BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI (Hyderabad)

PROJECT TITLE: COLLISION DETECTING SMART HELMET

Submitted as part of the course

INSTR F311 - Electronic Instruments and Instrumentation Technology

and

INSTR F312 Transducers and Measurement Systems

BY

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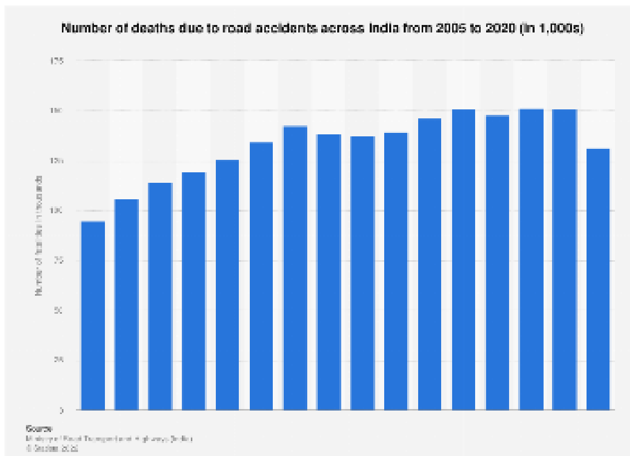
ABSTRACT

Accidents are one of the most common causes of deaths. This project aims to make a collision detection smart helmet which shall detect that a collision has occurred and send call emergency services and notify the victims emergency contacts as well. The smart helmet will detect the collision on the basis of the principle of piezoelectric effect. Once the collision is detected we shall use a bluetooth module to notify emergency contact and services. We have also tried to cover the possible areas of defect like faulty and unmanned collisions by using the principles of instrumentation technology by using an inertial measurement unit(IMU).

1. INTRODUCTION

Road accidents are considered to be one of the most common ways to cause death to an individual. In our country itself, nearly 17.4 lakh people die due to road accidents in a year. A lot of deaths can be avoided if prompt medical intervention takes place.



Here we come up with a solution which solves the problem of late information of the accident to the concerned authorities and families. A smart helmet works on the principle of the piezoelectric effect, which uses a piezoelectric sensor that measures the intensity of shock and generates an electric charge.

Based on the results of this sensor, an SMS is sent to the emergency contacts of the person. In this way, it helps to minimize the time of information. The GPS location of the person is sent directly to the concerned person and authorities which makes the process even faster.A notification to the person is also provided so that he/she can cancel the alert if the injury is not that fatal.

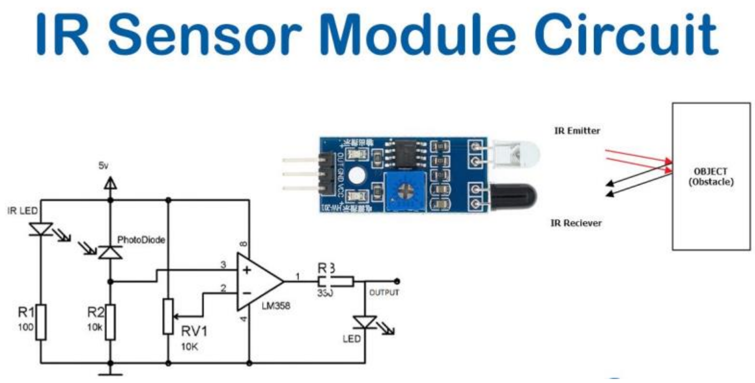
2. COMPONENTS USED IN THE PROJECT

2.1 Arduino Uno

The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits. The IDE is common to all available boards of Arduino.

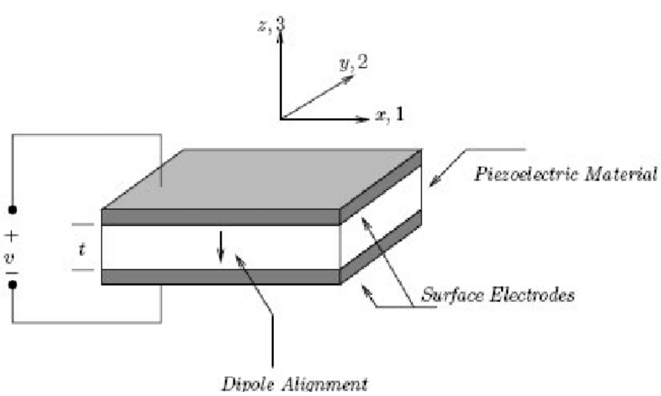
2.2 Infrared sensor MHB

An infrared sensor is a sensor that measures and recognises infrared radiation in its environment.Infrared sensors are of two types, active and passive.Active infrared sensors have both, an emitter and a receiver. The emitter is basically an LED. Whenever an object comes close to the infrared sensor, the LED emits IR waves which are reflected back by the object. The emitter receives those radiations and indicates an object in front of the sensor. Active IR sensors act as proximity sensors. In our project, the infrared sensor is used to detect if a person is wearing the helmet - that is if there is a head inside the helmet enabling us to avoid any false alarms that might be generated by the helmet simply falling while not in use. In this project the sensor can detect objects up to a distance of 20cm. This distance can be changed with the help of the variable resistor attached to the sensor.



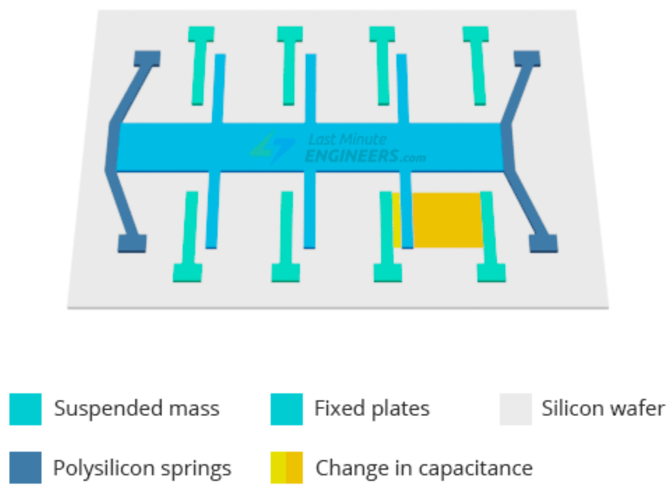
2.3 Piezoelectric sensor

Piezoelectric effect can be explained as the ability of certain materials to produce an electric charge on the application of pressure,shock,temperature.It is also called a piezoelectric transducer because it converts mechanical energy to electrical signals. Piezoelectric sensors have two output pins: one given the potential of ground and the other is given a positive potential which is connected to the analog pin of the arduino. These devices help in measuring physical quantities like changes in pressure, temperature, rate of motion. These sensors come handy for the measurement of impact or collision for the case of smart helmets.



2.4 Accelerometer (ADXL 335)

The ADXL335 is a compact, thin, full 3-axis MEMS accelerometer with low power and voltage outputs that have been signal-conditioned. It has a full-scale range of 3g and operates on 1.8 to 3.6VDC. For interfacing with arduino 3.3V is used. It can measure both: static acceleration caused due to gravity and dynamic acceleration caused by motion,shock or vibration. The accelerometer has a silicon wafer base and two polysilicon springs. These springs allow the structure to deflect when there is an acceleration along any of the three axes. This causes a change in the capacitance between the fixed plates and the plates attached to the structure.This change in capacitance is proportional to the acceleration along the axes.



2.5 HC05 Bluetooth Module

The HC05 Bluetooth module is an IEEE 802.15.1 rated protocol that can be used to have personal area network. This module communicates with microcontrollers using a serial port. The maximum voltage limit of this module is 3.3 volts. It uses the 2.45 Hz frequency band.The red light on the module indicates the connection. It consists of 6 pins.

- key/EN
- VCC
- GND
- TXD
- RXD
- State

For communication with the mobile device, the mobile device needs to have both an emitter and a receiver,which is present in all the new age mobile phones. The module gets connected to the smartphone just in a way any other Bluetooth device would get. The transfer rate of the data can vary up to 1 mbps and in the range of 10 meters. This module can be operated with a power supply of 5 volts. Band rates of 9600,19200,38400,57600 are supported by the module for communication. In the data mode, the module can be used to transfer the data files with the connected device.

3. WORKING

The infrared sensor is used to detect the head inside the helmet.This is done so that there is no false signal due to the helmet falling down on the ground.It is used to sense if the helmet is in use .It does by measuring the reflected infrared wave from the head, i.e. around 20 cm which could be adjusted using the potentiometer on the IC.

The second part includes the piezoelectric sensor which produces voltage signals on application of pressure on it. So the sensor is connected to Arduino which detects the voltage values, which when a spike in the value is detected, alerts the system.

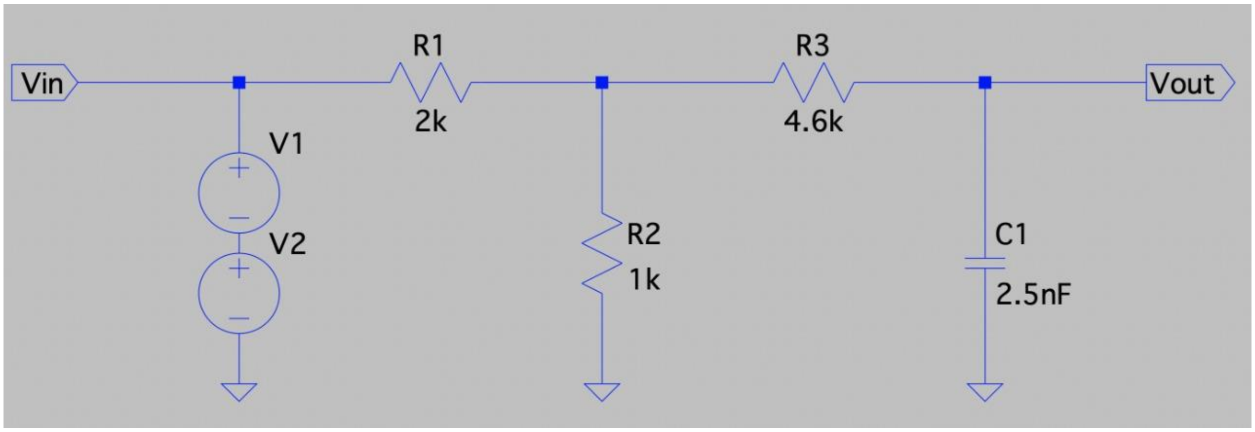


Fig 3.1 Piezoelectric equivalent circuit

This is connected to a L-shaped attenuator which attenuates the input signal 3x. This attenuated signal is then passed through a passive capacitor based low-pass filter with a cutoff frequency of 60Hz. This frequency was chosen from a series of trial and error method.

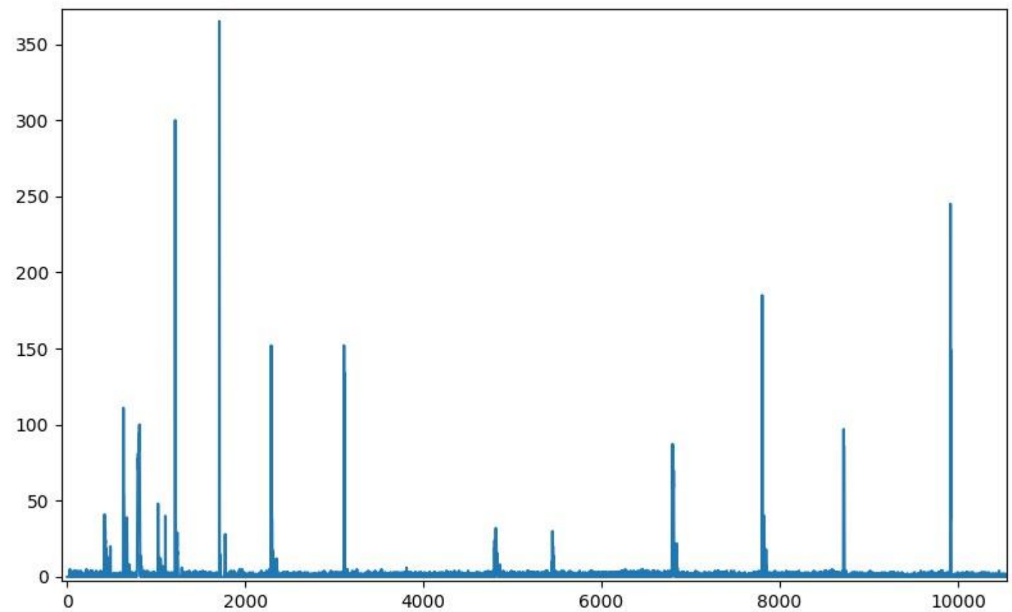


Fig 3.2 Piezoelectric Normal Graph

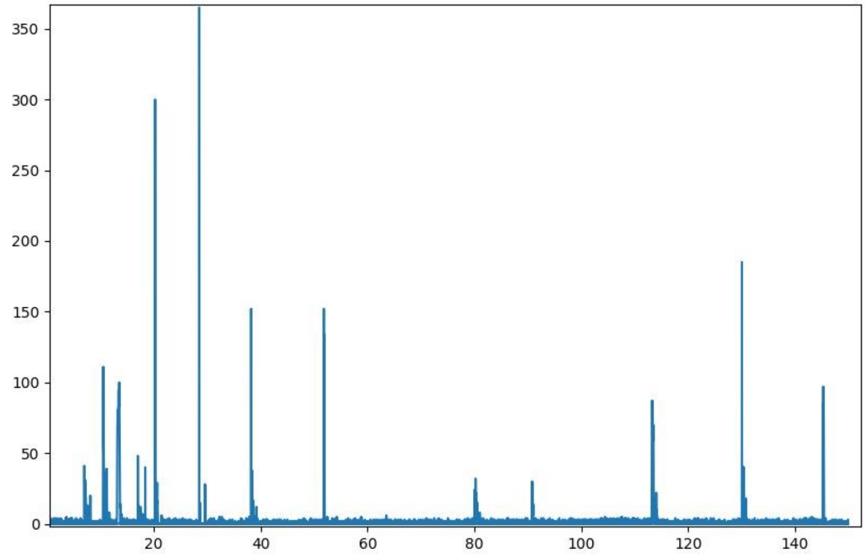


Fig 3.3 Piezoelectric Fast Fourier Transform

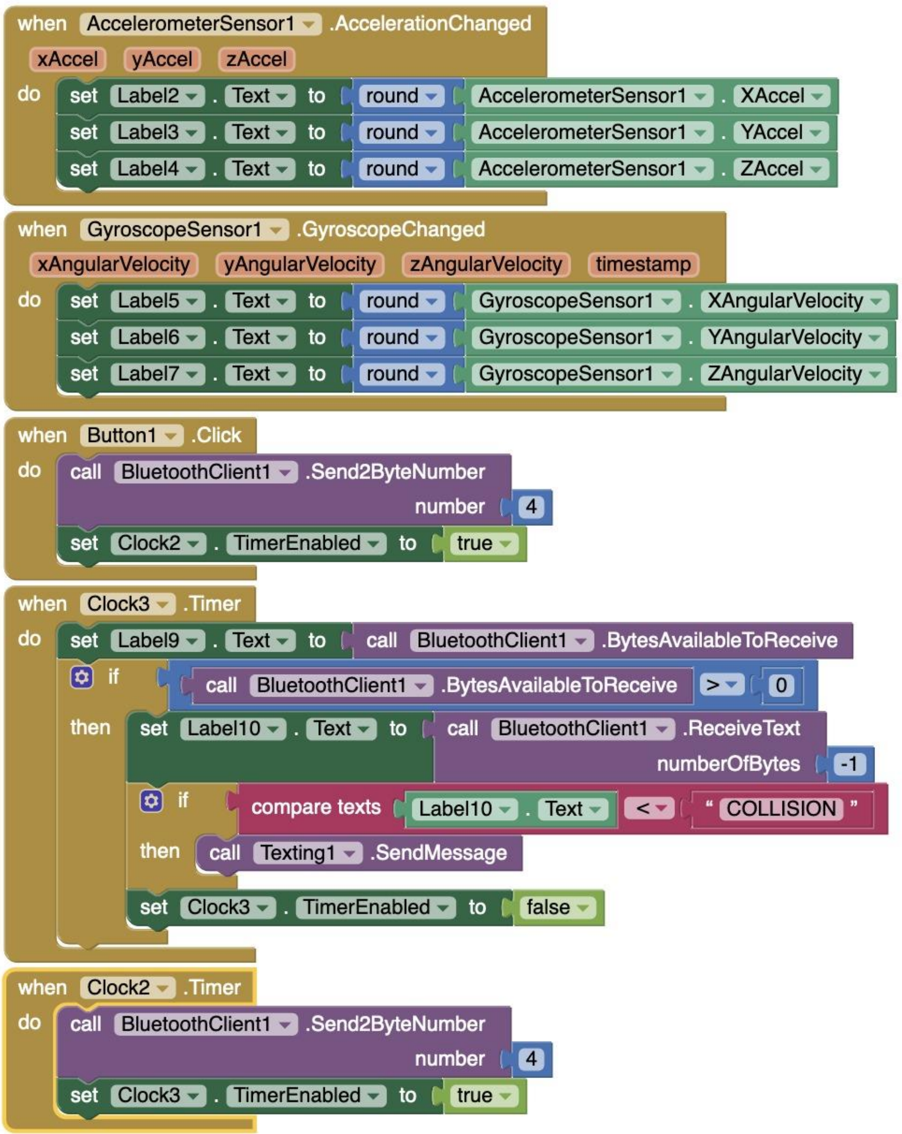
Data was taken from a piezoelectric sensor with noise and FFT was applied to see the frequency response of the sensor. Most of the noise resides above 100Hz and useful spikes below 62Hz.

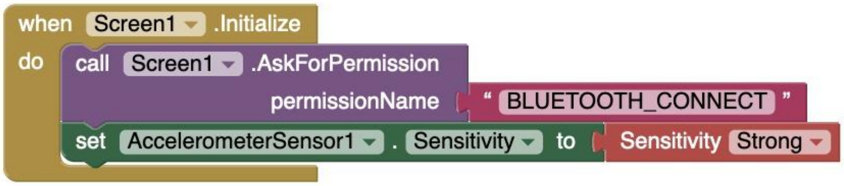
Also with the piezoelectric data, accelerometer data was taken into account.

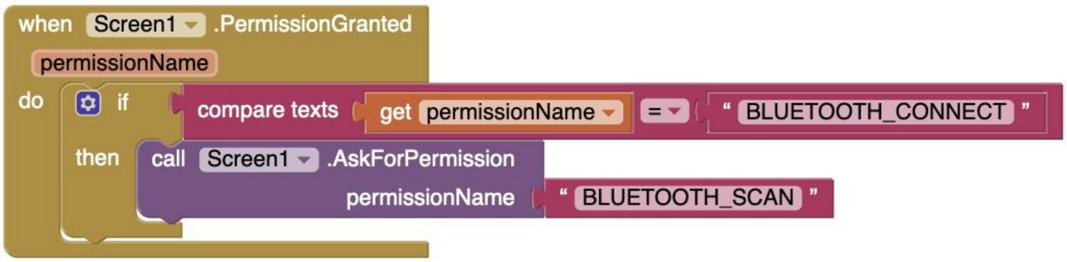
By finding out the acceleration and deceleration of a normal car to be between 0.2g to 0.8g, we set an appropriate threshold value.

After a collision is detected by satisfying certain outputs from transducers, a boolean variable is set true, which sends the data through bluetooth to an android device.

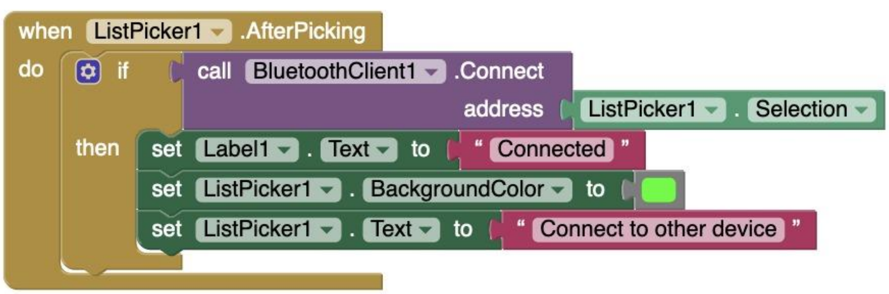
The android device has an implementation of an internal clock which ticks every 10 seconds to check whether there is a collision or not. If there is collision, it is then taken and represented as text on screen.

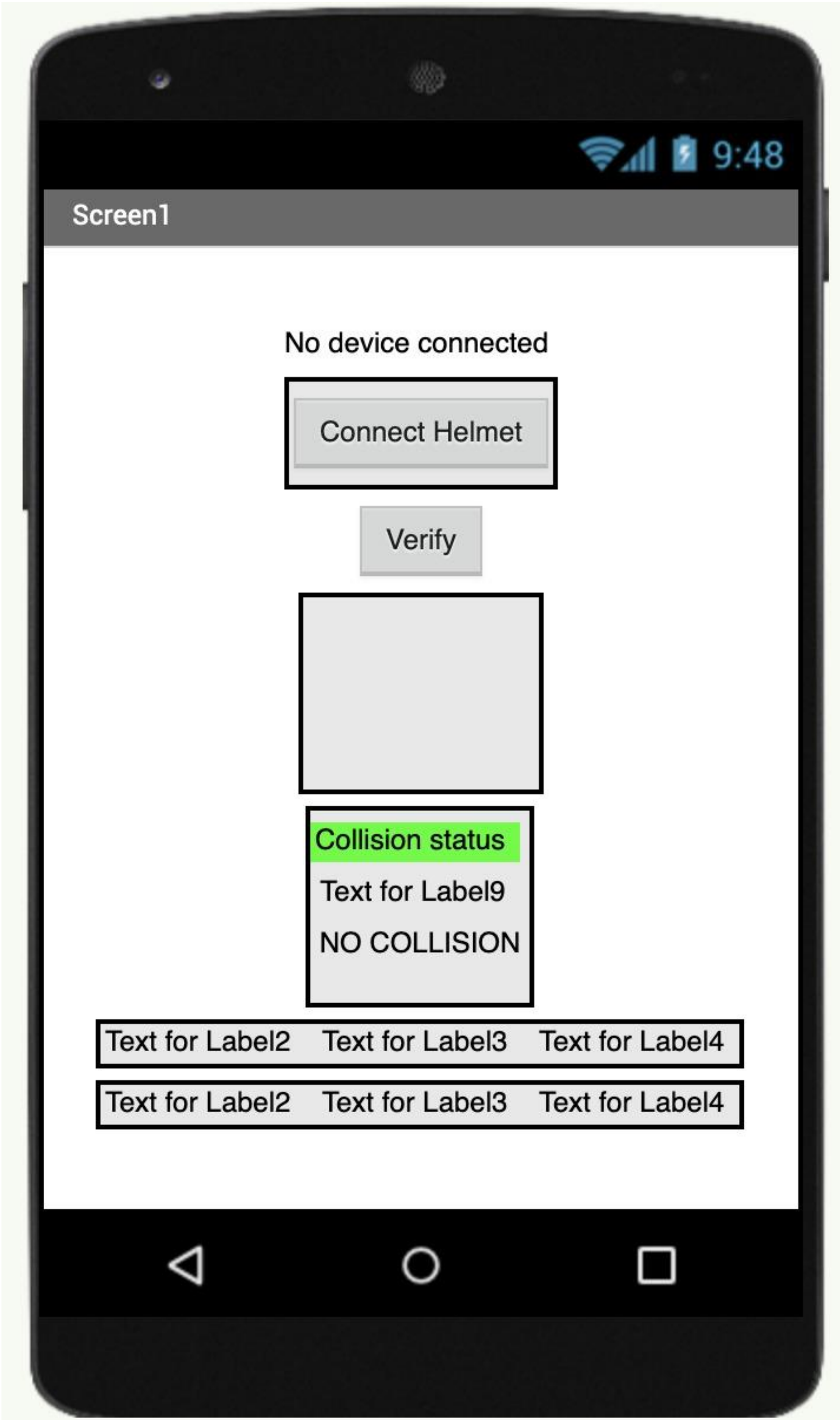



when Screen1 .Initialize
do call Screen1 .AskForPermission
permissionName " BLUETOOTH_CONNECT "
set AccelerometerSensor1 . Sensitivity to Sensitivity Strong

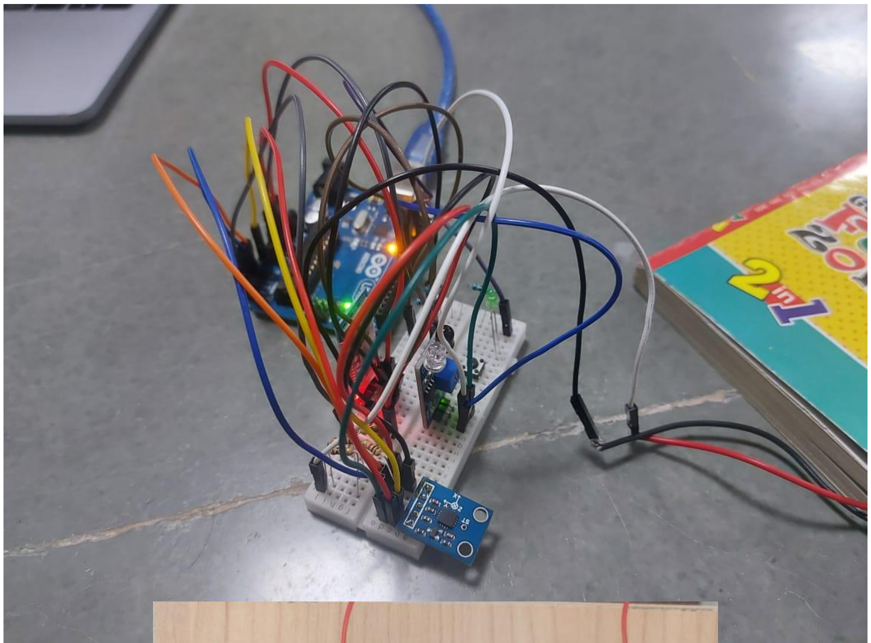

when Screen1 .PermissionGranted
permissionName
do if compare texts get permissionName = " BLUETOOTH_CONNECT "
then call Screen1 .AskForPermission
permissionName " BLUETOOTH_SCAN "

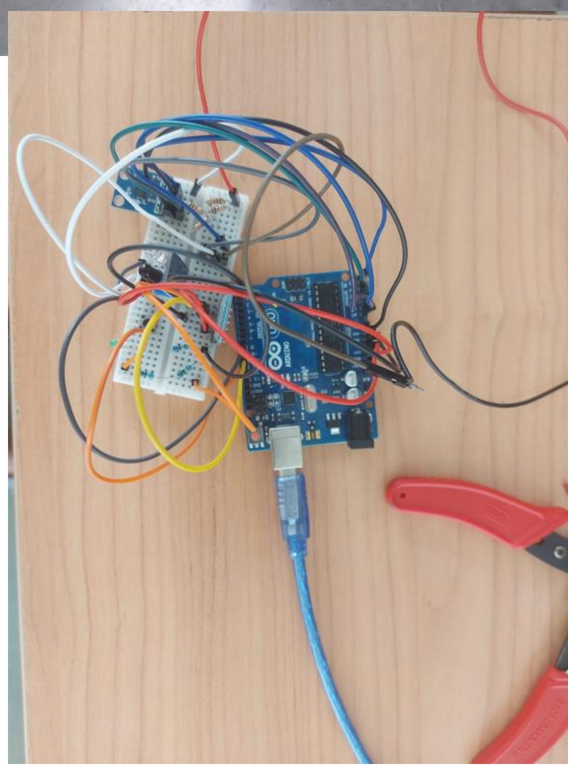

when ListPicker1 .BeforePicking
do set ListPicker1 . ItemBackgroundColor to
set ListPicker1 . Elements to BluetoothClient1 . AddressesAndNames


when ListPicker1 .AfterPicking
do if call BluetoothClient1 .Connect
address ListPicker1 . Selection
then set Label1 . Text to " Connected "
set ListPicker1 . BackgroundColor to
set ListPicker1 . Text to " Connect to other device "



This signal could further be used and the project could be built up on to add additional features.





4. CODE

4.1 Complete Arduino Code

```
#include <SoftwareSerial.h>

#define baud_rate 9600

#define BT 5
#define X A0
#define Y A1
#define Z A2

#define INF_RED 8

bool collision;
SoftwareSerial Bluetooth(10, 11); //Rx|Tx

void setup()
{
        Serial.begin(baud_rate);
  Bluetooth.begin(baud_rate);

  pinMode(INF_RED, INPUT);
  pinMode(LED_BUILTIN, OUTPUT);
}

void loop()
{

  if (Bluetooth.available() > 0)
  {
    Serial.println(Bluetooth.read());
    delay(20);
    if (collision == true)
    {
      Bluetooth.println("COLLISION");
    }
  }
```

```
  if (digitalRead(INF_RED))
  {
    digitalWrite(LED_BUILTIN, HIGH);
  }
  else
  {
    digitalWrite(LED_BUILTIN, LOW);
  }

  double p_elec = analogRead(PORT_pzelec);

  double acc_x = analogRead(X);
  double acc_y = analogRead(Y);
  double acc_z = analogRead(Z);

  if (acc_y > 380 && p_elec > 80)
  {
    collision = true;
  }
  if (acc_x > 380 && p_elec > 80)
  {
    collision = true;
  }
  if (acc_x > 380)
  {
    collision = true;
  }
}
```

4.2 Python Code To Read Data

```
import serial
import numpy as np
import pandas as pd

file_name = "./pz_data.csv"

port_name = "/dev/tty.usbmodem14401"
baud_rate = 9600

with serial.Serial(port_name, baud_rate) as conn:
    records = {"value": []}
    for i in range(18000):
        string = conn.readline()[:-2].decode('utf-8')
        data = int(string)

        records["value"].append(data)

    df = pd.DataFrame(records)
    df.to_csv(file_name, index=False)
```

4.3 Python Code To Make FFT

```
import numpy as np
import pandas as pd
from matplotlib import pyplot as plt

df = pd.read_csv("./pz_data.csv")
print(df.head())

data = df.to_numpy()

fft = np.abs(np.fft.fft(data))
freqs = np.fft.fftfreq(len(data))

#plt.plot(data[15000:17000])
plt.plot(data)
plt.show()

print(freqs[-1])

#plt.plot(freqs[15000: 17000]*300, fft[15000: 17000])
plt.plot(freqs[0:int(len(freqs)/2)]*300, fft[0:int(len(fft)/2)])
plt.show()
```

5. CONCLUSION

The aim of our project is to ensure that motorists get immediate help in case of an accident.The piezoelectric sensors fitted on the helmet will generate a voltage due to the potential gradient created due to the collision and display an alert message on the Serial monitor. In addition to the detection of spike in voltage,we are able to detect when the helmet is in use with the help of the infrared sensor.

This ensures that there is no false alarm when the helmet falls on the ground without being used. An accelerometer ADXL 335 is used to measure the speed of the rider. This feature can be further developed to measure accurate speed and the data can be made useful for court trials.

We used the HC05 Bluetooth module to send an alert message to the handheld device, the owner’s smartphone which would send alert messages to the emergency services. The collision detection algorithm would be improvised and made more robust for more accuracy and less false positives. The accelerometer would ensure the accuracy of speed improvisation

To conclude, a smart helmet is the device which is the need of the hour, with the road fatality rate of India increasing steadily, this device would be useful in saving the lives of many people by providing immediate aid.

6. REFERENCES

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3. https://www.electronicwings.com/sensors-modules/mpu6050-gyroscope-accelerometer-temperature-sensor-module
4. https://techexplorations.com/guides/arduino/peripherals/mpu6050/
5. https://www.electrical4u.com/piezoelectric-transducer/