TN & LR	8	2	100%
Measure the angles (Subsystem 2)	4	2	LA & TN	4	2	100%
Measure the distances (Subsystem 3)	4	1	LR	5	1	100%
Measure the distances (Subsystem 2)	5	1	LA & TN	8	1	100%
Measure the eye size (Subsystem 3)	5	2	LR	5	2	100%
Software and coding (Subsystem 3)	6	3	LR & RK	5	3	100%
Prepare midterm presentation and video	6	3	ALL	7	2	100%
Test subsystem 2	10	4	LR & RK	11	4	100%
Test subsystem 3	10	4	LA & TN	11	4	100%
Prepare final report	13	3	ALL	15	3	100%
Prepare final presentation	13	3	ALL	15	3	100%
Prepare project demo	15	1	ALL	15	1	100%
Submit Rpt/PPT/Brochure/Video...etc.	16	1	LA	16	1	100%



Subsystem 1: Car Chassis | Subsystem 2: Automatic Mirror Adjustment | Subsystem 3: Drowsiness Detection

Progress Details:	Issues (delay, etc.):

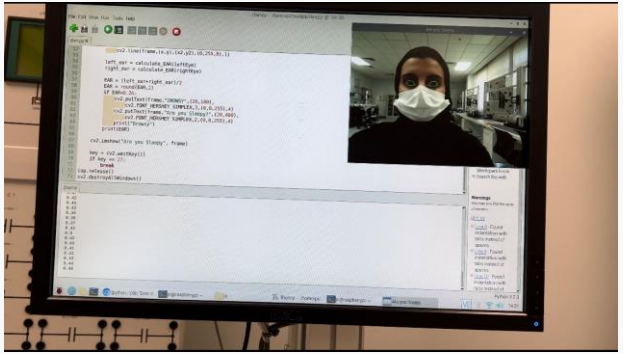
Project Management & Teamwork

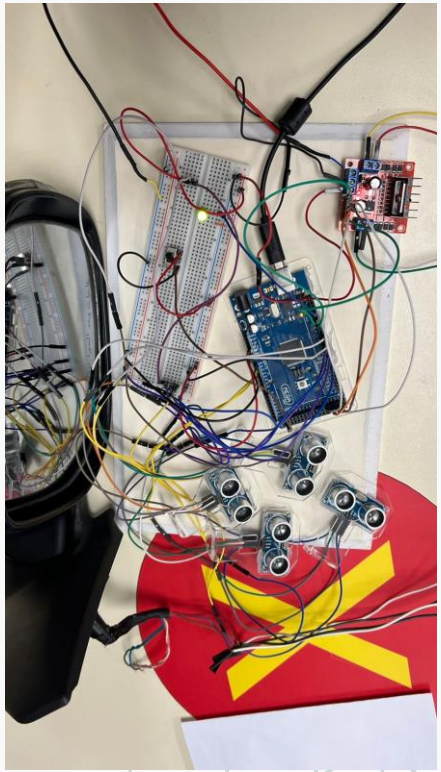
Task	Lujain	Tyma	Reem	Lama
Search & Acquire Components	25%	25%	25%	25%
Redesign & Implement Subsystem 1	30%	30%	10%	30%
Design & Implement Subsystem 2	40%	40%	5%	15%
Design & Implement Subsystem 3	15%	15%	30%	40%
Testing Subsystem 2	25%	25%	25%	25%
Testing Subsystem 3	25%	25%	25%	25%
Write Reports & Presentations	25%	25%	25%	25%

Project Management & Teamwork

#	Risk Description	Risk Management	Impact
1	Microcontroller connections.	Double checking the connections by different people.	Code not working due to wrong connection .
2	Damaging a component.	Replace component and double checking.	Not having back up components causing delay.
3	Heavy schedules.	Updates via texting.	Delay in progress.

Project Management & Teamwork





Impact of project

- To contribute to the vehicle's safety.
- In order to help the driver, avoid blind zones.
- To make sure the users is paying attention while driving.
- Blind spots and drowsy driving provide a significant risk of accidents.
- During the journey, keep the driver engaged and mentally busy.
- Increase public awareness of safe driving practices.

New Skills Acquired and Applied

- Design skills.
- Coding skills.
- Problem solving and critical thinking skills.
- Interfacing various hardware.
- Budgeting and finding cost-effective options.

Cost

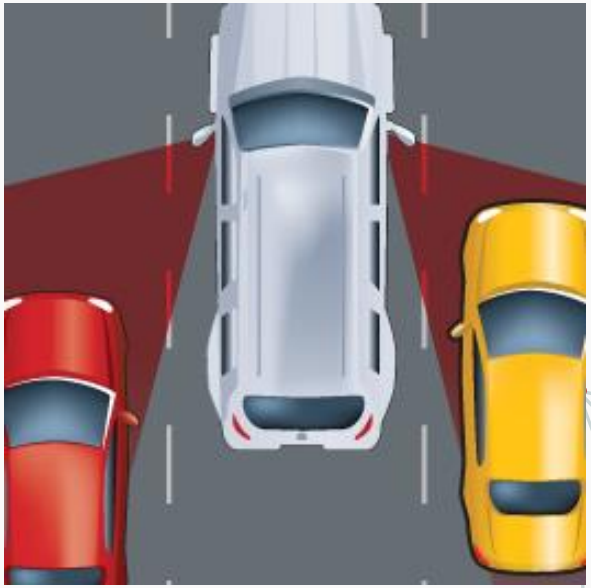
Item	Quantity	Unit cost (SR)	Subtotal
Car Chassis Structure	1	3000 SR	3000 SR
Car Seat	1	557.52 SR	557.52 SR
Rear View Mirror	2	200 SR	400 SR
Mega 2650 (Arduino- compatible)	1	65 SR	65 SR
Raspberry Pi IR Camera	1	116 SR	116 SR
Python for Computer Vision with OpenCV and Deep Learning (Course)	1	50.76 SR	50.76 SR
TOTAL			4189.28 SR

RESOURCES

- A. A. Suhaiman, Z. May and N. A. A.Rahman, "Development of an intelligent drowsiness detection system for drivers using image processing technique," 2020 IEEE Student Conference on Research and Development (SCOReD), 2020, pp. 233-236, doi: 10.1109/SCOReD50371.2020.9250948.
- Drowsy Driving. (n.d.). NHTSA. https://www.nhtsa.gov/risky-driving/drowsy-driving
- F. M. La Rota and L. Di Stefano, "Automatically adjustable rear mirror based on computer vision," 2017 International Conference of Electrical and Electronic Technologies for Automotive, 2017, pp. 1-7, doi: 10.23919/EETA.2017.7993218.
- J. Kholkhujaev, N. Abdurakhmonov, S. Ruzimov, N. Abdukarimov, J. Inoyatkhodjaev and A. Saidov, "Ray tracing simulation of wing mirrors for ultrasonic sensor based blind spot monitoring system," 2020 IEEE 14th International Conference on Application of Information and Communication Technologies (AICT), 2020, pp. 1-6, doi: 10.1109/AICT50176.2020.9368615.
- W. Tipprasert, T. Charoenpong, C. Chianrabutra and C. Sukjamsri, "A Method of Driver's Eyes Closure and Yawning Detection for Drowsiness Analysis by Infrared Camera," 2019 First International Symposium on Instrumentation, Control, Artificial Intelligence, and Robotics (ICA-SYMP), 2019, pp. 61-64, doi: 10.1109/ICA-SYMP.2019.8646001.
- What if My Car Accident Was Caused By a Blind Spot? (2020, November 24). The National Law Review. https://www.natlawreview.com/article/what-if-my-car-accident-was-caused-blind-spot#:%7E:text=Blind%20spot%20collisions%20are%20more,spot%20accidents%20occur%20each%20year
- Karlsson, J., & Alexander Morch. (n.d.). (rep.).

Project Demo Video:

https://youtu.be/7S7a9cCS3Jw



Thank you for Listening!