Spy Hit and Run Detector for 2-wheelers

Submitted in partial fulfillment of the requirements

Of the degree of

Bachelor of Engineering

By

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CERTIFICATE

This is to certify that the project entitled SPY HIT AND RUN DETECTOR is a bonafide work of Ojaas Hampiholi (26) submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of BACHELOR OF ENGINEERING in ELECTRONICS AND TELECOMMUNICATION.

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Declaration

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

Transport or transportation is the movement of humans, animals and goods from one location to another. In other words the action of transport is defined as a particular movement of an organism or thing from a point A to the Point B. Modes of transport include air, land (rail and road), water, cable, pipeline and space. The field can be divided into infrastructure, vehicles and operations. Transport is important because it enables trade between people, which is essential for the development of civilizations. A traffic collision, also called a motor vehicle collision (MVC) among other terms, occurs when a vehicle collides with another vehicle, pedestrian, animal, road debris, or other stationary obstruction, such as a tree, pole or building. Traffic collisions often result in injury, death, and property damage.

Hence, it can be seen that transportation industry which on one hand improved the connectivity between different places, kept on growing fatal year by year on the other hand. Now a days many systems have come up which can provide security to vehicle, along with limited functionalities of sensing accidents. Most of these systems exist for four wheeler vehicles. However, by the data that is maintained by Road Transport Departments across the world, it is evident that two wheelers (including cycles, bikes and mopeds) are more susceptible to accidents rather than four wheeler vehicles. This was the basic motivation factor that lead us to conduct a primary research in existing technologies to detect accidents for two wheelers. We studied the existing technologies and their pros and cons and decided to come up with a new system to help solve this problem. The proposed work here uses IoT (Internet of Things) in accordance with a raspberry pi processor and a bunch of sensors and modules in order to detect any accident and to send the intimation to nearby emergency services and to send the location of accident along with the time to the registered contacts. This is done with the help of an android device that is in connection with processor using Bluetooth link. This project also deals with capturing images at the time of accident and sending them to stored addresses over the internet through Email.

Acknowledgement

I would like to express gratitude to my guide Mrs. Manisha Joshi who has allotted the project work to me and also helped me immensely in getting important information and data required for successful completion of the project. Special thanks to madam for her valuable guidance, encouragement and immense support during the entire course of the work. Your remarks and suggestions gave a better direction to the project.

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Table of Content

List of Figures

List of Tables

List of Abbreviations

Abbreviation	Full Form
3GPP	Third Generation Partnership Project
GLL	Lat/Lon Data
GPRS	General Packet Radio Services
GPS	Global Positioning System
GSA	Overall Satellite Data
GSM	Global System for Mobile Communication
IR	Infrared
LTE	Long Term Evolution
MCU	Microcontroller
NMEA	National Marine Electronics Association
RPI	Raspberry Pi
SIM	Subscriber Identity Module
SoC	System on Chip
USB	Universal Serial Bus
VANET	Vehicular AD-Hoc Network
VGA	Video Graphics Array

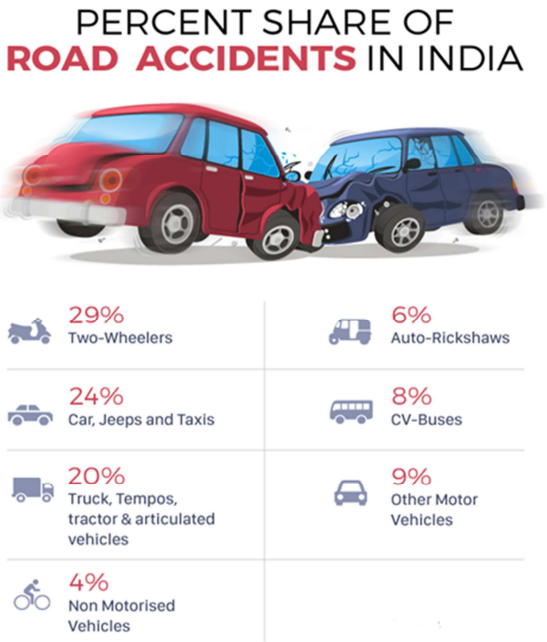
Chapter 1

Introduction

1

1.1 Motivation

The development of a transportation system has been the generative power for human beings to have the higher civilization above all comparable creatures on the earth. Automobile has a great importance in our daily life. We utilize it to go to our work place, keep in touch with our friends and family, and deliver our goods. But every coin has two sides and fatality of automobiles can be seen through life claiming accidents. Speed is one of the primary risk factor involved in driving. It not only increases chances of a crash, but also affects severity of the crash. Despite many efforts taken by different governmental and non-governmental organizations all around the world by various programs to create awareness against careless driving, data suggests that accidents are on a regular event on busy streets. Many lives can be saved if the emergency service can get the crash information at appropriate time. In such a case, efficient automatic accident detection with an automatic notification to the emergency service with the accident location and images of the perpetrators of crime as a proof becomes a prime need to save precious human lives.



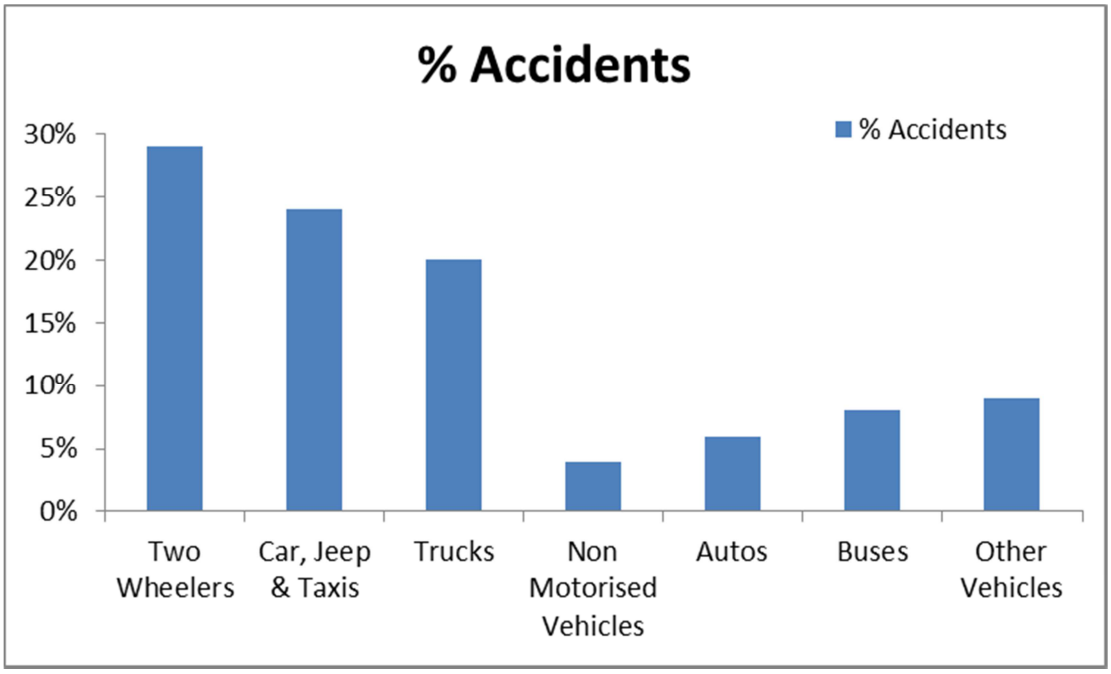


Figure 1.1 Percentage of accidents per vehicle type in India with Graph [8]

Therefore our aim is build a project based on Raspberry-pi processor based system. The project propose is to utilize the capability of GPS technology to monitor the speed of a vehicle and detect an accident based on the monitored speed and to send the location and time of the accident from the GPS data processed by a raspberry-pi by using the GSM network to the stored contacts on the android application and to the emergency services.

The possibility of loss of life due to accidents is at a fore now-a-days. The implementation of this system lets the authorized person to retrieve records pertaining to the victim, time and location of accident. This will potentially increase the chances of survival of the victim, apart from this; the system also effectively captures images of the surroundings. These images are sent over to the Email addresses stored in the raspberry-pi. This is done with a view to make the project easily usable to the common man with need of any expertise to use the device.

The project deals with various issues including accident detection and calling for help, and the implementation of the system along with modifying the currently existing systems, this project would be one of the most important lives saving technology application.

Motorbikes are equipped with Anti-lock Braking Systems, Airbags, Safety belts etc., which has helped our generation of 2-wheel drivers to have a better grip on roads, but at times mishaps have caused hindrance and making motorbikes accustom to road accidents. On an

average, thousands of motorcycle accidents are reported but many cyclist casualties are not reported to the police, even when the cyclist is injured badly enough to be taken to hospital.

The whole system is embedded on a Raspberry-Pi (Version 3B+) and its compact design makes it less prone to damage by the accident or destruction by the perpetrators of the accident. With this project our vision is to help create an access platform to get justice for victims by using an array of sensors to detect any collision, using GPS (in-built in Raspberry Pi version 3B+) to pinpoint the location of accident, using GSM (in-built in Raspberry Pi version 3B+) to send text message to the registered number, and camera to capture images of the other party involved /responsible for accident. The image captured by the camera is sent via Email to the addresses that the user saves, and hence the images can be accessed at ease. Keeping the above factors in mind we proceeded to design the system discussed in detail further.

Chapter 2

Review of Literature

2

2.1 Introduction

This chapter deals with all the latest literature that have been proposed and implemented to solve the problems discussed in the introduction. Also it includes the problem statements that we have taken up to be implemented after going through the recent works in the same field

2.2 Automatic Road Accident Detection Techniques: A Brief Survey [1]

2.2.1 Description

This paper discusses the various methods of accident detection systems that can be designed. This paper also gives the features and limitations of the various methods that are shown in the table that is specified:

Table 2.1 Features and limitations of various systems

SYSTEM	FEATURES	LIMITATIONS
Smartphone	Portability and it can provide accident detection and notification in every type of vehicles, even for a bicycle or a motor bike.	I may not be possible to detect all the accidents with smartphone due to the filters utilized to prevent false positives; it may be possible to experience a low speed fender-bender without the application detecting it.
GSM and GPS	Information of an accident is sent through GSM modem, so we do not need an internet facility to send a message to the rescue team. This feature is beneficial in area	In this system IR sensor is used as an accident detection sensor. IR sensor works on reflection principle; hence IR sensor has a flaw of detecting dark colour vehicles which absorb IR rays.

	which lack 3G/WiFi coverage.	
VANET	In this system, Vehicular AD-Hoc Network (VANET) is employed to deliver the message of an accident to the rescue services. VANET also helps these services in finding the optimum route to the accident spot, using ABEONA algorithm and a traffic signal module. This feature can save a lot of time for an ambulance to reach the accident spot.	VANET might have an efficiency issue in different road scenarios like intersections, in an under-pass or in a tunnel. Moreover, it may not perform well under different environmental conditions like rains.
Mobile Application	After detecting an accident the system countdown up to 10, user can cancel it as well. Then it performs the eCALL to the emergency department. So this feature prevents the system to perform the false alarm.	Different smartphone models have different sensitivity level so this system may not perform well in all the smartphone models. Apart from the sensitivity, smartphone models have different processors with varying speeds and response times. This may create problems in detecting accidents on time.

2.3 Intelligent System for Vehicular Accident Detection and Notification [2]

2.3.1 Description

The system described in the paper uses a microcontroller in conjecture with flex sensor, accelerometer, GPS and GSM sensors and a camera to detect accidents. GPS module gives output in NMEA (National Marine Electronics Association) format. The NMEA output messages are given with their descriptions in the table below.

Table 2.2 NMEA Output Message Format

OPTION	**DESCRIPTION**
GGA	UTC Time, Latitude, Longitude and fixed type data
GLL	Latitude, Longitude, UTC Time of position fix and status
GSA	GPS receiver operation module, satellites used in position detection and DOP values
GSV	SNR, No. of GPS satellites in view, Satellite ID Numbers, Elevation, Azimuth

The highly popular SIM 300 model is used here as it comes with a standard RS232 interface which can be used to easily interface the modem to microcontrollers and computers. Flex sensor is a patented technology which is based on resistive carbon elements in which substrate is bent, the sensor produces resistance output correlated to the bend radius, smaller the radius, higher the resistance value. Basically this is analog sensor i.e. its output is in the analog form. Flex sensor has large range of applications such as collision detection on mobile robots, automotive controls, medical devices, virtual reality games etc. A low-power accelerometer is used, which can measure static as well as dynamic acceleration in all the three directions. Real time transmitting camera is used, which is interfaced through the relay to AVR and it has an inbuilt transmitter in it.

2.3.2 Advantages

- Better services by the emergency services during accidents as they would not have to search for the accident site.
- Real time transmitter camera helps in monitoring each and every movement of the vehicle surroundings at all the times.
- Since the device is based on a microcontroller, the overall cost of the project is less than the cost of project based on microprocessor.
- This system can be used in both two wheelers as well as four wheelers.
- Interfacing has to be done only for the basic sensors and camera.

2.3.3 Disadvantages

- The output of flex sensor is an analog signal, which has to be converted to digital signal before sending it to the microcontroller for further action.
- Accelerometer also provides an analog output, which has to be converted to digital before it reaches the controller.
- The receiver of the camera has to be tuned to the same frequency as that of the transmitter in order to receive the data correctly.
- Since a microcontroller is used here, image processing applications cannot be applied to the captured images.

2.4 Accident Detection and Reporting System using GPS, GPRS and GSM Technology [3]

2.4.1 Description

This system defines whether an accident occurs or not is by the threshold speed limits that are dynamically defined with reference to the current speed of the vehicle. If an accident occurs the system uses a GSM modem to transmit the information to the emergency services. The system also has a predefined 5 seconds waiting time for the accident situations, within which the user can manually abort the sending of information, in case a false case of accident is detected. The information is transmitted once the waiting time is over, the accident information containing the location, time and the speed along with the contact number of relative of the occupant will be sent as a GPRS data to the Alert Service Center through the GPRS modem by the MCU.

2.4.2 Advantages

- Speed is considered as the basic parameter for accident detection and hence it can be used for both two wheelers and four wheelers.
- The system uses dynamic speed thresholding, which reduces chances of false accident reporting by the system drastically.
- In case a false case of accident is detected by the system, the user has an option of cancelling of sending the data within the stipulated, predefined time period.

- Emergency services can be provided for the victims on time without any hassles, as the location of the vehicle is transmitted to the emergency service center.

2.4.3 Disadvantages

- Speedometers of vehicles provide an analog output, hence the GPS modem has to be used to make the speed threshold calculations for the vehicle.
- Speed threshold table has to be updated every second, to ensure that the system can detect accidents with reliability.
- The cause of accident and the perpetrator cannot be judged from the MCU transmitted data, as no camera module is used here.
- Image processing applications do not work on this system, as a processor is need for advanced image processing techniques.

2.5 An IoT Approach to Vehicle Accident Detection, Reporting, and Navigation [4]

2.5.1 Description

This paper defines an advanced system that is entirely based on IoT platform for accident detection and post-accident services. This system primarily uses a data base, a server, message sending facility and HTTP services to detect the accident and to intimate the emergency services.

NFC (Near Field Communication) technique is used here, as most of the modern smartphones support this technology. The IoT Bluetooth Low Energy (BLE) communication protocol can be used as an alternative to NFC, to signal the presence of the passenger inside the vehicle.

In case of vehicle's accident, the airbag, or any shock detection mechanism triggers the shock sensor and consequently a Hypertext Transfer Protocol (HTTP) request alerting the occurrence of an accident and its geographical location is sent to the server. Since the server has previously recognized the passengers inside the vehicle, it can now spot the passengers that are in danger. A rescue team can then be sent immediately to the acknowledged location carrying out appropriate medical support since pre-medical info have already been identified by headquarters' operator.

2.5.2 Advantages

- On the headquarter side illustrates a pin instructing the occurrence of an accident. The map also shows the geographical coordinates (longitude, latitude) of the accident location.
- When the operator clicks on the pin, a popup window is displayed, showing all passengers' information. This allows the rescue team to prepare the required medication, treatments, and toolkits beforehand as they have all the information about the passengers.
- New popup window is also displayed showing a sorted list of all rescue teams along with the calculated distances to accident location.
- When the operator select "Team 1", a push notification is sent instructing Team 1 leader to route to the accident location.

2.5.3 Disadvantages

- The system is fully based on 3GPP or LTE system for its working.
- This system is easy to install in a four wheeler but it is very difficult to implement this system in a two wheeler system.
- One operator always has to be present to the monitor the system, as the operator has to allocate the nearby and available emergency service to the accident site.
- If the database to the system crashes, the user information may be lost and it will also lead to wastage of time when an accident has taken place as a general kit has to be taken, instead of the passenger specific kits.

2.6 Design of Accident Detection and Alert System for Motor Cycles [5]

2.6.1 Description

This system uses a MCU in coordination with sensors like piezo, accelerometer, GPS and GSM. The MMA7431 and piezo film sensor give analog voltage outputs corresponding to the deceleration and impact respectively. A deceleration above 2.5g (1g=9.8m/s2) is not likely to occur during a normal bike ride. For 2.5g acceleration, an output of 2.8V is obtained from the accelerometer. A comparator circuit with a reference voltage of 2.8V is used to detect this.

A similar method is followed for the impact sensor also where the reference voltage set to 1V, which is corresponding to a force of 100g.

2.6.2 Advantages

- This system is specially designed according to the accident parameters for two wheelers.
- The system uses two parameters to detect accidents- input from accelerometer and input from piezosensor.
- This is a portable system and occupies very less space on the bike.
- This system uses a GSM modem to transmit the information, hence the system works even in the absence of 3G/Wi-Fi networks.

2.6.3 Disadvantages

- There is no way the perpetrator of the accident can be caught, if the victim is in critical condition or in no state to answer.
- Camera module can be integrated in the system to capture images of the accident.
- If a processor is used instead of MCU, then image processing can be used to extract the required information from the image.

2.7 Intelligent Accident Detection and Alert System for Emergency Medical Assistance [6]

2.7.1 Description

The proposed system consists of an accident detection system and an Android smartphone. The accident detection system will constantly monitor the bike and detect whether the vehicle is in normal driving posture or has fallen own. When the bike fall is detected, the body condition or heartbeat rate of the driver is checked. If any abnormality is found, the Android application connected to the accident detection system, through Bluetooth, will send alert to the nearby medical center about the accident. The system will inform the basic details of the person and the place of the accident using GPS coordinates from the mobile. The system will also inform friends and relatives of the driver, whose contact numbers are already stored in the Android application. The communications between the modules are done by using Bluetooth. The smart phone with the android app will end message to the nearest medical center. The system will also inform the friends and family of the victim

through message. A buzzer is also provided to alert the fellow passengers on the road that an accident has occurred to invite their help.

2.7.2 Advantages

- Compact system design, which can be placed easily on the two wheeler.
- Use of Bluetooth module allows easy information exchange between the smartphone and the system installed on the bike.
- Android smartphone can use either GSM or WiFi/3G services to send the intimation about the accident to the emergency services.
- The system is easy to implement and requires very less initial costing.

2.7.3 Disadvantages

- The system lacks a camera, which can provide the necessary images.
- The system failure rate is high as it uses cheap & commonly available microcontroller.
- If a false case of accident is detected, the user has no option to abort the information exchange midway.

2.8 Intelligent Transportation System for Accident Prevention and Detection [7]

2.8.1 Description

The accident is detected by the fall of the vehicle, using accelerometer sensor. An accelerometer measures the acceleration forces in which it is fitted. Such forces may be static, like the continuous gravitational force or as in the case with many mobile devices, dynamic to sense movement or vibrations. Acceleration is the measurement of the change in velocity or speed divided by time. The accelerometer sensor measures the acceleration in three orthogonal axes. If an accident is detected, then the information is sent to the android mobile using Bluetooth module. The sensor with Bluetooth module will trigger emergency and transmit the data over Bluetooth communication. The Smart phone will sent the message along with other information like current location tracked by GPS on phone, mobile number (person's identity) and incident time. Program in Smartphone can be used to forward the same information to a registered number via TCP/IP.

2.8.2 Advantages

- The system requires the optimum space amongst all the before mentioned systems.
- It takes into account, all the basic accident detection parameters for two wheelers.
- The system uses Bluetooth to transmit data to a powerful processor of a smartphone.
- The processor on the smartphone then processes the data and sends the GPS location and relevant data to emergency services using the in-built GPS or GSM modules.

2.8.3 Disadvantages

- This system can be improved further if a picture capturing camera is included in the setup.
- Since processor from the smartphone is already being used, the image that is captured can be easily processed to get relevant information.
- If the smartphone encounters any unwarranted issues, then the Bluetooth data cannot be transmitted and system becomes redundant.
- If the vehicle is travelling in region where there is no GSM connectivity, then the accident detection system becomes irrelevant.

Chapter 3

Working & Implementation

3

3.1 Block Diagram of System

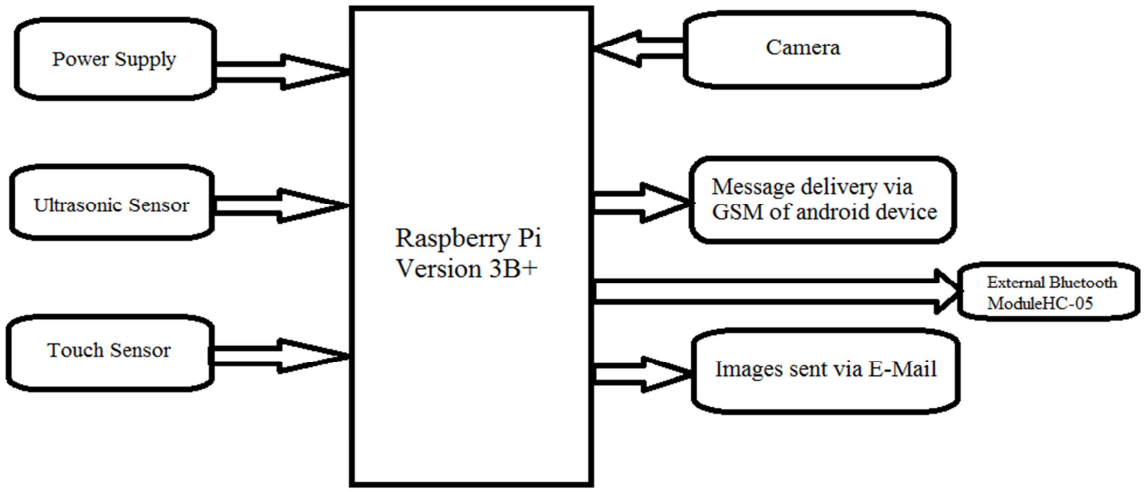


Figure 3.1: Block diagram of system

3.2 Accident Detection Circuit

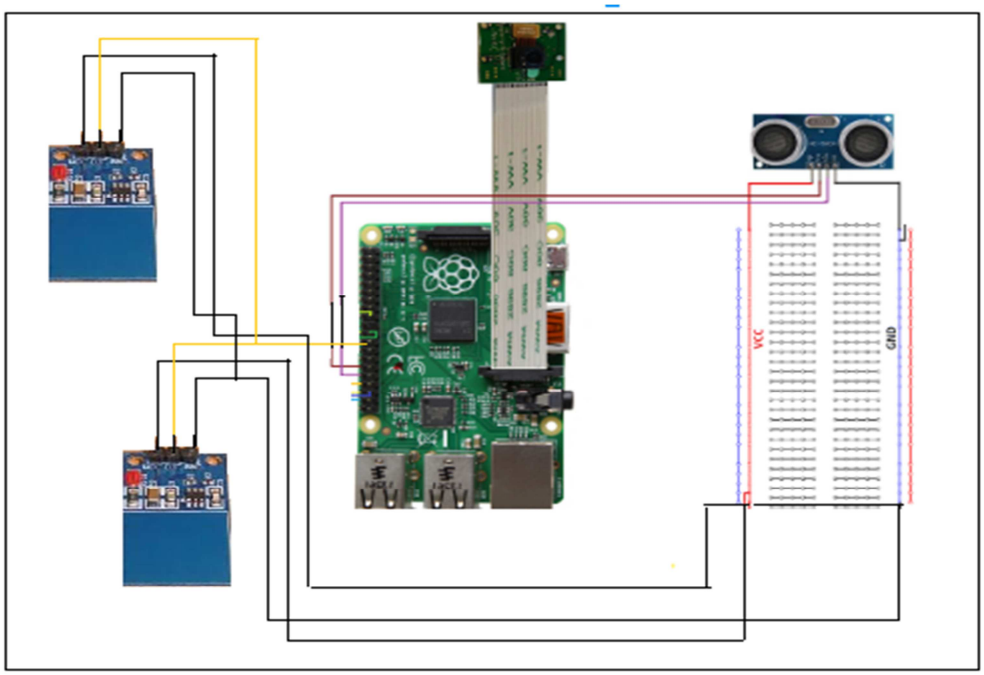


Figure 3.2: Accident Detection Circuit

3.2.1 Accident Detection Circuit Description

- Ultrasonic sensor is interfaced with raspberry pi using four pins VCC, GND, TRIG and ECHO to pin no 2, 6, 16 and 18 respectively.
- Android application is used for GSM and GPS to track the location and send the data to the registered users.
- Touch sensor is interfaced with raspberry pi using three pins VCC, GND, OUT to pin no 2, 6, and 11 respectively.
- The ribbon cable of the camera must be inserted at the camera port provided on the board.
- The required packages and drivers must be installed accordingly.
- The camera is mounted on the servo motor shaft to click the images at required angles.

3.3 Working and Flowchart of Accident Detection Circuit

The system uses two basic sensors and their parameters to detect if an accident has taken place. The primary sensor that is used is ultrasonic sensor. Python coding is required as the software counterpart for the sensor interfacing with the Raspberry Pi processor. The output is in the range from few mm to about 20 cm which can be taken into consideration as per the thresholds set in the python code for the sensor. Ultrasonic sensor works as a threshold trigger in this system, that is, the output of ultrasonic sensor is used to trigger other sensors.

Touch sensor is used as a secondary sensor in conjecture with ultrasonic sensor. Touch sensor converts the sensitivity of touch to electric signals. The threshold limiting value for touch sensor can be predefined in the python code. The output of touch sensor that crosses the threshold limit can be used as a trigger for camera to capture the image. The trigger by touch sensor is also taken as a signal to transmit the GPS and GSM output to the emergency services.

Accident detection system is designed in such a way that the camera is triggered to click an image whenever an accident is detected. The basic objective of adding a camera to the system is to ensure that the image of the surrounding can be taken, in case of accident. The camera is placed strategically on the vehicle to capture the image of surroundings. The image that is captured gets stored in the SD Card that is loaded on the Raspberry Pi. The image can be sent to a server after capturing or it can be sent for object detection using advanced image processing codes. If the image is sent to server, remote access can be

provided to the user and it will also be of help in finding the perpetrator of the crime. The steps that are followed during the execution of the project are as follows:

1. The code is initialized
2. Sensors take about 3-5 seconds to settle.
3. Android application has to be connected to the Raspberry Pi processor using the external Bluetooth Module HC-05.
4. The Ultrasonic Sensors sense the distance to nearest objects in all four directions.
5. The threshold distance for Ultrasonic sensors is set at 10cm. If any object comes closer than 10cm during the scanning process, then the camera is rotated in that direction.
6. Consider that sensor at front is sensor 1, sensor at right is sensor 2, sensor at back is sensor 3 and sensor at left is sensor 4. Initially the camera is facing the front. During scanning if any object comes closer than the threshold distance in the right direction, then sensor 2 senses the distance and sends a warning to processor. The camera is then rotated towards the right by 90” and an image is captured.
7. When there is a contact of any object with the host vehicle, the touch sensor sends the data to processor.
8. The processor sends a message to the android application. The code word used here is ‘Q’. ‘Q’ is used as a code word because it has very less probability of occurrence in the spoken language and hence the chance of corruption of data command is very less.
9. When the code word is received by the android application, it sends a message to the numbers stored in the database by the use of GSM module in Mobile device stating that an accident has taken place. It also sends the location of accident along with the intimation. (Refer results for images)
10. The image that is captured by the camera is then sent via E-Mail to the address of the recipient that is stored on the processor.(Refer result for images)

Chapter 4

Software and Component Description and Specifications

4

4.1 List of Components

- Raspberry-Pi Version 3B+
- Pi Camera
- Touch Sensor
- Ultrasonic Sensor HC-SR04
- Bluetooth HC-05

4.2 Component Description

4.2.1 Raspberry -Pi 3 Model B Version -2

The Raspberry Pi is a Linux based microcomputer based on ARM architecture. It was built mainly to aid in developing open source game. The Raspberry Pi 3 Model B Version 2 is the most updated version of the Raspberry pi family. This model use the same SoC (System on Chip - combined CPU & GPU)

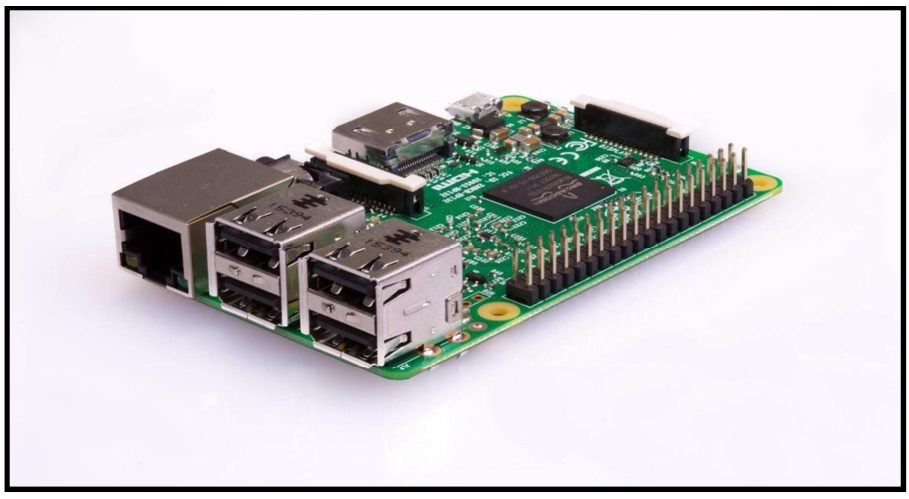


Figure 4.2.1: Raspberry-Pi Model 3 [9]

The Raspberry Pi is at the heart of the project applications, the part that ties all the other components together and allows them to function in coordination to one another. The Raspberry Pi is a fully functioning computer, albeit a low cost, credit-card sized one, that is capable of doing almost everything expected from a desktop computer. On-chip Bluetooth

module as well as the Wi-Fi module eases the connectivity and interfacing with peripheral devices. [9]

Raspberry Pi Operating Systems: An operating system makes Raspberry Pi run. Since Raspberry Pi is a credit sized computer that is based on Linux, optimum performance of RPI can be achieved if it is therefore operated in this environment. Raspbian OS is the basic Operating System that is used for Raspberry-pi. It comes with over 35,000 packages, precompiled software bundled in a nice format for easy installation on RPI. [16]

The Raspberry Pi may be operated with any generic USB computer keyboard and mouse. It may also be used with USB storage, USB to MIDI converters, and virtually any other device/component with USB capabilities. Other peripherals can be attached through the various pins and connectors on the surface of the Raspberry Pi.[9]

Table 4.2.1 Specifications of Raspberry-Pi Model 3 [9]

On-Chip Hardware	**Specifications**
CPU	Quad-core 64-bit ARM Cortex A53 Clocked at 1.2 GHz
GPU	400MHz VideoCore IV Multimedia
Memory	1GB LPDDR2-900 SDRAM (i.e. 900MHz)
USB ports	4
Network	10/100 Mbps Ethernet and 802.11 Wireless LAN
Power Source	5V via MicroUSB or GPIO header
Video Outputs	HDMI, composite video (PAL and NTSC) via 3.5mm jack
Peripherals	17 GPIO plus specific functions and HAT ID bus

Size	85.60mm x 56.5mm
Weight	45g
Bluetooth	4.1

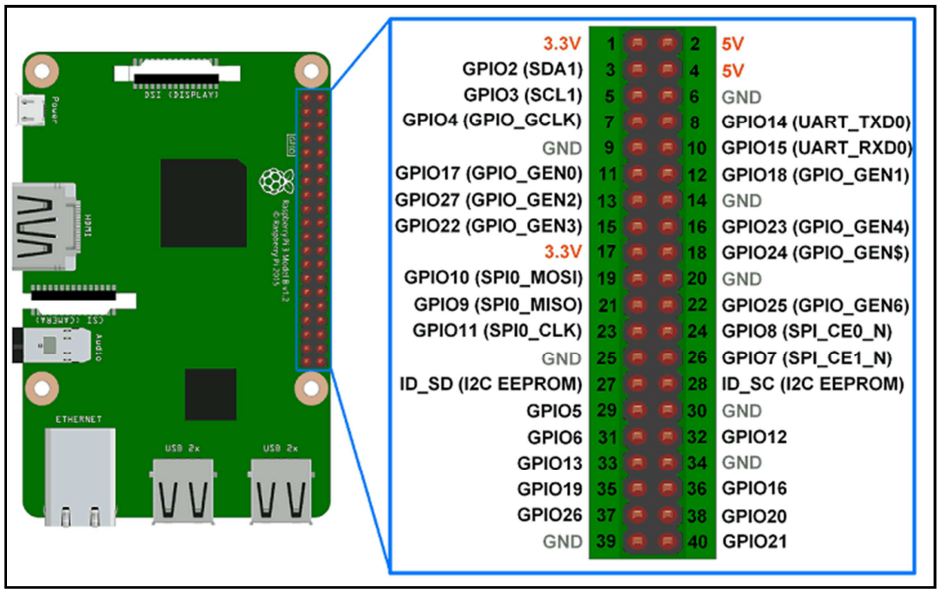


Figure 4.2.2: General purpose input-output (GPIO) connector [10]

4.2.2 The Pi Camera

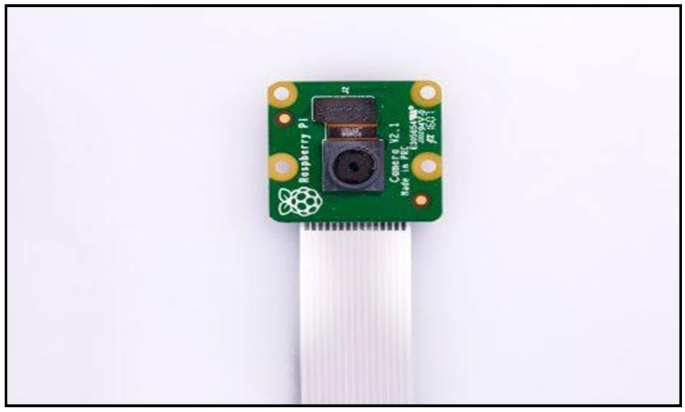


Figure 4.2.3: Raspberry-Pi Camera Module [11]

The Camera Board on the Raspberry Pi is a small printed circuit board with a camera on it. The PCB is connected to a ribbon cable which connects to the Pi itself on its own port.

The ribbon can be extendable. The camera on the board is very small (5MP camera). As for now it is the only Camera made specifically for the Pi. Since it uses 250mA, externally powering the Pi should be sufficient enough for the camera Specific configuration settings are required to initialize the camera plus a Python script to enable it take pictures. The module has a five megapixel fixed-focus camera that supports 1080p30, 720p60 and VGA90 video modes, as well as stills capture. It attaches via a 15cm ribbon cable to the CSI port on the Raspberry Pi. It can be accessed through the MMAL and V4L APIs, and there are numerous third-party libraries built for it, including the Picamera Python library. The camera module is very popular in home security applications, and in wildlife camera traps. [11]

4.2.3 Touch Sensor

Figure 4.2.4: Touch Sensor [12]

The TTP223 is a touch pad detector IC which offers 1 touch key. The touching detection IC is designed for replacing traditional direct button key with diverse pad size. Capacitive touch allows electronics to sense when your finger is within a few millimetres of a surface to simulate a button “press” just like how the pushbutton works. Capacitive sensing may be used in any place where low to no force human touch sensing is desirable. [12]

Specifications

- On-board TTP223 capacitive touch a single bond induction IC
- Board level indicator
- Working voltage: 2.0 V to 5.5 V
- Size of the PCB board: 29mm x 16mm.

Pin Configuration

1. VCC: 2V to 5.5V DC
2. OUT: high/low output
3. GND: ground

4.2.4 Ultrasonic Sensor HC-SR04

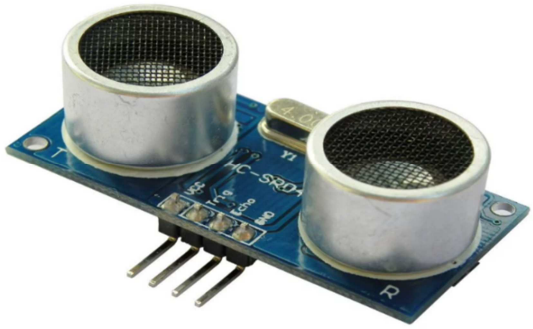


Figure 4.2.5: Ultrasonic sensor HC-SR04 [13]

The ultrasonic sensor uses sonar for detecting the distance to an object in front of it. Ultrasonic waves are used because they are relatively accurate across short distances and don't cause disturbances as they are inaudible to human ear. It has 4 pins that are +5V, GND, Trigger and Echo. Its working current is 15mA, which is within the maximum current is withdrawn for the Pi's 5V power pin. The trigger is used to send a pulse to the sensor, which tells it to start measuring distance. It then sends a sonic pulse and measures the time it takes for the pulse to reflect off the surface in front of it and return to the sensor. Finally, it sends a high pulse on the Echo pin and the time for which this pulse remains high is equal to the time it took for the sound to return to the sensor. The distance can be calculated by the basic formula that is given as

$$\text{Distance} = \text{Speed} \times \text{Time}$$

This, however, gives us the total distance, which includes travelling to the object and back. Therefore, it must be halved to get the actual distance of the object from the sensor. [13]

Table 4.2.2 Ultrasonic Sensor Specifications [13]

Electrical Parameters	HC-SR04 Ultrasonic Module
Operating Voltage	DC-5V
Operating Current	15mA
Operating Frequency	40KHZ
Farthest Range	4m
Nearest Range	2cm
Measuring Angle	15 Degree
Input Trigger Signal	10us TTL pulse
Output Echo Signal	Output TTL level signal, proportional with range
Dimensions	45*20*15mm

Timing of ultrasonic sensor HC-SR04

The sensor has 4 important pins VCC, TRIG, ECHO and GND. In order for the activation of sensor, supply the voltage to TRIG pin and set it to high for 10µS impulse. Once the trigger input is set to high, the signals are sent and the module will send out 8 cycle of ultrasound at 40 kHz in order to set the ECHO pin to high. The ECHO pin is set to high when the signal has reached back to the sensor. Once the signal has reached, the distance is determined based on the difference between the starting and the ending time. Equation shows how to compute the distance in microseconds per centimeter. [14]

Distance = Speed/170.15 m × Meters /100 cm × 1.6 us/ 170.15 m × 58.772us cm

Equation for Distance calculation

The timing diagram is shown in the below figure

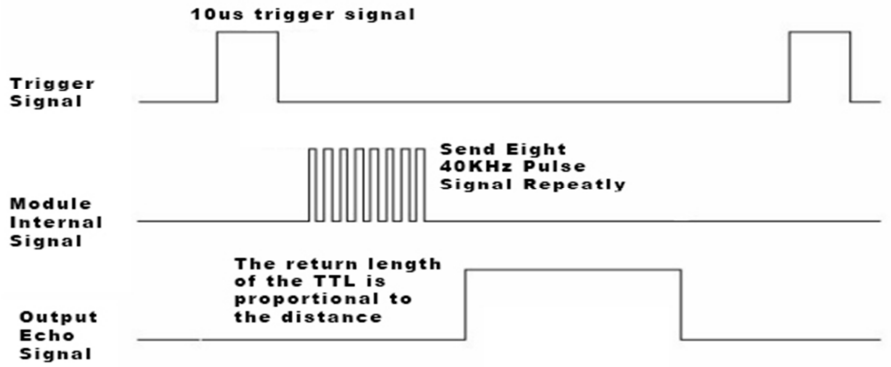


Figure 4.2.6: Timing Diagram for Distance Measurement [14]

4.2.5 Bluetooth Module HC-05

The **HC-05** is a very cool module which can add two-way (full-duplex) wireless functionality to your projects. You can use this module to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop. There are many android applications that are already available which makes this process a lot easier. The module communicates with the help of USART at 9600 baud rate hence it is easy to interface with any microcontroller that supports USART. We can also configure the default values of the module by using the command mode. So if you looking for a Wireless module that could transfer data from your computer or mobile phone to microcontroller or vice versa then this module might be the right choice for you. However do not expect this module to transfer multimedia like photos or songs; you might have to look into the CSR8645 module for that. [17]

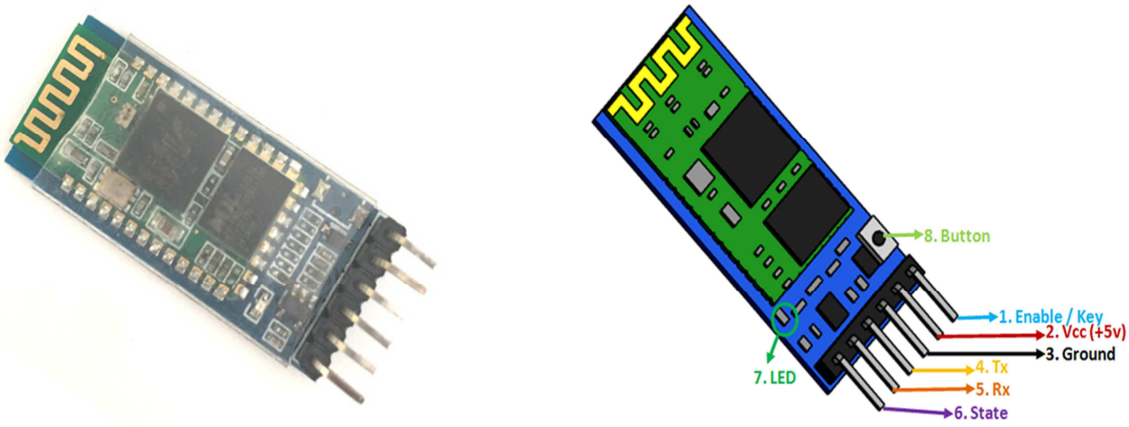


Figure 4.2.7: Bluetooth Module HC-05 with its Pin Configuration [15]

The **HC-05** has two operating modes, one is the Data mode in which it can send and receive data from other Bluetooth devices and the other is the AT Command mode where the default device settings can be changed. We can operate the device in either of these two modes by using the key pin as explained in the pin description. [15]

It is very easy to pair the HC-05 module with microcontrollers because it operates using the Serial Port Protocol (SPP). Simply power the module with +5V and connect the Rx pin of the module to the Tx of MCU and Tx pin of module to Rx of MCU.

HC-05 Technical Specifications

- Serial Bluetooth module for Arduino and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

4.3 Software Used

- Python 3.4.3
- Android

4.4 Software Description

4.4.1 Python 3.4.3

Python is an interpreted, high-level, general-purpose programming language. Created by Guido van Rossum and first released in 1991, Python has a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales. Van Rossum led the language community until July 2018.

Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including procedural, object-oriented, and functional programming. Python features a comprehensive standard library, and is referred to as "batteries included". Python interpreters are available for many operating systems. CPython, the reference implementation of Python, is open-source software. Python programming is used as a primary programming code to control the working of different sensors in the system. [18]

The libraries mainly used for this project are the following two main libraries, with an optional third:

1. Python-OpenCV
2. Numpy
3. Matplotlib.

1. OpenCV

OpenCV is an image and video processing library with bindings in C++, C, Python, and Java. OpenCV is used for all sorts of image and video analysis, like facial recognition and detection, license plate reading, photo editing, advanced robotic vision, optical character recognition. The basic goals of OpenCV are as follows:

- Advance vision research by providing not only open but also optimized code for basic vision infrastructure. No more reinventing the wheel.
- Disseminate vision knowledge by providing a common infrastructure that developers could build on, so that code would be more readily readable and transferable.
- Advance vision-based commercial applications by making portable, performance-optimized code available for free – with a license that did not require code to be open or free itself. [19]

2. NumPy

NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays. The ancestor of NumPy, Numeric, was originally created by Jim Hugunin with contributions from several other developers. In 2005, Travis Oliphant created NumPy by incorporating features of the competing Numarray into Numeric, with extensive modifications. NumPy is open-source software and has many contributors.

Limitations of NumPy and why it is used in coordination to OpenCV can be due to the following reasons:

- Inserting or appending entries to an array is not as trivially possible as it is with Python's lists. The np.pad(...) routine to extend arrays actually creates new arrays of the desired shape and padding values, copies the given array into the new one and returns it. NumPy's np.concatenate([a1,a2]) operation does not actually link the two

arrays but returns a new one, filled with the entries from both given arrays in sequence. Reshaping the dimensionality of an array with np.reshape(...) is only possible as long as the number of elements in the array does not change. These circumstances originate from the fact that NumPy's arrays must be views on contiguous memory buffers. A replacement package called Blaze attempts to overcome this limitation.

- Algorithms that are not expressible as a vectorized operation will typically run slowly because they must be implemented in "pure Python", while vectorization may increase memory complexity of some operations from constant to linear, because temporary arrays must be created that are as large as the inputs. Runtime compilation of numerical code has been implemented by several groups to avoid these problems; open source solutions that interoperate with NumPy include scipy.weave, numexpr and Numba. Cython and Pythran are static-compiling alternatives to these. [20]

3. Matplotlib

Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, wxPython, Qt, or GTK+. There is also a procedural "pylab" interface based on a state machine (like OpenGL), designed to closely resemble that of MATLAB, though its use is discouraged. SciPy makes use of Matplotlib. Matplotlib is an optional choice for displaying frames from video or images. We are using the python-specific bindings for OpenCV called python-OpenCV. [21]

4.4.2 Android

Android is a mobile operating system developed by Google. It is based on a modified version of the Linux kernel and other open source software, and is designed primarily for touchscreen mobile devices such as smartphones and tablets. In addition, Google has further developed Android TV for televisions, Android Auto for cars, and Wear OS for wrist watches, each with a specialized user interface. Variants of Android are also used on game consoles, digital cameras, PCs and other electronics. Android has been the best-selling OS worldwide on smartphones since 2011 and on tablets since 2013. As of May 2017, it has over two billion monthly active users, the largest installed base of any operating system, and as of December 2018.

The open and customizable nature of Android allows device makers to use it on other electronics as well, including laptops, netbooks, and desktop computers, cameras, headphones, home automation systems, game consoles, media players, satellites, routers, printers, payment terminals, automated teller machines, and robots. Additionally, Android has been installed and run on a variety of less-technical objects, including calculators, single-board computers, feature phones, electronic dictionaries, alarm clocks, refrigerators, landline telephones, coffee machines, bicycles, and mirrors. An android application was designed for this project to send the GSM message that an accident has occurred and to pinpoint the location of the accident on the android supported phone. [22]

4.5 Algorithm for Code

1. Initialize the sensors
2. Create a Bluetooth Socket for connecting android device to the raspberry pi processor.
3. Calculation of distance by ultrasonic sensor put into a function
4. Calling the distance calculation function for each ultrasonic sensor.
5. Verify if distance calculated is less than threshold distance?
6. If no go to step 3
7. If yes, then rotate the camera in the direction in which the distance is less than the threshold distance.
8. Capture the image.
9. Touch sensor is then activated.
10. If no object touches the bike, go to step 3
11. If any object touches the bike system, then a command is sent to android application.
12. The GSM of android device is used to send a message to the numbers stored in the application.
13. The images that are captured are sent via E-Mail to the address stored in the processor.

4.6 Flowchart for the Code

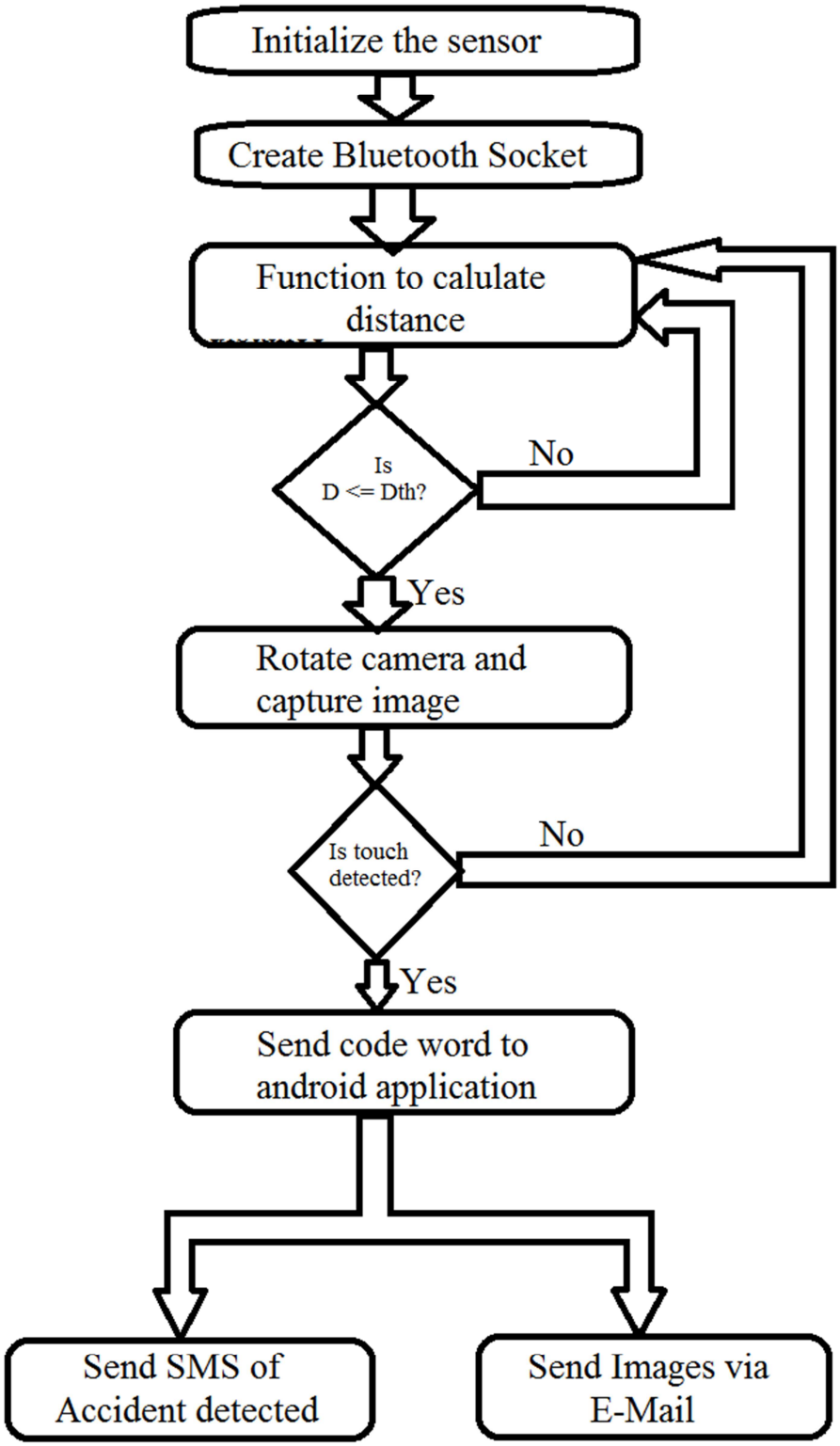


Figure 4.2.8: Flowchart of Code

Chapter 5

Results

5

- The first part of the system i.e. sensors were implemented with camera module and output was observed with various steps snipped and output attached.
- Python code for camera module and sensors was implemented in a loop and was made to run in a single code.

Work done in Semester VII

- Implementation of ultrasonic sensor for distance measurement and as a trigger for activation of other secondary sensors.
- Implementation of touch sensor as a secondary sensor that works due to the trigger provided by primary sensor.
- Output of Touch sensor is used to trigger the camera module to capture image.
- OpenCV module for image processing was installed along with all its libraries necessary for image processing (Numpy, Matplotlib).

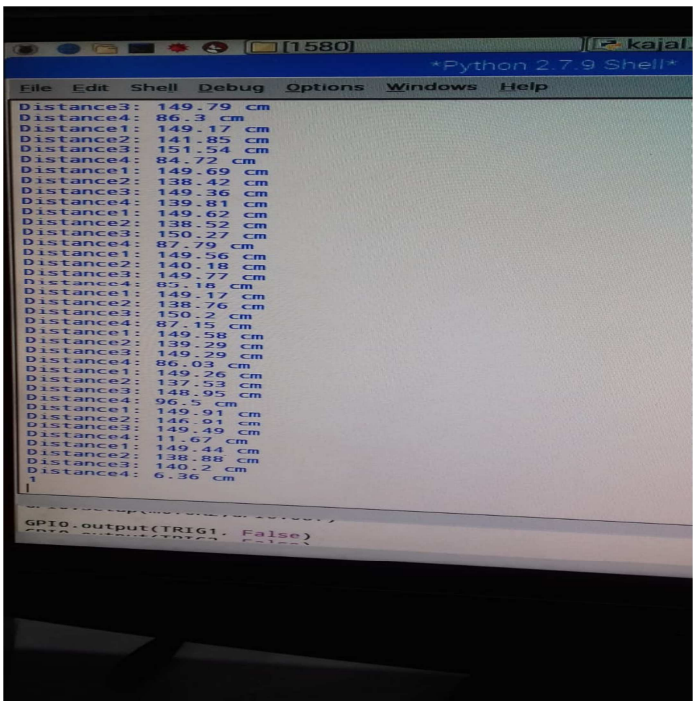


Figure 5.1: Output of Ultrasonic Sensors

Work done in Semester VIII

1. Developing android application for GPS and GSM to pin point the location and send the location to registered users respectively.
2. Developing an android application as an interface between smartphone and the Raspberry Pi processor.
3. Using the in-built GPS module from the smartphone and data sent from the Raspberry Pi processor using Bluetooth to send the data to registered contacts and emergency services.
4. PCB implementation for the project.

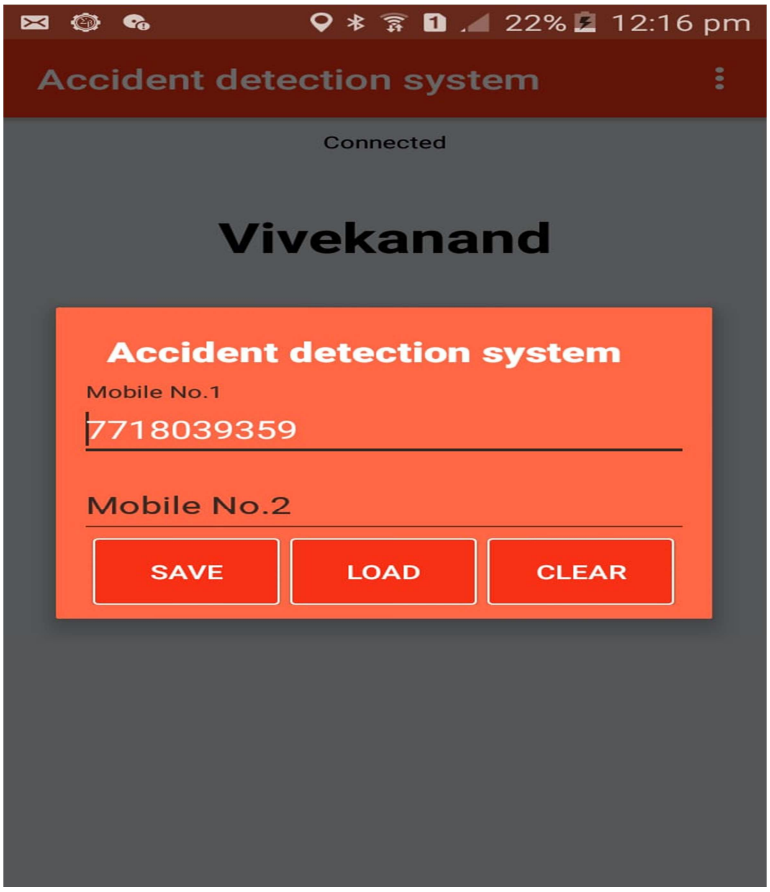


Figure 5.2: Screenshot showing number being loaded for SMS to be sent

Figure 5.3: SMS indicating occurrence and location of accident

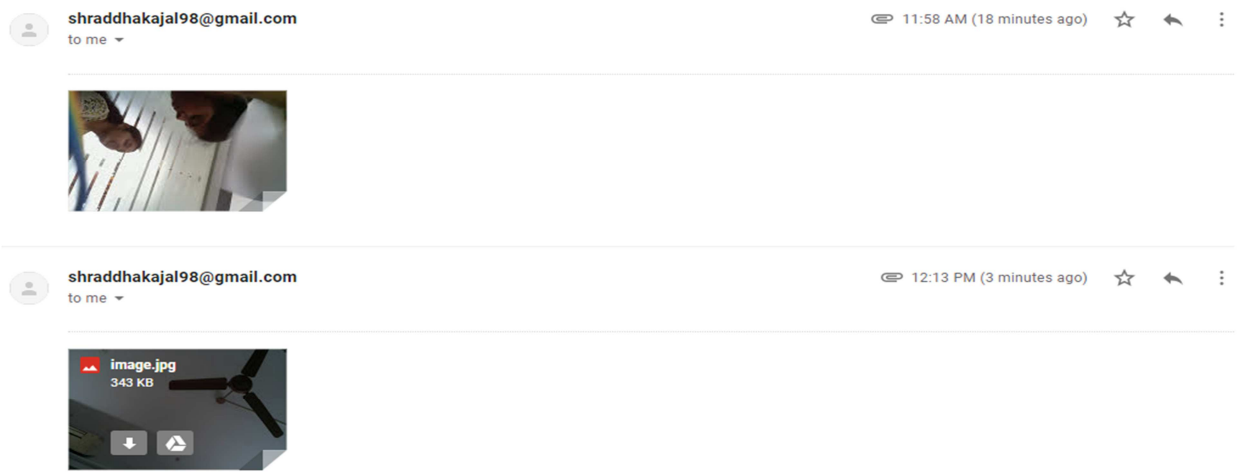


Figure 5.4: Images captured by the Pi camera sent on E-Mail

Figure5.5: Sample of images captured by the Pi camera

Future Scope:

1. With certain basic modification it can be implemented on four wheeler vehicles with the help of which accidents can be detected.
2. By processing the image we get as output we can extract the vehicle number plate information.
3. The System can be developed in such a manner that as soon as accident is detected a quick emergency response will be sent to nearby hospitals.
4. It can be implemented in trains also by increasing the sensitivity of sensor and if accident is detected information has to be sent to train drivers as well as to main server

Chapter 6

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6

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