Smart Helmet

Submitted in partial fulfillment of the requirements
of the degree of

BACHELOR OF ENGINEERING

In

COMPUTER ENGINEERING

By

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CERTIFICATE

This is to certify that the project entitled **“Smart Helmet”** is a bonafide work of

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Abstract

Our project aims to integrate various critical as well as practical additions to a basic helmet to create a Smart Helmet. One of the biggest risks associated with two wheeler usage is the exposed nature of travel that puts one at immense risk in case of an accident.

With top priority given to safety, our primary feature includes installing FSR (Force Sensitive Resistors) on the interior of the helmet. In the case of an impact/accident, the GSM module will relay the GPS coordinates of the person to predefined emergency contacts. This feature is crucial, as a delay in timely first aid is one of the leading causes of fatality in two wheeler accidents.

Additionally, the Smart Helmet will be equipped with a camera module that can be used to record video/pictures. This feature can be used extensively by adventure enthusiasts to document their trails as well as casual users.

Mobile Application and Cloud Integration - The Smart Helmet will have a mobile application. The application can be used to establish the safety contacts, to access the recorded photos/videos and have an integration with Google Maps API.

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Chapter 1

Introduction

1.1 Introduction

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements.

It has always been practiced informally, but began to emerge as a distinct profession in the mid-20th century.

Project management processes fall into five groups

- Initiating
- Planning
- Executing
- Monitoring and Controlling
- Closing

Recently technological and population development, the usage of vehicles are rapidly increasing and at the same time the occurrence accident is also increased. Hence, the value of human life is ignored. No one can prevent the accident, but can save their life by expediting the ambulance to the hospital in time. A new vivid scheme called Intelligent Transportation System (ITS) is introduced. The objective of this scheme is to minimize the delay caused by traffic congestion and to provide the smooth flow of emergency vehicles.

The concept of this scheme is to green the traffic signal in the path of ambulance automatically with the help of RF module. So that the ambulance can reach the spot in time and human life can be saved and the accident location is identified sends the accident location immediately to the main server. The main server sends the exact accident location to the emergency vehicle. The control unit monitors the ambulance and provides the shortest path to the ambulance.

1.2 Aim & Objectives

The main aim of this project is to develop a smart helmet for accident detection. This helmet is made with the intention of providing emergency services to the user after he/she has encountered an accident. In case of an accident when the impact detected by the Force Sensitive Resistor (FSR) is greater than the safe limit, the helmet sends an SMS to all emergency contacts with the help of a GSM module.

These emergency contacts have been saved by the user with the help of a mobile application. The sent SMS contains the coordinates at which the helmet is present so that the exact location of the accident site can be reached. This will ensure that emergency medical help reaches the user with minimum delay.

The helmet also has a camera module attached so that the user can click pictures and take videos while travelling. This media is gets saved on cloud storage. The inbuilt WiFi module transfers this data from the camera module to the cloud. These stored images and videos can then be viewed by the user on the mobile app.

1.3 Scope

Over 1,37,000 people were killed in road accidents in 2013 alone, that is more than the number of people killed in all our wars put together. There is one death every four minutes due to a road accident in India. Many of this can be prevented if emergency services are made available at the earliest and no time is wasted in waiting for a response from passersby.

Every moment that lapses post an accident is crucial, and a delay of even a couple of seconds can cost someone their life. The system proposed aims at ensuring that a potential accident is recognized and no time is wasted in providing help to the injured.

The proposed system's main functionality lies in the detection of accidents using the Force Sensitive Resistor (FSR). The FSR detects the force impulse and initializes the process of intimating emergency contacts.

The system also contains a camera module to record trails and also click pictures.

The Project Scope pertains to the work necessary to deliver a product. Requirements and deliverables define the project scope, and it is critical that the stakeholder is in agreement with the information discussed in the proposed plan.

Chapter 2

Review of Literature

2.1 Domain Explanation

The "Internet of things" (IoT) is becoming an increasingly growing topic of conversation both in the workplace and outside of it. It's a concept that not only has the potential to impact how we live but also how we work. But what exactly is the "Internet of things" and what impact is it going to have on you, if any? There are a lot of complexities around the "Internet of things”. Broadband Internet is become more widely available, the cost of connecting is decreasing, more devices are being created with Wi-Fi capabilities and sensors built into them, technology costs are going down, and smartphone penetration is sky-rocketing. All of these things are creating a "perfect storm" for the IoT. Simply put, this is the concept of basically connecting any device with an on and off switch to the Internet (and/or to each other). This includes everything from cellphones, coffee makers, washing machines, headphones, lamps, wearable devices and almost anything else you can think of. This also applies to components of machines, for example a jet engine of an airplane or the drill of an oilrig.

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer.

There are many examples for what this might look like or what the potential value might be. Say for example you are on your way to a meeting; your car could have access to your calendar and already know the best route to take. If the traffic is heavy, your car might send a text to the other party notifying them that you will be late. What if your alarm clock wakes up you at 6 a.m. and then notifies your coffee maker to start brewing coffee for you? What if your office equipment knew when it was running low on supplies and automatically re-ordered more? What if the wearable device you used in the workplace could tell you when and where you were most active and productive and shared that information with other devices that you used while working?

On a broader scale, the IoT can be applied to things like transportation networks: "smart cities" which can help us reduce waste and improve efficiency for things such as energy use; this helping us understand and improve how we work and live. The reality is that the IoT allows for virtually endless opportunities and connections to take place.

Security is a big issue that is oftentimes brought up. With billions of devices being connected together, what can people do to make sure that their information stays secure? Will someone be able to hack into your toaster and thereby get access to your entire network? The IoT also opens up companies all over the world to more security threats. Then we have the issue of privacy and data sharing.

Another issue that many companies specifically are going to be faced with is around the massive amounts of data that all of these devices are going to produce. Companies need to figure out a way to store, track, analyze and make sense of the vast amounts of data that will be generated.

2.2 Existing Solution

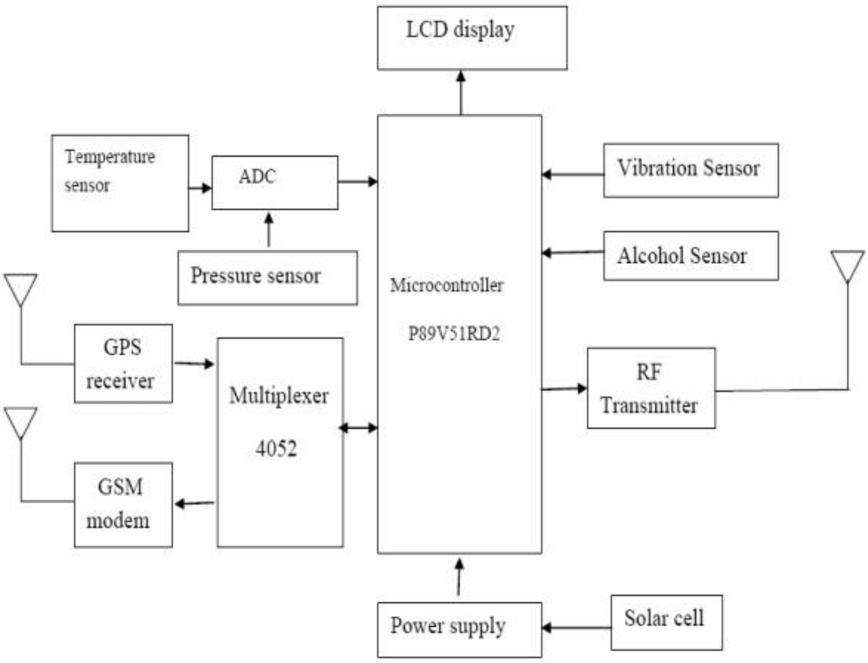


Figure 2.1 - Existing System Architecture

In this system P89V51RD2 microcontroller is used. When the system is switched on, LED will be ON indicating that power is supplied to the circuit. The RF is used to start the two wheeler - firstly it will check whether the driver is under alcoholic influence it will not allow the two wheeler to start.

The small voltage of ignition of the two wheeler is grounded. In normal condition when the helmet is worn the pressure sensor senses pressure and the RF transmitter radiates the FM modulated signal. The RF receiver is connected with the two wheeler which receives the radiated signal and activates the relay. The relay removes the ignition wire from the ground and connects with the starter switch allowing the vehicle to start. If the driver meets with an accident, the vibration sensor sends message to microcontroller.

The GPS receives the location of the vehicle that met with an accident and gives the information back. This information will be sent to a mobile number through a message. This message will be received using GSM modem present in the circuit. The message will give the information of longitude and latitude values. Using these values the position of the vehicle can be estimated. To run the GPS and GSM module, microcontroller is a user friendly device which can be easily interfaced with any sensors or modules and is very compact in size.

IoT application-specific framework should be able to provide support for the following:

1) Reading data streams from sensors directly

2) Transparent and scalable processing of the data

3) When events of interest are detected, the predetermined set of actions has to be triggered.

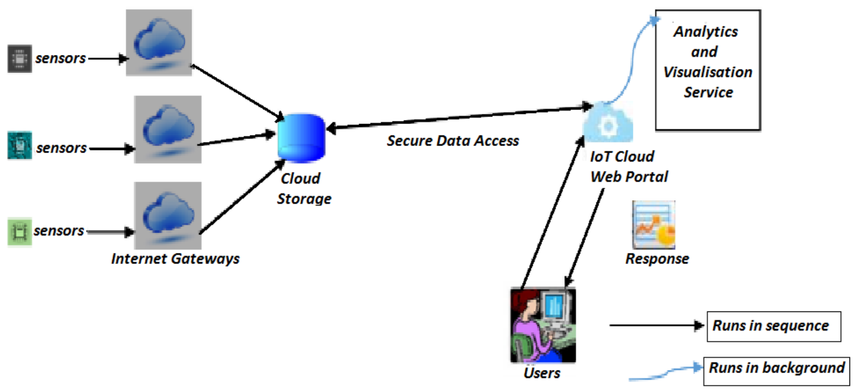


Figure 2.2 - Procedure Diagram

2.2.1 Challenges associated with automatic detection and notification of accidents

1. Detection of the accident forces accurately

Conventional accident detection systems rely on sensor networks embedded in the car. For example, the sensors detect airbag deployment, acceleration/deceleration etc. However it is not possible to get such vast amounts of data from two wheelers. Thus, with the available resources and limited logistical capability, accurate detection of accident is needed.

2. Delay in notification reaching the emergency contacts

As soon as the monitoring system detects an accident, the information has to be securely transferred to the emergency contacts. In case the contact misses out the accident notification, then the system must be designed to recursively send the message until the message has been acknowledged.

2.2.2. Working Principle

Provides a cheap, effective accident detection and notification. Though integrating sensors with a high-end microcontroller provides rapid accident detection, they are limited in terms of processing and notification capabilities. The TI CC3200 is a Wi-Fi enabled controller, which is used to connect to a data network for accessing cloud services. (Accomplished by a WiFi module attached to the Raspberry Pi in our project.)

Wearing a helmet can reduce shock from the impact and may save a life. With this reason, this project is specially developed as to improve the safety of the motorcycle's rider. Motorcyclist will be alarmed when the speed limit is exceeded. A Force Sensing Resistor (FSR) and BLDC Fan are used for detection of the rider's head and detection of motorcycle's speed respectively.

A 315 MHz Radio Frequency Module as wireless link which able to communicate between transmitter circuit and receiver circuit. PIC16F84a is a microcontroller to control the entire component in the system. Only when the rider buckled the helmet then only the motorcycle's engine will start. A LED will flash if the motor speed exceeds 100 km/hour.

Force Sensing Resistor (FSR)

Force Sensor Resistor (FSR), structure shown in Fig. 1 (a) is placed inside the helmet as a tactile sensor to detect whether the wearer is wearing their helmet. It consists of a Polymer Thick Film (PTF) device which exhibits a decrease in resistance with an increase in the force applied to the active surface [2].

The force vs. resistance characteristic shown in Fig. 1 (b) provides an overview of FSR typical response behavior. For interpretational convenience, the force vs. resistance data is plotted on a log/log format [2]. A mathematical formula produced based on the graph in Fig. 1 (b). Two point's method is used to find the mathematical formula. The formula represents as below:

$y=-0.0014\ 9\ x+9$ Where: y = Resistance (ohm) ; x= Force (gram)

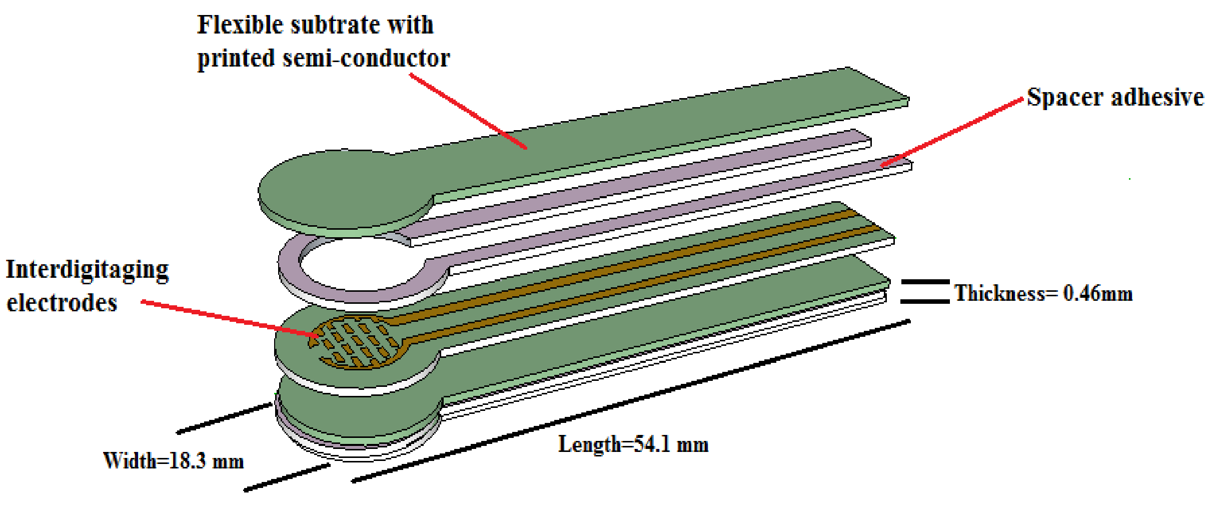


Figure 2.3 – Force Sensitive Resistor

Based on the graph, a switch-like response is evident. This turn-on threshold, or ‘break force, that swings the resistance from greater than 100 kΩ to at about 10 kΩ (the beginning of the dynamic range that follows a power-law) is determined by the substrate and overlay thickness and flexibility, size and shape of the actuator, and spacer-adhesive thickness (the gap between the facing conductive elements). Break force increases with increasing substrate and overlay rigidity, actuator size, and spacer-adhesive thickness.

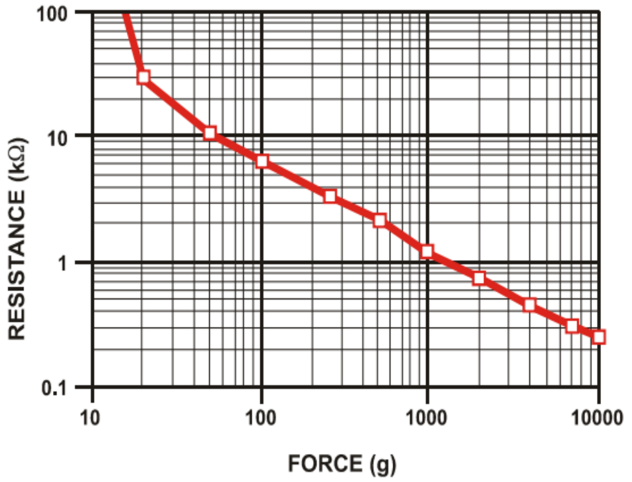


Figure 2.4 – Force Graph

2.3 H/W & S/W requirement

Hardware requirements:

- Raspberry Pi (Model B RASP-PI-3 motherboard)
- 16GB Micro SD card
- Force Sensitive Resistor (FSR) with detective capacity of 100g – 10kg
- Ethernet cable
- Power Supply
- Micro USB cable
- Analog to Digital Converter (Adafruit MCP3008)
- GSM Module (SIM800)
- SIM card
- General purpose Matrix 0 Board
- Jumper wires
- Bread Board
- LEDs
- Raspberry Pi Camera Module with 5mp camera

Software requirements:

1. From Developer's side:
   - Python 3 IDE
   - Raspbian Wheezy
   - Android Studio
   - SSH client (PuTTY)
   - X forwarding client (MobaXterm)
   - VNC Viewer
   - Java/Eclipse IDE

2. From User's side:
   - Android SDK 21 or higher

Chapter 3

Analysis

3.1 Functional Requirements

In case of an accident, the system contacts emergency services/helplines and sends the location of the accident.

- The GSM module will also send an SMS to the emergency contacts.
- System can click pictures by using a Camera Module
- System can be used to document trails in the form of videos by using a Camera module.
- Documented pictures and videos can be stored over Cloud and can be accessed by the user using a mobile app.

3.2 Non-Functional Requirements

- **Promptness :** The system will have minimum delay in sending an SMS on impact
- **Interactive :** The GUI is interactive and easy to navigate
- **Reliability :** The system will be able to recuperate fast from crashes, which will not be a frequent occurrence
- **Usability:** The application will be user friendly and will function seamlessly as it is to be used in emergencies.
- **Supportability:** The system will be cost-effective to maintain.

3.3 Proposed System

The system is divided into two major functional blocks:

1. Accident Detection (FSR, GSM)
2. Trail Documentation (Camera module and cloud)

3.3.1 Accident Detection

The success of an intrinsic accident detection system relies on the accurate identification of an accident and efficient rejection of false alarms. In order to achieve this, the proposed implementation mechanisms are:

a. Force Sensitive Resistor : To detect sudden increase in pressure

The impulses being evaluated by the FSR are delivered to the Raspberry Pi for further processing. The safety mechanism is activated.

b. GSM Module: If the user does not a cancel the alert, the GSM module sends an SMS to the emergency contacts. This message has the coordinates of the accident site.
c. Safety Mechanism: This mechanism is present to detect false alarms. On impact, an alert is sent to the user on the mobile app. If the user does not respond to this alert within one minute, the GSM module sends an SMS to all emergency contacts.

3.3.2. Trail Documentation

The smart helmet has a camera module attached to it. Using this module, the user can take pictures and record videos. This media can be saved in an online library. All saved media can be accessed by the user on the mobile app.

Chapter 4

Design

4.1 Design Consideration and Details

While designing the system, we have taken into consideration its reliability and usability. The system should be able to respond immediately to impact and hence time delay should be minimum. To make is convenient for the user to use the app, it should be simplified and easy to navigate.

4.2 Design Details

A number of diagrams are made to completely understand the design of the the system. These diagrams explain the working of the system and the actions performed by the involved components.

4.2.1 System Diagram

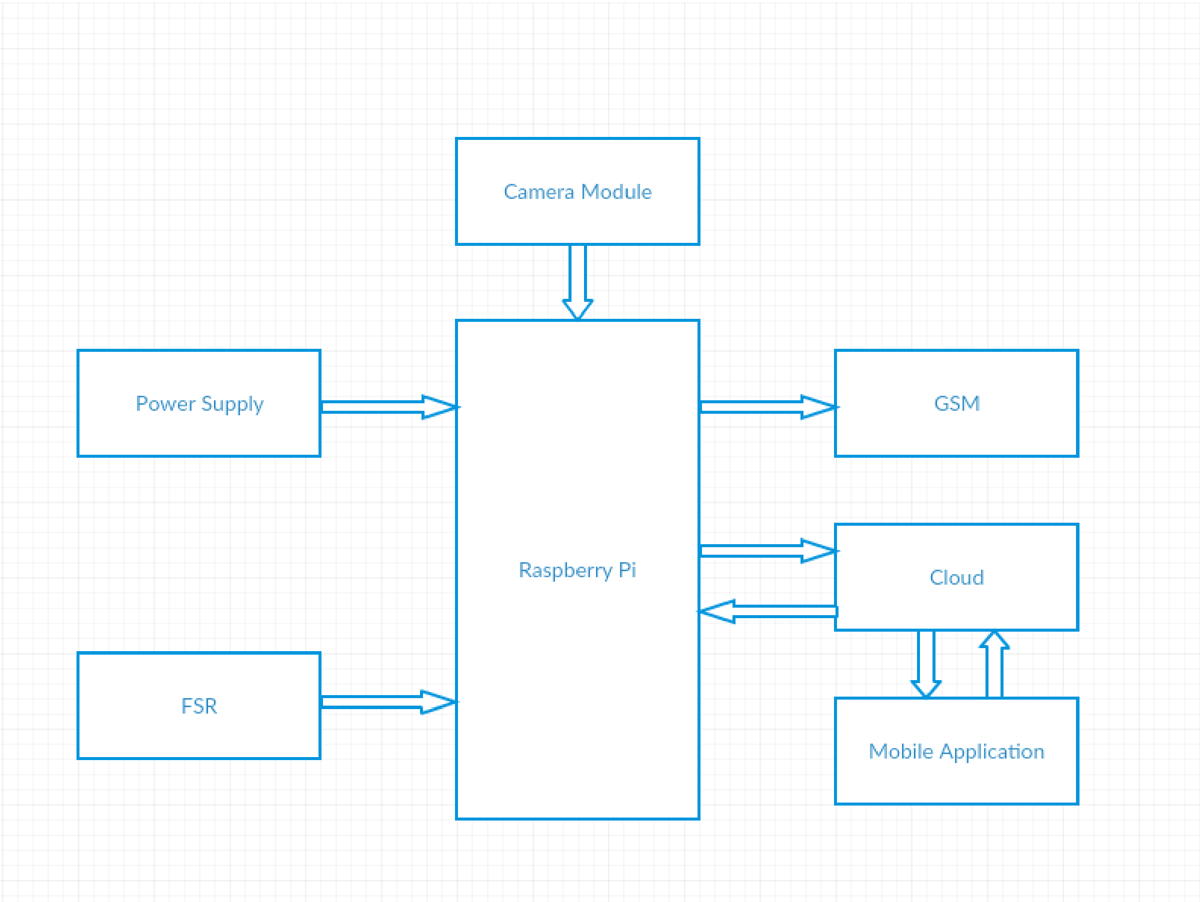


Figure 4.1 – System Diagram

4.2.2 Sequence Diagram

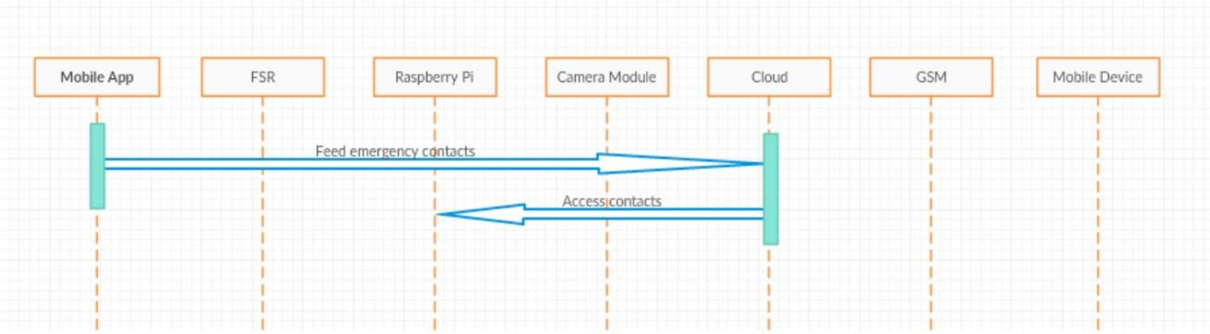


Fig 4.2 Sequence Diagram - 1

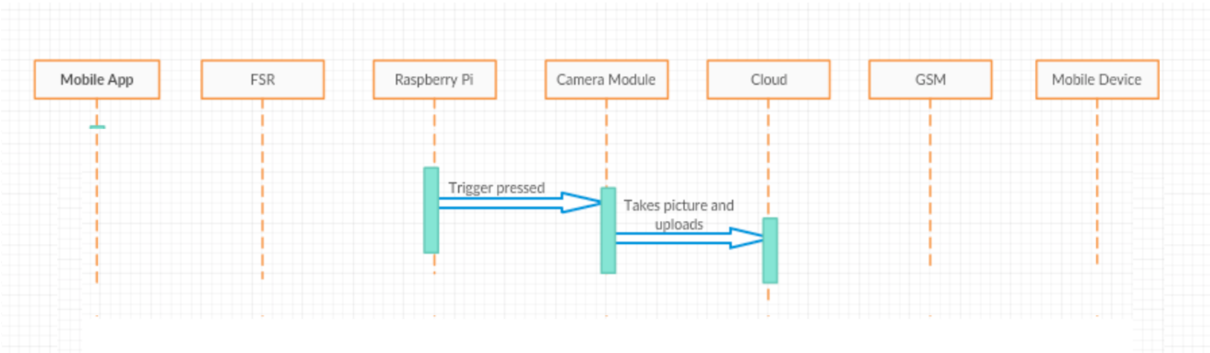


Fig 4.3 Sequence Diagram - 2

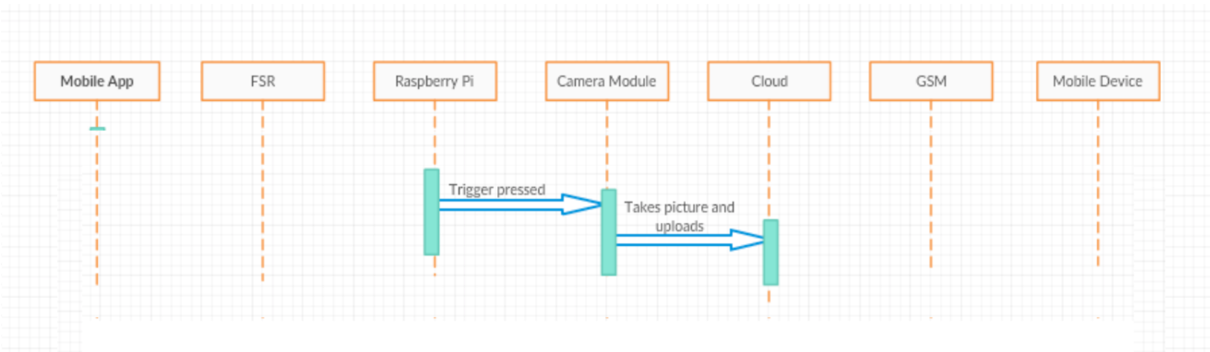


Figure 4.4 Sequence Diagram - 3

4.2.3 Data Flow Diagrams

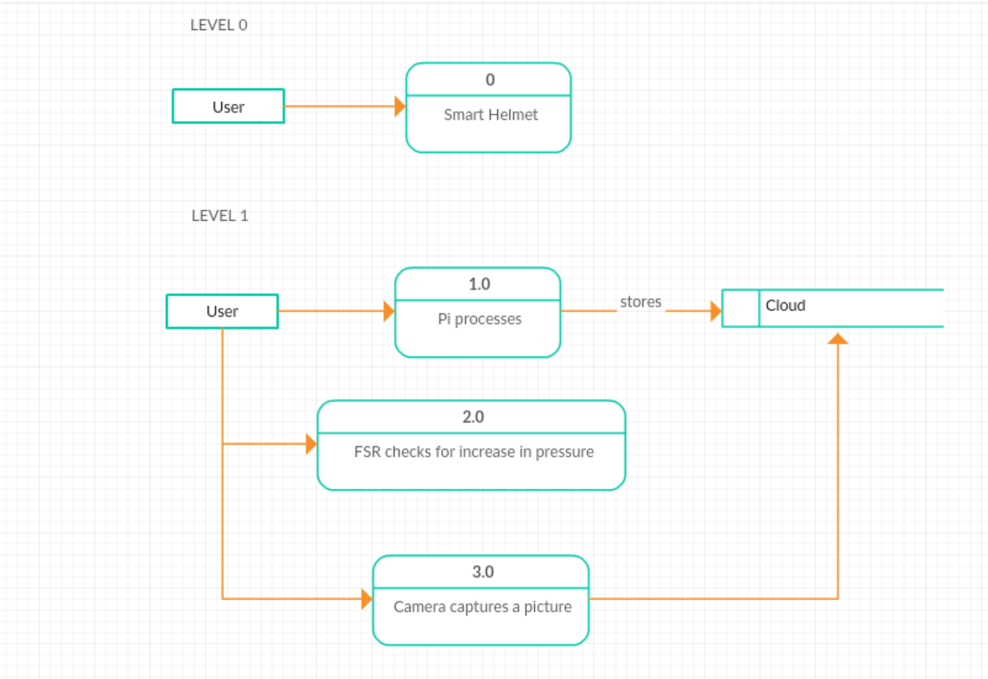


Figure 4.5 – Level 0 and Level 1 DFD

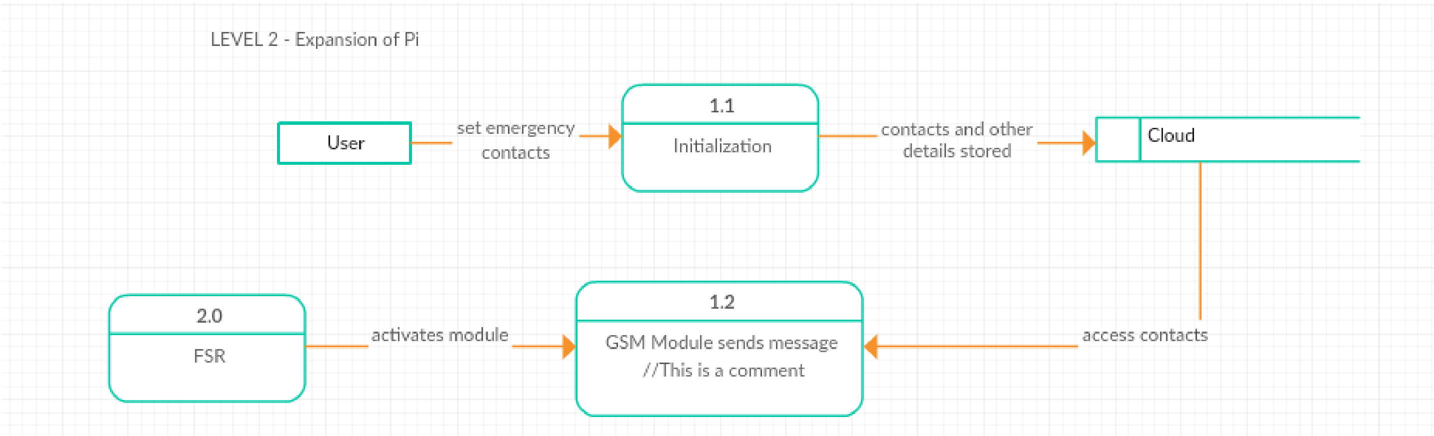


Figure 4.6 – Level 2 DFD – Raspberry Pi

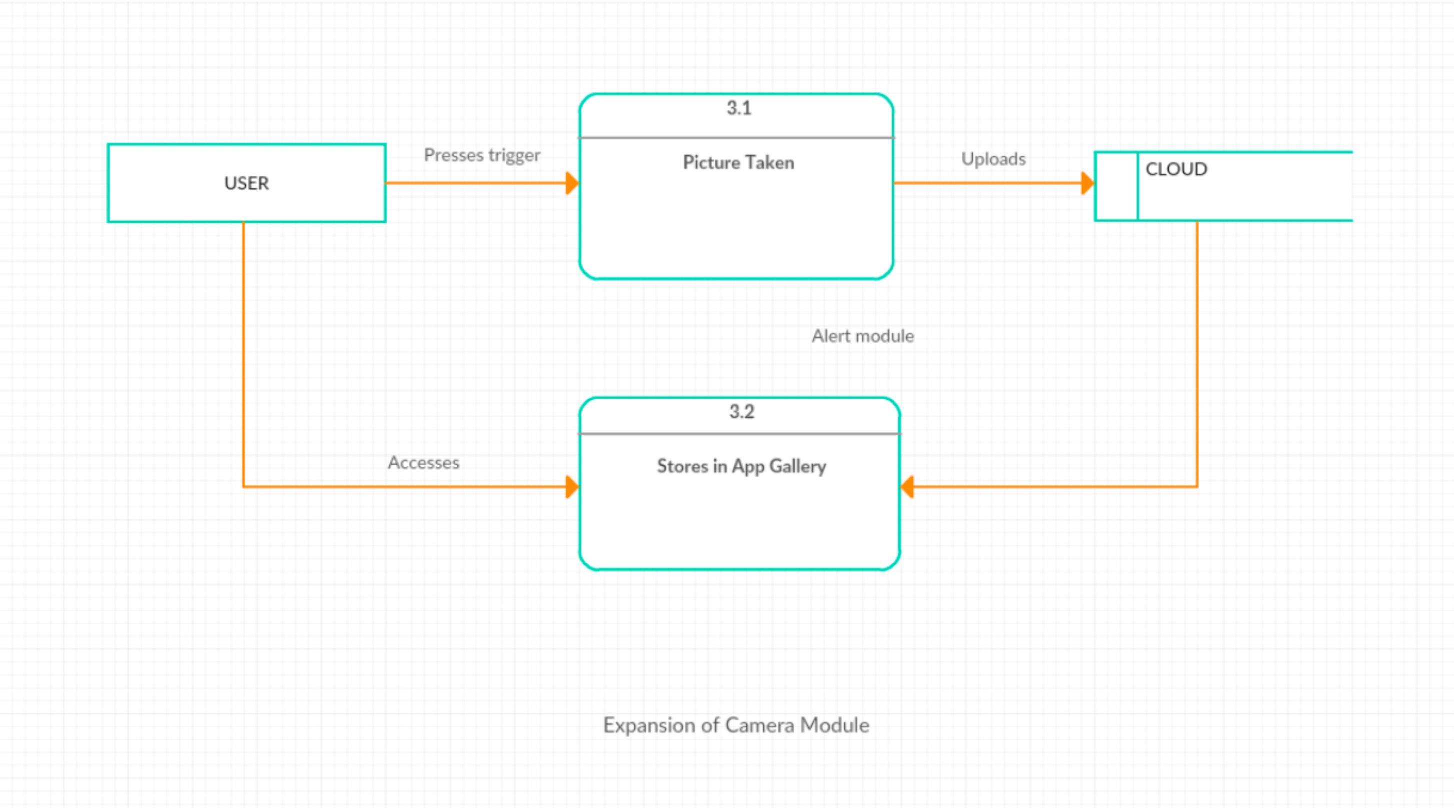


Figure 4.7 – Level 2 DFD – Camera Module

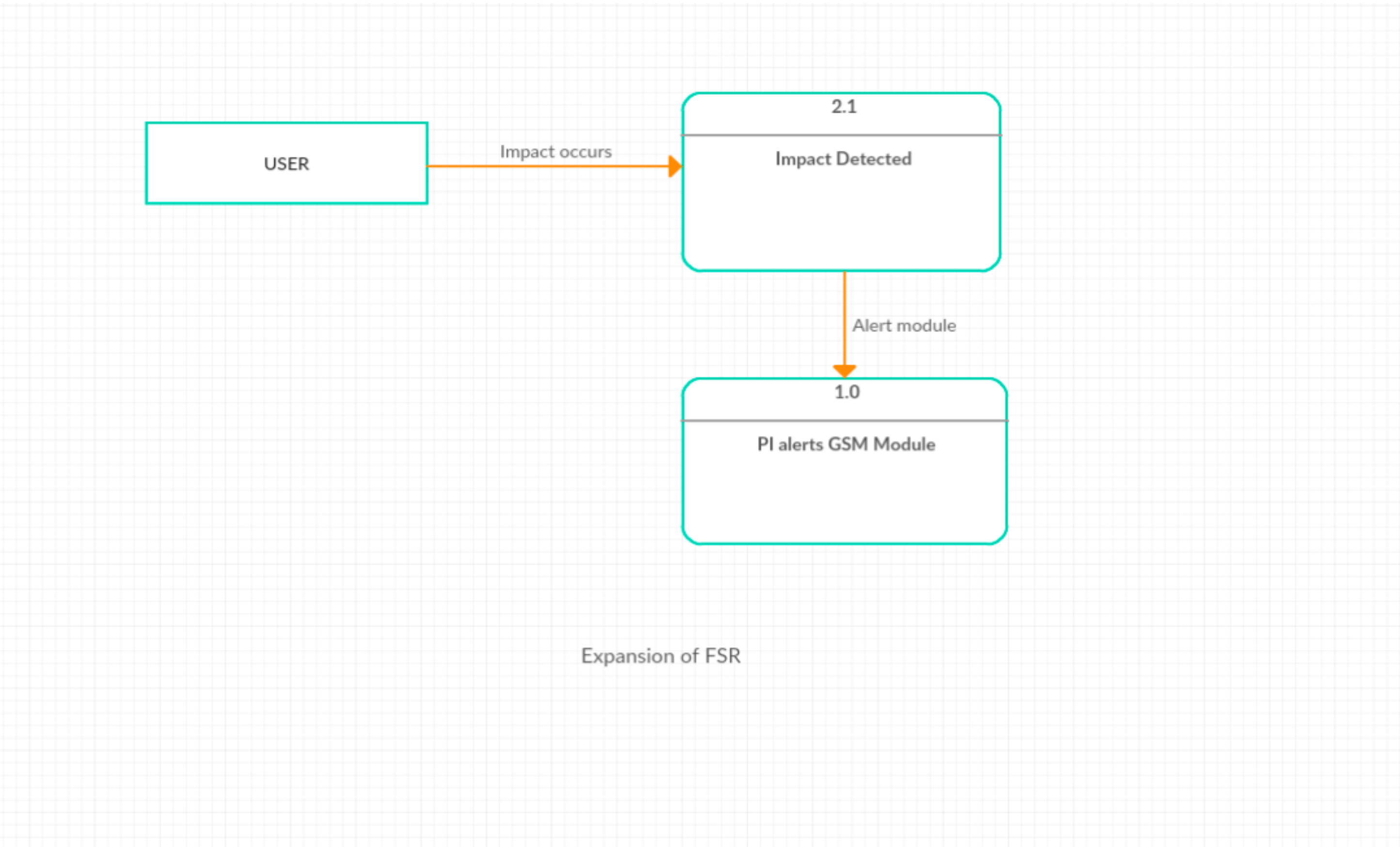


Figure 4.8 - Level 2 DFD - FSR

Chapter 5

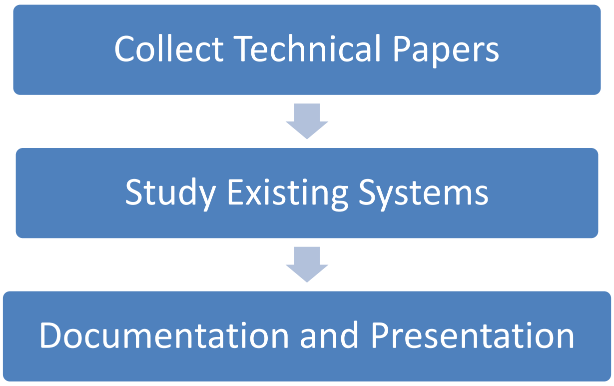
Implementation

Our Implementation can be divided into 4 phases as follows:

5.1.1 Phase 1

Phase 1 mostly comprises of extensive study on the topic and collecting data for the practical implementation of the system.

This phase was implemented between July to August.



5.1.2 Phase 2

Setting up the Raspberry pi and Initial Android Application Development - In Phase 2 the Raspberry Pi is set up using a remote SSH connection.

- An operating system is loaded onto a 16gb SD card with an SD card adaptor.
- Using an ethernet cable, the network sharing feature of a laptop is used to enable the pi to have internet access.
- An advanced IP scanner is used to scan and find the IP address allocated to the pi.
- Using this IP address in an SSH client+X forwarding client(MobaXterm), we gained headless access to the Raspberry pi.

Alternately, a monitor can also be used in tandem with an HDMI cable to get the pi set up without any networking hassles. Once booted, the pi is updated and ready for further implementations.

Parallelly, development of the application is done. The design of the logo along with the loading splash screen, home page along with the activation menu including the contents of the application are made.
This was done in the month of September.

5.1.3 Phase 3

Implementation of the modules and cloud setup–

1) Camera module – A Raspberry Pi Camera Module with 5mp camera is used. On the press of a trigger, the input to a GPIO pin becomes high, triggering the camera to take a picture.
2) FSR – An FSR is connected to the interior of the helmet. A sudden increase in pressure makes the pi prompt the GSM module to send the emergency messages including the coordinate of the accident site.
3) GSM module – This module contains the SIM card that sends the emergency messages when an accident is detected by the FSR.

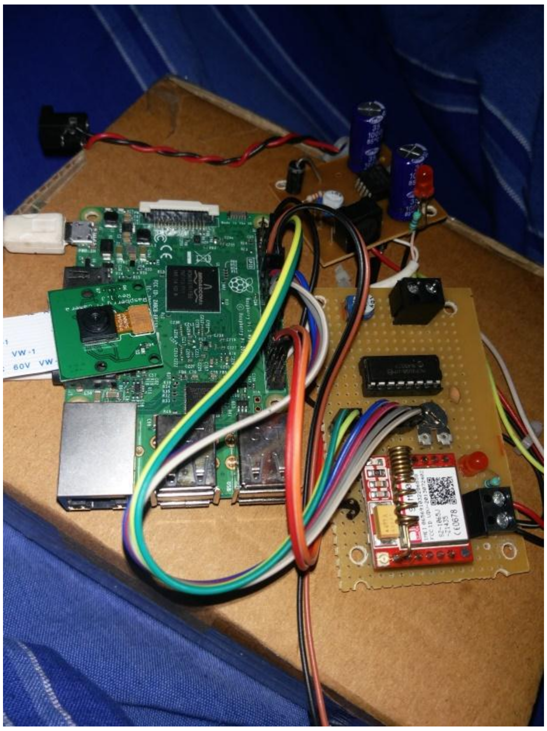


Fig 5.1 Project Circuitry

4) Cloud Setup – This phase was started in September and was completed in January. The application used on the Raspberry pi was OverGrive, a Google Drive desktop client for Raspbian OS.

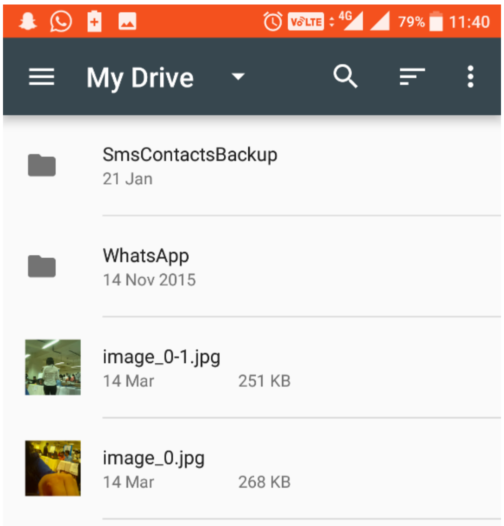


Fig 5.2 Cloud API

5) Coding- The coding for the entire project was done on Python.

We have used the UART (Universal Asynchronous Transmitter / Receiver) interface to set up the GSM module. It uses two data lines for sending (Tx) and receiving (Rx) data. The ground of both devices were made common. AT commands have been used to control the SIM module. The command +CMGF (command name in text: Message Format) is used to select the operating mode of the GSM/GPRS modem or mobile phone. It takes one parameter. The value of the parameter can either be 0 or 1. The values 0 and 1 refer to SMS PDU mode and SMS text mode respectively. SMS PDU mode is the default mode if it is implemented on the mobile device. The AT+CMGS command sends an SMS message to a GSM phone.

```
def sim800Init():
    uart.write("AT\r\n")
    time.sleep(0.2)
    uart.write("ATE0\r\n")
    time.sleep(0.2)
    uart.write("AT+CMGF=1\r\n"
)
```

```
def sim800SendSMS(MN,MSG):
    uart.write("AT+CMGS=\"")
    uart.write(MN)
    uart.write("\"\r\n")
    time.sleep(1)
    uart.write(MSG)
    uart.write("\x1A")
    time.sleep(3)
    return
sim800Init()
```

For the FSR readings, we have taken an inverse of the raw values to enable a better comprehensibility in the observations.We have used an Analogue to Digital Converter to process the analog input from the sensors to a digital input that can be read by the Pi.

```
RawValue = 1023-mcp.read_adc(0)
  print(RawValue)

  if RawValue > 900:
      print('Pressed')
      led.blink(1,1,1,True)
      sim800SendSMS("+919820497927","RPI:Accident Detected.")
```

The trigger threshold has been kept at 900 units (out of a maximum of 1024 units). The second if condition calls the send SMS function when this threshold is crossed, sending the alert message to all the predefined emergency contacts.

5.1.4 Phase 4

This phase includes the testing and removal of all and any perceivable glitches in the system and the completion of the entire application. This phase was completed in the month of March.

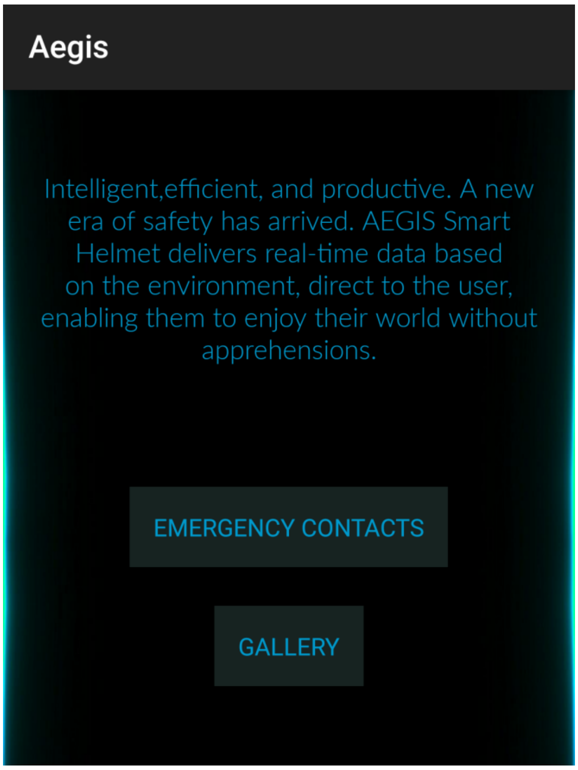


Fig 5.3 Application home screen

5.2 Results and Evaluation

The final working model was completed in the month of March. The working model consists of a Force Sensitive Resistor (FSR), a GSM Module with a SIM card, and a camera module. An android application has been developed to sync images and contacts over cloud.

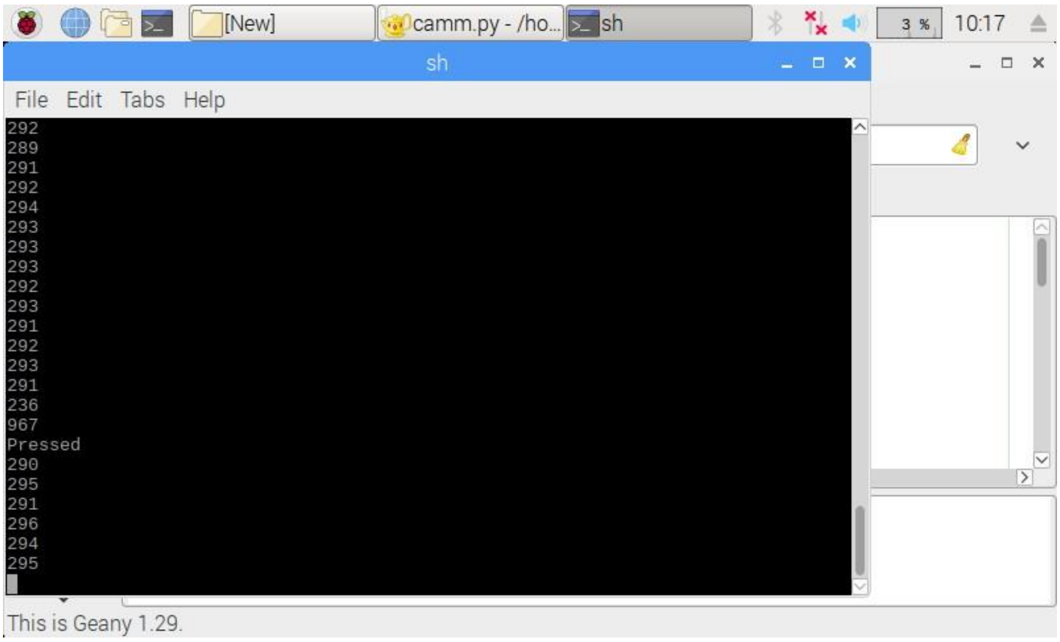


Fig. 5.4 Live FSR Readings

The Force Sensitive Resistor (FSR) sends an SMS to the emergency contact number when the impact exceeds a certain threshold. The current threshold set to trigger the FSR is 900 units. When the pressure applied exceeds 900 units, the FSR gets triggered and activates the GSM Module. The GSM Module sends an SMS containing the location coordinates of the accident site to the emergency contact number. This makes it possible for the emergency contact to send immediate help to the accident victim.

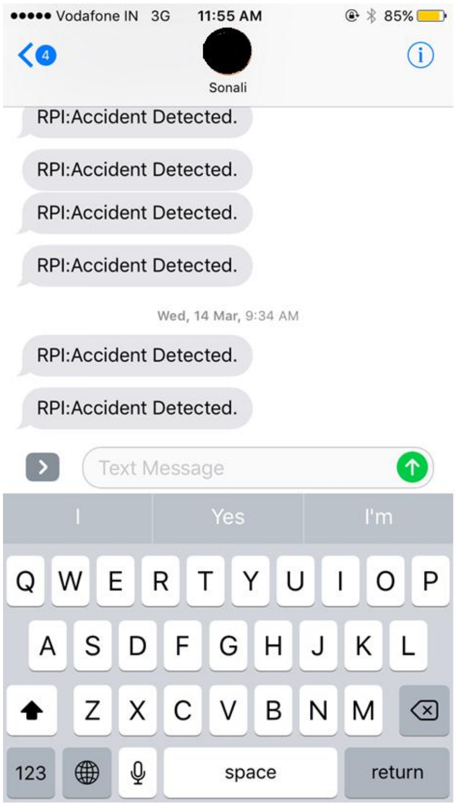


Fig 5.5 Message sent to Emergency Contact

The camera module allows the wearer of the helmet to take pictures on the click of a button. These pictures get stored on a folder which is synced with the android application over cloud. The user can access all clicked pictures over the android application.

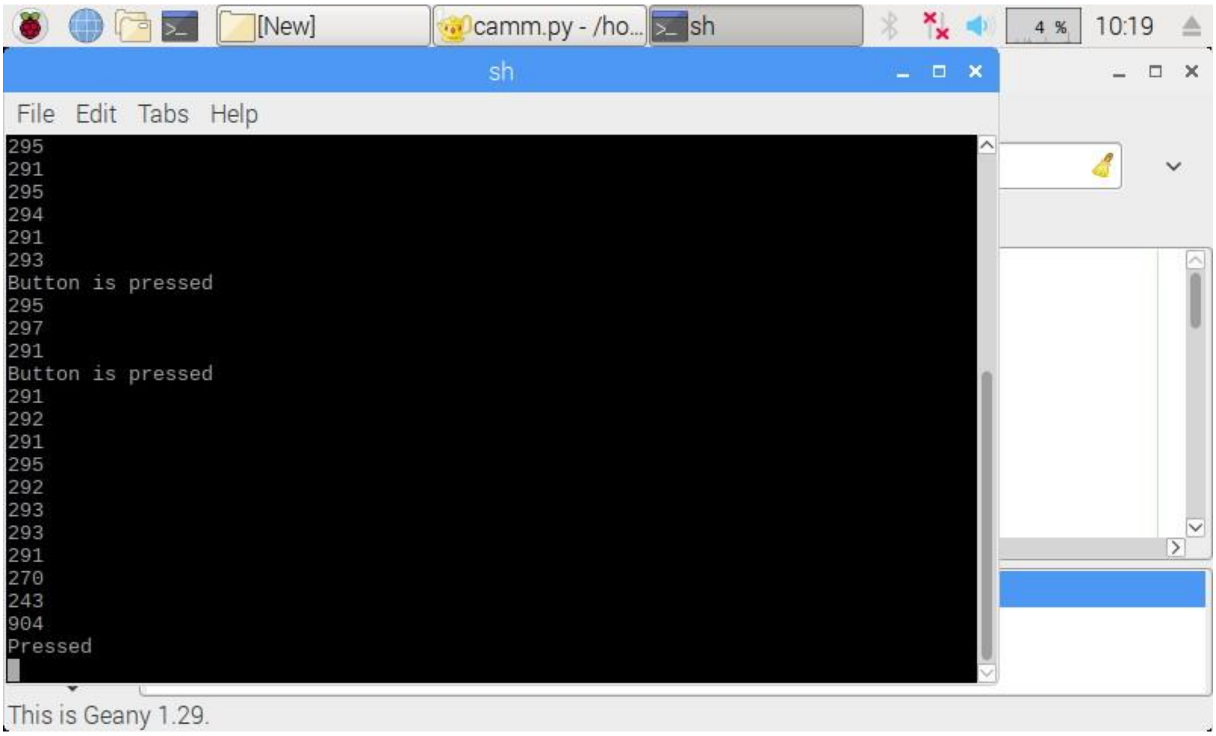


Fig 5.6 Parallel functioning of Camera and FSR

Chapter 6

Conclusion

The system is successfully designed and built. The Smart Helmet shall have various uses besides its primary use of providing timely aid to its owner in case of an accident. The only limitation was the budget constraints which didn’t allow us to integrate the circuit within the helmet. The Project has been built keeping in mind all functional as well as non – functional requirements stated and thus build an efficient and well documented system.

`

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