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Coursework Title: **Driver Rescue System Technical Specification Document**	
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Group 60

Driver Rescue System

Technical Specification Document

Abstract

In modern days, traffic accident has become a common thing in day to day life. The amount of damage that an accident can cause is un measure.

Each year, 1.35 million people are killed on roadways around the world. Every day, almost 3,700 people are killed globally in crashes involving cars, buses, motorcycles, bicycles, trucks, or pedestrians. More than half of those killed are pedestrians, motorcyclists, or cyclists. Crash injuries are estimated to be the eighth leading cause of death globally for all age groups and the leading cause of death for children and young people 5–29 years of age. It is estimated that fatal and nonfatal crash injuries will cost the world economy approximately $1.8 trillion dollarsexternal icon (in 2010 USD) from 2015–2030.5 That's equivalent to a yearly tax of 0.12% on global GDP (gross domestic product) (www.cdc.gov, 2020).

There no way to stop these kinds of accident completely. But people can reduce the number of accidents happen by being very careful when going on road.

With the modern technology people can reduce theses kinds of accident to. But still they might not save all the lives. But it can reduce the number of damages significantly.

In this document we discuss about how technology can save a life after a fatally accident on a vehicle. Our goal is to automatically call an emergency service as soon as possible when the driver fatally injured or lost conscious. Situations like these, time is very important, because a second is enough to save someone's life.This report shows the technical aspects and project summery of our project.

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Table of Figures & Tables

Chapter 01

Introduction

First car accident happened on August 31,1869 in a town in Ireland because of that accident women lost her life. After that incident according to the WHO (World Health Organization) estimates,1.25 million people die every year due to road traffic accidents. In Sri Lanka also number of accidents increasing year by year and day by day. In 1967 The national Transportation Safety Board was created in 1967 and later on known as National Highway Traffic Safety Administration (NHTSA). In 70s as the NHTSA began testing vehicle safety which forced manufactures to put a bigger focus on servility. Its clear road safety has risen dramatically, Thanks to technology and policy improvements, but that doesn't mean there isn't room for improvement. When we talk about cars as example we know with the improvement of the technology there's so many options and equipment's are develop with safety as a example suspension systems in cars designed for tracks will always have stiff suspensions this helps them keep their tires in contact with the ground , ensuring traction is not lost in corners through tilting ,while maintain a consistent ride height, an important characteristic for vehicle like cross bow ,as it's undercarriage forms a significant part of its downface generation through its rear diffuser it's important to maintain a low center of gravity too, as this minimizes that rolling effect. We all know when it comes to a vehicle first priority is safety and this project is all about next step in safety options in a vehicle.

Problem Definition

As we all aware when an accident happened most of the time driver and passengers passed away and they need help if the help late injuries can be serious or maybe they lost their life because of that. Present days with the technology improvement vehicle companies add many options to avoid an accident as an example There are so many sensors to detect vehicle distant and automatically brakes before it gets hit. But when it comes to after someone faced an accident there is no any option to get help if the person lucky, he or she gets help from people who are around but let's think someone faced an accident in a lonely road at night there is no any help because of that one or many lives are in danger.

Project Objectives

As explain in the problem definition part this project is about helping person who faced an accident. After an accident most of the time it can be serious and they need emergency help in this project system detect the accident and it gives an emergency alert to the driver through a mobile app if the driver doesn't respond to the emergency alert within the time system define, system detect it as an emergency situation and through the system it automatically calls police station and medical team with location.

Scope of project

When it comes to Scope of project main process is with the sensor, with this sensor it can detect if the vehicle roll, yaw and pitch. Let's get through these three words first in the vehicle coordinate system,

rotation along the longitudinal x-axis is called roll.

rotation along the lateral y-axis is pitch.

rotation along the vertical z-axis is the yaw.

rotation along the longitudinal x-axis(roll)

roll is the rotation of the car about the longitudinal axis it is also referred as side to side motion of a car about the longitudinal axis passing through the cg of the vehicle it's also defines that how well car can distribute its weight while turning role is experienced in response to the cornering centrifugal forces whenever there is sharp turning maneuver roll comes into act but if it is excessive the literally the car swing into a drift in general positive roll angle is measured when the vehicle poses an upward movement on the right side while the upward movement on left side termed is negative roll angle.

rotation along the lateral y-axis (pitch)

It is the rotation of the car about the traverse axis it is also referred as the front and rear motion of the car about the transverse axis passing through the cg of the vehicle it's also defines that how well car can distribute its weight during the active acceleration and deceleration pitch is experienced in response to acceleration and deceleration forces so when a car is underbracing vehicle decelerates where the weight of the car is transferred to the front making the car body to lean forward similarly when it accelerates the lean's back transferring its weight on rear wheels proper pitching of a vehicle leads to maintains correct altitude and ensures comfortable ride in general positive pitch angle is measured when the vehicle nose is in upward movement while the downward movement of vehicle nose is negative pitch angle.

rotation along the vertical z-axis (yaw)

it is the rotation of the car about the vertical axis it is also referred as the left to right motion of a car about the vertical axis passing through the cg of the vehicle yaw is experienced in response to cornering and also sometimes induced by the side wind so whenever there is a turning maneuver the car wheels rotate at different speed when the car turns left the right wheels rotate faster than the left wheel this is because the right wheel covers the maximum distance than the left wheel which in turn creates an imbalanced force and vehicle turn is influenced by this force leading to yaw to be more precise more the sharper the turn in general positive yaw angle is measured when the vehicle's front end rotates towards right while the negative yaw angle is measured as the vehicle's front end rotates towards left.

And also, with this sensor it can detect quick accelerations, quick decrease in speed with this sensor system can detect those variables and system detect if the situation is bad or not if the situation bad it gives alert to the person through the application.

Chapter Summery

This system is for vehicles and it can be help to saving people life or getting seriously injured. With the sensor in the system detect if there any accident and it gives an emergency alert to driver through the mobile app if the driver doesn't respond to the emergency alert within the time system automatically inform to the police and medical team for help with the location. This sensor detect roll, yaw, pitch, speed increase and speed decrease this data helps to the system to define the situation.

Chapter 02

Requirement Gathering Techniques

In this project our target is to provide a solution for one specific type of user. There won't be any unintended users. So, we need to get a very good understanding about the requirement. To understand these requirements, we need to work in the targeted environment. In this case, they are drivers' perspectives, hospitals and polices. We can learn about how often and what kind of situation they have being experienced. Depend on those experiences we can build the solution for the most efficient way possible.

For the system we need to access Internet through a cellular network as the provide GPS support as well. The system requires ability to call and track the vehicle. Most of the modern vehicles seems to have inbuild cellular network for various purpose. So we can access this network to implement the system. But we need to figure out, how to call a near by emergency service via cellular network. For this we may need industry support.

The final goal of this project is to provide the prototype of our solution. This is an excellent way to share or present ideas to the user. So, we can demonstrate the prototype to stakeholders and improve the solution more before the implementation.

For the final implementation we need to choose an optimal position to place the system in the vehicle. So wee need support from industry level team to discuss about vehicle third party installations.

Existing system

Talking about existing systems for our solution, currently there only driver's safety systems to monitor the driver's health, but not a system of solution for an after accident. In modern cities there are many surveillance systems to monitor, but in case the accident takes place in a place that those system are do not exists, these existing systems are not perfect. In our solution, the system always monitors the vehicle momentum and triggers the system if unusual momentum happens. This will increase the chance of survival of the victim more than any other existing system.

Diagrams

Entity Relation Diagrams

****Note that, the following figure(2.1) is an ER of an optional feature of the system. May not include in the final release****

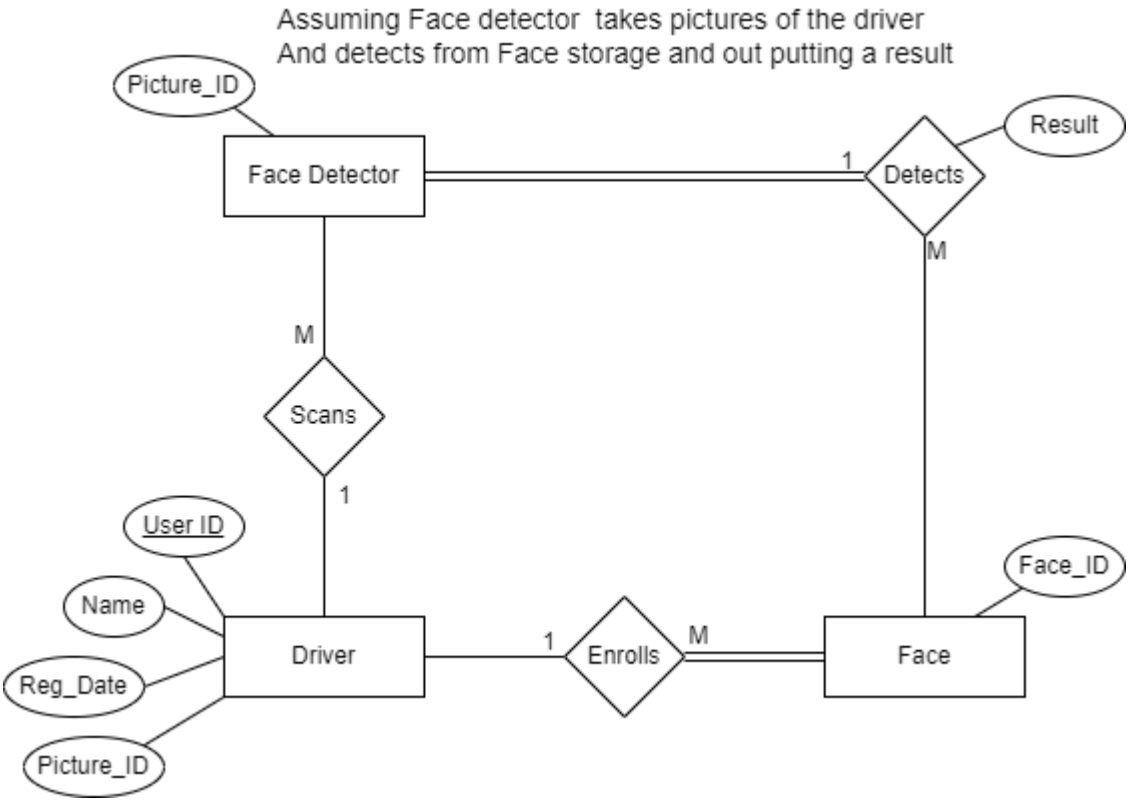

FIGURE 2.1(ER DIAGRAM FOR FACIAL RECOGNITION SYSTEM)

Use Case Diagrams

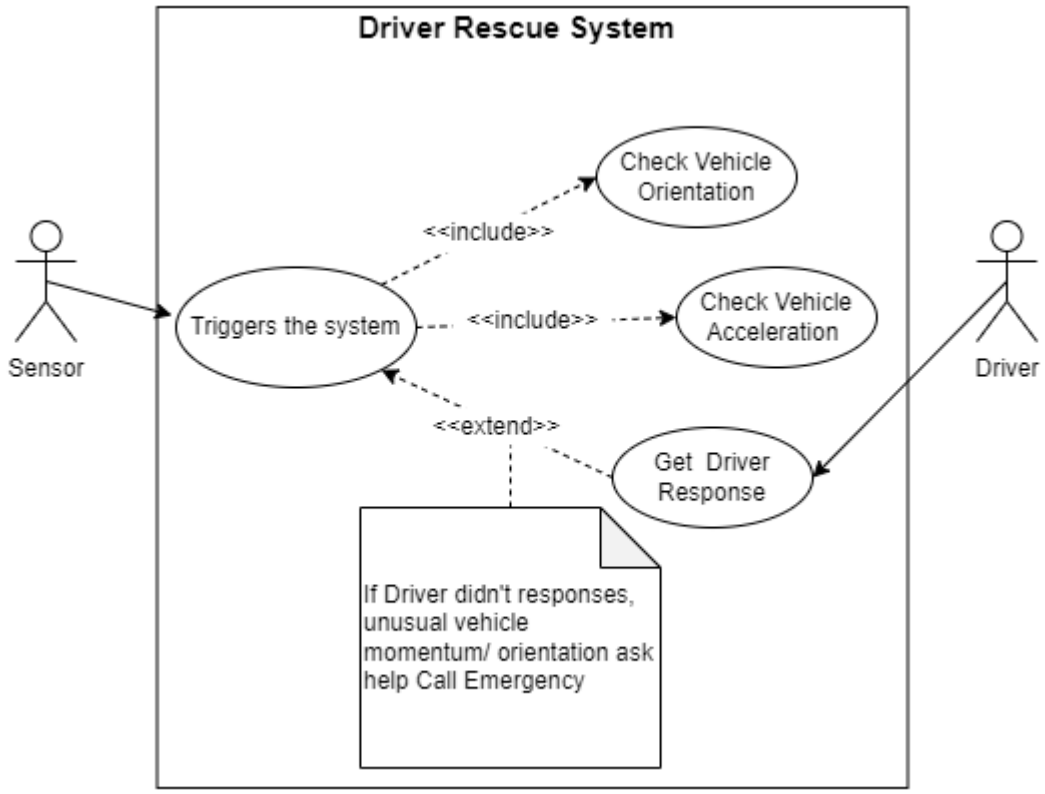

FIGURE 2.2(USE CASE DIAGRAM FOR DRS)

High Level Architecture Diagram

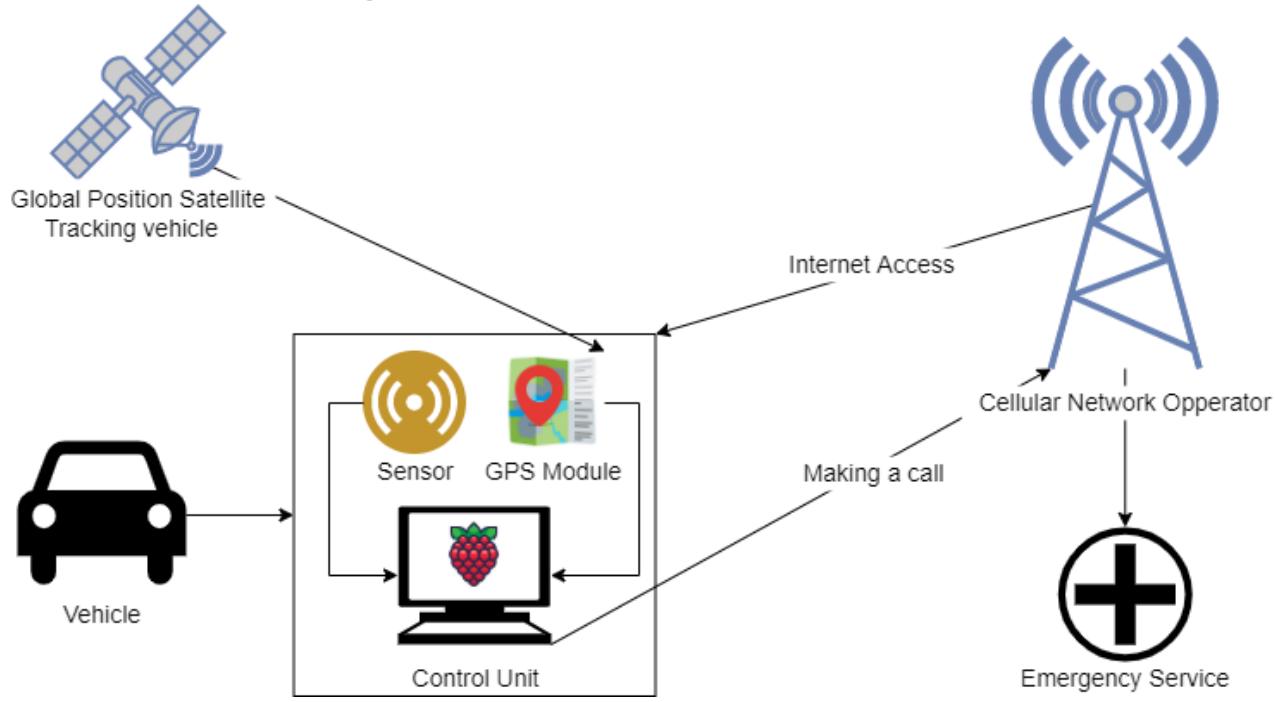

FIGURE 2.3(HIGH LEVEL ARCHITECTURE DIAGRAM)

Chapter Summery

In this chapter we have discussed about the basic requirements for this system. The final goal is to build a more efficient and reliable solution that the existing solution. The final product will be a full functioning prototype, but it will be enough for demonstration and presenting to the stockholders. We may seek some industry level guides to implement some key points of the system.

The diagram figures in this chapter shows how the full system is divided.

Chapter 03

Functional Requirement

Make a call instantly at the accident

this device is designed to make an emergency call or give an emergency massage to emergency lines. As it is it must be giving a call or a message to the emergency line instantly because this is the main output of this project. Because of these things raspberry Pi must give output as a call or a message to the emergency line as soon as possible.

calculate angles precisely

As an above point, this system will not work properly if the program must not calculate angles that are given by the “MPU 6050” axis sensor then it will ignore the accident if this did not work.it is important the calculations must be precise because the whole device will fail if this program does not work or stop working.

sensors must be precise

Sensors are the inputs of this device and if these parameters did not give the inputs correctly or precisely program will not work as it should be and output will not be delivered to the output device. That means the device will not work if these input sensors did not give precise inputs to the Raspberry Pi

program must decide it’s an accident or not precisely

If some accident happens this device must calculate the inputs precisely and process the inputs and other variables to make the output decision to make a call or reject the false alarm. This must be precise than other things in this device because the false call will make a whole system looks like a failure and make some false emergencies and accidents. To prevent this from happening each above functional requirement must meet its minimum requirements.

Non – Functional Requirement

Device mount should be rigid

This is a physical device that is based on hardware and mostly on software to make decisions if this device fall or roll unintentionally this will make a false alarm or worst it will make this device unresponsive to the inputs. Because of this reason, the mountings on this device to the vehicle must be tough and rigid as well.

should have a good inbuilt battery

Sometimes battery in the vehicle will die randomly or unexpectedly, when these kinds of things occur device will not work because of a lack of power to the hardware. To make power constant we can add an inbuilt battery and charge it using the user's vehicle by using a charger or external power supply by making a charging slot to the device.

case of the device should not brake easily

The case of this device should be strong because it's going to face real accidents, also if this case breaks the hardware will expose to the outside and could destroy some important parts of the device and stop working. the case must be nonconductive inside because if hardware touches the case, it will short out the board or maybe fry the hardware in a worst-case scenario.

Case should be waterproof

If somehow liquids get inside the hardware will be short and make the device unresponsive. So, it needs to be waterproof to save the hardware inside if an accident occurs in non-land places (river or ocean) .to make this we can use hot glue or some silicone glue that works on fish tanks to seal the air gaps in our case.

should have a method to tell user if device not working

If the GPS or the Calling module breaks the device didn't work, scenarios like this make a whole new problem to the user, we are planning to attach a LED to indicate if these modules in the device work or not. so, user can identify the problem and contact the manufactures if a problem occurs in the device as well.

take a confirmation from the user

Because nothing is perfect this device will send some false alarms to the emergency. We are going to integrate our own software (Android) to take a confirmation whether it's a false alarm or not. It asks the user to confirm alarm is false because if a real accident occurs, sometimes users can't respond to the message. We give the user 10 seconds to cancel the alarm, if an alarm is not cancelled device will make the call to the emergency line as the program intended.

Hardware Requirement

ASUS Thinker board (Functional)

As main board we chose ASUS Thinker board because it has very good processing power and built-in network adapter. Also, this main board is compatible with all other sensors we use in this project to communicate with GSM and Axis sensor. Because ASUS Thinker board is a ARM based board we can use Python to program the code back bone and as we researched python and Linux is very good with hardware. Because this is an emergency system, we thought to use ASUS Thinker board as the alternative to Raspberry Pi. It has a performance of a raspberry Pi 4 yet cost is less.

Brand	-	**ASUS**
CPU socket	-	**Rockchip**
RAM Technology	-	**DDR3**
Memory clock speed	-	**600 MHz**
CPU	-	**Rockchip RK3288**
RAM	-	**2 GB**
GPIO	-	**40pin**

MPU 6050 axis sensor (Functional)

Currently, widespread microelectromechanical systems (MEMS). This was made possible due to their small size, high functionality, high reliability, low power consumption and low cost. Typical examples of MEMS are accelerometers and gyroscopes, which are in every Smartphone, tablet computer, etc. The former is used to measure linear accelerations, and the latter, angular velocities. The combined use of the accelerometer and gyroscope allows you to determine the movement of the body in three-dimensional space(Fedorov et al. no date).

With these measurements we can use this sensor for our system. This sensor will update the system with linear acceleration and orientation and detect any kind of accidents. The control unit will identify any sudden change of the velocity, acceleration and unusual orientation then triggers the system.

For an example, a vehicle hitting head-to-head with another vehicle means, the velocity and acceleration will drop within a second. The control unit will identify the difference and produce to the next step. In case of the vehicle flipped, the sensor can measure that to. So, the CU will identify any unusual positioning of the vehicle and triggers the system.

GSM module (Functional)

This module is for the calling or messaging part. It requires a SIM card to make a call to the emergency line and they can locate and help the user of the device if accident occur. Emergency services can locate GSM devices easily and that’s the main reason we use this module rather than internet calling.

The European Telecommunications Standards Institute (ETSI) produced the GSM (Global System for Mobile Communications) standard (ETSI).

It was established to specify the protocols for mobile phones' second-generation (2G) digital cellular networks, and it is currently the worldwide standard for mobile communications, with over 90% market share and operations in 219 countries and territories.

NEO6MV2 GPS module (Non-Functional)

This module is an optional device that we have planned to use in case the vehicle we are going to implement this system does not have any cellular network. If emergency service could not locate the user this module will give the rough location of the accident via internet somehow.

The NEO-6MV2 is a navigation module that uses GPS. The module simply determines its position on the globe and outputs the longitude and latitude of its position. It's part of a line of standalone GPS receivers that use the u-blox 6 positioning engine for great performance. In a small compact, these versatile and cost-effective receivers provide a variety of connecting choices. NEO-6 modules are suited for battery-operated mobile devices with severe cost and space requirements because of their tiny design, power, and memory choices. Even in the most difficult conditions, the NEO-6MV2's innovative design provides superb navigation performance.

LoRa module (Non-Functional)

LoRa is a low-power wide-area network modulation method developed by LoRa Alliance. It is based on chirp spread spectrum technology and spread-spectrum modulation methods. This module can do edge computing. So, we can communicate with nearby mobile device that has the app that wea are going to make to take the confirmation. This module is an alternative for Wi-Fi and this module does not require internet connection. Because of that we can use this device even without internet.

Chapter Summary

In this chapter, we talked about functional, non functional stuff and also about hardware. When we talk about functional requirements most important part is our device must make a call to the emergency line and if not, the output of the device is failed. Also, the program must calculate vehicle angles perfectly to avoid confusion around the program and input modules must be precise and correct, if not program will give the wrong output. If these parameters succeed program must calculate the inputs and decide whether it will give a call to the emergency line or not. Even if one of these requirements fail the product will fail as an emergency supporting device.

When we talk about Non functional requirements device should be tough because if the device brake when an accident occurs it will not make any output to emergency services. Also, the mounting of the device must be rigid so it can hold to the vehicle correctly and if it has rigid mountings it will not fall and make false alarms. When we talk about these non functional requirements, we should ad a built in battery to power the device so it will not die if the car battery did not work. If the accident occurs underwater, this device should be waterproof so it can make the call to the emergency line and get help as fast as possible. If this device is not waterproof fluids can get into the casing and break the components. Also, the device must give some warning to the user if the device stops working. Then the user can contact technical support to fix the device.

To make this project possible we need some hardware. To gather data from the vehicle we use an axis sensor and shock sensor, To process the data we use the Asus Thinker board(Raspberry Pi alternative) and to output, we use a GSM module, so the device can communicate with the emergency line.

Chapter 04

Development Methodology

To develop this project, we are going to divide this to 9 parts. likewise,

1.Develop a physical prototype according to our assumptions

We are planning to make rough prototype of the device according to our assumptions so we can debug the problems the prototype has. to achieve this, we are going to use breadboard and jumper wires so we can check if everything works before soldering components to the case

2.Develop a code prototype according to our assumptions

According to the prototype we talked above we are going to write a program using phyton programming language to take inputs via sensors and give an output using GSM module.

3.Develop a solid software

After cording prototype software, we are going to change the program to optimize the performance so we can get inputs quickly, process quickly and give output quickly

4.Change hardware according to software optimally

After developing the solid software, we are going to change the sensor locations to better position so we can get precise inputs from the sensor

5.Reinforce the hardware

After software and hardware development we are going to reinforce the hardware using a prototype case.

6.Make a waterproof and rugged case for the Hardware

To protect the hardware, we are going to make a good case for the device that has good quality and has quality waterproofness.

7.Researching about mount

We need to find a best place to mount this device to the vehicle so we can get better output from the device and save lives from critical situations.

8.Testing on a prototype model

This step is for debug the problems so far in the device and make sure this device can implement to a Realtime scenarios.

9.Implement finished product to a real vehicle

After all work done, we can attach this device to a real vehicle so this device can do what its designed for.

Programming Languages and Tools

python program language

We choose the phyton programing language to code our project because it is easy to use in Linux. Also, python is very good with hardware so we can control our inputs and outputs from the hardware modules easily. When the program calculates the inputs to take a decision it needs to calculate degrees and it needs to be precise, when we searched about good languages to calculate degrees, we find python is very good at this kind of mathematical calculation. Also, python is platform independence and easy to code on any computer. While we using Raspberry Pi, it has inbuilt python to its operating system as well. For these reasons, we choose phyton as our main language.

Hardware tools

Soldering iron

It's used for soldering cables, electric cord, sericites and such as. and it's also a hand tool. It generated heat to melt to join 2 workpieces. We use this bout to connect the wire in the module outside. Also, we use to connect bulb using this soldering iron bout and our module related things how to use It. This bout can reach the heat temperate 200 to 480 C^0(392 to 896 ^{0}F) of range.

Silicone glue

As we talk about non-functional requirements, our devices should be waterproofed. So, we used silicon glue. There are many types of silicon glue. Specially we use silicon glue for related waterproofing and water resister stuff. Silicone glue using for automobiles, appliances, sealing cables, and sensors in electronic devices. There are different types of silicon glue used according to the situation such as weather-resistant seals, sealing sinks, tubs, windows, and aquariums.

Hot glue gun

This tool is use to glue things for the places where nails can't be used. Mostly the hot glue gun is used for craft because they're easy to use, can be used for many materials, and is durable. It can be applied to materials such as wood, fabric, cloth, glass, metal, etc. glue stick used in hot glue guns is manufactured from thermal plastic. Thermal plastic can be melted and reshaped

Breadboard

A breadboard is a construction base for prototyping electronics. This is what we used in Our project. This device is finalized and testing some other codes. we are assuming to develop our project and add the siren. it's simply called a police siren. this device is used for making a typical louder sound to alert. the vehicle is accident siren is work. that is why we are using this breadboard.

Screwdriver

Screwdriver is manual or powered tools. And it is used for driving screws. these tools are used to Our project is we made device casing our own hands in this case we use screwdriver some nuts are Holding in the case. a screwdriver is a tool for turning screws with slotted heads that is normally used by hand.

Chapter Summary

We divided our project progress to 9 stages so we can track our work easily. also we can complete tasks one by one according to our milestone list. These stages will help us to track our work. These followings are the 9 stages we divide our project to,

- Develop a physical prototype according to our assumptions
- Develop a code prototype according to our assumptions
- Develop a solid software
- Change hardware according to software optimally
- Reinforce the hardware
- Make a waterproof and rugged case for the Hardware
- Researching about mount
- Testing on a prototype model
- Implement finished product to a real vehicle

Main programing language we are going to use is python, because we need to user Raspberry Pi single board computer to program our device. Also, we use python because its good wit ARM based CPUs

When we make our device, we needed some tools to build this. Likewise,

- Soldering iron – to solder fixed parts
- Silicone glue – to waterproof the case
- Screwdriver- to mount input modules and mount the device to prototype
- Hot glue gun -to mount un-screwable parts
- Breadboard- to test the prototype

References

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Team Plan & Responsibility Matrix

Name	NSBM ID	PLY ID	Group Position
R.M.R.M.L.Rathnayaka	19365	10747919	Programming Leader (GL)
R.M.H.C. Rathnayake	19412	10747887	Technical leader
R.M.L.P.Sandaruwan	19491	10747909	Testing and Maintenance
R.B.I.K.Subasingha	19270	10747883	Leader Planning leader
Y.M.S.K.Y.Bandara	19369	10749057	Quality Leader

TABLE 1(RESPONSIBILITY MATRIX)

PLY ID Work	10747919	10747887	10747909	10747883	10749057
Develop a physical prototype according to our assumptions					
Develop a code prototype according to our assumptions					
Develop a solid software					
Change hardware according to software optimally					
Reinforce the hardware					
Make a waterproof and rugged case for the Hardware					
Researching about mount					
Testing on a prototype model					
Implement finished product to a real vehicle					

TABLE 2(TEAM PLAN)

End