Telematics Control Unit & Driver safety in Modern Vehicle

SUPERVISED BY

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Nada Mohamed ibrahim	Eslam Walid Alham
Samaa Khalid Mohamed	Abdulrahman Muhammed Abdulmotalb

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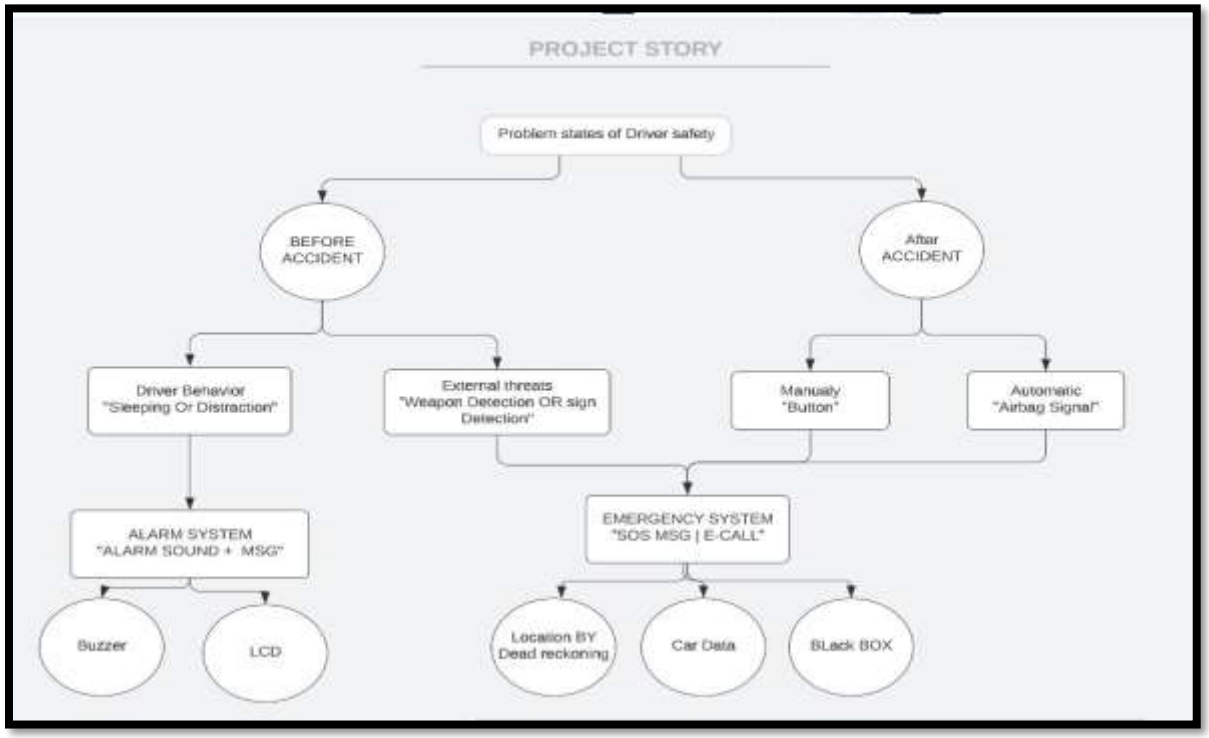
INTRODUCTION

Our Projects have two main topics to make driver more safe, we have mainly telematics unit for the first part of the system which responsible of Dead reckoning, SOS, E-call and this system work on after accident case which help driver in critical cases like location if no GPS signal & Emergency call in any critical situation like airbag, button in any other cases.

Second topic is before accident safety we try to make our driver more safer before accident to avoid the accident by reaching to reasons of many accident we found there is two main reasons, driver attitude of sleeping or distracting and threats of detecting weapon or if any other threat the driver will make a sign to the camera system and it will make the same response of weapon detection in this case.



PROJECT OBJECTIVES

Providing more safety after accident in accurate data location
Providing more safety for drivers against Driver behavior & crimes

PROBLEM STATEMENT:

In 2022, National highway traffic safety Administration published a paper about Road Accident Each year, 1.35 million people are killed on roadways around the world every day, and almost 3,700 people are killed globally in crashes involving cars, buses, motorcycles, bicycles, trucks, or pedestrians.

-We have to main reason of it “Driver behavior” of Sleeping or distracting or other threating like weapon threating or any other external threat.

-We all safer of losing GPS signals in many roads or tunnels we think about the location of accident and how will Ambulance reach to it if we losing this signals it’s a horrible problem in critical situation like accident

PROPOSED SOLUTION:

- We start to think about the new technology of “Dead Reckoning” to avoid losing GPS signals.
- We making Ai models to help us to detect the Cases of danger before accident to avoid accident.

TECHNICAL DESCRIPTION OF THE SOLUTION

-Emergency & breakdown call system

- Emergency call (Ecall)

In the event of a collision in which a car's airbags are deployed, ECall automatically contacts emergency services. It uses GPS to relay the time, your location, what type of car you're in, and what fuel it uses to the authorities, while a microphone in the car allows you to speak directly to call handlers when the system is activated.

All this allows ambulance, police, and fire crews to reach you as quickly as they can, having the required information.

ECall is claimed to reduce emergency-service response times by 50% in the countryside, and 60% in built-up areas, potentially bringing accelerated medical attention and helping to prevent injuries from developing into something worse.

- Breakdown call (Bcall)

BCall is short for breakdown call. It refers to a service, which allows the driver to call local road assistance in case of a breakdown. At the same time, a BCall makes it possible for the call centre to gather information about the vehicle.

It can also be used in cases of having a medical emergency or seeing someone else in need for help.

-After & before accident Dead Reckoning:

Dead reckoning is a navigation technique that involves estimating a current position based on a previously determined position, along with knowledge of the speed and direction of travel. It is commonly used in situations where other forms of navigation, such as GPS, are not available or unreliable.
The term "dead reckoning" comes from the phrase "deduced reckoning," which refers to the process of using a known position and making deductions based on speed, direction, and time elapsed to estimate a current position.

Dead reckoning requires careful tracking of distance and direction traveled over time, often using specialized instruments such as odometers and compasses. In the case of a vehicle, for example, dead reckoning might involve tracking the number of wheel rotations and the direction of travel in order to estimate a current position.

While dead reckoning can be a useful tool for navigation, it is not always accurate and can be subject to errors caused by factors such as changes in speed or direction, as well as environmental factors such as wind or currents. As such, it is often used in conjunction with other forms of navigation, such as GPS, to improve accuracy and reliability.

Automotive dead reckoning algorithm uses the vehicle internal sensors readings from the (OBD) to create an inertial navigation system (INS) that can function well in the absence of (GNSS) Signal after it has been properly initialized, sensor fusion is implemented to merge and enhance the overall estimation of the vehicle state space in real time.

-Driver behavior in case of sleeping:

The sleeping detection component of the driver monitoring system is designed to detect when the driver is becoming drowsy or falling asleep behind the wheel. This is done using computer vision, which analyzes the driver's facial features and movements to determine their level of alertness.

The camera in the system captures images of the driver's face and feeds them into a deep learning algorithm. This algorithm is designed to detect specific facial features that are associated with drowsiness, such as drooping eyelids, slack jaw, or nodding head. The algorithm can also monitor the driver's eye movements, such as blinking rate and gaze direction, to determine whether they are becoming less attentive.

If the deep learning algorithm detects that the driver is becoming drowsy or falling asleep, it triggers an alert in the system. This alert can take various forms, such as an audible alarm or a visual warning displayed on the dashboard. In your case, you mentioned using a buzzer to alert the driver, which is a common method of alerting drivers in similar systems.

The alert is designed to be immediate and attention-grabbing, so that the driver can respond quickly and take appropriate action. For example, they might be prompted to pull over and take a break, or they might be given tips on how to stay alert while driving, such as opening a window, turning up the radio, or adjusting their seating position.

Overall, sleeping detection is a critical safety feature that can help prevent accidents caused by drowsy driving. By monitoring the driver's behavior and alerting them when they are becoming less attentive, the

system can help ensure that they stay alert and focused on the road ahead.

-Driver behavior in case of Distraction:

The distraction detection component of the driver monitoring system is designed to detect when the driver is becoming distracted, either by external factors or internal factors. This is done using computer vision technique and other sensors that monitor the driver's behavior and surroundings.

The camera in the system captures images of the driver's face and the interior of the vehicle. This allows the system to detect a wide range of distractions, including using a phone, eating or drinking, smoking, or interacting with passengers.

In addition to the camera, the system may also use other sensors, such as accelerometers or gyroscopes, to detect sudden movements or changes in the vehicle's position. This can help the system detect distractions that are not visible to the camera, such as sudden swerving or braking.

The system's deep learning algorithm is designed to detect specific behaviors and movements that are associated with distracted driving. For example, if the driver's eyes are frequently looking away from the road or their head is turned to the side, the system may infer that they are looking at their phone or interacting with a passenger.

When the system detects that the driver is becoming distracted, it triggers an alert to notify the driver. The alert can take various forms, such as a visual warning displayed on the dashboard or an audible alarm. The alert is designed to be immediate and attention-grabbing, so that the driver can respond quickly and refocus their attention on the road.

Overall, the distraction detection component of the driver monitoring system is an important safety feature that can help prevent accidents caused by distracted driving. By monitoring the driver's behavior and surroundings and alerting them when they are becoming distracted, the system can help ensure that they stay focused on the road and avoid dangerous situations.

--External threats by weapon & Sign Detection:

The gun detection component of the driver monitoring system is designed to detect the presence of firearms or other weapons within the vehicle. This is done using computer vision technique, which analyze the images captured by the camera to detect the weapon

The system's deep learning algorithm is trained using machine learning models that have been pre-trained on a large dataset. The algorithm analyzes the images captured by the camera and compares them to the pre-trained models to determine whether a gun or other weapon is present.

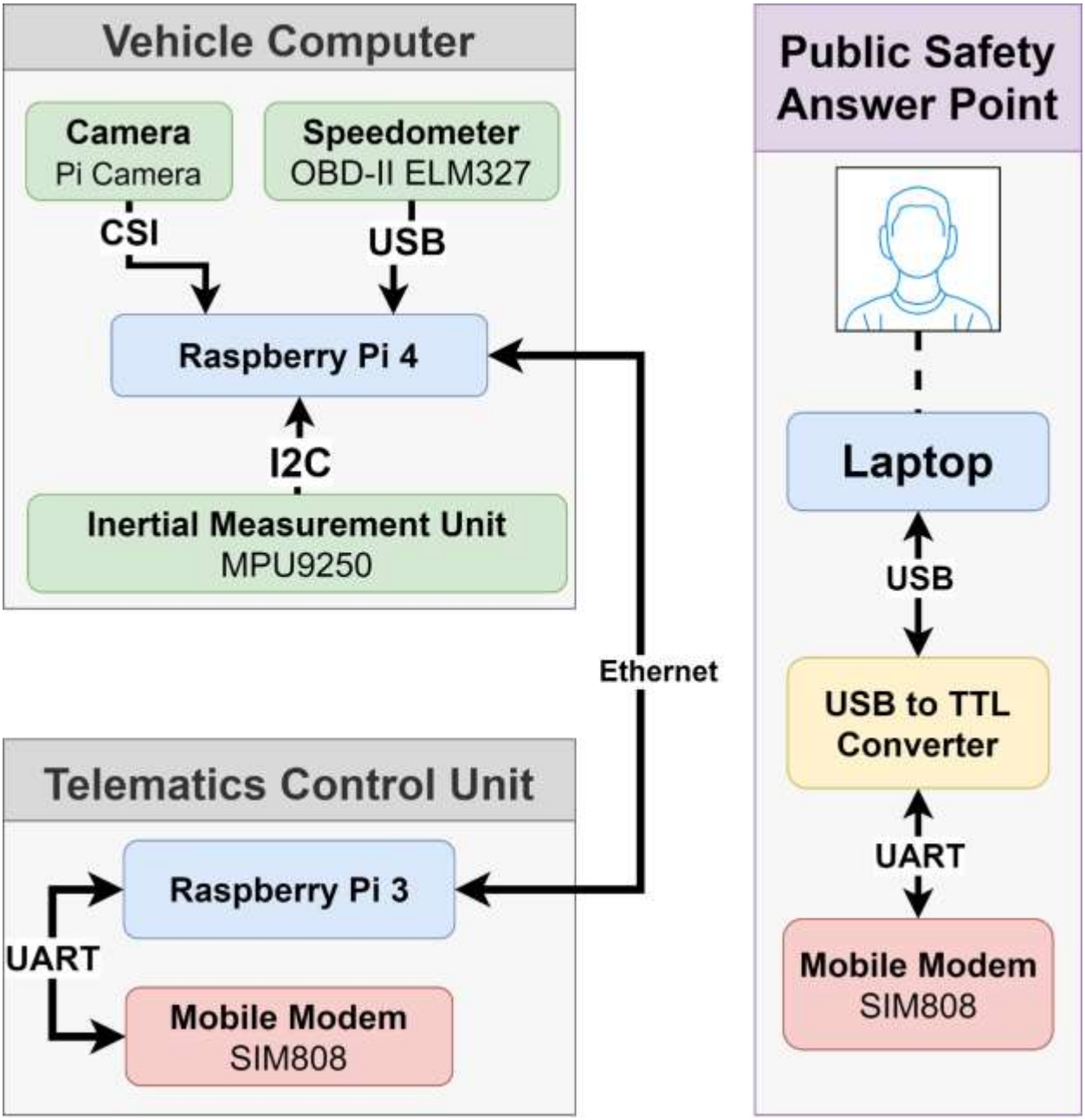
If the system detects the presence of a firearm, it triggers an alert to notify the driver and/or a remote monitoring station. The alert can take various forms, such as a visual warning displayed on the dashboard or an audible alarm. The alert is designed to be immediate and attention-grabbing, so that the driver can respond quickly and appropriately.

In the event that a gun or other weapon is detected, the system may be configured to take additional actions to ensure the safety of the driver and any passengers. For example, the system may initiate a call to emergency services or a remote security team, or it may provide

instructions to the driver on how to safely exit the vehicle and seek assistance.

Overall, the gun detection component of the driver monitoring system is an important safety feature that can help prevent accidents and other dangerous situations. By monitoring the vehicle for the presence of firearms and other weapons and alerting the driver and/or remote monitoring stations when a gun is detected, the system can help ensure that the driver and passengers remain safe and secure at all times.

DESIGN:


Vehicle Computer
Camera
Pi Camera
Speedometer
OBD-II ELM327
CSI
USB
Raspberry Pi 4
I2C
Inertial Measurement Unit
MPU9250
Ethernet
Telematics Control Unit
Raspberry Pi 3
UART
Mobile Modem
SIM808
Public Safety Answer Point
Laptop
USB
USB to TTL Converter
UART
Mobile Modem
SIM808

Project Plan & Timeline

Generate ADR code	2/22 to 3/1
develop hand signature threat detection algorithm	2/22 to 3/5
Deploy ADR algorithm on RPI	3/1 to 3/10
Deploy models on raspberry pi	3/5 to 3/15
Connect ADR with Ecall	3/10 to 3/15
Integrate	3/15 to 4/1

The current achievements

1. Simulation of emergency call as there is air bag opened we simulated the air bag as a button or signal, then sent this signal to TCU ECU(raspberry pi 3 + SIM808) by using the Ethernet, then TCU sent the MSD to the PSAP and we simulated the PSAP as SIM808 Module connected to the PC.

   This link shows this output:

   https://www.youtube.com/watch?v=5Tn4Fj7zFqc

2. Implement the algorithm of ADR on Matlab then we started to collect some data from accelerometer sensor and speedometer then we used these data to estimate the position, GPS outage happened, the GPS outage lasted for 3 min and we got estimated position with 23 Meter, all of that simulated on PC.

3. First, we have collected datasets including examples of kinds of distractions that can happen to the driver like: texting, looking right or left, making calls, eating and drinking. And divided these data into classes to manage the model classify them, Second, we preprocessed this data for training our model. We used pertained model (VGG16) then fine-tuned this model and got 92% accuracy of the training set and 88% val_acc.

4. We haven't found a comprehensive dataset includes all kinds of weapons so we collected knives dataset, guns dataset and rifles dataset then merged them into one dataset and classified it into 2 classes : images includes weapon , images not include a weapon. We used pertained deep learning model (MobileVnet2) and fine-tuned it for our task then trained our model on our dataset after preprocessing this data. We have got 97% training accuracy.