Final Year Design Project
Design Report
EEE 400C

Project Title:

Automatic Motorbike Accident Detection and Notification System

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Chapter 1: Introduction

1.1 Introduction

Rapid urbanization has led to a staggering growth of civilization which has further resulted in an increase in the standard of living. Because of this, more and more people now have the capacity to buy their own motor vehicles. As a result, the number of motor vehicles in the streets are increasing day by day. While motor vehicles are the best way of transportation nowadays, but more and more motor vehicles in the streets also means a rise in the automobile accidents as well.

1.1.1 Problem Statement

Among all the motor vehicles that runs in the streets, motorcycles are the most cost efficient and more affordable to the people. Despite its affordability, it is also the most unsafe automobile. Among all the other automobiles, the motorcycle accidents are the most fatal ones. An analysis conducted by the Accident Research Institute, Bangladesh University of Engineering Technology (BUET), revealed that the fatalities of motorcycle accident is 74% in rural areas and 45% in the national highways [1]. These data are more than enough to describe how fatal the motorcycle accidents are. On the good side, there is also a remedy to decrease the rate of fatalities and that is wearing helmets while riding. The fatalities that occurs during motorcycle accidents are mostly because of severe head injury. That is why, of those involved in fatal crashes, 88% of the motorcyclists did not wear helmets [1]. While helmets can protect from head injuries and prevent fatalities, there is another way that can reduce these fatalities even more and that is emergency assistance to the injured motorcycle rider. Most of the casualties from accidents are due to poor communication of the concerned agencies and late arrival of medical assistance [2]. After an accident, if the victim remains unattended, it puts the life of the victim in more danger as the time goes by. It is stated that a delay of 5 minutes or more to initiate the rescue operations increases the fatality by 10% to 20% [3]. Again, the family and friends of the victim remains totally unaware of the situation when an accident occurs as the victim is not able to communicate with them in most cases. No other but only the family members can know what a tense situation it puts them in when they cannot contact to their dear one and know his/her whereabouts. That is why, our main focus is to introduce a solution for these kinds of problems.

1.1.2 Background Study

Lots of researches are being conducted simultaneously all over the world by scientists and they all have different approach in this regard. Kattukkaran, N., George, A. and Haridas has focused on a system which senses the abnormality if heart bit using the heart rate sensor and deduces the occurrence of an accident and sends the location of accident to the nearest hospital via Bluetooth based Android application [2]. In another article of L. Rupesh, it has been proposed to continuously use a high definition camera for visual input. The raw images of an accident will be processed by a Raspberry Pi and thus detect the accident and notifies the authority [4]. S. Chandran, in his article, monitored the value received from accelerometer embedded in helmet and detects an accident by analyzing those values and sends an emergency notification to contacts with Global positioning system location [5], while Shabbeer, S.A. and Meleet, M. has decided to use a six axes accelerometer for detecting the accident.

1.1.3 Literature Gap

While in these researches, the researchers have mentioned some fascinating ways to detect an accident. The only thing they all have common is they have talked about notifying only the authorities but not the friends and family members during the time of accident. Another very important part is that we added a pulse rate and $Sp0_2$ saturate rate monitor in our concept, which will be able to provide us with physiological data of the rider and later send it with message along with the real time location of the rider. This will allow the emergency contact number holder to know about the current health condition status of the rider and if he is alive or not.

1.1.4 Relevance to current and future Industry

Right now, there are no current industries that produce accident detection and notification systems. Currently, there are some companies which provides real time GPS services which only gives the services related to vehicle theft. DUPNO, Car tracker BD, FINDER, Prohori etc. are some of the companies that provides these services.

In our opinion, the future of accident detection system is huge and could be very much effective as well. A study has been conducted by the Accident Research Centre (ARC) of BUET on this issue and it has found that road accidents claim on average 12,000 lives annually and lead to about 35,000 injuries [6]. Again, according to the Bangladesh Road Transport Authority (BRTA) statistics, from 2009 to 2016 (up to July), 19,450 accidents occurred in Bangladesh by which 18,510 died and 14,442 injured [6]. So, we can tell how bad the situation is. In order to reduce the fatality rate as well as giving the chance to

know about the situation to the families, we think it could be a revolutionary industry in future.

1.2 Objectives, Requirements, Specification and constraint

1.2.1. Objectives

The main objective of the project is to design a smart helmet for immediate accident detection. We tend to achieve the following objectives through this device.

- Detecting an accident as soon as it occurs.
- Notifying friends and family members about the condition through SMS.
- Tracking the real time location of the victim.
- Monitoring the physiological activity like heart rate in real time.

1.2.2 Functional and Nonfunctional Requirements

Functional Requirements:

1. Detects accident almost instantly by analyzing the motion in x and y axis simultaneously and thus the accident will be detected using the tilt angle of the rider with the surface of the road.
2. As soon as the accident is detected, the system will send an SMS to the emergency contact number using GSM module notifying about the situation.
3. The SMS will contain the real time location of the victim which will be derived from a GPS module and will also contain the physiological activities data which will be provided by a physio monitor.

Non-Functional Requirements:

1. When the system detects abnormal motion data which is actually not possible, it will wait for five seconds and if it still gets the abnormal data it will consider this as an accident.
2. The entire system which is divided into two parts can be easily mounted into helmet and the physio monitor is wearable like a wrist watch respectively. Both of them will be connected using WIFI based synchronization which is faster and much more effective.
3. The receiver of the SMS will be immediately notified as soon as the accident happens so that they could take further steps and reach the location of accident so that a fatality does not occur.

4. The pulse rate and $Sp0_2$ saturation rate will provide the receiver with the valuable information that the victim is alive or not.

1.2.2 Specifications

Table 1: Specifications

Sub-System	Components	Purposes
Accident Detection System	Accelerometer (ADXL-345)	An accelerometer is made of piezoelectric material, typically a quartz crystal or polycrystalline ceramic material to sense changes in acceleration in motion. It continuously detects the motion of an object on three different axes and detects accident when an abnormality occurs in the motion.
System Connectivity	Wi-Fi Module (Node MCU)	An ESP8266 Wi-Fi module is a SOC microprocessor that is primarily used to construct end-point Internet of Things (IoT) applications. It's referred to as a stand-alone wireless transceiver, and it's inexpensive. It is used to connect many embedded systems applications to the internet.
Notification system	GSM module (SIM-800L)	Sends SMS to the emergency contact numbers about an accident.
Location Tracking	GPS module (Ublox Neo-6M GPS Module)	Detects the real time location of the victim after an accident.

Heart Rate Tracking	Heart Rate sensor (MAX30102)	Tracks the pulse rate of the victim.

1.2.3 Technical and Non-technical consideration and constraint in design process

Technical Considerations:

1. Components availability.
2. Size is very small and wearable.
3. Easy maintenance.
4. Easy user interface.
5. WIFI based faster data transmission between the sub-systems.
6. The components used in the system is absolutely safe for users.

Non-technical considerations:

1. Cost effective.
2. Reduction in fatality rate.
3. No heating issue created by the device.
4. The system is safe for environment as well.

Constraints

1. No signal to GPS and GSM indoor.
2. SMS won't be sent if there is no cellular network.
3. Uses 2G network connectivity.
4. As we are limited by the resources available in our country, the used components might get damaged in case of a very severe accident when the helmet itself gets destroyed.

1.2.4 Applicable compliance, standards, and codes

Table 2: Specifications

Device	Standard Number	Explanation
Node MCU (Wi-Fi)	802.11 support b/g/n	Backward compatibility with 802.11a/b/g/n is provided, as well as bandwidth of up to 1300 Mbps on the 5 GHz band and 450 Mbps on the 2.4 GHz band. This standard is supported by the majority of residential wireless routers.
Global System for Mobile Communication (GSM)	ETSI	The Global System for Mobile Communication (GSM) is a standard developed by the European Telecommunication Standard Institute (ETSI) FOR 2nd generation digital cellular networks.
Global Positioning System (GPS)	WGS-84	The GPS is developed by the US Defense Department as a reference System for position and vector referencing which uses World Geodetic System (WGS-84)

1.3 Systematic Overview/summary of the proposed project

The smart accident detection system, which was developed using an IoT-based application, is a clever and effective piece of technology that will help to prevent road accidents by innovating and evolving. Furthermore, it has a number of distinct advantages over current models of post-accident detection and warning systems, which rely mainly on data received from the devices used by drivers on the road. However, currently available solutions in the vehicle industry are only meant for motorcycles. It will primarily be more successful in reducing the number of bike accidents in our country. Furthermore, because of the smart accident detection system's additional characteristics, reckless drivers will be more cautious before putting their automobiles on the road.

1.4 Conclusion

The proposed smart system is capable of detecting accidents. It will first use an accelerometer to detect an accident by dictating its abnormality. Then, following the accident, it will send SMS to the emergency numbers and track the riders' current location using the GSM and GPS modules, respectively. A feature has also been introduced to the smart system that will track the rider's physiological activities at the time.

Chapter 2: Project Design Approach [CO5, CO6]

2.1 Introduction

A project design is a methodical organization of ideas, resources, and processes aimed towards achieving a specific objective. Project design approach helps a student to have clear vision of what they intend to do. The primary features, structure, success criteria, and major deliverables of a project are all planned out during the project design phase. The purpose is to create one or perhaps more designs that can be used to accomplish the project's objectives. The goal of a multiple design approach is to bring up the expertise and methodologies of engineers from several disciplines in a collaborative process. A consistent and coherent design concept simplifies future decisions. While there are a variety of models for depicting a project's life cycle, it's important to make sure that the model chosen accurately matches the sort of product in issue to make management easier and more accurate. The engineering technique (also known as engineering design) is a way for arriving at a desired solution to a problem through a methodical approach. It helps the student to brainstorm about the project and act accordingly. While designing, students get proper idea of the pros and cons of a certain approach and know that how to solve the obstacles. In the long run, it enables us to think critically and tackle complicated technical challenges by allowing us to address problems in a variety of ways.

2.2 Identify multiple design approach

A project's design approaches are determined by a variety of factors and criteria. These criteria are based on the number of possible solutions to the complex engineering problem and the project's objectives.

Our main target of FYDP is to make a system for motorcycle riders which will detect the accident as soon as it occurs and notify the previously inserted numbers with rider’s location and primary health condition. When an accident occurs, we can observe few things. The condition of the bike, how much the rider is injured and if the rider is able to keep his eye open or not. We have devised three alternative ways based on our objectives.

Our first approach is based on the angle of the bike. We have used an accelerometer inside a helmet to detect the accident. The accelerometer sensor operates as a sensor for detecting the movement of the bicycle, which is controlled by the microcontroller. The tilt angle of the bike will be measured in order to detect an accident. This system

continuously detects the rider's and the bike's tilt, and as soon as it exceeds the tilt angle that the system considers abnormal and not feasible under any conditions, it considers it an accident. The microcontroller will also send a message to the GSM modem, which will subsequently transmit the message to the smartphone as an automatic SMS.

Our second alternative for accident detection is to measure the pressure or force that the rider experiences during an accident in order to develop a safety system in a helmet and a speed alert for enhanced motorcycle safety. Riders must take extra steps to protect their bodies while riding a motorcycle. Protecting the head is the most crucial place to begin. In a motorcycle collision, the head and brain are the most vulnerable. To detect the accident, we are employing a force sensing resistor to measure the pressure. The connected sensors will verify if the pressure exerted to the helmet exceeds a specified limit. If it does, the system will recognize it as an accident and relay the information to the emergency lines.

Our last and final approach involves image processing to detect an accident using the rider's eye sight. Accidents can occur due to a variety of reasons, including decreased vigilance, slower reactions, and a proclivity to fall asleep while riding. This system assesses the drivers' state using several methods such as eye blinking, yawing, and head position. Drowsiness is being diagnosed via eye blinking data in this experiment. The web camera records the driver's eye expression and calculates how many times he closes his eyes to determine if he is drowsy or awake. If the system detects the rider's drowsiness, it will make an audible alert so that the rider is aware of the situation. In the event of an accident, the vibration caused by the collision will be recognized by this design. When the system identifies an accident, it sends SMS notifications to the emergency contacts.

We are employing a pulse rate sensor while riding the bike to detect physiological activity such as heart rate in real time. Section 1.3 delves into the specifics of the following three approaches.

2.3 Describe multiple design approach

1st Approach: Tilt-angle based Accident Detection System:

The main thing about the project is how to detect the accident as soon as it occurs. In this particular design, this accident detection will be done by measuring the tilt angle of an object, and in this case a bike. This system detects the tilt of the rider and the bike continuously and as soon as it reaches the threshold of the tilt angle which the system considers it as abnormal and not possible at any circumstances, it considers it as an accident.

Now, the question arises that how this tilt angle is going to be calculated. There are three different types of angular rotation in three different axes. They are Roll (in X - axis), Pitch (in Y - axis) and Yaw (in Z – axis). A graphical demonstration is also given in Figure 1.

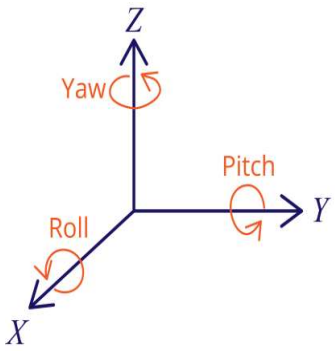


Fig 1: Various angular rotation in different axes

If we compare those rotation with a bike, we can see that the tilt of the bike is actually the Roll rotation of the bike if we consider the forward and backward motion of the bike in X – axis (shown in Figure 2). So, we can easily say that if we can find the Roll

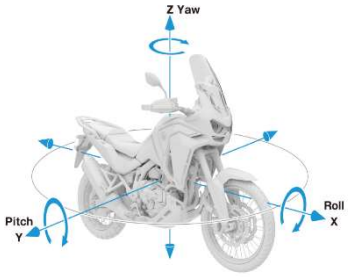


Fig 2: Roll, pitch and yaw in a motor

angle of the bike, we can easily find out the tilt angle of the bike in order to detect the accident. The equation that is derived to find out the Roll angle is,

$$\boldsymbol{Roll, \varphi = arctan\left(\frac{a_y}{a_z}\right)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \boldsymbol{(i)}$$

Here a_y and a_z are the values derived from the g-force of an object.
Since, we know now how to find determine the Roll, hence the tilt angle, it is time to find out which range of tilt angles we will consider to be dangerous in this design. The total angle on the surface of the road is 180°. When the bike is erect and absolutely vertical with the surface of the road, the accelerometer will give a tilt angle of 90°. So, any roll rotation done in the X – axis will generate a tilt angle more than or less than 90°. To determine the threshold, we have decided that if a motorbike goes below the range of 20° and goes above the range of 160° the system is going to consider it as an accident.
This system intends to detect a bike accident as soon as it happens and then send a SMS to the pre-recorded emergency contact numbers which will contain the accident notification and real-time location of the victim. As we have discussed how the system is going to determine the accident, now we are going to talk about the components in order to implement this concept.

Accelerometer (ADXL335):

In our opinion, the perfect device to execute this operation in this design is the accelerometer, specifically we intend to use ADXL335 accelerometer sensor. An accelerometer is an electromechanical device that measures both static forces (such as gravity) and dynamic forces (such as motion or vibration) accelerations in three

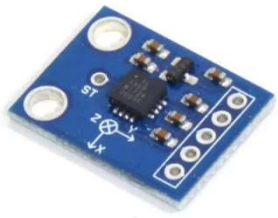


Fig 3: ADXL335

different axes simultaneously. It is built with piezoelectric quartz crystal and due to

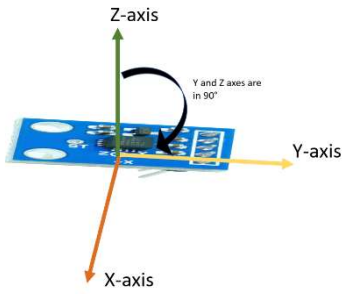


Fig 4: ADXL335 when parallel to surface

its special self-generating property, the crystal produces a voltage which is proportional to the accelerative force. Thus, the acceleration in the

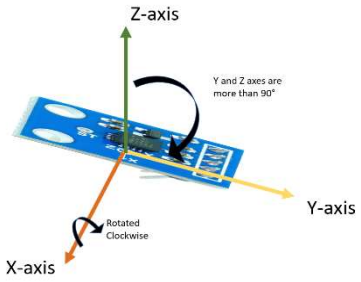


Fig 5: ADXL335 when rotated clockwise

axes is found. In most cases as well as in this design, the forces due to gravity are being measured in Z – axis. The dynamic forces in our project are the motion of the object which will be measured in X and Y axes continuously. Thus, we will be able to obtain the g-force of the rider in three axes and use those values to finally calculate the tilt angle of the bike with respect to the surface of the road and thus detect the accident successfully.

Now, using the accelerometer ADXL335, we are going to see how we can find the tilt angle. If we want to implement this concept using the accelerometer, we will be able to see that, when the accelerometer is absolutely parallel with the ground and there is no roll, the angle between the Z – axis and the X – axis is 90° (shown in Figure 4). If we rotate the accelerometer in X – axis in clockwise direction, we can see that the angle between those two axes are increasing (shown in figure 5) and if done in anti-clockwise direction, the angle will decrease (shown in figure 6). When the

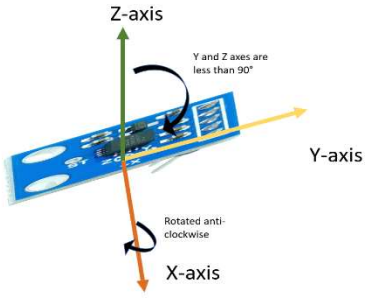


Fig 6: ADXL335 when rotated anti-clockwise

accelerometer is totally vertical with the surface, it will give an angle of 0° or 180° based on the direction of the rotation. This way, we are going to use the accelerometer to find the correct tilt angle of the biker. Finally, we will apply the threshold of the tilt ranges which we earlier have said dangerous in the code and thus this system will be able to determine the accident.

GSM Module (SIM800L):

In our design, what we tend to do after we have successfully detected the accident is to send a SMS to the emergency contact numbers. This particular process will here will be done by a GSM module. GSM stands for Global System for Mobile Communication. In

Fig 7: SIM800L

this particular design, we have chosen the SIM800L for executing the communication process which is sending SMS to the emergency contact numbers.

The **SIM800L** is a GSM module from "Simcom" that gives any microcontroller GSM functionality, meaning it can connect to the mobile network to receive calls and send and receive text messages, and also connect to the internet using GPRS, TCP, or IP. Another advantage is that the board makes use of existing mobile frequencies, which means it can be used anywhere in the world.

The reason behind choosing this exact model is that SIM800L is a very small (25*23 mm) and consumes very less amount of power. It works within a voltage level of 3.8V to 4.2V and an average current consumption is 350mA with a peak consumption of 2000mA. In conclusion, as this device is very small and lightweight but still very efficient in long range connectivity, that is why we are going to use SIM800L.

GPS Module (Ublox Neo-6M GPS Module):

Earlier we said that the system is going to send an SMS containing the real time location of the victim. This real-time location can only be detected by using a Global Positioning System also known as GPS. In this particular design, we tend to use the Ublox Neo – 6M GPS Module for obtaining the real time location.

The Ublox NEO-6M GPS engine on these modules is quite a good one, and it also has high sensitivity for indoor applications. Furthermore, there's one MS621FE-compatible

Fig 8: Ublox Neo 6M GPS Module

rechargeable battery for backup and EEPROM for storing configuration settings. The module works well with a DC input in the 3.3V to 5V range because of its built-in voltage regulator.

As indicated, the GPS modules are based on the Ublox NEO-6M GPS engine. The type number of the NEO-6M is NEO-6M-0-001, and its ROM/FLASH version is ROM 7.0.3 (PCN reference UBX-TN-11047-1). The NEO-6M module includes one configurable UART interface for serial communication, but the default UART (TTL) baud rate here is 9,600. Because the GPS signal is right-hand circular-polarized (RHCP), the style of the GPS antenna will be different from the common whip antennas used for linear polarized signals. The most popular antenna type is the patch antenna. Patch antennas are flat, generally have a ceramic and metal body, and are mounted on a metal base plate. They are often cast in a housing. The position of the antenna mounting is very crucial for optimal performance of the GPS receiver. When using the patch antenna, it should be oriented parallel to the geographic horizon. The antenna must have full view of the sky, ensuring a direct line of sight with as many visible satellites as possible.

MAX30102:

The MAX30102 is an integrated pulse oximetry and heart-rate monitor biosensor module. It includes internal LEDs, photodetectors, optical elements, and low-noise electronics with ambient light rejection. The MAX30102 provides a complete system solution to ease

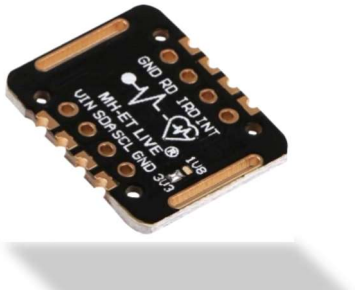


Fig 9: MAX30102

the design-in process for mobile and wearable devices. The MAX30102 uses a method called photoplethysmography to measure the heart rate of someone. This method shines light on the skin and the perfusion of the blood is measured. One of the practical aspects of this approach is that it is possible to differentiate between the light reflected by the blood of an artery (produces an AC output) and other components of the body such as bones and tissues (produces a DC output). The photo-diode in the sensor then converts the light to current that we can use as comprehensible data.

2nd Approach: Accident Detection Using FSR

Our second approach for accident detection to build a safety system in a helmet and speed alert for better safety of motorcyclists includes measuring the pressure or force the rider undergoes during an accident. We are using a force-sensing resistor to measure the pressure to detect the accident. For connecting the inter-system with the mobile application, we are using NodeMCU. It is a low-cost enabled microchip with microcontroller capabilities. Then we use the GPS module, which gets the location information from satellites. This processing is done by the microcontroller and sent to the GSM modem. Finally, the GSM modem sends the information to the respective mobile numbers.

Force Sensing Resistor [FSR]:

A force-sensing resistor is a material whose resistance changes when a force, pressure or mechanical stress is applied. They are also known as force-sensitive resistor and are sometimes referred to by the initialism FSR. FSR402 is manufactured by interlink electronics. It is similar to a resistive or a strain gauge type and is commonly used in applications to find acting forces pressure detector position or even the presence of an object or event. This can also be used as an input signal for another system or just simple to record data. FSR's are widely used in robotics and automation. They are even used as human to machine interfaces and even in various touch-based applications.

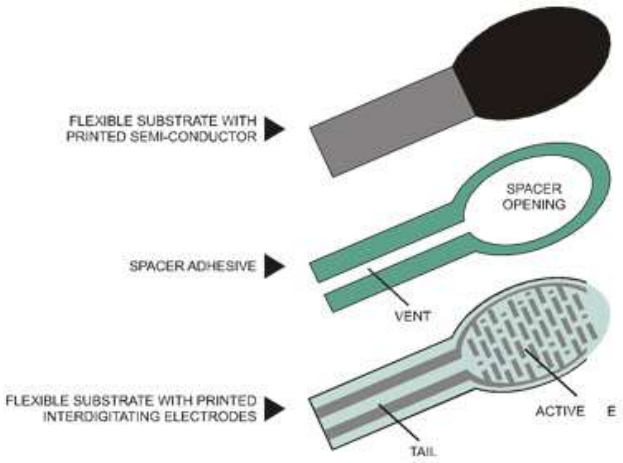


Fig 10: Force Sensing Resistor [FSR]

FSR consists of a metal foil attached to a body using some form of an adhesive. When a force is applied, the body undergoes some amount of deformation which results in a strain. This strain causes a change in resistance. This change in resistance can be picked up using a circuit called "Wheatstone bridge". It consists of four strain gauges r1 to r4 and input voltage V_{in} and an output voltage V_0. So, when a force is applied, there is a change in resistance which results in a change in V_o.

FSR402 has three main layers. The bottom layer is a flexible substrate which is coated with a layer of conductive ink. In the middle there is a plastic spacer and the top layer houses the electrodes or the active region. These electrodes are somewhat similar to the metal foil on the strain gauge. The FSR is made of 2 layers separated by a spacer. The more one presses, the more of those Active Element dots touch the semiconductor and that makes the resistance go down. The relationship here is 'force (f) is inversely proportional to the resistance (R)'.

$$\boldsymbol{f \propto \frac{1}{R} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (ii)}$$

Another point is electrodes and all these components are kept at a micrometer level apart which makes them more flexible and can be easily integrated into tight and small space. This also helps to reduce its dependency on temperature so that the readings will be more accurate. The main advantage of using Force Sensitive Resistor sensor is that they are cheap and easy to use.

The data sheet provides a log/log graph of the pulldown resistor versus force. As, the FSR's resistance changes as more pressure is applied. When there is no pressure, the sensor looks like an infinite resistor (open circuit), as the pressure increases, the resistance goes down. This graph indicates approximately the resistance of the sensor at

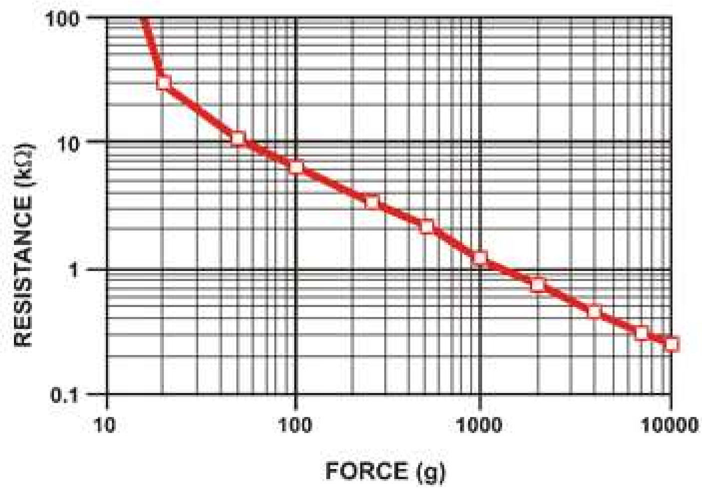


Fig 11: Force Curve

different force measurements. The 10kΩ resistor more or less allows the entire range of the FSR402 sensor. When the resistance of the FSR decreases, the total resistance of the FSR and the pulldown resistor decreases from about 100kΩ to 10kΩ. That means that the current flowing through both resistors *increases* which in turn causes the voltage across the fixed 10kΩ resistor to increase. The force is measured by Newtons*100. We can use the output voltage, V_0 using voltage divider equation:

$$\mathbf{Vo} = \frac{R}{R+FSR} \, \boldsymbol{Vin} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\boldsymbol{iii})$$

When no force is being applied, the resistance of the FSR is at its maximum.

$$\boldsymbol{Vo} = \frac{10k}{10k+10M} \times 5V = 0.05V \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\boldsymbol{iv})$$

When the maximum force is applied, the FSR becomes saturated. If there is a further increase in force, resistance will not change.

$$\boldsymbol{Vo} = \frac{10k}{10k+200} \times 5V = 4.9V \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\boldsymbol{v})$$

<u>NodeMCU:</u>

NodeMCU is an open-source firmware for which open-source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit). The term "NodeMCU" strictly speaking refers to the firmware rather than the associated development kits.

Both the firmware and prototyping board designs are open source.

The firmware uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open-source projects,

such as lua-cjson and SPIFFS. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

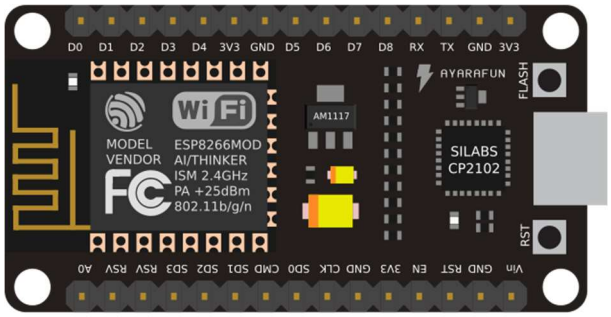


Fig 12: NodeMCU [ESP8266MOD]

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications.

The ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers.The ESP8266 module is an extremely cost-effective board with a huge, and ever growing, community.

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existance interfaces, it contains a self-calibrated RF allowing it to work under all operating conditions, and requires no external RF parts.

Pulse Rate Sensor:

The Heartbeat rate information knowing is very useful while doing exercise, studying, etc. But the heartbeat rate can be complicated to calculate. To overcome this problem, the pulse sensor or heartbeat sensor is used. An optical heart rate sensor measures pulse waves, which are changes in the volume of a blood vessel that occur when the heart pumps

blood. Pulse waves are detected by measuring the change in volume using an optical sensor and green LED. Its diameter is 0.625 and thickness is 0.125. This is a plug and play type sensor. It includes the circuits like Amplification & Noise cancellation.

Fig 13: Pulse Rate Sensor

3rd Approach: Accident detection using Image processing system

Most accidents are caused by drowsiness and not reached to the hospital in time. It is very easy to diagnose drowsiness through image processing and alert the driver with a buzzer. Even if the accident occur it could be detected by vibration sensors. All the sensors are connected to raspberry pi which further collect data from the sensors and nature of the driver's eyes. Victim's location is transmitted through a GPS system and sends a message to the victim's parents by GSM module.

In this design, like it is mentioned earlier that the image processing will be solely used for detecting if the rider is drowsy or not. The image processing will be carried out by Haar-Cascade method which is a very efficient way to detect the opening and closing of the eyes. Image processing requires a lot of processing memory, that is why in this design we have used Raspberry Pi in order to execute all the operations.

If the system detects any drowsiness by the rider, it will immediately make a sound so that the rider gets alerted about the situation. In case of an accident, in this design the accident will be detected by the vibration occurred during a collision. As soon as the system detects an accident it will send SMS to the emergency contacts. Now, to carry out all the operations, we tend to use the following components.

Raspberry Pi:

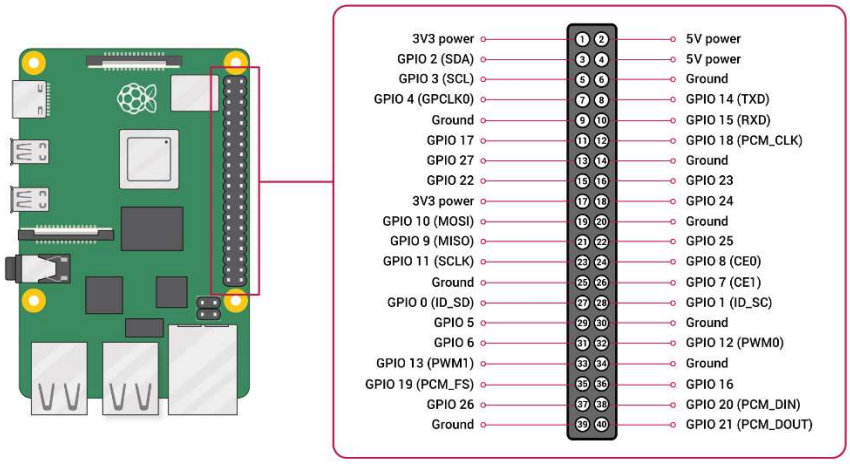


Fig 14: Raspberry Pi

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. All models feature a Broadcom system on a chip (SoC) with an integrated ARM-compatible central processing unit (CPU) and on-chip graphics processing unit (GPU). SYSTEM DEVELOPMENT 21 Processor speed ranges from 700 MHz to 1.4 GHz for the Pi 3 Model B+ or 1.5 GHz for the Pi 4; on-board memory ranges from 256 MB to 1 GB with up to 4 GB available on the Pi 4 random-access memory (RAM). Secure Digital (SD) cards in MicroSDHC form factor (SDHC on early models) are used to store the operating system and program memory. The boards have one to five USB ports. For video output, HDMI and composite video are supported, with a standard 3.5 mm tip-ring-sleeve jack for audio output. Lower-level output is provided by a number of GPIO pins, which support common protocols like I²C. The B-models have an 8P8CEthernet port and the Pi 3, Pi 4 and Pi Zero W have on-board Wi-Fi802.11n and Bluetooth. There are 40 pins present in raspberry pi. Of the 40 pins, 26 are GPIO pins and the others are power or ground pins (plus two ID EEPROM pins). A general-purpose input/output (GPIO) is an uncommitted digital signal pin on an integrated circuit or electronic circuit board which may be used as an input or output, or both, and is controllable by the user at runtime.

Vibration sensor:

801s vibration sensor is used for detecting any vibration or shake. This sensor has four pin which are Vcc, Gnd, A0 and D0. Here A0 pin is used for detecting different level of vibration. There is limit for the vibration. When the limit is crossed it will detect as an accident. D0 pin is used for obtaining either high or low when vibration is detected.
Features

- Detect slight vibration.
- Cost efficient.
- 60,000,000 times shock guarantee.
- Both analogue and digital value can be obtained.

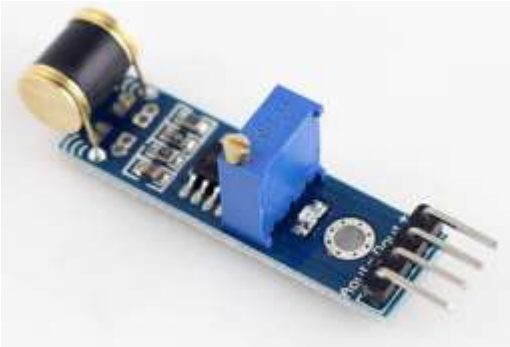


Fig 15: Vibration Sensor

2.4 Analysis of multiple design approach

1st Approach: Tilt-angle based Accident Detection System:

We'll be able to determine the accident by determining the roll angle. Now, we are going to see if the accelerometer can actually do that job properly.

We said that, when the accelerometer is going to be parallel to the surface, it will be considered that the tilt is at 90°. We can see in figure 16 that the same thing has happened. As we continue to rotate it in the clockwise direction, we can see in figure 17 that the tilt angle is increasing continuously and when it reaches its threshold which is 160°, it shows that accident is detected (shown in figure 18).

Similarly, as we rotate the accelerometer in X – axis in anti-clockwose direction, the tilt angle slowly continuous to decrease (shown in figure 19). When it goes below 20°, we can see that it has also detected it as an accident (shown in figure 20).

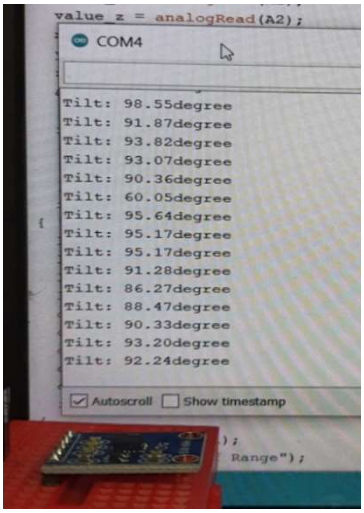


Fig 16: When ADXL335 is parallel

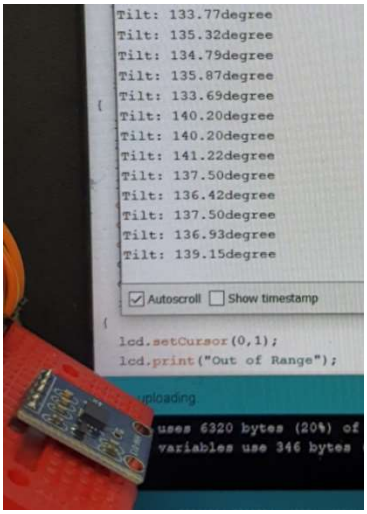


Fig 17: When ADXL335 rotated clockwise

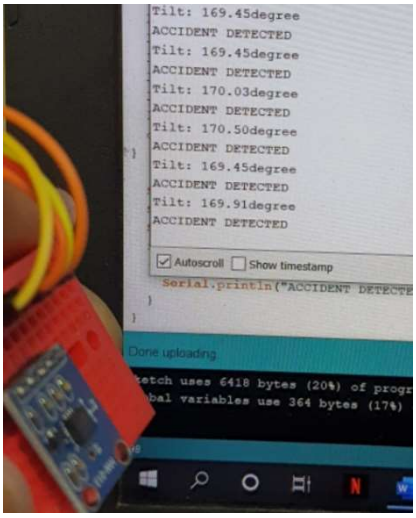


Fig 18: When ADXL335 is more than 160°

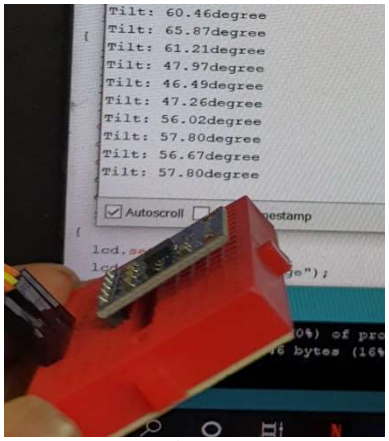


Fig 19: When ADXL335 is rotated anti-clockwise

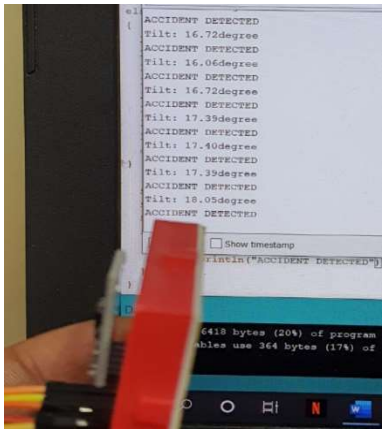


Fig 20: When ADXL335 is less than 20°

Finally, the overall budget of the first design is given below in the following table.

Table 3: Price list of 1st design

1st Design				
Serial	**Component Name**	**Amount**	**Price (BDT)**	**Total (BDT)**
1	Arduino UNO	1	620	**4155**
2	ADXL335 Accelerometer	1	400	
3	SIM800L GSM Module	1	400	
4	Ublox Neo-6M GPS Module	1	800	
5	nRF24L01+ 2.4GHz RF Transceiver Module	2	240	
6	Arduino Micro	1	650	
7	HC05 Bluetooth Module	1	345	
8	MAX30102 module (Pulse Rate and O_2 level)	1	350	
9	0.96 OLED Display	1	350	

2nd Approach: Accident Detection Using FSR

We have used an Arduino UNO, an operational amplifier (OP-AMP: LM324), resistors, FSR402 and some connecting wires.

The FSR402 is connected in series to a 10kΩ resistor which forms a voltage divider. The output of the voltage divider runs through the op amp and then into the analog pinA_0 of Arduino. We have also connected an LED to pin2 which acts as an identification for when the FSR has been pressed or when a force has been applied.

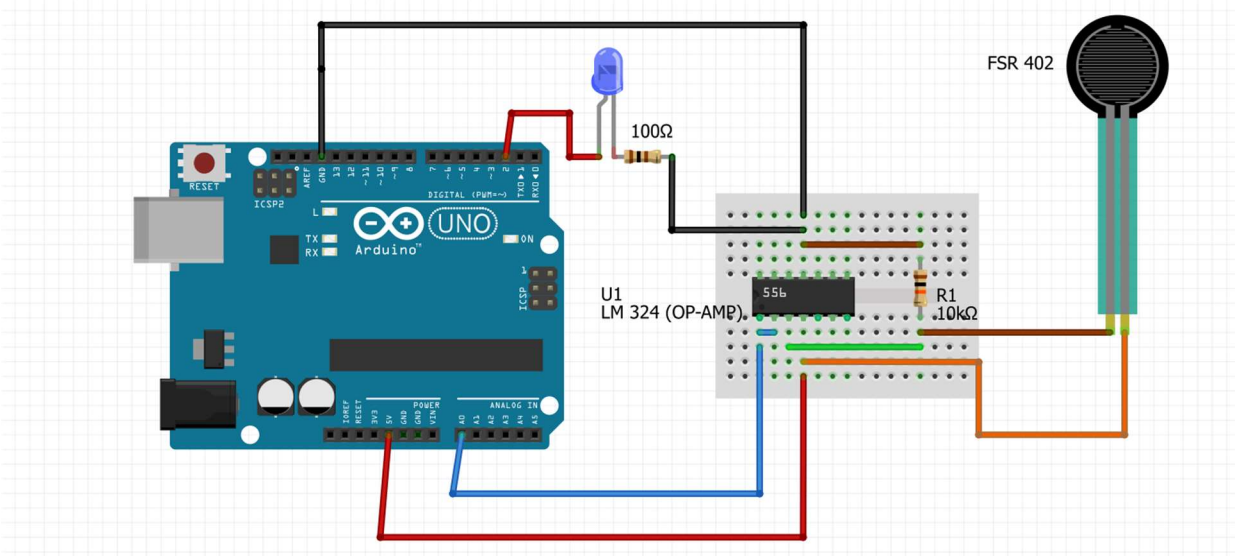


Fig 21: Circuit for FSR

The LM324 IC has four op-amps in it. We have used the first one. The first pin here corresponds to the output of the op-amp. The second pin is the negative pin and the third pin is the positive pin. The fourth pin is for the power rails of the op-amp which is plus five from the Arduino and opposite to that pin is ground. So, the output is taken across the 10kΩ resistor. This connection between op-amp and output forms a unity gain

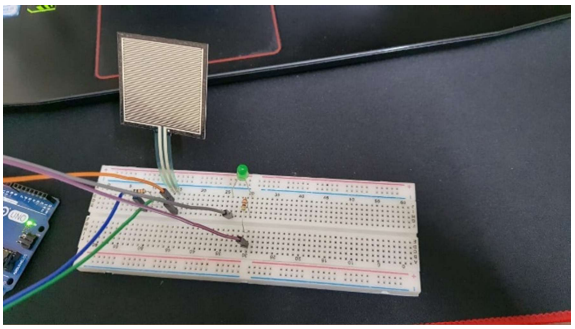


Fig 22: When force is not applied

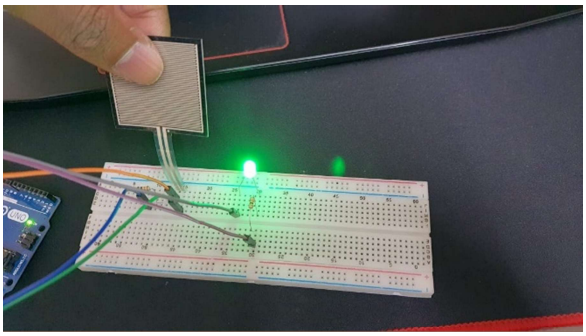


Fig 23: When force is applied

configuration where the gain is of the op-amp is equal to 1. Therefore, the input voltage is exactly the same as the output voltage. The reason behind using an op amp is that for

an op amp, the input has an infinite impedance which means there is no current draw at the input. On the other hand, the output of the op-amp has zero impedance which means there is no voltage drop across the output. So practically using an op-amp provides a level of isolation between the sensor and the Arduino and it prevents any signal attenuation due to the mismatching impedances.

In conclusion, we would get an analog value when reading the output voltage into the Arduino. This analog value would have to be converted into a voltage to represent the output voltage. The output voltage can then be used to find the resistance of the FSR by:

$$\boldsymbol{FSR} = \left[\frac{\boldsymbol{R}}{\boldsymbol{Vo}} \times \boldsymbol{Vin}\right] - \boldsymbol{R} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\boldsymbol{vi})$$

From the value of the resistance of FSR, we can calculate the conductance which is equal to $\frac{1}{R}$. The conductance can then be used to approximate a value for the force by the resistance vs force graph. Once the force is known, the pressure can be calculated. Pressure is simple force over area where the area corresponds to the area of the active region of the FSR.

There are multiple methods that can be used to transfer data from one device to another. For example, I2C or Serial Communication. In this approach, we have used this method as it is one of the easiest and most convenient methods. In this part, we will start by

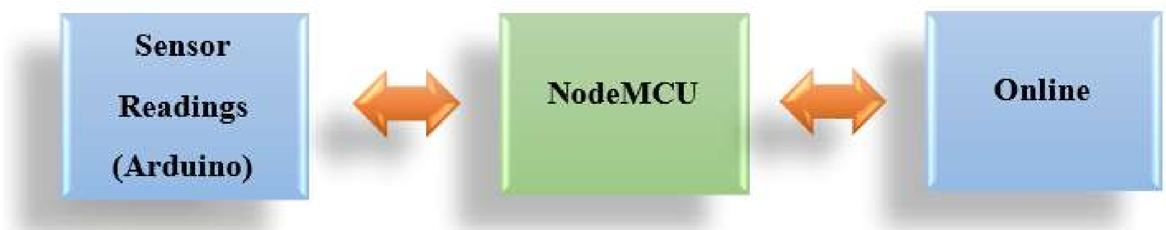


Fig 24: NodeMCU data transfer flowchart

collecting sensor's readings via Arduino and place that data on the serial port. This will then be sent to the NodeMCU and from the NodeMCU the data can be pushed to online via the ESP-12 WIFI module housed inside the NodeMCU.

First of all, the devices have to grounded to each other. The connection between the Arduino and nodeMCU is a serial connection. We would have two data connections. One would be receiving R_X and one would be transmitting T_X. We have used pin5 on the Arduino connected to pinD5 on the nodeMCU followed by pin6 on the Arduino connected to pinD6 on the nodeMCU. These pins have to be assigned as receiving R_x and transmitting T_x pins. Here, when nodeMCU is transmitting, the Arduino has to receive. We need two programs for the set up. One for the Arduino and one for the nodeMCU as they are both separate programming boards. For Arduino, we need to include the sensors library for Arduino site code. Also, we need to include the library for software serial to enable serial communication between the two devices. We enabled the serial connection

by specifying the R_x and T_x ports on the Arduino side. For nodeMCU, we also need the software serial library. In this case, the software serial has to be initialized with D6 being the receiving pin for R_x and D5 being the transmitting pin for T_x. We need a function to if the sensor reading was sent or not. If the reading is not sent, it would print it to the serial monitor and return to the beginning of the loop. This loop would continue until a valid set of readings are obtained. If the valid data is sent to NodeMCU, it would print the sensors reading on the serial monitor. We can obtain the reading from different sort of commands. We have to allocate different variable and read the attribute of the object data as force sensing resistor.

We are also using a pulse rate sensor to monitor the heartbeat of the rider while riding the bike. When a heartbeat occurs, blood is pumped through the human body and gets squeezed into the capillary tissues. Consequently, the volume of these capillary tissues increases. But in between the two consecutive heartbeats, this volume inside capillary tissues decreases. This change in volume between the heartbeats affects the amount of light that will transmit through these tissues. This can be measured with the help of a microcontroller. The pulse sensor module has a light that helps in measuring the pulse rate. When we place the finger on the pulse sensor, the light reflected will change based on the volume of blood inside the capillary blood vessels. This variation in light transmission and reflection can be obtained as a pulse from the output of the pulse sensor. This pulse can be then conditioned to measure heartbeat and then programmed accordingly to read as heartbeat count using Arduino. We can the reading to respective connect numbers using NodeMCU.

Finally, the overall budget of this design is given below in the following table.

Table 4: Price list of 2nd design

2nd Design				
Serial	**Component Name**	**Amount**	**Price (BDT)**	**Total (BDT)**
1	Arduino UNO	1	620	**14268**
2	Force Sensing Resistor	16	9920	
3	SIM800L	1	400	
4	Ublox Neo-6M GPS Module	1	800	
5	nRF24L01+ 2.4GHz RF Transceiver Module	2	240	

6	Arduino Micro	1	650	
7	Pulse Rate Sensor	1	760	
8	ESP8266 NodeMCU Wifi Module Lua V3	1	528	
9	0.96 OLED Display	1	350	

3rd Approach: Accident detection using Image processing system

Driver's drowsiness can be diagnosed in two ways. Psychological measurement and behavioral measurement. Most suitable for behavioral measurement efforts for image processing. This system analyzes the state of the drivers using different method like eye blinking, yawing or head pose. For this project, eye blinking analysis is being used to diagnose drowsiness. This system is divided into two parts. Detecting layer and Transport layer.

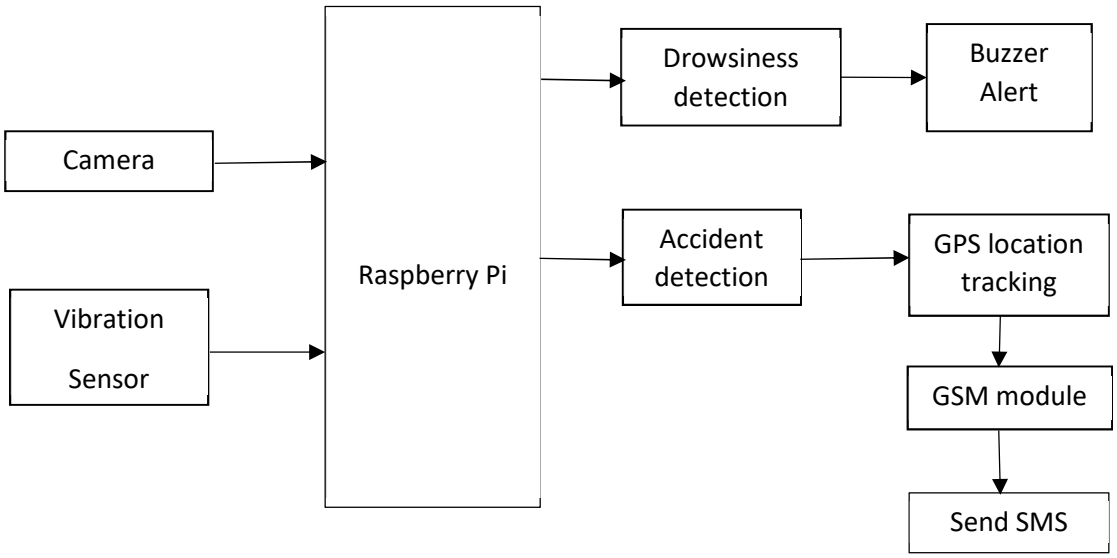


Fig 25: Image Processing flowchart

In the detection layer we used image processing system to detect the driver's drowsiness. The web camera captures the eyes expression of the rides and calculate how many times closes his eyes and determine whether the driver drowsy or active. Haar-Cascased technique is used for processing the image. For detecting the drowsiness Opencv software

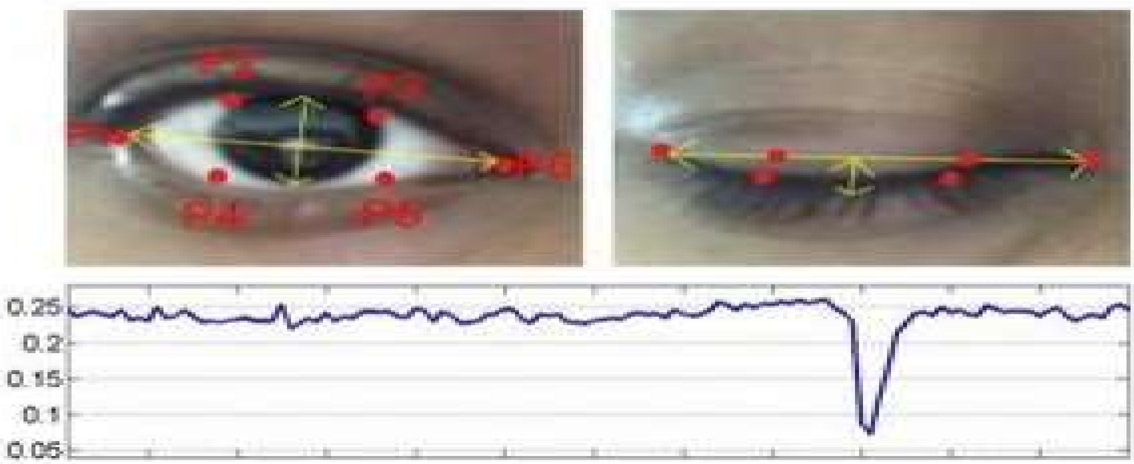


Fig 26: Eye open close detector

is used along with raspberry pi. In this system the eye is marked into 6-pixel values like P1, P2, P3, P4, P5, and P6. Basically, drowsiness is mainly diagnosed through vertical value calculations. If the eye is closed for a certain moment is indicate the driver falling into drowsy.

Eye Aspect Ratio (EAR) is used to determine the parameter whether the driver drowsy or active.

$$\boldsymbol{EAR} = \frac{\|P2-P6\|+\|P3-P5\|}{2\|P1-P4\|} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots . (\boldsymbol{vii})$$

801s vibration sensor is a sensitive micro shock detecting sensor that operates by changing its resistance when a shock or vibration is detected. It is a highly sensitive non-directional vibration sensor. When the module is stable, the circuit is turned ON and the output is i. When the movement or any vibration occurs on the module, the circuit will briefly be disconnected and it will show an output as in low. We can also customize the sensitivity needs for the sensor. For the simulation, the power pin goes to the raspberry pi GPIO2 to supply 5V and the ground pin goes to GPIO6. Also, the signal pin goes to GPIO11. The BCM number is GPIO17. While conducting raspberry pi code, we need to import GPIO pin and the time function. We set the channel 17 as the GPIO BCM number is 17 which is used to read the signal. We have defined the function as sensor vibration and passing the signal and printing the value like high and low. The working principle of vibration sensor is a sensor which operates based on different optical otherwise

mechanical principles for detecting observed system vibrations. The sensitivity of these sensors normally ranges from 10 mV/g to 100 mV/g, and there are lower and higher sensitivities are also accessible. The sensitivity of the sensor can be selected based SYSTEM DEVELOPMENT 34 on the application. So, it is essential to know the levels of vibration amplitude range to which the sensor will be exposed throughout measurements. If a vehicle has met accident, vibration sensor gives the electric signal to microcontroller through signal conditioner. Then GPS provides latitude and longitude information about vehicle location to control section through GSM.

Finally, the overall budget of this design is given below in the following table.

Table 5: Price list of 3rd design

3rd Design Price				
Serial	**Component Name**	**Amount**	**Price (BDT)**	**Total (BDT)**
1	Raspberry Pi 4 (2GB)	1	6000	**9650**
2	Raspberry Pi Camera	1	750	
3	Percussion Piezoelectric Vibration Sensor Module	1	500	
4	SIM900A GSM Module	1	1600	
5	Ublox Neo-6M GPS Module	1	800	

2.5 Conclusion

Multiple design approaches are feasible by adhering to the desired objective, requirements, and constraints. Each one demonstrates particular contentment in obtaining those conditions, and with additional study and development, a component specification has been chosen to accomplish the design project. Later on, each design has its own set of advantages and disadvantages, which is why they've all been scrutinized thoroughly to fulfill many criteria. The multiple design method not only aids in the development of creative solutions, but it also aids in the identification of the passenger's specific problems and the most effective targeting of the project needs.

Chapter: 3 Use of Modern Engineering and IT tools

3.1 Introduction

Designing items is, without a question, quite challenging nowadays. Engineers are faced with a plethora of competing criteria and restrictions, all of which must be addressed with exceptional solutions developed on tighter timelines.

However, the complexity does not remove the necessity to understand how successful engineering firms are in attaining their objectives. In reality, a performance baseline may be established by studying how most engineering companies function in today's demanding operational environment. Comparing organizational performance across cohorts that use different approaches and technologies can reveal what makes a difference. Designing items is, without a question, quite challenging nowadays. Engineers are faced with a plethora of competing criteria and restrictions, all of which must be addressed with exceptional solutions developed on tighter timelines.

3.2 Select appropriate engineering and IT tools

The selection and selection of appropriate tools is critical at the outset of every project. The best project management software begins with a clear and honest assessment of what is required. Then we'll decide on the best and most appropriate options. Furthermore, test-trials and evaluations against the requirements are required. Furthermore, the cost evaluation and, eventually, the implementation of all processes will offer a faultless outcome in project shape. As a result, for a proper solution, we will require the assistance of Proteus, Arduino, and Python in our project.

- **Proteus**: Proteus is an electronic circuit simulation, design, and drawing program. The Lab center electronic was the one who thought of it. Two-dimensional circuits can also be designed with Proteus. With this engineering program, we can create and recreate unique electrical and electronic circuits on your PCs or workstations. Recreating circuits on proteus before building them in the real world has a variety of advantages. On the proteus, circuit design takes less time than circuit construction in practice. The possibilities of making a mistake in software simulation are reduced, such as a loose connection, which takes a long time to find in a real circuit. Because some circuit components are not practical, circuit simulations have the advantage of allowing you to create your circuit on Proteus. There is no danger of any electrical component being burned or damaged in proteus. One of the most expensive electronic tools in proteus, for example, is an oscilloscope. We can use proteus to find different types of circuit parents, such as

current, the voltage value of every component, and resistance at any point, which is difficult to do in a real circuit.

- **Arduino**: Arduino is an open source microcontroller that executes a program to generate a certain display. A microcontroller is a single-chip device that contains a CPU, RAM, ROM, Clock, Timers, Interrupts, and GPIOs that can do numerous tasks simultaneously. Arduino is a microcontroller that may be used to create hundreds of thousands of projects and programs. Using the Arduino to program the Arduino board. The use of an IDE is feasible, and the programming language chosen determines how computer programs are written. It is the best alternative for students from all around the world who want to learn about microcontrollers and devices. We may use Arduino to work with a variety of sensors, modules, and shields, as well as various communication upgrades like Wi-Fi, Zigbee, BLE, NRF, and so on.
- **Python**: Python is a programming language used to construct websites and apps, automate operations, and conduct data analysis. Python is a general-purpose programming language, meaning it can be used to create a wide range of applications and isn't focused on a single problem. It has become one of the most extensively used programming languages today due to its versatility and beginner-friendliness. Python is a programming language that is widely used for online and software development, task automation, data analysis, and data visualization. Due to its relative ease of learning, Python has been used by many non-programmers, such as accountants and scientists, for a variety of typical activities, such as arranging finances. Python is widely used to develop the back end of a website or application—the parts that users don't see. Python's involvement in web development includes sending data to and from servers, processing data and interacting with databases, URL routing, and guaranteeing security. A number of web development frameworks are available in Python. Two prominent ones are Django and Flask. Some of the web development roles that require Python are back end engineers, full stack engineers, Python developers, software engineers, and DevOps engineers.
- **U-center:** U-center is an easy-to-use, customizable GNSS evaluation software that is compatible with leading u-blox technologies. The u-blox M10 platform, which is developed for asset tracking and wearable devices, is supported by u-center 2, the latest edition of the software. The enhanced user experience in u-center 2 offers customizable workspaces and adaptive window elements. Its log player features customizable playing speed and u-center log file import, as well as message-based and time-based navigation. Users can define or adapt GNSS product configurations for specific use cases using the u-center 2 fast product configuration. It's simple to save, restore, or share configurations between multiple products and users. The software allows for product evaluation with a variety of views to observe the

linked Ublox GNSS receiver's static and dynamic performance. We have used this technology for location tracking purposes in our system.

3.3 Use of modern engineering and IT tools

In the earlier chapters we have mentioned that we have divided our whole system into few sub systems. They are for the accident detection purpose, location tracking and getting the instantaneous physiological activities of the rider after an accident occurs. And so, to execute and implement for the best outcome of the designed solution we have used Proteus, Python, Arduino and U-center. The purpose of using this modern engineering and IT tools in order to design, develop and validate the solution is described below:

Table 6: Purpose & Validation of Modern IT tools

No	Modern Engineering and IT tools	Purpose	Validation
1.	Proteus	• For simulation purpose of the multiple approaches and final design • In doing the PCB designing of the system.	Output with animation
2.	Python	Used in image processing.	Programming of Image processing.
3.	Arduino IDE	Programmed Node MCU	Programming all the modules
4.	U-center	For GPS calibration	Detected signal accuracy and location.

We have identified appropriate techniques, gathered resources and tools as required to develop the solutions of our proposed project. In multiple design approaches we have assessed and experimented the design by using simulation techniques of Proteus. After that coming to the final design solution, we have built the prototype we selected appropriate tools to develop and validate the selected solution using Arduino IDE in programming and merging the connections of Node MCU and its necessary components. Furthermore, we have used U-center for calibrating the GPS and tracking issues.

3.4 Conclusion

We made proper selections in developing the final prototype of our system to ensure its success. It is critical to use Modern Engineering and IT tools correctly in order for it to function properly and in accordance with the rules. Thus, with proper help of each and every group-mates, peer work, determination we have made it possible to work the way we wanted.

Chapter 4: Optimization of Multiple Design and Finding the Optimal Solution. [CO7]

4.1 Introduction

Design optimization is a method of engineering design that use a mathematical formulation of a solution problem to aid in the selection of the best design from numerous options. It removes material from unneeded portions of the product design while adding material where it is most needed. It allows users to maximize the usage of materials while ensuring that companies do not have to compromise on product quality. In various fields of study, optimization methods are used to identify solutions that maximize or minimize specific study parameters, such as minimizing expenses in the manufacture of a thing or service, maximizing earnings, minimizing raw material in the development of a good, or maximizing productivity.

In designing a helmet for rider's safety, we have to consider different parameters of optimization method so that not only it ensures the rider's safety but also encourages them to wear a helmet. That is why our project optimization of multiple design is very important in order to get the most suitable outcome. After optimizing different approaches, we can compare if the approach is sustainable, if it fully satisfies our requirement, if the approach is budget friendly or not. Therefore, we have chosen 3 different methods for our project to detect the accident to find the best approach among them. We have tried to detect the accident using accelerometer which will measure the tilt-angle. Then we have used a sensor which will calculate the force applied on the helmet while riding the bike. Lastly, image processing is used to detect the drowsiness of the rider. All these approaches are discussed in chapter 2. In this chapter we are going to briefly discuss about design optimization.

4.2 Optimization of multiple design approach

Motorcyclists need to take extra precautions to protect their body. The most important place to start is by protecting the head. The head and brain are most vulnerable to injury in a motorcycle accident. Drivers and passengers wearing helmets increase their chance of survival significantly over non-helmet wearers. Our first approach for designing smart system is title-angle based accident detection system. Second approach relates to the force sensor resistor and third approach is about image processing and vibration sensor. All of these methodologies are distinct and strive to meet the project's requirements in different ways. Section 1.3 discusses the specifics of these approaches. We can analyze the approaches based on the discussion by taking into account several criteria.

Table 7: Design Parameters Comparison

Design Analysis								
Design	**Range of Data**	**Efficiency**	**Usability**	**Budget**	**Maintenance**	**Accessibility**	**Manufacturability**	**Impact**
Approach-01 ***[Tilt-angle]***	85kbps At 850-1900 MHz	Provide maximum performance	Convenient	Satisfied	Simple	Satisfied	Mostly Available	Comfortable to use
Approach-02 ***[FSR]***	25mbps At 2.4 GHz	Difficult as too many sensors are needed	Inconvenient	Exceed	Complex	Partially Satisfied	Mostly Available	Uncomfortable and complex
Approach-03 ***[Image Processing]***	85kbps At 850-1900 MHz	Does not fully satisfy our objective	Convenient	Exceed	Complex	Unsatisfied	Unavailable	Uncomfortable

4.3 Identify Optimal Design Approach

The identification of optimal design is the process of selecting the optimum design method among all alternatives that reflect the stated objectives, requirements and specifications. Certain aspects must be taken into consideration when selecting a design. Cost analysis, efficiency, usability, manufacturability, sustainability, maintainability these are the most common criteria to taken into account while choosing a design. Considering these elements enables students to align on concepts, methods, and deliverables to prevent errors and establish parameters to preserve critical components of the project, such as the timeline and the budget, on track.

Firstly, cost comparison is essential to pursue an appropriate project based on profitability and meet the demand. It enables students to assure that the project is completed within the financial constraints. Budget comparison is a significant component since it reveals whether a project is viable from a business standpoint. For our first design, we have used Arduino UNO, ADXL335, SIM800L GSM Module, Ublox Neo-6M GPS Module, 2 pieces of nRF24L01+2.4 GHz RF Transceiver Module, Arduino Micro, HC05 Bluetooth Module, MAX30102 pulse rate sensor and 0.96 OLED display which in total cost us 4155 taka which is only 15% compared to other two approaches.

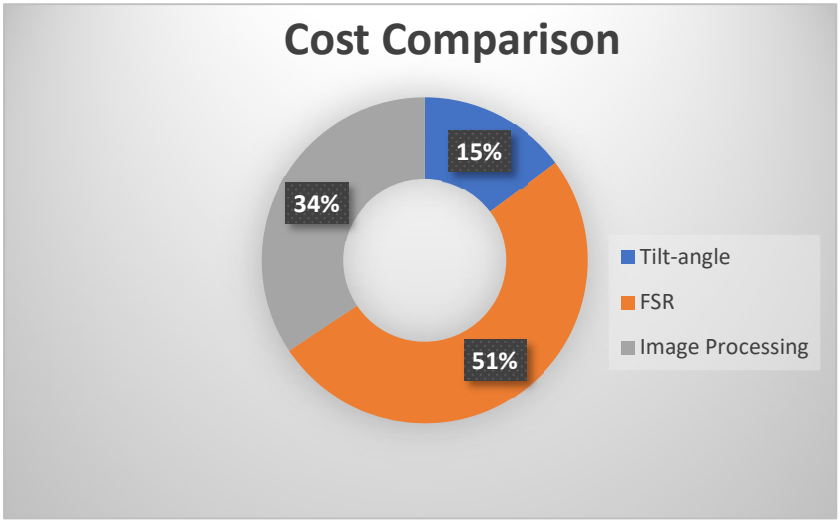


Fig 27: Budget Comparison (Pie Chart)

For our second design which is accident detection system using FSR requires the highest amount of 51% compared to other two. Reason behind this big amount of percentage is we need to use almost 16 FSRs to cover the full helmet. The calculations can be shown as:

For Large size helmets. Given, Helmet size [circumference], $2\pi r = 60$ cm [approximately]

Table 8: Helmet size

Helmet Size Chart

	U.S. Hat Size	Inches	CM
YS	6 1/8 - 6 1/4	19 5/16" - 19 11/16"	49 - 50 cm
YM/XXS	6 3/8 - 6 1/2	20 1/16" - 20 7/16"	51 - 52 cm
YL/XS	6 5/8 - 6 3/4	20 7/8" - 21 1/4"	53 - 54 cm
S	6 3/4 - 7	21 5/8" - 22"	55 - 56 cm
M	7 1/8 - 7 1/4	22 7/16" - 22 13/16"	57 - 58 cm
L	7 3/8 - 7 1/2	23 1/4" - 23 5/8"	59 - 60 cm
XL	7 5/8 - 7 3/4	24" - 24 3/8"	61 - 62 cm
XXL	7 7/8 - 8	24 13/16" - 25 3/16"	63 - 64 cm
XXXL	8 1/8 - 8 1/4	25 5/8" - 26"	65 - 66 cm
XXXXL	8-3/8	26 3/8" - 26 3/4"	67 - 68 cm

∴ Radius, r = $\frac{60}{2\pi} = 9.549cm$;

We know,

Surface area of a sphere = $4\pi r^2$

∴ Surface area of a helmet = $4\pi(9.549)^2 = 1145.847\ cm^2$;

Without the front face shield,

Total area of a helmet = $1145.847\ cm^2 \times \frac{3}{4} = 859.38525\ cm^2$;

We have to cover $859.38525\ cm^2$ area of a helmet.

For FSR:

Length and width of sensing area of FSR (Square) = 38.35 mm = 3.835 cm

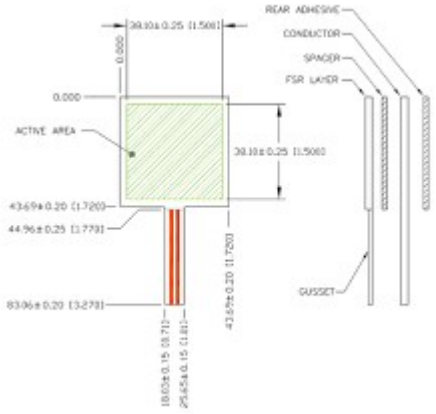


Fig 28: Force Sensing Resistor

We know,

Surface area of a square = length× width = a^2;

∴ Surface area of FSR = $(3.835)^2 = 14.707cm^2$;

So, one piece of FSR can cover only $5.067cm^2$ surface area. To cover full helmet, we need $\left(\frac{859.38525}{14.707}\right) = 58.434 \approx 58$ pieces of FSR.

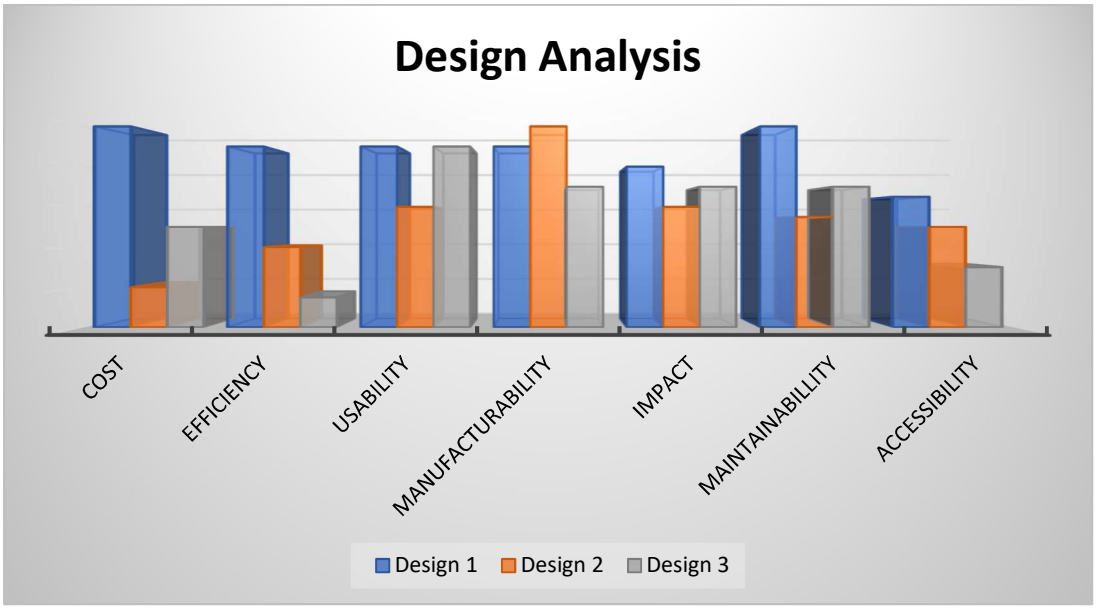
Fig 29: Crash statistics on motorbike helmet

We can divide the helmet in 16 major parts. The numbers on the helmet represent the crash statistics for that part of the helmet to be damaged in an accident. Therefore, if we want to cover full helmet, we need minimum 16 FSRs. For this reason, overall cost of our second approach has increased significantly. Other than FSR, we also have used Arduino UNO, SIM800L GSM Module, Ublox Neo-6M GPS Module, 2 pieces of

nRF24L01+2.4 GHz RF Transceiver Module, Arduino Micro, ESP8266 NodeMCU Wifi Module Lua V3, MAX30102 pulse rate sensor and 0.96 OLED display which in total cost us Tk. 14268. Lastly, for our third and final approach, we have used Raspberry Pi 4 as a microcontroller which took the most portion of the budget of this approach around Tk. 6000. Other than the microcontroller, we have also used Raspberry Pi Camera, Percussion Piezoelectric Vibration Sensor Module, SIM900A GSM Module and Ublox Neo-6M GPS Module. All these components cost us around Tk. 9650 in total.

Comparing all the designs, we can come to the conclusion based on cost analysis is that the budget for our first approach which is tilt-angle based accident detection system is the most convenient and reasonable. In a country like ours, other two designs might not affordable to the bike owners and they might not be interested in purchasing them.

Another important factor in project design optimization is sustainability of that project. The sustainability outlines the various parts of the project that must be maintained in order for it to continue to operate in the long run. The long-term viability of your project is outlined in the sustainability plan. It ensures that the project's resources are not wasted. Comparing our approaches, our first approach is more sustainable for long term viability as the maintenance of our first approach is much easier compared to other two designs.



Graph 1: Design Analysis

Maintainability refers to the ease and speed with which a system can be restored to its regular operational state in terms of avoiding unforeseen working conditions, improve the performance of systems and infrastructure, and improve efficiency, dependability, and safety. As we can see that we need minimum 16 FSR sensors for our second approach to cover the whole helmet, it will be almost impossible to figure out the problem if the circuit stops to function properly. On the other hand, Raspberry Pi microcontroller is a

complex microcontroller to handle. That is why, for maintenance our first approach is the best one.

Usability is the extent to which a product can be utilized by specific users to fulfill defined objectives with effectiveness, efficiency, and satisfaction in a particular context of its application. For our project, the third approach does not satisfy our objectives completely as using a vibration sensor might not give the accurate data. Also, our main purpose is detecting accident. It may not be able to detect accident properly and send SMS to the contact number at the right time. Moreover, our second design is much complex because of too many wirings.

Therefore, considering all the aspects, our first approach which is tilt-angle based accident detection system is the optimal solution.

4.4 Performance evaluation of developed solution

SIM800L interfacing with Arduino:

The SIM800L is a cheap and portable GSM breakout board with all the capabilities of the largest SIM900 shields. The SIM800L module comes with a helix antenna, a PCB antenna and two male headers. After necessary soldering, the module is ready to use. We need to attach a standard size sim. To start testing the module, we need to attach power and Arduino UNO. As the SIM800L module requires 3.4V to 4.4V and a current of 2A, here we have used an LM2596 DC to DC converter to provide the required voltage and current. Then we have attached the VCC and GND pins of the module to the out plus and out minus pin of the LM2596. Since SIM800L module uses serial communication, RX pin receives the data and TX pin is used to transmit. Then we have attached the TX pin of the SIM800 to pin 7 of the Arduino and RX pin to pin 8. We also need to connect the Arduino's ground pin to that of the SIM800. Then provide power to the LM2596 for that using lithium battery is the best option. The provided input power to the LM2596 should be at least 7V to 12V. The output voltage should be set at minimum 3.7V by turning the potentiometer. When the SIM800 receives enough power, the onboard LED starts to blink once per second. This means that the SIM800 is searching for a network signal. If the SIM800 is connected to the network, the blinking becomes once every three seconds. By using an Arduino code, we can establish communication with SIM800L. In the code, SoftwareSerial is used to send messages to the module. Every message we send and receive is reflected in the serial monitor. If we send AT to the module, SIM800 will reply OK. AT commands are a set of commands for communicating with modems We have used "AT+CMGF=1" and "AT+CMGS= " commands for configuring text mode and inserting the sim number to the code. After giving the text, the recipient will receive the SMS.

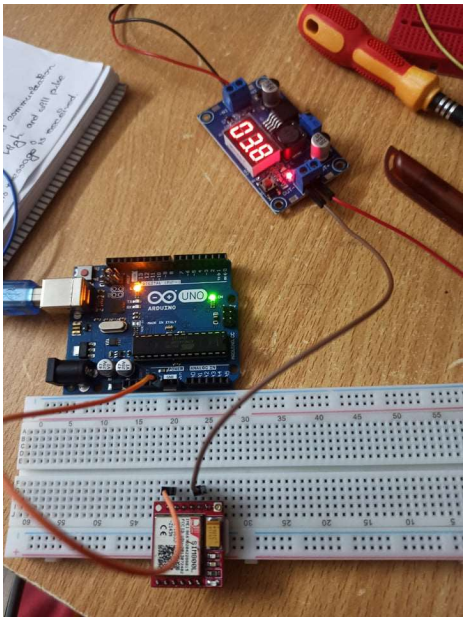


Fig 30: SIM800L Circuit Setup

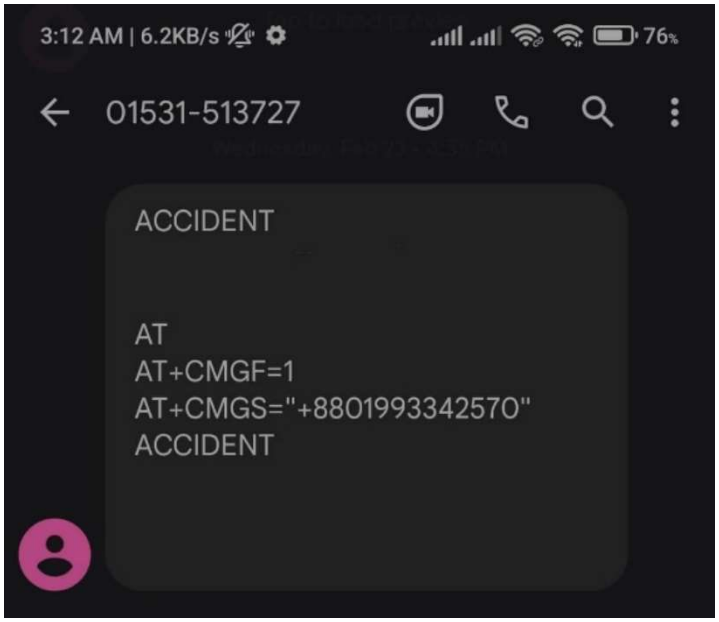


Fig 31: SIM800L Output

While working with SIM800L, we have faced some problems.

- ✓ Even if the power supply is alright the GSM module its not powering on or even it powers on then it cannot register itself to the network. To solve the problem, we have to use a capacitor or voltage regulator. In this case, we have used a DC-to-DC buck converter to provide proper power supply.
- ✓ In serial monitor, we have to choose both NL and CR and the baud rate to 9600. This is the safe baud rate for software serial.
- ✓ In serial monitor, after entering AT we should get OK as reply. We were not getting the same reply as one of our wirings was not correct.

GPS interfacing with Arduino:

GPS module supports serial communication. We have used Ublox NEO 6M GPS module. The heart of the module is the NEO 6M GPS chip which is located at the center of the module. We have an EEPROM and a button cell to retrain the information of the clock in last position. Using the four pins of this GPS module, we are going to connect this module with Arduino. As this module operates at 2.7V to 3.6V, we are going to connect the VCC pin to 3.3V on Arduino UNO using a jumper wire. The RX pin on the module is connected to the RX pin and TX pin on the module to Tx pin on Arduino UNO. Finally, the ground pin of the module and Arduino UNO should be connected. It takes few seconds to get the stabilized data. The one data that we can monitor is GPGLL which is GEO positions latitude and longitude. After few seconds we can see the full-fledges data which we can use to track the position. The data that are broadcasting on our serial monitor is NMEA sentences which is a protocol that most of the GPS devices supports in order to read the latitude and longitude and other data.

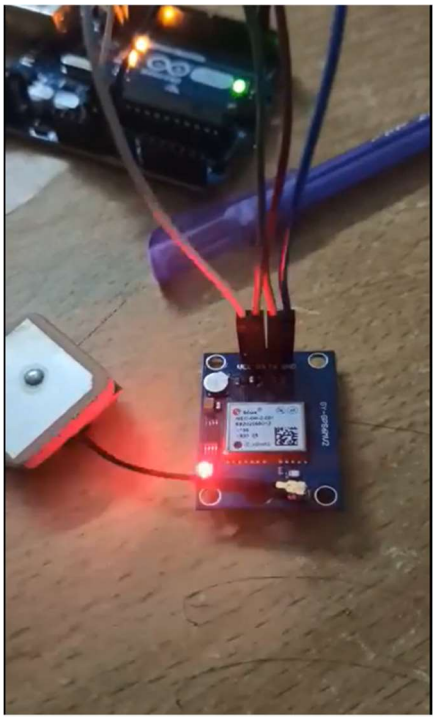


Fig 32: GPS Module interfacing with Arduino

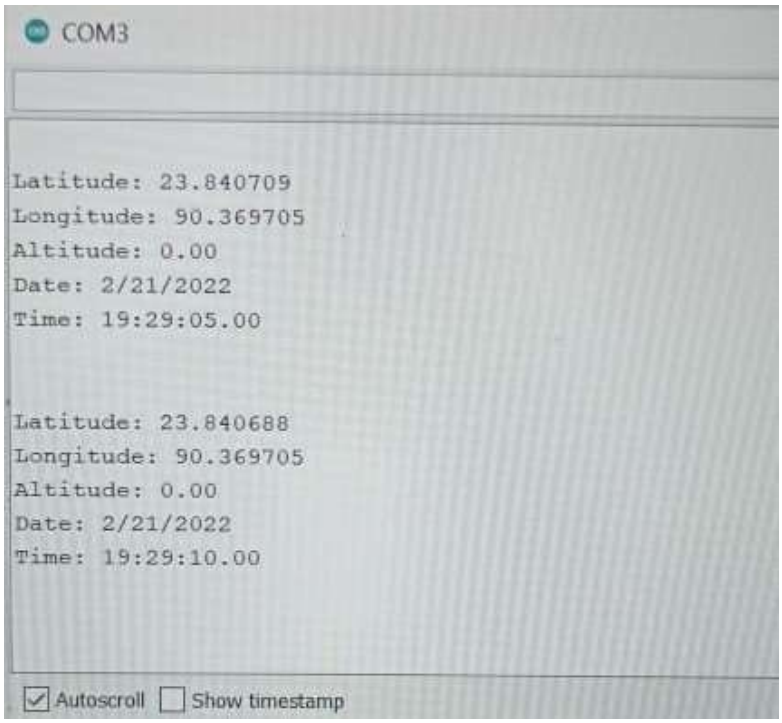


Fig 33: Serial Monitor for GPS Module

The problems we have faced while using it:

- ✓ The TX and RX pins should be connected after uploading the code on Arduino. The reason is when we upload the code, it uses TX and RX pin in order to upload the code into the chip and once the code is uploaded then this pin will be free to use.
- ✓ We need to make sure the antenna is away from RF interference sources.
- ✓ The VCC pin of the module should not be connected to 5V of the Arduino as it exceeds the operating voltage of NEO 6M GPS module and might burn it.

SIM800L interfacing with GPS:

The Ublox NEO 6M GPS module gets data from satellite like latitude, longitude, etc. We have to connect it with Arduino and test it when sky is clear. SIM800L sends GPS data to webserver using GPRS. For that, we have to install sim card. We have used a Li-on battery for powering it with 3.7V.

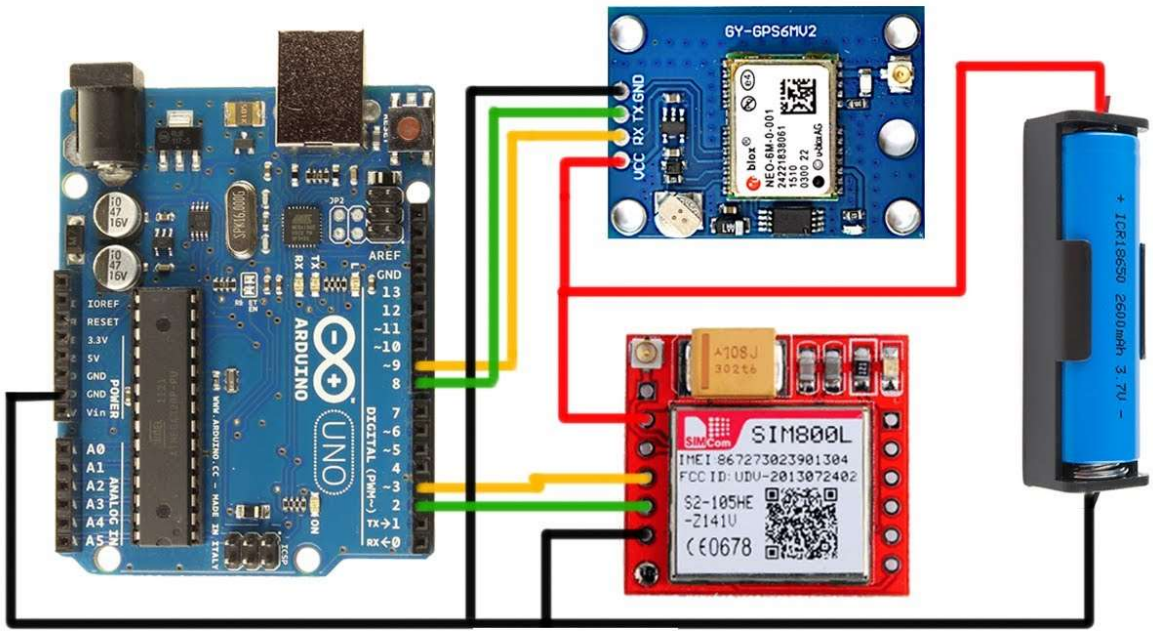


Fig 34: SIM800L interfacing with GPS module using Arduino UNO(PCB)

The circuit connection is given in figure 35.

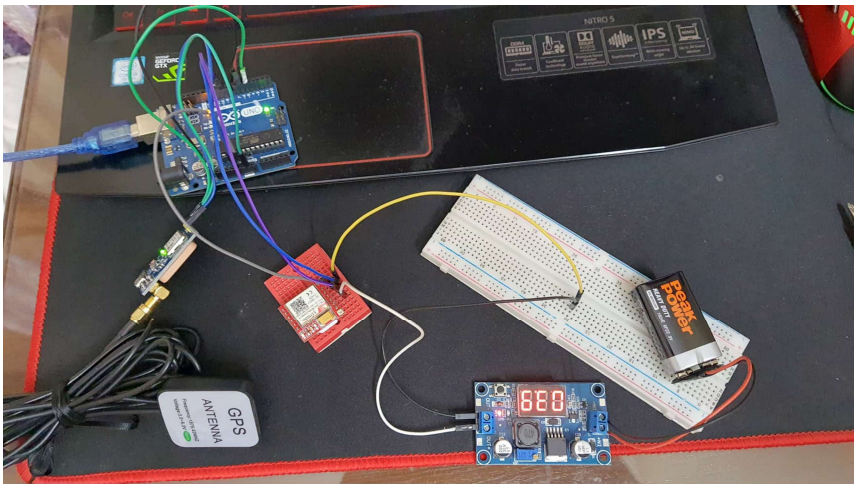


Fig 35: SIM800L interfacing with GPS module using Arduino UNO

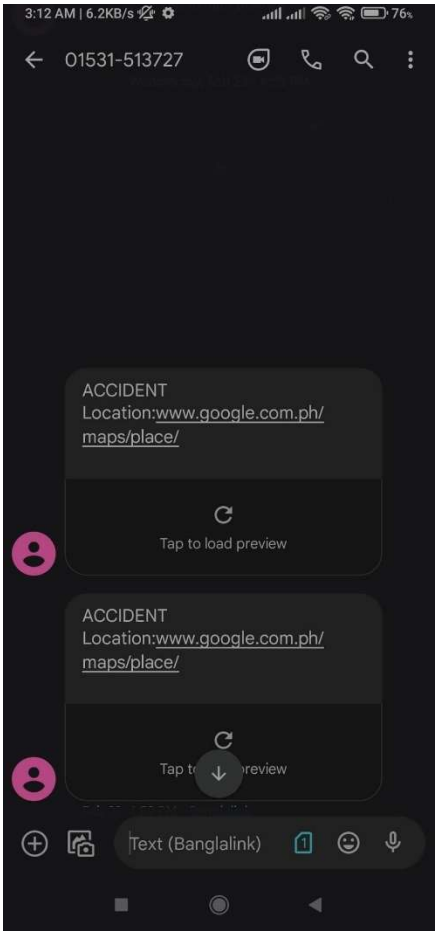


Fig 36: Received SMS after GPS and GSM interfacing

After testing the connections between the communication system and Bluetooth module we found some difficulties. Sending the information through Bluetooth needs much space and needs another microcontroller. That is why, we have decided to use NodeMCU instead of Arduino UNO as our microcontroller since it has built in Wi-Fi. It will help us to transmit data without using a Bluetooth module. Also, there are many other advantages of using NodeMCU instead of Arduino UNO as microcontroller. The boards based on the NodeMCU ESP8266 offer a low power consumption, a substantial memory capacity, and built-in Wi-Fi. Even though the Arduino has 19 GPIO pins, you will need internet to function on IoT. As a result, you'll need to connect an ESP8266(Wi-Fi shield) externally. The ESP8266 is at the core of NodeMCU, which also includes 13 GPIO pins. As a result, NodeMCU is best suited for IOT projects.

Table 9: Differences between NodeMCU and Arduino UNO

Specifications	**NodeMCU**	**Arduino Uno**
Power	3.3V	5V
Io Max	120mA	40mA
Frequency	80-160MHz	16MHz
Microcontroller	ESP8266	ATmega32
Flash Memory	Up to 4MB	32KB
SRAM	64KB SRAM/ 96KB DRAM	2KB
USB	No	Yes
GPIO	Up to 16	14
Analog I/O	1	6
Wifi	IEEE 802.11 b/g/n	No
PWM	9	6

As NodeMCU has only one analog input pin, we have to change our ADXL335 to ADXL345. Besides, ADXL345 consumes less power and gives more accurate data.

Table 10: Differences between ADXL345 and ADXL335

Parameters	**ADXL345**	**ADXL335**
Range	±16g	±3g
Interface	SPI, I^2C	Analog
Power	Low	Standard
Consumption	Typical: 140µ	Typical: 350µ
Pricing	Low	Lowest
Bonus Function	Some inbuilt functions	No bonus features

For monitoring riders' physiological condition, we have used 1.3-inch OLED display, ESP8266 D1 mini, a battery charger, 350mAh lithium polymer battery, I2C display. The primary problem we had to confront here was adjusting all of these components in such a short space. Furthermore, the battery we desired was modest in size, but we were forced to use it owing to limited resources. The heart rate sensor's SD and SC pins were declared with caution.

4.5 Conclusion

We tested each component of the system separately so that we could quickly identify and resolve any issues. The entire system has been separated into four segments. To summarize, the subsystems were implemented individually into different sections in order to share the effort. There were numerous challenges in each component to achieve the desired result, thus after a few attempts and analysis, it was eventually working as planned. Individual parts work in distinct subsystems, therefore the complete system can be said to be operating appropriately. The integration of all systems is completed in the next section.

Chapter 5: Completion of Final Design and Validation

5.1 Introduction

After the detailed comparison between the three designs, as mentioned earlier that we have decided that the most efficient in all way to detect an accident is through measuring the tilt angle of the rider. That is why, we have selected the tilt-angle based accident detection system as the optimum solution for the problem we mentioned. It has also been mentioned earlier that as soon as the accident is detected, our system will send an SMS to an emergency contact number containing a link which will provide real time location of the victim as well as the pulse rate and oxygen saturation of the victim.

Now to achieve this objective, firstly we divided the entire system into two sub-systems. One is the onboard circuit present in the helmet which will contain the circuit for detecting the accident as well as sending the SMS and acquiring the real time location of the rider. The second system is going to be in the hand of the rider shaped like a watch which will detect the pulse rate and oxygen saturation of the rider. Now the question arises that how we are going to merge these two systems into one and get all the data together required for further operation. For this reason, we have decided that both the systems will be connected with each other via WIFI where the onboard helmet circuit is going to act like a server and the pulse rate monitor is going to be a client. The pulse rate monitor is going to send the data to the onboard circuit though WIFI and it will do the rest of the operation by combining all the data.

5.2 Completion of final design

After a thorough analysis we came to a conclusion that for accident detection, in the onboard helmet circuit, NodeMCU (ESP 8266) microcontroller is going to be used since it has a built in WIFI module required for establishing wireless communication between the sub-systems. Then we are going to use an accelerometer named ADXL345 which can detect tilt angle in three different axes simultaneously. Next, comes the GSM module named SIM800L which will be used for sending the SMS and finally Ublox Neo-6M GPS Module has been used for acquiring the real time location of the rider. The onboard circuit is going to be powered by a 3.7V Li-ion 18650 battery of 2500mAh and for charging it we have used TP4056 1A Li-ion charging module.

Again, in the pulse rate and oxygen saturation monitor, firstly we have used D1 Mini Pro which is just a smaller version of NodeMCU and has built in WIFI module. Next, we have used MAX30100 pulse rate and $Sp0_2$ saturation sensor and a 1.3inch OLED display for showing the data. This part of the system is going to be powered by 3.7V 350mAh Li-po battery and for charging it we have again used TP4056 Li-po charging module. The two sub-systems are explained in the following.

5.2.1 Onboard circuit (Helmet)

As we have mentioned, the main objectives of the onboard circuit is to detect the accident as well as send a SMS to a emergency contact number containing the real time location and pulse rate and $Sp0_2$ saturation. A detailed diagram containing all the components and connections is given below.

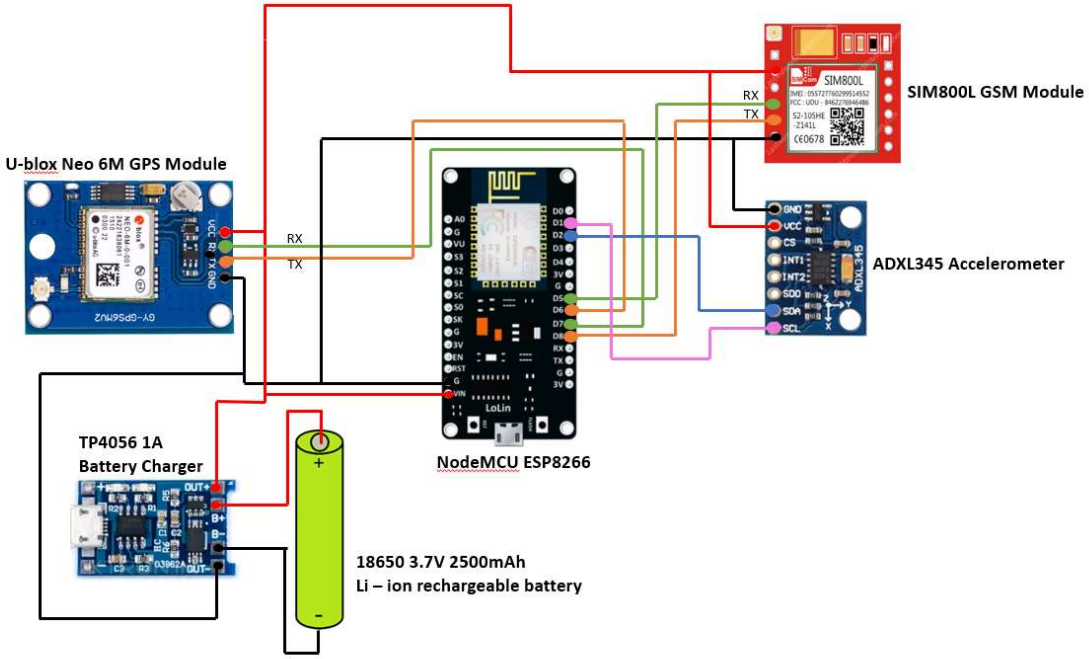


Fig 37: Connection Diagram of Onboard Helmet Circuit

i. NodeMCU (ESP8266)

One of the most important part of the onboard circuit is the microcontroller itself. In this particular sub-system, we have decided to use NodeMCU (ESP8266) as the microcontroller. The main reason behind selecting this one is because it has a built in WIFI module.

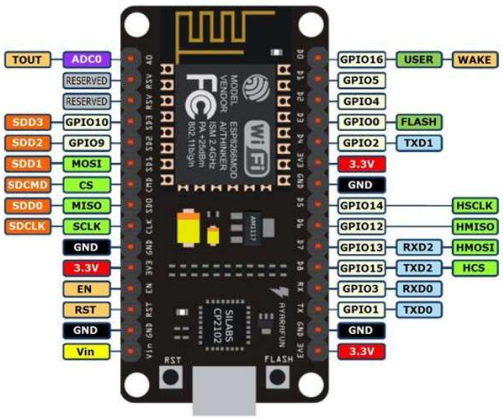


Fig 38: NodeMCU (ESP8266) pinouts

In the previous design, we have mentioned that we are going to use Arduino as the microcontroller, but now we think that will not be an efficient thing to do. The reason behind is that we at first wanted to use Bluetooth as the wireless connection medium between the two sub-systems. Again, we also have to ensure that we can change the emergency contact number through a mobile application from our cellphone. So here, we faced a problem that if the onboard circuit and the pulse rate monitor gets connected by Bluetooth, how we are going to connect it later with our cellphone. That is why, we came to a conclusion that it is not possible or not very efficient design. Then we found another idea that what if we remove the Bluetooth modules and add a WIFI modules instead. But in this case, what will happen is that we are just adding another new separate module which will have to be connected with Arduino which will increase more wires and again we will also have to ensure power supply for that module as well. This in our opinion was not an efficient design. That is why, we shifted to NodeMCU since it has a built in WIFI module. This will help us to reduce power consumption of the system, reduce number of wirings as well as it will help us make the circuit a bit smaller.

Accelerometer (ADXL345):

In our opinion, the perfect device to execute this operation in this design is the accelerometer, specifically we intend to use ADXL345 accelerometer sensor. An accelerometer is an electromechanical device that measures both static forces (such as gravity) and dynamic forces (such as motion or vibration) accelerations in three different axes simultaneously. It is built with piezoelectric quartz crystal and due to its special self-generating property, the crystal produces a voltage which is proportional to the accelerative force. Thus, the acceleration in the axes are found. In most cases as well as in this design, the forces due to gravity are being measured in Z – axis. The dynamic forces in our project is the motion of the object which will be measured in X and Y axes continuously. Thus, we will be able to obtain the g-force of the rider in three axes and use those values to finally calculate the tilt angle of the bike with respect to the surface of the road and thus detect the accident successfully.

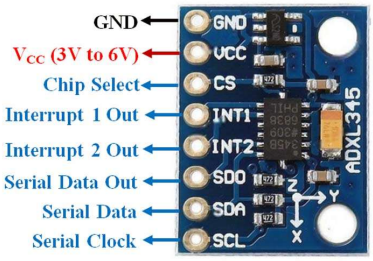


Fig 39: Accelerometer ADXL345 pinouts

Now, using the accelerometer ADXL345, we are going to see how we can find the tilt angle. If we want to implement this concept using the accelerometer, we will be able to see that, when the accelerometer is absolutely parallel with the ground and there is no roll, the angle between the Z – axis and the X – axis is 0. If we rotate the accelerometer in X – axis in clockwise direction, we can see that the

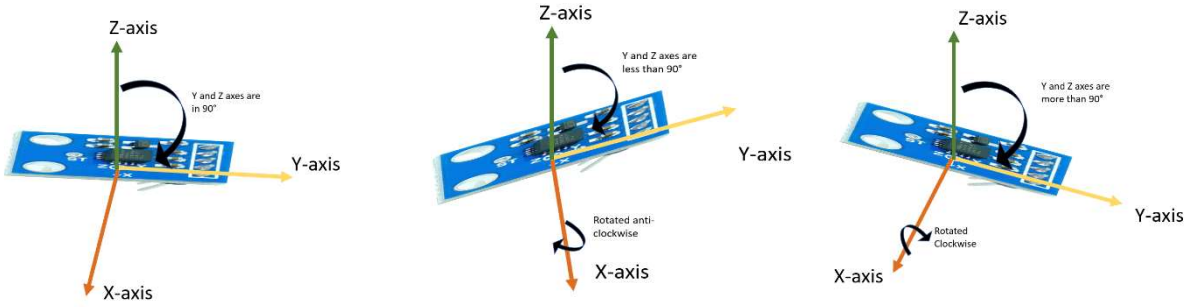


Fig 40: Different motion of accelerometer

angle between those two axes are increasing and if done in anti-clockwise direction, the angle will decrease. When the accelerometer is rotated in either x or y axis, it will start to give data from -200 to +200. This way, we are going to use the accelerometer to find the correct tilt angle of the biker. Finally, we will apply the threshold of the tilt ranges which we earlier have said dangerous in the code and thus this system will be able to determine the accident.

GSM Module (SIM800L):

In our design, what we tend to do after we have successfully detected the accident is to send a SMS to the emergency contact numbers. This particular process will here will be done by a GSM module. GSM stands for Global System for Mobile Communication. In this particular design, we have chosen the SIM800L for executing the communication process which is sending SMS to the emergency contact numbers.

Fig 41: GSM Module SIM800L pinouts

The **SIM800L** is a GSM module from "Simcom" that gives any microcontroller GSM functionality, meaning it can connect to the mobile network to receive calls and send and receive text messages, and also connect to the internet using GPRS, TCP, or IP. Another advantage is that the board makes use of existing mobile frequencies, which means it can be used anywhere in the world.

The reason behind choosing this exact model is that SIM800L is a very small (25*23 mm) and consumes very less amount of power. It works within a voltage level of 3.8V to 4.2V and an average current consumption is 350mA with a peak consumption of 2000mA. In conclusion, as this device is very small and lightweight but still very efficient in long range connectivity, that is why we are going to use SIM800L.

GPS Module (Ublox Neo-6M GPS Module):

It is previously mentioned in Chapter 2.3.

18650 3.7V Li-ion 2500 mAh rechargeable battery

One of the most crucial part in our project is to maintain a proper power supply to both the sub-systems. Since our system is going to be used outside, we needed a rechargeable power source which is reliable and efficient as well. For this reason, we have selected 18650 3.7V Li-ion 2500 mAh rechargeable battery.

Now the question arises is that why we have selected specifically 3.7V. If we look at Table 11, it shows us the input voltage requirement for all the components used in the onboard circuit.

Table 11: Voltage requirement of the components

Component	Input Voltage
NodeMCU (ESP8266)	3.3V
ADXL345	3.3V
Ublox Neo 6M GPS Module	2.7V – 3.6V
SIM800L GSM Module	3.4V – 4.4V

Here, we can see that, all of the components require an input voltage from a range of 3.3V to 4.4V. Here, another concern is, if we supply 3.7V to a component of 3.3V, is it going to damage the component or not. The answer is no. All the components present here has LDO or Low Dropout Regulator. What is does is reduce the input voltage to its favorable value and discharge the excess input voltage in the form of heat.

In our case, the LDO present in the NodeMCU, ADXL345 and Neo 6M GPS module will actually reduce the 3.7V delivered by the battery to 3.3V which is favorable for all of them. So, there is absolutely no chance of damaging the components. Again, the GSM module SIM800L actually works between 3.4V to 4.4V. So, supplying it with 3.7V which is in between its operating voltage is going to ensure proper operation of GSM module.

Final concern was for us is to ensure that the system works for a long time. If we look at the following Table 12, we get the idea of the current consumption of each of the components.

Table 12: Current consumption of the components

Component	Current Consumption
NodeMCU (ESP8266)	70 mA
ADXL345	0.15 mA
Ublox Neo 6M GPS Module	45 mA
SIM800L GSM Module	18 mA (standby)
Total	**133.15 mA**

Here, we can see that the total current consumption of all the components is 133.15 mA. The battery is of 2500mAh. If we calculate the hour by dividing the capacity of the battery by the total current consumption, we get (2500/133.15) hours = 18.78 hours. Here, it is really safe to say that 18.78 hours which is 18 hours and 48 minutes is a very long time and this is enough time if the rider of the bike decides to travel long distance without any way to recharge the battery.

TP4056 1A Li-ion battery charger:

The system we have developed is completely for external use only. A user will obviously have to charge the battery when necessary. That is why, for maintaining a continuous power supply, we have used TP4056 charging module, which not only recharge the battery but also provide us with a more stable DC power supply so that it does not fluctuate.

5.2.2 Pulse rate and $Sp0_2$ monitor:

Pulse rate and $Sp0_2$ monitor will be always present in the hand of the rider. The main function of this monitor is to continuously display the data of the rider in a 1.3inch display. The micro-controller in this monitor is D1 mini pro which is just smaller version of NodeMCU (ESP8266) with lesser number of pinouts but enough for the components present in the monitor. The pulse rate and $Sp0_2$ saturation is going to be acquired by the MAX30100 pulse rate and $Sp0_2$ saturation sensor and will be displayed in 1.3inch OLED display. The micro-controller D1 mini pro is going be act as a client and continuously send its data to the onboard helmet circuit. A detailed diagram containing all the components and connection is given below.

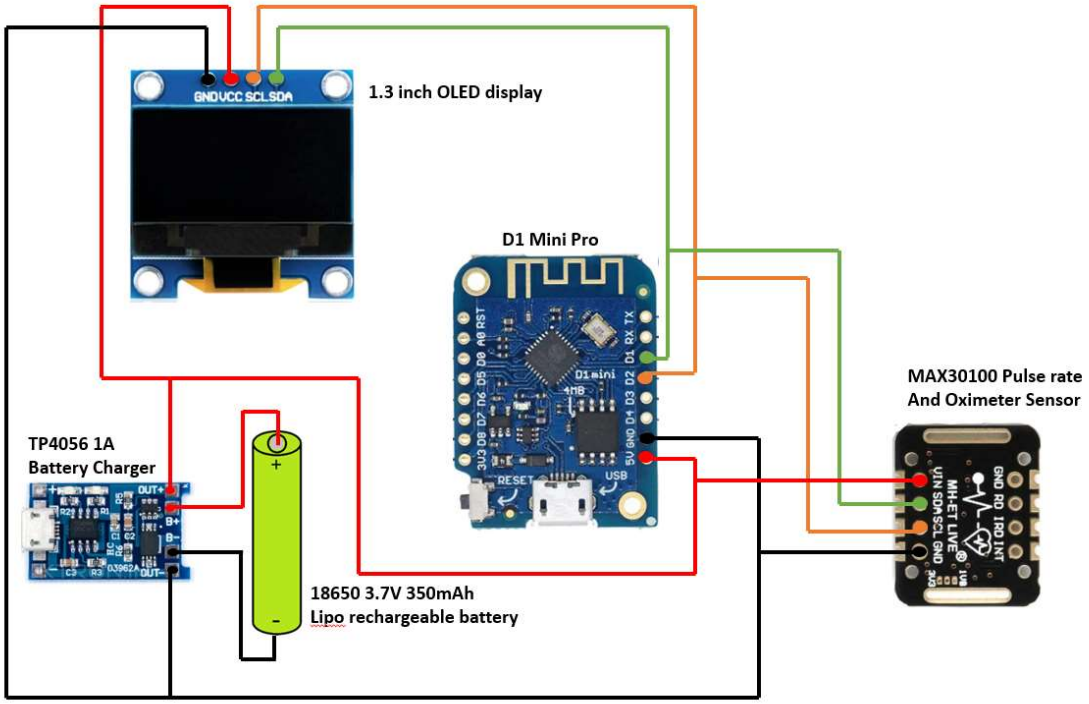


Fig 42: Connection Diagram of Physio Monitor

D1 Mini Pro:

D1 mini pro is just the small version of NodeMCU (ESP8266). The main reason behind using this particular component as micro-controller is because of its built-in WIFI which we are going to use for maintaining communication with the onboard circuit. The second reason is, we wanted to design the pulse rate monitor which can be wore in hand like a wrist watch. So, we needed something very small so that it could fit along with other components. The MAX30100 pulse rate and $Sp0_2$ saturation module and the 1.3inch OLED display follows I2C protocols, that is why they both are connected with the SDA and SCL pinouts which are required for I2C connections.

MAX30100 Pulse rate and $Sp0_2$ saturation sensor

This sensor detects pulse rate and $Sp0_2$ saturation through using IR. This sensor follows the I2C protocol, that means it will have SDA and SCL pins. A serial clock pin (SCL) that the micro-controller board pulses at a regular interval, and a serial data pin (SDA) over which data is sent between the two devices. By processing the IR values further, we get the pulse rate and $Sp0_2$ saturation and show it in the display and send it to the onboard circuit present in the helmet as well through WIFI.

5.2.3 Operation

i. Step 1: Accident Detection

The accident detection part of the system will be done by the accelerometer present in the onboard circuit in the helmet. As we mentioned earlier, that accelerometer can detect tilt angle in three axes. For detecting the accident, we only need the angular motion in x and y axis, that is the roll and pitch. After testing the accelerometer by putting it in a helmet and comparing it to the real life motion of a bike, we came to a conclusion that when the accelerometer reading goes below -200 and more than +200 in both x and y axis, it reaches such an angle with the ground, which is impossible for a bike to still have a grip on the road. The reading is continuously being sent to the NodeMCU and when the micro-controller gets the reading less than -200 or more than +200 for more than 5 seconds, it determines that an accident has happened.

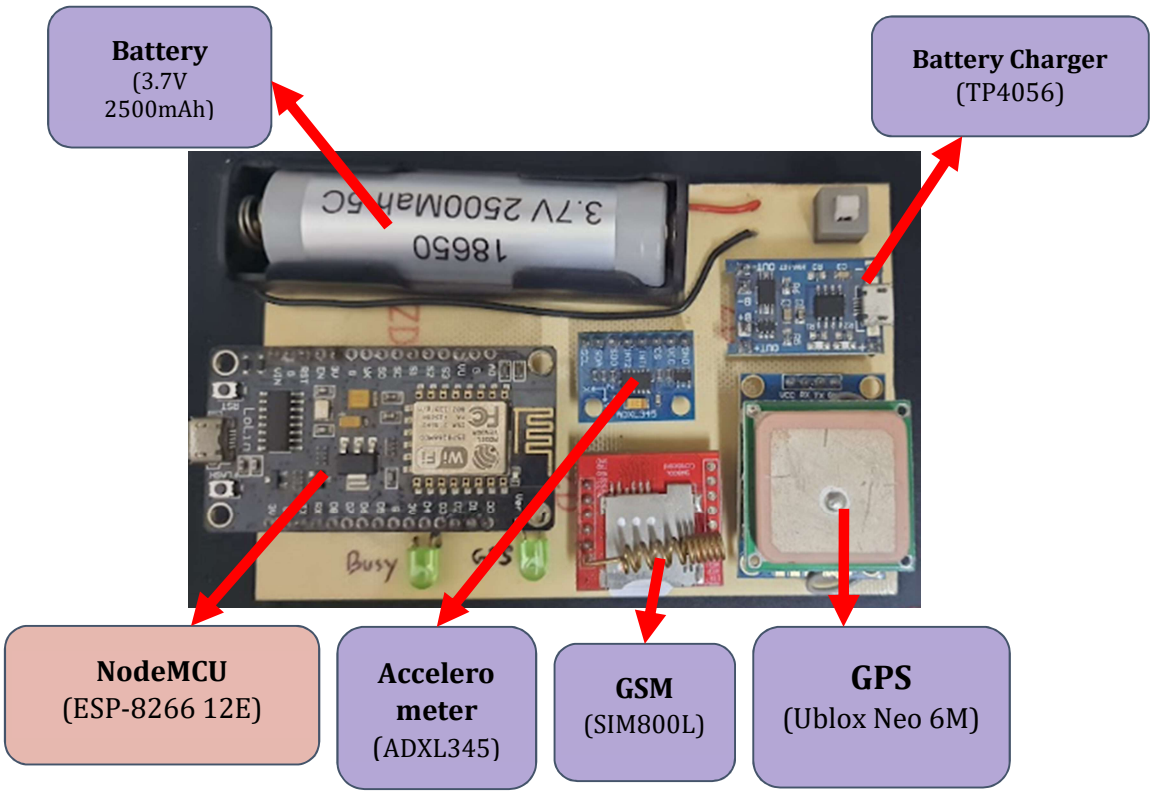


Fig 43: Real circuit of Onboard Helmet Circuit

ii. Step 2: Pulse rate and $Sp0_2$ saturation monitor

The pulse rate and $Sp0_2$ saturation monitor will run continuously which is present in the hand like a wrist watch. As the NodeMCU (ESP8266) in the helmet circuit and the D1 Mini Pro present in the Pulse rate and $Sp0_2$ saturation monitor both are wirelessly connected via WIFI, the Pulse rate and $Sp0_2$ saturation monitor is continuously going to transfer the physiological data to the helmet.

Fig 44: Physio Monitor

iii. Step 3: Sending SMS to the emergency contact numbers

As soon as the accident is detected, our next step is to send an SMS to the emergency contact number containing the real time location of the rider along with the pulse rate and $Sp0_2$ saturation data which continuously being transferred to the onboard circuit via WIFI. The message sending operation will be carried out by SIM800L.

When the micro-controller has decided that an accident has happened, it starts to configure the SIM800L for sending the SMS. The configuration of the SIM800L done through AT commands. AT commands synchronizes the baud rate with the micro-controller. Then for selecting the message sending option, we had to use the AT+CMFG command. After that, we get to put the phone number to which the message will be sent. The NodeMCU already has all the data from the accelerometer sensor, GPS location as well as the Pulse rate and $Sp0_2$ saturation

rate. After completing all the configurations of the GSM module, it finally sends the SMS about the condition of the rider to the emergency contact number.

5.3 Evaluate the solution to meet the desired need

We have mentioned that the main objective of our entire project is to detect an accident and send an SMS to the emergency contact number instantly which will contain the real time location and physiological activities data.

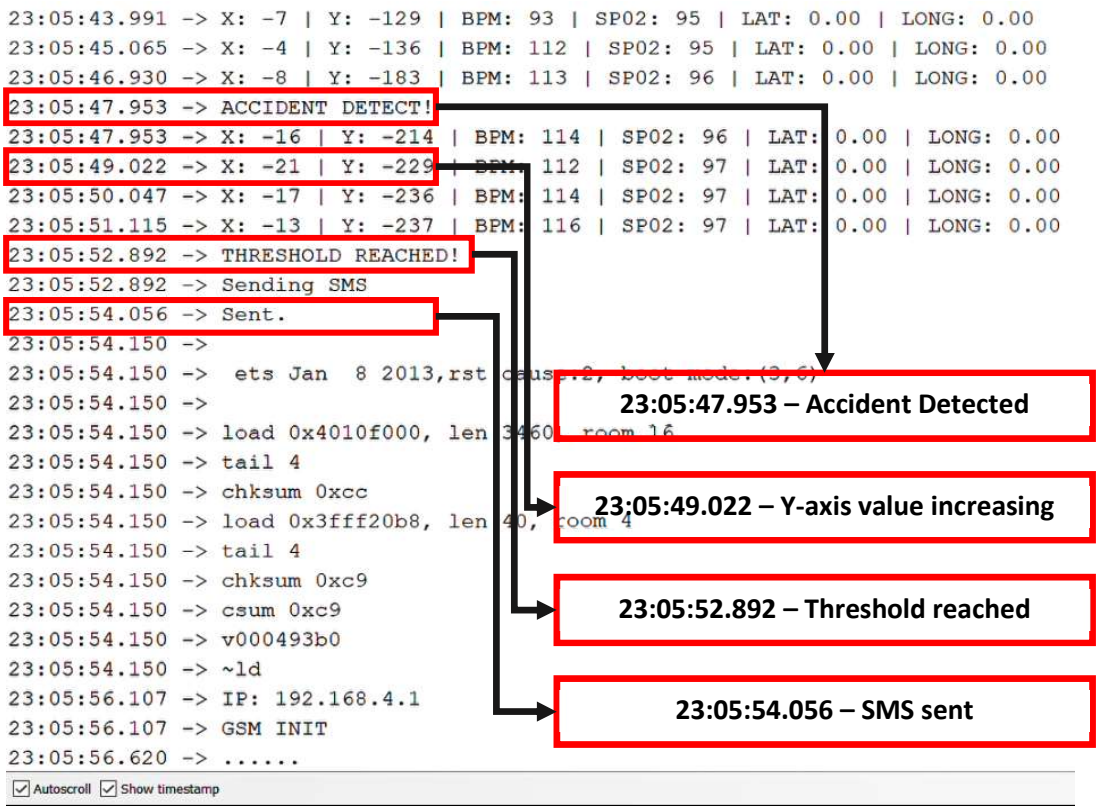


Fig 45: Time table and how the operation has been executed

The following picture shows all the data the entire system is providing. Here, we can see that it is showing the accelerometer data of both X and Y axis. We can see as we have moved the accelerometer towards x-axis, the data has continued to increase.

When the value of x-axis has climbed more than 200, our system has notified us about an accident has been detected at 13:57:02. But still it wouldn't send the SMS because we wanted it to check of the data still gives more than 200 after 5 seconds. As we can see,

the system still recorded the values of y-axis more than 200. For this reason, after 5 seconds at 23:05:52, the system has determined the Threshold has been reached, thus it will consider that an accident has happened. Then, we can also see the system has notified us that it is sending an SMS and also tells us when sending is completed.

Next to the values of accelerometer are the data provided by the pulse rate monitor. The system is continuously recording the data of pulse rate and $Sp0_2$ saturation. Along with it, we can also see the latitude and longitude values. The pulse rate and $Sp0_2$ saturation values will be sent with the SMS directly, but the latitude and longitude will be added with the Google maps link which will give us the real time location of the rider.

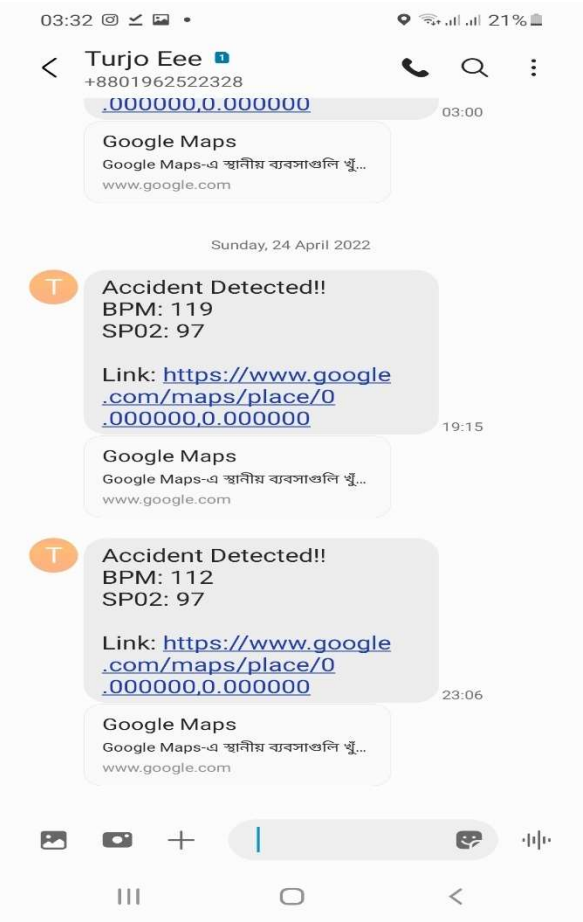


Fig 46: Sample of the message

Like we said, at 23:05:54, the system showed us that an accident has happened and an SMS has been sent. As we can see from the next picture is that we have received a SMS from the system in our phone exactly at 23:06:00.

5.4 Conclusion

From our point of view, we think we have successfully completed our objectives. There are to be honest some points that we failed to execute. One of them is that we said in last semester that we will send SMS to 5 emergency contact numbers. But in reality, we could only send SMS to one emergency contact number. This was not possible due to the component operating clock frequency, which is not enough to actually send SMS to five numbers simultaneously. A faster more powerful microcontroller might be able to do that in future.

Chapter 6: Impact Analysis and Project Sustainability.

6.1 Introduction

Children account for more than one out of every four deaths on the streets in rural and urban vulnerable families. Although the number of passes experienced by men was higher among the poor, there was no significant difference between poor and non-helpless men. If we can ensure the majority of people by adopting smart helmets in this instance, we would like to see a decrease in fatal occurrences. In fact, Bangladesh's street incidents kill roughly thousands of people every day. People between the ages of 15 and 44 bear a disproportionate share of the burden. Our smart helmet project could be extremely beneficial in resolving this pressing problem. Furthermore, high rate of fatal accidents in Bangladesh is a concerning issue, and time has proven to resist this multi-sectoral challenge. People must be required to wear helmets, and strict instructions must be issued. In this way, the legal implications of our smart helmet technology will be beneficial. Hence, Smart helmet wearing habits and experiences will be incredibly advantageous in the context of our country. Teenagers in our country's cultural setting, once they pass the age of 12, tend to make their own decisions, particularly in rural and metropolitan areas.

6.2 Assess the impact of the solution

- ✓ **Societal**

  The majority of those killed and truly harmed in recent years have been men, according to police and medical clinic data. Although the number of passes experienced by men was higher among the poor, there was no significant difference between poor and non-helpless men. While the elderly were the most common victims, children accounted for more than one out of every four deaths on the streets in both rural and urban vulnerable families. Despite the fact that impoverished people report more contributions from children as street accidents and are hurt as a result, there is no significant difference between poor people and non-helpless children. If we can ensure the majority of people by adopting smart helmets in this instance. Then, at the very least, we would like to see a decrease in these kind of fatal occurrences.

- ✓ **Health**

  In agricultural countries like Bangladesh, people between the ages of 15 and 44, particularly men, bear a disproportionate share of the burden of road accidents at various times. According to the Bangladesh Health Injury Survey (BHIS), street incidents kill roughly 23,166 people per day. Following a thorough investigation by Analysis BD during the previous ten years, it was discovered that

approximately 63,000 people died in traffic accidents. According to these findings, approximately 3,132 people died in street crashes in 2018 [9]. While fewer families have negative consequences after a true injury, the majority of helpless families report a decrease in pay, food consumption, and expectations for everyday amenities, with the country's helpless suffering the most. One of the worries is that in the majority of cases, the family's breadwinner is wounded. Our smart helmet project, along with its health monitoring system, could be extremely beneficial in resolving this pressing problem.

- ✓ **Legal**

  The high rate of fatal accidents in Bangladesh is a concerning issue, and time has proven to resist this multi-sectoral challenge. Allowing citizens of an agrarian country like Bangladesh to die in street car accidents is not only startling, but also improper. The government has made numerous advancements in the development of street well-being. Despite this, just a few significant findings have been achieved to date. Examine the activities taken to identify execution faults and enhance or alter them to make them more attractive. The Bangladesh Road Transport Authority (BRTA), one of the government bodies that has filed a large number of road accident cases, should work together to prevent accidents [10]. People must be required to wear helmets, and strict instructions must be issued. In this way, the legal implications of our smart helmet technology will be beneficial.

- ✓ **Cultural**

  Teenagers in our country's cultural setting, once they pass the age of 12, tend to make their own decisions, particularly in rural and metropolitan areas. Proper methods and information should be instilled in them so that they strictly adhere to and do not deviate from the rules of government administration. As a result, smart helmet wearing habits and experiences will be incredibly advantageous in the context of our country.

6.3 Evaluate the sustainability

We anticipate that our project will be long-term sustainable if we are able to minimize all potential environmental concerns. With the framework and prototype that we developed, we are confident that our project will run smoothly for a long time without causing any environmental damage. Furthermore, our project is primarily hardware-based, with only limited software programming. As a result, there is no risk of contamination, no carbon emissions, and no waste as a result of effective completion of our project. As a result, we believe that our proposed project, with its low environmental effect and long-term viability, will be able to last for a long time while delivering the best possible results while gradually reducing health concerns.

Table 13: SWOT Analysis

Strengths	Weaknesses
• Rapid transfer of the information • Ability of the rescue services and drivers respond rapidly to the undesirable situation. • Communication with the rider and persons around. • Tracing rider's location along with physiological data	• Obsolete system that does not allow connections to GSM emergency services. • At low speeds, where the system struggles to consistently determine whether the user is in the vehicle, there is a risk of misleading accident reporting.
Opportunities	**Threats**
• Increase of safety, security and decrease of road mashups.	• Occurring accident in a remote area with less network connectivity.

6.4 Conclusion

As mentioned in previous chapters, assessing the implications of each solution's predicted outcome is crucial. The expected consequences of the problem, as well as assessing the consequences after our accident detection system's final proposed solution, are rather basic and straightforward. It would rather eliminate the dangers of death and aid in long-term survival.

Chapter 7: Engineering Project Management.

7.1 Introduction

Engineering project management is an aspect of project management that is entirely focused on engineering projects. It follows the same methodologies and processes as other forms of project management. Project management for engineers entails meticulous preparation and communication of that strategy to a team of engineers. It includes determining project objectives and milestones, as well as creating multiple scenarios and contingency plans. It's an important phase for any engineering team since the unexpected can disrupt the efforts of dozens, if not hundreds, of individuals.

7.2 Define, plan and manage engineering project

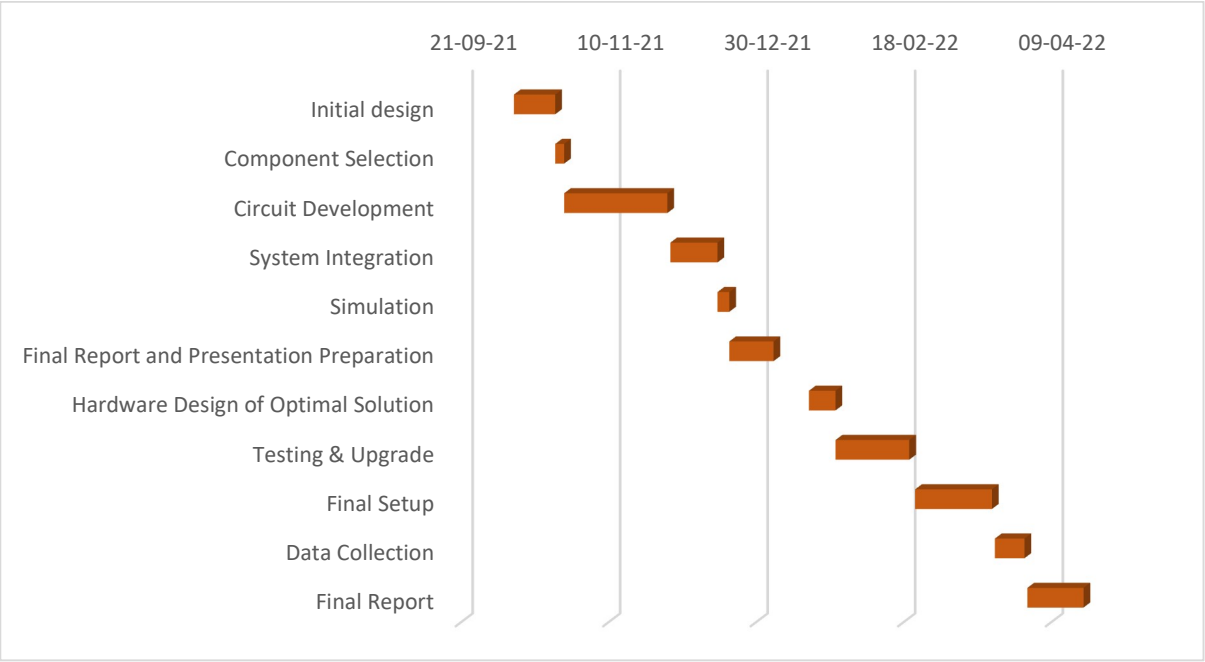
Management is the process of identifying problems and demands, as well as directing the allocation of resources, costs, time, scope, and quality whereas project management is the use of procedures, methods, expertise, knowledge, and experience to meet specified project goals while staying within agreed-upon parameters, as defined by the project acceptance criteria. Final deliverables for project management are bound by a finite schedule and budget. It is vital to learn project engineering in order to:

- Examine the most recent project management principles and approaches.
- Increasing the organization's value/contribution
- Increasing the organization's value/contribution Demonstrate project management expertise.
- Acquire a new cognitive process that aids in ordered thinking and a structured approach.
- Obtaining a professional degree/recognition in order to improve career opportunities.
- Numerous advantages and opportunities.

Project planning enables the execution stage structure and foresight, allowing inefficient activities and patterns to be avoided. Planning is the key to a successful project. The Project Management Plan incorporates all of the comprehensive planning work for all parts of the project into one uniform system. To plan a successful project, we need to have a specific purpose, a well-coordinated team, adequate resources, and adequate time. Without any of these, we will be unable to develop a successful project and meet the essential objectives and standards.

In terms of the project timetable, we attempted to stick to the previously established schedule. Initially, we developed and designed a project plan for the completion of FYDP(D). Prior to the start of FYDP-(D), we planned, scheduled, and assigned a precise

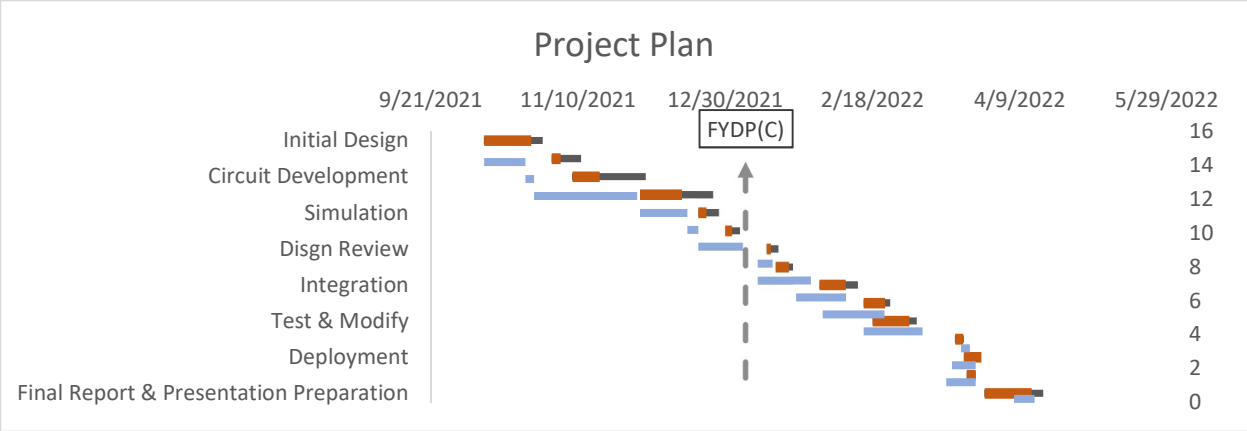
time to each activity. However, towards the conclusion of the semester, each task had taken a different amount of time to complete.



Graph 2: Project Plan during FYDP(D)

7.3 Evaluate project progress

When it comes to successfully implementing a project, project management is a must. A progress is observed in order to keep a consistent outcome by accomplishing any work. All tasks are assigned in a systematic manner. Initially, a plan was devised based on estimates, however things did not go as planned due to component testing concerns. As a result, a new revised strategy with a new timeline has been created. This, presumably, will result in accurate project progress. Furthermore, each member has been assigned duty in order to split the labor. Furthermore, because risk is an unpredictable situation, a backup plan is required to manage resources. During the implementation of our project, we encountered some component damage and troubleshooting. As a result, steps were taken in order to continue operating properly.



Graph 3: Project Plan during FYDP(C)

The goal of project risk management is to identify, analyze, and respond to project hazards. It consists of the following elements:

- Risk Management Plan
- Acknowledging dangers
- Conduct a qualitative risk assessment
- Conduct a quantitative evaluation
- Make a systematic process.
- Keep a track on and manage risks

Risk management is an essential strategy in program, system, and project management. It comprises identifying and categorizing risks, as well as assessing the risks' chance of occurrence and consequences, risk mitigation strategies, risk status tracking and reporting, and risk action plans to ensure that unacceptable risks do not arise or are minimized. System safety engineering and other significant technological disciplines perform these types of risk management responsibilities. Furthermore, in project management, a contingency plan is a stated, actionable plan that will be implemented if a recognized risk materializes. It's essentially a "Plan B" that's put in place when things don't go as planned. As a result, we've devised a contingency plan for any complications that may arise during the course of our project.

Risk Management Matrix:

Table 14: Risk Management Matrix

Associated Risks	Feedback	Contingency Plan	Timeline	Who is Responsible?
Product Unavailability	Contact with more than one seller	Find alternative components	Within 7-10 days	Md. Rakib Al-Amin
Defective Component	Choose a reliable vendor who offers a replacement.	Buy equipment from different seller	Within 2-3 days	S.M. Kayser Mehbub Siam
Problem Identification	Evaluate the model to identify the issue.	Stop the system and test components separately	As soon as possible after the problem being identified	Tamim Hasan Turjo
Abnormal Reading	Use different component of same model	Change the specific component	As soon as possible	Khadiza Islam Sumaiya
System Failure	Evaluate the model to identify the issue.	If needed, double-check the connections and restart the system.	Within a week	S.M. Kayser Mehbub Siam
Application Failure	Update or upgrade the application or else recovery the detected issue.	Recovery the problem as soon as possible and program the application	7-14 days	Khadiza Islam Sumaiya

7.4 Conclusion

Project management assists in defining what activities will be completed, who will be active in accomplishing the tasks, and when the tasks should begin and end. Projects usually develop in phases or incremental stages, although other methods for quick, participatory project management are also popular. To summarize, project management is critical to the success of every project. It aids in the organization of the strategy and the achievement of goals. While demonstrating that the estimated plan caused problems, a new organized plan was executed. Another key aspect of project management is risk management, which demonstrates a backup plan for effective management. Improvising is sometimes important to arrive at a swift answer in a short amount of time.

Chapter 8: Economical Analysis

8.1 Introduction

Economic analysis is essentially the assessment of costs and benefits. It focuses on the assessment of the welfare impact of a project. The main target of the analysis is to know how the project is performing. It also indicates proper use of the components in the right way. One of the purposes of the project is to generate profit. Therefore, economic analysis mostly focuses on how much profit it generates and confirms the best way of utilizing the resources.

8.2 Economic analysis

Economic analysis is a process of assisting in the better allocation of resources. It provides an accurate idea of how the business will be conducted. An economic analysis purpose for business is to present a clear picture of the current economic condition. It also provides an idea of how much people can afford the helmet and how much will come from it. Our smart helmet project will be used by the bikers for their safety purposes. So, if the product reaches the customers at a reasonable price then everyone can easily buy it. Therefore, to establish this system required good resource management. This enables an effective method to reach our desired goal. After purchasing the product customer support will be needed for a better experience. So, customer care needs to be established to provide maximum support. To attract the customer, it is required to make variations and create a new design of the helmet. Furthermore, if it is possible to change the graphic according to age, then a huge quantity of product will be sold. In this way the economic goal will be obtained.

8.3 Cost benefit analysis

A project's feasibility can be verified through a cost-benefit analysis, resulting in a picture of the organization's present, future, and potential risks. The chosen design has specific strengths and weaknesses in terms of performance and management that are relevant to this project. It is important to remember that each component has its own strengths and weaknesses. Customer’s satisfaction, competition, and organizational strategies all have a significant impact on an organization's success. Initially it costs Tk. 4200 taka to create this project but it is possible to reduce this cost to Tk. 3000. The operating cost of our product is very low. This means if it is fully charged for one time it

will run on the same charge for at least 20 days. So, the battery charging cost is very small and the customers do not need to charge repeatedly. So, if the customer spends this money than they are getting many safety features which will give them more confidence in riding their motorcycle. The number of vehicles is much more than the road capacity of Bangladesh. So, everyone is choosing small vehicles for easy movement. Since people use bikes to reduce the cost of travel, the project has been completed at a reasonable price keeping in mind their needs. So, any motorcycle rider can easily purchase it and use it for extra safety purposes. The components which are used to build the project are very suitable for long-term support. So, the customer does not have to worry about maintenance. So, it can be said that the cost benefit of the product is very reliable.

8.4 Evaluate economic and financial aspects.

Our project is performing according to our expectations. We want to make this product more available. For this we need a good amount of funds. If our government or any authority comes to us for this project, it will be really helpful to reach our goal. We want to reduce the manufacturing cost by purchasing the components directly from the dealer. With the increase in accidents, people are being concerned about safety. So, the demand for this project will increase day by day. If the earnable member of the family dies or becomes crippled due to lack of immediate medical treatment, then the economic condition of the whole family collapses. Since the system provides information about accidents to the selected numbers, everyone will be more interested in using it if it is readily available. Next, we will aim to design and build the components according to our own requirements. As a result, the overall cost of the project will be further reduced. In addition, collaborating with a helmet company will increase the availability of the project. Proper service and discounts can be arranged to achieve complete customer satisfaction.

Current budget of the product

Table 15: Current budget of the product

SL No	Components	Quantity	Price
1	NodeMCU (ESP 8266)	1	580
2	ADXL345	1	480
3	SIM800L GSM Module	1	450
4	Ublox Neo 6M GPS Module	1	845
5	TP4056 Charging Module	2	60
6	18650 3.7V 2500 mAh Li-ion battery	1	55
7	MAX30100 Sensor	1	350
8	1.3inch OLED display	1	550
9	D1 Mini Pro	1	440
10	3.7V 350 mAh Li-po battery	1	390
	Total		**4,200**

To achieve the desired goal of our targeted budget

Table 16: Desired goal of our targeted budget

SL No.	Components	Quantity	Price
1	NodeMCU (ESP8266)	1	420
2	ADXL345	1	340
3	SIM800L GSM Module	1	300
4	Ublox Neo 6M GPS Module	1	700
5	TP4056 Charging Module	2	50

6	18650 3.7V 2500 mAh Li-ion battery	1	40
7	MAX30100 Sensor	1	280
8	1.3inch OLED display	1	450
9	D1 Mini Pro	1	280
10	3.7V 350 mAh Li-po battery	1	270
	Total		**3,130**

8.5 Conclusion

In this chapter, the economic analysis is what we have emphasized on. Since, economic analysis is concerned with determining a project's welfare impact. The analysis' primary goal is to determine how well the project is performing. It also denotes the correct use of the components. Profit generation is one of the project's objectives, and economic analysis primarily focuses on the amount of profit it makes. Furthermore, the system distributes accident information to specific phone numbers, everyone will be more inclined to use it if it is readily available. If a family member who earns a living, dies or becomes disabled owing to a lack of timely medical treatment, the entire family's financial situation collapses. Moreover, a cost-benefit analysis can be used to confirm the feasibility of a project. The chosen design has certain performance and management strengths and limitations. Thus, it's crucial to keep in mind that each component has its own set of advantages and advantages.

Chapter 9: Ethics and Professional Responsibilities

9.1 Introduction

"Norms for conduct that distinguish between acceptable and unacceptable behavior" is the most popular definition of ethics [11]. Researchers have certain obligations regarding the Status of Personnel Involved in Research and Development which include the following:

- To uphold intellectual property rights and confidentiality agreements reached with research colleagues and funders;
- In order to avoid creating a conflict of interest or unfair competition by working multiple jobs;
- To further scientific, technological, or innovative activities without infringing on human rights or restricting freedom. To adhere to the research-development activity's ethics and deontology;
- To adhere to the research-development activity's ethics and deontology

In every research and project, it is essential to ensure professional responsibilities and ways to adhere that to maintain ethical ways to the solution of our proposed project. These responsibilities are founded on moral principles and processes outlined in the Research and Development Personnel Code of Ethics and Professional Deontology [12].

The correct behavior in research and development, according to the law, excludes:

- Obfuscation of results; obfuscation of results; obfuscation of results
- Substituting fictional data for the outcomes;
- Plagiarism of the results or other authors' publications; purposeful misleading interpretation of the data and conclusions;
- Purposeful distortion of other authors' results; erroneous attribution of a paper's paternity;
- False information is included into grant applications, and conflicts of interest are hidden.
- Embezzlement of research funds; inadequate data storage and retention;
- lack of information on wage wrights, responsibility, co-authors, intellectual wrights on research outcomes, funding sources, and associations among research team members prior to project start-up;
- The recurrent publication or funding of the same results as scientific news; a lack of objectivity in evaluation and non-observance of confidentiality rules.

9.2 Identify ethical issues and professional responsibility

The following are the primary ethical problems that may be addressed in our project management

are [13]:

- **Scientific fraud**: is defined as the intentional fabrication, falsification, plagiarism, or unlawful alienation of scientific research.
- **Data fabrication:** data registration and presentation based on the imagination rather than scientific methodologies;
- **Falsification:** misrepresent research materials, equipment, processes, or outcomes; omission of data or results of any type to misinterpret study results;
- **Plagiarism:** appropriation of another person's ideas, methods, procedures, technologies, findings, and papers, regardless of how they were gained, and presenting them as personal creation;
- **Conflict of interests**: a state of incompatibility in which a person's personal interests influence the impartiality and objectivity of their efforts in research and development evaluation, monitoring, implementation, and reporting.

Furthermore, in any project method, the project manager must present all necessary information to the research team prior to the commencement of the project.

The system's primary goal is to detect accidents.

Phase 1: The determination of the existing research in the subject, the analyzing of information on the potential for accident detection, and the progression of demands.

Phase 2: The selection of the concept, the design, the fabrication of the prototype, the integration of the system, the implementation, and the portable system testing, as well as the analysis and multi-criteria evaluation of the suggested alternatives.

Phase 3: In writing final report for the proposed system

Table 17: The determination of the existing research in the subject, the analyzing of information on the potential for accident detection, and the progression of demands.

No.	Activity	Ethical Issues
1.	Identification of the requirements and limits of the actual stage in the field of the research	❖ Plagiarism in the results or publications by other writers ❖ Unfair attribution of a paper's paternity. ❖ Deliberately erroneous interpretation of the results of other authors. ❖ Authorship or information source misrepresentation
2.	Limits and methods for optimizing sub system for use in accident detection have been identified.	❖ Objectivity in evaluation and non-compliance with confidentiality requirements ❖ Uncertain limits discussed and underlined in relation to the actual stage of study ❖ Information selection that leads to a faulty foundation for subsequent investigation.

Table 18: The selection of the concept, the design, the fabrication of the prototype, the integration of the system, the implementation, and the portable system testing, as well as the analysis and multi-criteria evaluation of the suggested alternatives.

No.	Activity	Ethical Issues
3.	Selection and validation of the conceptual solution of the accident detection system.	❖ Plagiarism in the findings or in the works of other authors. ❖ Unwanted outcomes are hidden or eliminated due to a lack of objectivity in evaluation and non-observance of confidentiality conditions. ❖ Fabrication of results is a term used to describe the process of fabricating results. ❖ Using fictional data to replace the outcomes

		❖ Deliberately distorted results and conclusion deformation, as well as deliberatively distorted results from other writers.
4.	The structural design of the proposed solution.	❖ Deliberately skewed unfair attribution of a paper's paternity ❖ Deliberately distorted interpretation of the research and conclusions distortion due to numerical simulation and erroneous portrayal of benefits ❖ Lack of objectivity in evaluation and non-compliance with confidentiality standards, resulting in the concealment or elimination of undesirable outcomes ❖ Falsification of data ❖ Inserting false data into the results
5.	Realization, implementation, and experimental testing of physical prototypes.	❖ *In acquisition:* ➢ concealing potential conflicts of interest ➢ misappropriation of research funds ❖ *In the works:* ➢ misrepresenting authorship in technologies ❖ *In evaluating:* ➢ Unwanted results are hidden or eliminated during testing. ➢ Fabrication of outcomes. ➢ Falsification of data. ➢ Inadequate data storage and retrieval. ➢ Inserting bogus data into the results. ➢ Intentionally skewed view of findings and conclusions deformation. ❖ *In implementation:*

		➢ When it comes to implementation, the unwanted results should be hidden or eliminated. ➢ Results fabrication ➢ Fake data for the diagrams obtained.
6.	Recommendations for disseminating and putting the findings to use	❖ Eliminating or reducing undesirable outcomes ❖ Results fabrication ❖ Using fictitious data to replace the results

Table 19: In writing final report for the proposed system.

No	Activity	Ethical Issues
1.	References and proper citation	❖ Plagiarism in the findings or in the works of other authors ❖ Misrepresenting authorship.

9.3 Apply ethical issues and professional responsibility

Throughout various phases regarding the development of the project we have always tried to follow ethical principles, norms etc. in leading and building up a project.

In addition to other things, an ethical case might take the form of an explanation, image, or sensible on a thing or group name, in item constructing, promoting, or standing. To have a wise thinking about the project and obtain information about various sections, we needed to read a variety of publications and papers. We have also provided suitable citations and references to any assertion or anything from these articles that we have used in our project. When it comes to commercial helmet manufacture, there are a few things to keep in mind. When purchasing materials from any organization, a commercial agreement must be created to ensure that the project is unique in comparison to others.

The ethical issues and professional responsibilities that we have applied in leading to our project completion in different phases throughout our entire FYDP period are:

- ✓ *In determining the existing research in the subject and the analyzing of information*
- ✓ *System design and working prototype*
- ✓ *Report Writing*

- **In determining the existing research in the subject and the analyzing of information**

  In our initial stage of proposing this project, we first considered the needs of the system in the current phase. In any research as a team, voluntary participation is essential. No one should ever feel compelled to participate in a research study. Any sort of persuasion or deception used to acquire someone's trust falls under this category. Individuals must offer their explicit approval to engage in a study using informed consent. A consent form can be thought of as a trust pact between the researcher and the subjects. And so, this is the reason we four group members worked constantly hard for the demands needed. We ensured every bit of help for each other when needed the most.

- **System design and working prototype**

  After FYDP development phase and stepping into the final semester we divided our work among ourselves. Our accident detection system comprises of sub-system that includes: Communication system interfacing, location tracing and monitoring the health situation of the rider. In first phase of the semester we constantly made ourselves engaged in the making the working prototype of the system and giving its final shape. We searched for the possible ways to made it possible and ensure that it no point it is plagiarized, fabricated and disrespect other author's works. We made it possible by all our integrity, hard work, voluntary participation and sheering determination.

- **Report Writing**

  In the last phase of FYDP and still now we are focusing in report writing. We are following the guidelines and sample given to us by our faculty advisors. We are following the right process in this manner. At no point it should violate the ethical principles of the provided guidelines.

9.4 Conclusion

The chapter emphasizes the complexities of the ethical problems that the project members must consider when leading a project. The ethical research standards are not only an issue of morality for each researcher, but they are also a matter of obligation the respect for human dignity, the value of a project, the precaution against hazards that may influence safety, health, and social welfare, and justice are the four primary principles that underpin any research effort. The ethical norms could be observed in the studied project if the project members and researchers:

- ✓ Are dedicated to their job.
- ✓ Consistently upgrade their expertise.
- ✓ Have the bravery to express themselves and reciprocal respect.
- ✓ Work as a team.
- ✓ Do research with accountability and honesty toward the institution, client, and financer.

Professional responsibilities against ethical principles and issues, such as altruism, recognition, financial advantages, peer review, institutional evaluation, and financer evaluation, are required in any project and so our proposed project is also not indifferent. To ensure ethical and professional responsibilities we have research and analyzed how could we implement and maintain those in our project. And so, we tried every bit to ensure by working as a team, dedicated to our work, integrity and sheer determination in making our proposed project successful.

Chapter 10: Conclusion and Future Work

10.1 Conclusion

The system is solving one of the problems of the present time. The proposed system immediately sends SMS to the selected number with exact location and Physiological data to avoid mortality. It helps to provide proper facilities and Minimize the overall design of the helmet and place it neatly on the helmet to the victim of the accident. To complete the system, we made three multiple designs and found the optimum one which can fulfill all the requirements, objectives and specific conditions. The project budget has been rationalized with the general people and ideas have been provided on how to further reduce the cost of the project in the future. However, as of now systems that are available in the automobile market are designed only for accident detection but this system also provides physiological data through SMS. So, it will be more effective for the victims after an accident. Moreover, bikers will get more confidence while riding the motorcycle. As a future scope we can develop the system to run for enforced agencies such as; Police, Highway police etc. to run fast when this sort of fatal accident occurs.

10.2 Future Work

There are many things already considered for the project. As there is no limit for improving the system, we need to work on some part for future improvement. So, some future works are given:

1. **Overall Design:** Minimize the overall design of the helmet and place it on the helmet in a better way.
2. **Customer Care Service:** Gaining customer satisfaction by increasing customer care service to solve any kind of problem very quickly.
3. **Charging System:** Adding fast charging technology which will charge the battery within a few minutes and save valuable time for the customer.
4. **Battery Efficiency:** Increasing battery performance by optimizing the overall system.
5. **Build Quality:** To make the overall build quality stronger by using better materials.
6. **Adding New Features:** To enhance the features by adding different types of sensors.
7. **Camera:** We can add a camera which will serve as a black box like an airplane. It will capture the live event of the accident. So, the reason behind the accident can be found easily.

Chapter 11: Identification of Complex Engineering Problems and Activities

11.1 Attributes of Complex Engineering Problems (EP)

Table 20: Attributes of Complex Engineering Problems

	Attributes	Put tick (√) as appropriate
P1	Depth of knowledge required	✓
P2	Range of conflicting requirements	✓
P3	Depth of analysis required	✓
P4	Familiarity of issues	✓
P5	Extent of applicable codes	✓
P6	Extent of stakeholder involvement and needs	✓
P7	Interdependence	✓

11.2 Provide reasoning how the project address selected attribute (EP)

Depth of knowledge:
In this project we gone through in-depth knowledge from online search, reading published papers related to our topic. The project has been designed using information from the mentioned resources and our academic knowledge.

Range of conflicting:

We went through a series of tests to identify the best design. There was a trade-off between complex design and maintenance for some designs. It was clear that certain designs had great promise, but at a considerable expense. Additionally, several designs had issues to fulfill our desired objective.

Depth of analysis:

In order to come up with the best possible design, we conducted a thorough evaluation of factors such as cost, user convenience, maintenance, efficiency, sustainability, and associated risks. That was our main concern for a design that would serve our needs.

Familiarity of issues:
The demand for bikes in Bangladesh is constantly increasing and the number of deaths in bike accidents is also much higher. However, such a system like our project is not used. After introducing the ride sharing system the rate of increasing bikes is beyond the capacity of the road. Especially in the city's area, bike accidents rise rapidly and the delays of getting emergency treatment are likely to increase the damage several times over.

Extent of applicable codes:

All of the relevant codes for certain components and services have been gathered together in order to complete this design in a logical manner. We are following all of their instructions and gathered them up. Some apps have also been used to meet our specific requirements.

Extent of stakeholder involvement and needs:
Project stakeholder is a group of people who are responsible for the project's outcome. The title of our project is "Smart system for accident detection and notification along with physiological data". Our system is suitable for both urban and rural people. In many cases, people do not want to help the accident victim. In that case, if the information about the accident reaches a known person very quickly, that person can take immediate action. Since the project applies to everyone, we have many stakeholders.
Basically, there are two types of stakeholder.

1. Internal stakeholder.
2. External stakeholder.

Internal stakeholder:
Internal stakeholders are the main people of the project. For our project the faculty members and group members are playing that role.

External stakeholder:
An external stakeholder is a person or organization that is not performing to the company directly but somehow they affected the business by their actions. For our project customers, suppliers and investors are performing as an external stakeholder. The roles

of stakeholders are critical to any project success. That's why all of the group members need to be more careful about every action. Some steps need to be followed,

1. Putting the stakeholder at the top of the list.
2. A clear understanding of the parties' respective responsibilities.
3. Effective communication with stakeholders.
4. Understanding the role of every person.

So, it is very important to have a good relationship with the stakeholders to get maximum outcome from the project.

Interdependence:

We have two subsystems in our project. Every subsystem performs individually. Then a combined data has been sent to the selected number.

1. Accident detection system.
2. Smart watch.

Accident detection system detects the accident and the smartwatch sends some physiological data. So, one subsystem is interdependent with another.

11.3 Identify the attribute of complex engineering activities (EA)

Table 21: Attributes of Complex Engineering Activities (EA)

	Attributes	**Put tick (√) as appropriate**
A1	Range of resource	✓
A2	Level of interaction	✓
A3	Innovation	✓
A4	Consequences for society and the environment	
A5	Familiarity	✓

11.4 Provide reasoning how the project address selected attribute (EA)

Range of resource:
In order to make our project we are creating a prototype with the right components to meet our goals. We purchased all of the components by ourselves. After a lot of investigation into the components, we arrived at a conclusion about the cost. In addition, we analyzed numerous datasheets to determine the best design.

Level of interaction:
We needed to discuss with a wide range of professional people to build our project and we also took help from one of my friends to make a 3D print of the watch. Every one of their ideas was generous enough to allow for a steady stream of new ideas to be implemented.

Innovation:
There are many similar projects like this but we have added some new features in it. Accident detection as well as pulse rate and oxygen saturation level send in the form of SMS.

Familiarity:
The type of helmet that bikers are currently wearing in our country provides protection at the time of an accident but does not provide any support after the accident. Therefore, our system will provide post-accident support and help reduce mortality. Furthermore, it will not cost much to add any feature in the future to ensure maximum comfort to the customers.

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FYDP (C) Spring 2022 Summary of Team Log Book/ Journal

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General Notes:

1. In addition to detail journal/logbook fill out the summary/key steps and progress of your work
2. Reflect planning assignments, who has what responsibilities.
3. The logbook should contain all activities performed by the team members (Individual and team activities).

FYDP (C) Spring 2022 Summary of Team Log Book/ Journal

Date/Time/ Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
15.01.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Dividing sub-systems among group members.	1. Kayser (Accident Detection) 2. Khadiza (GPS and GSM) 3. Turjo (Pulse rate and oximeter) 4. Rakib (Connecting the sub-systems)	
16.01.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Independently conducting research and analyzing each component.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
23.01.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Collecting the rest of the components needed for the prototype and started working on hardware design.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
01.02.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Draft hardware design completed.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
02.02.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Completed calibrating and the simulation of the accelerometer so that accidents can be detected.	1. Kayser	
13.02.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Code ran successfully for both GSM and GPS separately.	1. Khadiza	
22.02.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. Working on combining GPS and GSM modules to work together. 2. Found problems for maintaining communication among the subsystems using Bluetooth Module.	1. Khadiza (GPS & GSM) 2. Rakib (Communication issue)	
24.02.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. Selecting WIFI for connecting the sub-systems instead of Bluetooth. 2. Changed the microcontroller from Arduino to NodeMCU.	1. Rakib(In switching to the WIFI module	

		3. Changed accelerometer model from ADXL335 to ADXL345.	instead of Bluetooth). 2. Kayser (Accelerometer)	
28.02.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. ADXL345 worked successfully with NodeMCU and selected a range of values for accident detection. 2.GPS and GSM Modules worked successfully.	1. Kayser (ADXL345) 2. Khadiza (GSM,GPS)	
05.03.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1.Monitoring the given data of pulse rate and Sp02 successfully.	1. Turjo	
07.03.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. Combining NodeMCU, ADXL345, GPS and GSM modules to work together successfully.	1.Khadiza 2. Rakib 3. Kayser	
19.03.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. Determined how to give sufficient power supply to the systems and charging method.	1. Rakib 2. Turjo	
21.03.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. The entire system after combining all the components worked successfully and WIFI communication was also successfully established between the subsystems. 2. PCB design was done.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
23.03.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. Got the PCB. 2. Preparing the slides of Progress Presentation.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
24.03.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. The components were soldered in the PCB.	1.Kayser	
25.03.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. Worked successfully after soldering on PCB.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
26.03.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1.Consultation with ATC.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
27.03.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. Divided chapters of final report among the group members.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
28.03.22	1. Kayser 2. Khadiza 3. Rakib	1. Got the 3D printed design for enclosing the components for pulse rate monitor.	1. Turjo	

FYDP (C) Spring 2022 Summary of Team Log Book/ Journal

	4. Turjo			
29.03.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	1. Setting up all the components inside the 3D printed module.	1.Turjo	
09.04.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Discussed among ourselves about the progress of final report writing.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
17.04.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Discussed among ourselves about the progress of final report writing.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
21.04.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	FYDP(C) final report draft submission to the ATC	1.Kayser	
22.04.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Preparing the slides of final presentation	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
24.04.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Rehearsal and practice among ourselves for the mock presentation.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
25.04.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Mock Presentation in front of our ATC Panel	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
27.04.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Rehearsal and practice among ourselves for the final presentation.	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	
06.05.22	1. Kayser 2. Khadiza 3. Rakib 4. Turjo	Final submission	1. Kayser	