ACCIDENT AND ALCOHOL DETECTION IN BLUETOOTH ENABLED SMART HELMETS FOR MOTORBIKES

Seminar Report

Submitted in partial fulfillment of the requirements for the award of degree of

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

of

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Submitted By

KIRAN K K
Register Number: MAC15CS035

Department of Computer Science & Engineering

Mar Athanasius College Of Engineering Kothamangalam

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CERTIFICATE

This is to certify that the report entitled **Accident and Alcohol Detection in Bluetooth Enabled Smart Helmets for Motorbikes** *submitted by* **Mr. KIRAN.K.K**, *Reg.No.***MAC15CS035** *towards partial fulfillment of the requirement for the award of Degree of Bachelor of Technology in Computer science and Engineering from APJ Abdul Kalam Technological University for December 2018 is a bonafide record of the seminar carried out by him under our supervision and guidance.*

....	....	....
Prof. Joby George	**Prof. Neethu Subash**	**Dr. Surekha Mariam Varghese**
Faculty Guide	***Faculty Guide***	***Head Of Department***

Date: Dept. Seal

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ABSTRACT

With the growing number of 2-wheel motor vehicles, frequency of accidents is on the rise. A major cause for the accidents is either not wearing a helmet, or his/her accident not reported in time, and he/she could not be saved because of the delayed admittance to a hospital, or because he/she was riding while drunk. The proposed mechanism can detect a helmet, detect accidents, and detect whether the person has over-consumed alcohol by use of on-board sensors flex sensor, impact sensor, accelerometer (ADXL355) and breath-analyser (MQ3). The accelerometer measures the change in tilt, in X Y and Z axes respectively, and sends the data to a server via an online application programming interface (API). The server also uses the data gathered from alcohol sensor to detect drunken driving and accelerometer and pressure sensors, to train a support vector machine (SVM) which can optimize accident detection to provide reliable accuracy. The application on the phone with internet access will communicate with API ensuring the holistic safety of the rider at all times.

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LIST OF ABBREVIATION

IoT	Internet of Things
GPS	Global Positioning System
GSM	Global System for Mobile communication
FSR	Force Sensing Resistor
BLDC	Brushless DC fan
PIC	Peripheral Interface Controller
HIC	Head Injury Criteria
INRSS	Indian Regional Navigation Satellite System
NMEA	National Marine Electronics Association
SVM	Support Vector Machines
HTTP	Hypertext Transfer Protocol
API	Application Programming Interface

Introduction

The invention of motorized vehicles were a milestone in human history. They changed the tides during the world war and quickly became a household name. After almost 124 years since the first production motorcycle hit the market they came a long way, from single engines to high power engines with advance electronics and designs. Nowadays Motorcycles and bikes form an integral part of personalized transportation all around the world. However, unfortunately, it also involves innumerable accidents and subsequent loss of lives. Every year, about 300,000 teenagers are admitted to hospitals because of bike injuries, and at least 10,000 teenagers have injuries that require a few days in the hospital.

Statistics suggests, motorcycle deaths accounted for 15% of all motor vehicle crash deaths in 2015 and were more than double the number of motorcyclist deaths in 1997. Through an ONEISS survey conducted by the Department of Health, it was found that 90 percent of the motorcycles rider killed in accidents were not wearing a helmet at the time of accident. This, along with drunken driving are a major reason of most of the two wheeler accidents in india. We aim to mitigate these problems and hence the associated casualties by ensuring that the rider will wear the helmet all time during his/her ride, thus ensuring safety. The helmet is able to understand if the person is wearing the helmet, using the pressure sensors, fitted inside the padding foam.

Alcohol intoxicates the body and prevents a person from thinking smart. More than 16,000 people are killed every year due to drunken driving accidents. Driving under the influence of alcohol (DUI) is a felony offense, often resulting in 4-5 years on first time charges. The biggest myth and mistake you can make while driving drunk is thinking that you can learn to drive drunk, Alcohol impairs your ability to handle surprises. Even at low speeds, a sudden roadblock, detour, or even a deer can cause you to lose control of the car.

During a long drive drunken drives or even non intoxicated drivers wander off to different place in their mind causing them to drive into other vehicles passing by. The alcohol relaxes mind and body, and the repetition of the landscape and highway features often lulls even sober drivers into distraction. Having an open container of alcohol in your car while you're driving is against the law. Depending on the state you live in, and whether or not this is your first time will determine if the crime is a felony or misdemeanor. Play it safe while getting in a car, stay sober because over 40% of accidents are alcohol related. And try not to drive out at night even after 1 beer because 85% of alcohol accidents in America happen at night rather than during the day.

The helmet can detect a possible accident, using the onboard accelerometer and pressure sensor. If the values detected exceeds a threshold, it is reported as a possible accident. Emergency contacts, specified by the rider during app setup, are informed about the possible accident, via a system generated email and text message, containing the address and GPS coordinates where the accident had been detected. The values of the accelerometer are also constantly sent to a remote server using an online application interface (API), and the server trains a support vector machine (SVM). An onboard alcohol sensor regularly analyzes the breath of the rider to detect if the current intoxication level is above the legal threshold. If it is so, he is first warned not to ride the motorbike. If he rides it anyway, emergency contacts are informed, so that they may handle the situation. The helmet can connect to any smartphone via Bluetooth so that it can communicate with the server using the smartphones internet access.

compared with other implementations of same idea, Built-in GPS tracker produces more precise geo-location with accuracy upto a 10 metre radius. The entire system is powered by a 9V battery positioned within the helmet along with neccessary voltage regulation hardware.the flex sensor planted inside the protective foam act as a trigger. It outputs an analog signal when the helmet is worn by the rider. This is used as to prevent falsely alerting the officials about a possible accident. The alarm system ensures that the rider is made to choose whether it is a real accident or not. Based on the absence of rider not responding to the alarm system, The prediction is done.

Related Works

Accident prevention always has been a long time debated topic, Lots of research and development is being carried out for refining the detection and alerting system. we found several smart helmet systems proposing similar ideologies with different approach and proposed solution. The following topics are some of the research and developments done on accident and detection.

Vital Health Monitoring

Wilhelm Von Rosenberg[2] Proposed a smart helmet with embedded sensors for cycling and moto racing drivers. The helmet is fitted with special electrodes within the helmet padding to detect possible impact occured from any accidents. A respiration belt around the thorax area is used for continuous validation of heartbeat, referencing ECG from the chest. Also a multivariate R-peak detection algorithm tailored specially for optimizing data acquisition and noise reduction in real time.

Konnect

The main cause of death in two-wheeler drivers is over speeding and careless driving. Numerous lives could have been saved if emergency medical service could get accident information and reach in time to the scene. Up to 75% of all deaths occur within the first one hour of impact. Thus, in this crucial phase of time, if proper aid reaches the victims, mortality rates can be reduced. The project named as Konnect[2] done by Sreenithy Chandran and her crew aims to build an Internet of Things (IoT) application that leverages on ubiquitous connectivity, sensing and data analytics that are the basis of IoT applications. The IoT is comprised of smart machines interacting and communicating with other machines, objects, environments and infrastructures. The huge volumes of data thus generated, is processed into useful actions that can command and control things, to make our lives much easier and safer.

IoT applications introduce numerous benefits like the capability to remotely monitor, manage and control devices, and to get new insights and useful information from massive streams of real-time data. The foundation however lies on the intelligence of the embedded processor. In order to realize the full potential of the cloud computing and the ubiquitous sensing, a combined framework of both is important. Thus, 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 by utilizing the various cloud computing applications.

Detecting Hazardous Gases

based on the hazardous environments mining people use to work, C. J. Behr[3] developed a smart helmet that is able to detect of hazardous events in the mines industry. In the development of helmet, We considered the three main types of hazard such as air quality, helmet removal, and collision (miners are struck by an object). The first is the concentration level of the hazardous gases such as CO, SO2, NO2, and particulate matter. The second hazardous event was classified as a miner removing the mining helmet off their head. An IR sensor was developed unsuccessfully but an off-the shelf IR sensor was then used to successfully determine when the helmet is on the miner's head. The third hazardous event is defined as an event where miners are struck by an object against the head with a force exceeding a value of 1000 on the HIC (Head Injury Criteria). An accelerometer was used to measure the acceleration of the head and the HIC was calculated in software. The layout of the visualization software was completed, however the implementation was unsuccessful. Tests were successfully done to calibrate the accelerometer. PCB's that were designed and made included a breakout board and a prototype board. A whole software implementation was done based on Contiki operating system in order to do the control of the measuring of sensors and of calculations done with the measured values.

Collision Identification

A. Ajay [4] created a smart helmet used for navigation and accident detection. The whole work is partitioned into four different verticals: Accident identification and alert module, navigation system, Voice call service through Bluetooth device and a solar panel for external power source. In Accident Identification and Intimation part, pressure sensors are used to sense when the pressure exceeds the preset value. ARDUINO board is used for sending an alert which is interfaced with a GSM module. The alerts can be sent to ambulance and guardians.

In Navigation, the helmet is interfaced with our mobile so once the navigating places are fixed then the route to the destination location is intimated using voice intimation. We can interface this with INRSS in future thereby promoting our nations navigation application. In voice call, as the helmet is interfaced with the phone whenever a phone call is received the user can attend his call by the use of voice recognition system. As the phone is interfaced the probability of charge reduction is maximum so we go for an external power source using a solar panel attached to the helmet. This can also be used as a power bank

Rider Speed Monitoring

Mohd Khairul Afiq Mohd Rasli[5] has designed a PIC16F84a microcontroller controlled smart helmet with force Sensing Resistor (FSR) to detect riders head and a BLDC Fan for speed detection. Helmet starts its alarm system whenever the speed crosses a certain limit and motorcycles engine will start only after the rider buckles the helmet.

The objective of this project is to build a safety system in a helmet and speed alert for a better safety of motorcyclists. The safety helmet that we created is embedded with sensors which act as detectors for riders head and the safety belt itself. The engine of the motorcycle can start only if the rider has buckle up itshelmet safety belt. The second safety method that we introduced is another sensor which acts as an alarm to the rider when the motorcycle speed exceeds 100km/h. Indicator is placed and will flash to alert the rider about the speed limit. A microcontroller is used in this project to control the system.

The microcontroller used to operate the project is Peripheral Interface Controller (PIC) 16F84a. The PIC is an 8- bit controller. Since it has a small number of inputs and output, PIC kit software is needed to write the program in basic compiler language. Other than that, Force Sensing Resistance (FSR) and the speed sensor (BLDC Fan) are used as sensors to operate this project. Therefore, the scopes of the project will be using two sensors which are Force Sensing Resistance (FSR) and a BLDC Fan. The main purpose is actually to make some research correlation on a Force Sensing Resistance (FSR) with resistance and a BLDC Fan with voltage. Signal transmission between the two circuits is using a radio frequency concept. 315 MHz Radio Frequency Module is used since the range between the circuits is short. While the microcontroller Peripheral Interface Controller (PIC) 16F84A is used to control the system.

The Proposed Method

The proposed system is a bluetooth enabled smart helmet which would detect and reports any forms of road accidents also drunken driving. The driver is allowed to initially save emergency contacts onto the smartphone application. The application also performs support vector machine learning using the input values from the array of sensors present inside the helmet. The initial step is the calibration phase where the rider's 'tilt' data is collected and the helmet is calibrated. This value is later used for accident detection.the output from accelerometer is checked initially, If there is a visible variation in the readings, Impact sensor is checked.

If the impact sensor also produces an output soon after the accelerometer, The scenario is a candidate for possible accident. If there is no impact after change in accelerometer, The smartphone rings an alarm for the user to respond to. If the rider does not acknowledge the alarm within thirty seconds, The outcome is predicted as a possible accident. In such case, The emergency contacts saved on the application is alerted about the possible accident with accurate global location.also a list of nearby hospitals are also taken and informed about the accident.

The Breath analyser is placed inside the helmet so that the rider will always be blowing on top of the sensor. If there is an output from the Breath analyser it means that the driver is riding while intoxicated. In such cases, the application installed on riders smartphone prompts the user not to drive while intoxicated. If the rider refuses to acknowledge the warning,Emergency

Fig. 3.1: Micro Controller

contacts are informed about the situation and necessary actions are taken. The emergency contacts are being alerted and the helmet regularly track and update the current location of the rider.

3.1 Materials and methods

3.1.1 Microcontroller (Arduino NANO with Atmega 328)

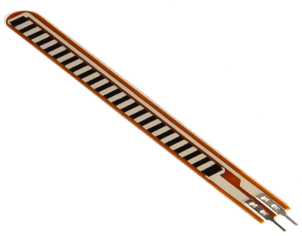
The microcontroler is less powerful device integrated into a small silicon chip. The Arduino NANO is the core of our device, a cheap and easily available and programmable Arduino NANO clone, with Atmega 328. The Atmega 328 chip allow additional integration of different electronic modules to the Arduino NANO microcontroller. the overall system provides limited processing capability, but it is enough for our computational operation purpose. It is small, and compact, which is an important factor because the entire hardware needs to be fitted inside a helmet. When the device is started for the first time, the application prompts to calibrate the helmet. Upon calibrating, the calibrated values of the accelerometer are stored in the microcontrollers 24Byte ROM. This is used to calculate the tilt of the helmet while riding the motorbike.

3.1.2 Flex Sensor

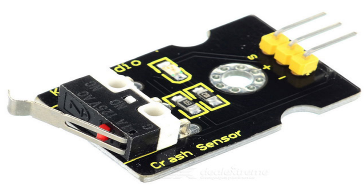
Flex sensors are strips with metal pads. On bending the metal strip, the resistance of the metal pad changes according to the amount of bend force applied to the strip. When used with an Arduino, it can be plugged into an analog pin. The analog pin reads values between 0-1023, and the value depends on how much the strip is bent. One such strip is attached to the interior of the helmet. This when the user wears the helmet, this head bends the strip, and the helmet is able to detect if the helmet has been worn. Our threshold value is set at 100 so that it can accurately detect the wearing of the helmet.

3.1.3 Impact Sensor

We use the Keyestudio Collision Crash Sensor Module as the impact sensor. Collision Sensor can detect whether any collision movement or vibration happens based on strength of the analog signal output. To make the output signal more reliable and neat, a necessary exterior circuit is present to reduce the noise impact. Thus, normal shaking will not cause any output. This module is attached to the exterior of the helmet. When the helmet falls down, there should be a vibration from the impact of falling down on the ground,impacting a hard surface. The collision sensor detects this vibration and outputs analog output in the range 0- 1023. Here too we have set a threshold of 100 so that it accurately detects the falling down of the helmet.



(a) Flex sensor



(b) Impact sensor

3.1.4 Accelerometer (ADXL355)

The accelerometer we use is a 3-axis accelerometer that measures tilt of the device with respect to the earth, in each X, Y and Z coordinates respectively. Since it measures the tilt with respect to the earth, we need to store the corresponding values when the helmet it normally worn. This is the calibration process needed at initial step. The values are stored in the ROM, and the difference of current readings with respect to previously stored value is taken and the stored readings are used to detect a possible accident.

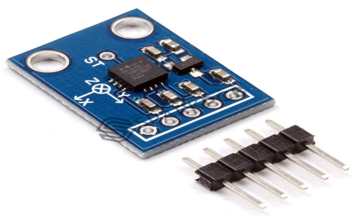


Fig. 3.3: Accelerometer

3.1.5 GPS module (SIM 28ML)

This module helps to get the present GPS coordinates of the device. The coordinates are required when an accident is detected or high alcohol consumption is detected. The phone GPS could be also used, but having a GPS module build in the helmet guarantees the accuracy of the reported location. The module we use follows the NMEA protocol, and thus the output coordinates need to be converted into a more usable form. Thus we use tiny GPS library to perform the necessary conversion. It is an open source library for Arduino, for NMEA GPS data.

3.1.6 Breath Analyzer (MQ3)

This module uses an Alcohol Gas sensor MQ3. It is a lowcost semiconductor sensor and can detect the presence of alcohol gases at concentrations from 0.05 mg/L to 10 mg/L. The sensitive material used in this sensor is SnO_2, whose conductivity is lower in clean air. Its conductivity increases as the concentration of alcohol gases increases. It has high sensitivity

Fig. 3.4: GPS SIM 28ML module

to alcohol and has a good resistance to disturbances due to smoke, vapor, and gasoline. This module provides both digital and analog outputs. MQ3 alcohol sensor module can be easily interfaced with microcontrollers.

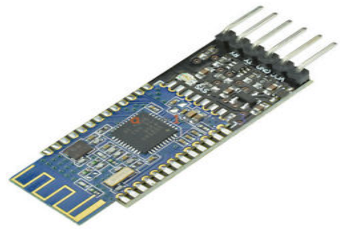
3.1.7 Bluetooth Module (BLE HM-10)

The HM-10 is a Bluetooth 4.0 Low Energy module containing the TI produced CC2540 or CC2541.It provides reliable and low power consuming Bluetooth connectivity. We use it for the communication between the device and the smartphone, and thus it is our medium of data communication. Another important reason why we use this particular Bluetooth module is that it is power efficient and low on cost.

3.1.8 Support Vector Machines (SVM)

In machine learning, support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. Given a set of training examples, each marked as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier (although methods such as Platt scaling exist to use SVM in a probabilistic classification setting). An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall.

(a) Breath analyser



(b) Bluetooth module

In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces. When data is unlabelled, supervised learning is not possible, and an unsupervised learning approach is required, which attempts to find natural clustering of the data to groups, and then map new data to these formed groups.

The Arduino NANO requires a voltage input of 5V. A 9V battery, connected to LM7805 5V voltage regulator IC, can be used to power the NANO. The flex sensor accelerometer and the impact sensor outputs analog data, and are thus plugged to the analog pins of the micro-controller. The breath sensor has an analog output pin too, but we only require the digital output pin. It is thus connected to a Digital pin of the microcontroller. The GPS module and the Bluetooth module require 2 digital input pins, for their RX and TX. The Bluetooth module sends data wirelessly to the smartphone via Bluetooth, and the smartphone calls the appropriate online API method. Thus an active internet connection in the smartphone is essential.

3.1.9 Smartphone Application

Development of a Smartphone application and our device's communication with the smartphone application is what makes our device so powerful, without compromising the affordability of the device. The application has several roles, as mentioned below:

- Register the user's name, email address, phone number for security.
- Register the user's emergency contacts, to inform about the accident detected, and if high alcohol consumption is detected.

- Calibrate the helmet's accelerometer. The first time the user wears the helmet, he will be prompted to look straight and click the calibration button.
- Communicate with the device, and perform HTTP request operations to the online API.

3.1.10 User Interface

The rider communicates with the device through his smartphone. Thus the following features in the user interface are essential and have been implemented.

- Screen to enter the user's details.
- Screen to enter details of emergency contacts.
- Prompt to calibrate helmet, when first used.
- Warning to not drive if high alcohol consumption is detected
- Email notification to emergency contacts in case of an accident.
- Email notification to emergency contacts in case of drunken driving.
- Track the rider using the application, in case any of the above notifications have been sent.

3.1.11 Calibration

The Calibration of the helmet is performed when the rider first wears the helmet and connects it to his smartphone via Bluetooth. He is prompted with a window on the application to calibrate his helmet by sitting

normally on the motorcycle and looking straight. He is then asked to click the button on his helmet to perform the calibration. The values of the accelerometer are stored in the Arduino NANO's ROM. These values are later utilized to calculate the instantaneous tilt of the helmet.

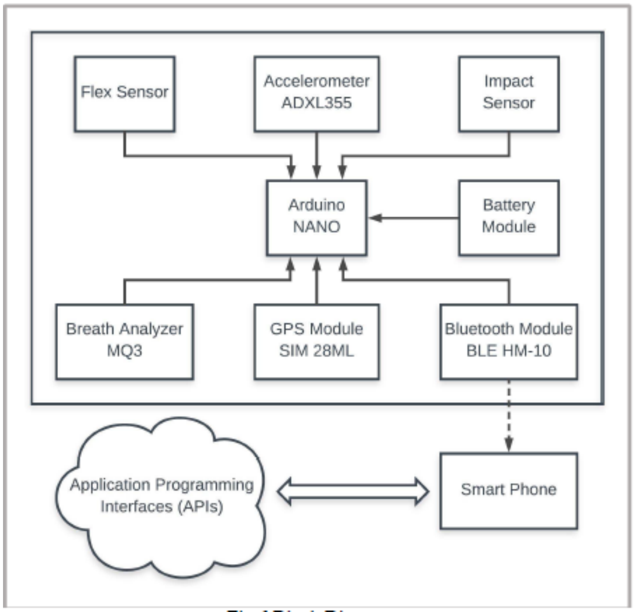


Fig. 3.6: Block diagram

3.2 Helmet Wear Detection

The initial steps is helmet wear detection. The flex sensors installed inside the helmet will bend to an extent, once the helmet is worn because it has been installed inside the protective foam in a way that the head will always press against it to be worn. Thus the sensor can accurately detect when the helmet is worn, and when it is taken off. The flex sensor outputs analog data in the range of 0-1023,based on how much the strip has been bent. Our threshold for wear detection is 100. It is low so that a slight bend from the pressure against the protective foam is enough to be detected accurately. As shown in the Flowchart above, the other functionalities of the helmet are only checked if the helmet is worn. This is essential so that emergency contacts are not falsely reported about an accident or drunken driving when the rider is not wearing the helmet. Suppose the rider drops the helmet from his hand, it meets the criteria of our accident detection. But the rider is not wearing the helmet, thus no action will be taken.

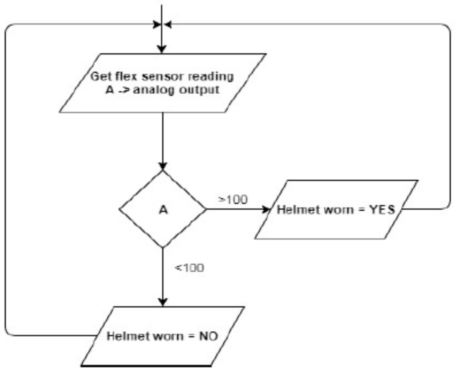


Fig. 3.7: Helmet wear Detection

3.3 Accident Detection

Accident Detection requires a pre-calibrated helmet. The device constantly monitors the analog output values of the accelerometer, as well as the impact sensor fitted to the exterior of the helmet. The difference between the current accelerometer values and the calibration values indicate its tilt. The tilt is checked with a particular threshold, which in our case is

$$|\delta X| > 40, \quad |\delta Y| > 40 \tag{3.1}$$

x - difference between current accelerometer reading and calibrated reading for X axis

y - difference between current accelerometer reading and calibrated reading for Y axis

If the tilt is beyond the threshold, the situation is considered as a candidate for accident detected. The impact sensors are then checked. If the impact sensors report a sudden impact too, the situation is immediately reported as an accident, and all the emergency contacts are immediately informed about it, and the location of the detection.

If the impact sensors do not report any such impact, an alarm is rung in the phone to notify the user that the device has detected a possible accident, and the user may click the provided button on the helmet, to indicate that it is a false alarm. If the user does not press the alarm in 30 seconds, it is reported as a true accident, and the emergency contacts are informed.

3.4 Alcohol Detection

The MQ3 sensor is a breath analyzer, that is fitted in the bottom of the helmet, near the mouth, concealed in the protective foam near the mouth. It can detect the alcohol content in one's breath if the user breathes on it. The sensor is fitted in such a way that the user will always breathe into the sensor. If the alcohol content detected, It causes the digital output pin of the sensor to become HIGH, In that case, The user is notified and warned to not drive the bike. If the user drives the bike anyway despite being warned before, The emergency contacts are informed about it, so that they may handle the situation.

The movement is detected by observing the change in GPS coordinates of the bike. Once the microprocessor is informed about the intoxicated driving, it stores the current GPS coordinates. It then constantly checks the difference between the current coordinates and the stored coordinates. If the difference exceeds a threshold of 100m, we can say that the rider has been driving the bike, in spite of being warned. Thus the emergency contacts are informed.

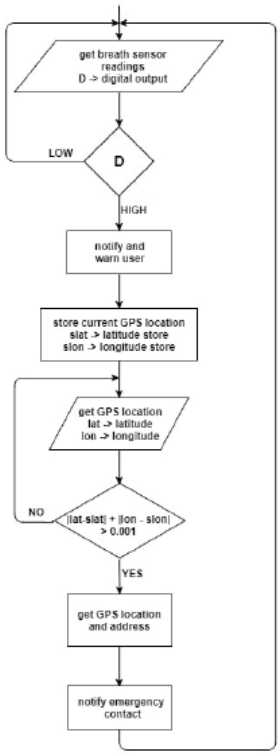


Fig. 3.8: Alcohol detection block diagram

3.5 Proposal for Optimization of Accident Detection

We propose an experimental mechanism to use SVM to optimize accident detection. While testing the accident detection, we noticed that the alarm was being triggered on many occasions, which might be cumbersome for riders to keep responding to while driving the motorbike. As already shown previously, if the alarm is rung, and the rider clicks the button, the device discards the detection and takes no action. If the button is not clicked, then the device assumes that it is a true accident, and takes action accordingly.

Every time the alarm is rung, and the button is clicked by the rider, we send the tilt data (x, y) to the servers as negative data. If the rider does not click the button, the tilt data(x, y) is sent to the server as positive data. This is how we propose to train the SVM. For accident detection, the device follows the aforementioned mechanism. If the alarm is needed to be triggered, the tilt data is first sent to the server. The server checks which side of the hyperplane does the values lie and predicts if it is an accident or not. We propose to train the SVM using a real-time simulation of accidents. The data set should be unique for every physical device, as the values will vary depending on physical design.

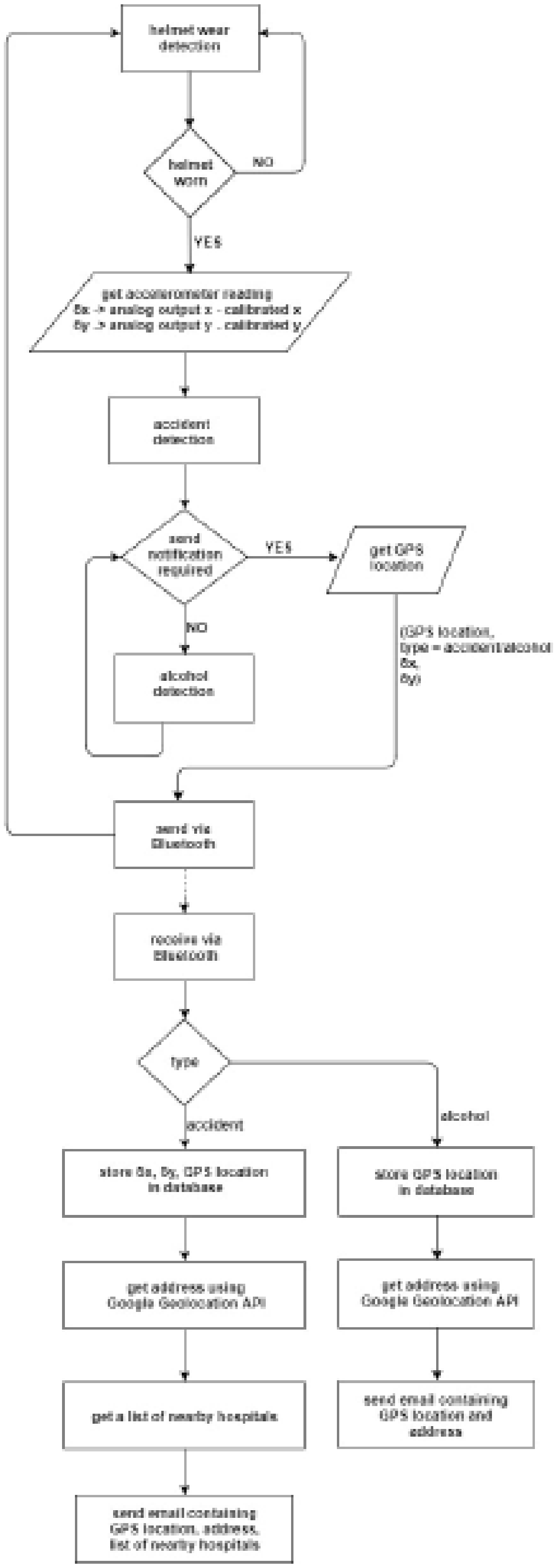


Fig. 3.9: Sequence of execution diagram

Conclusion

The proposed prototype yielded satisfactory results when tested against different scenarios. The accuracy and precision are high, which shows that our proposed mechanism is accurate in detecting an accident and high alcohol consumption. However, during accident detection, there have been many cases, where the alarm has been rung. The comparison of the parameters for accident detection, with and without the use of the alarm, shows how important the use of an alarm is, to report false accident detection. However, repeated unwanted need to respond to the alarm while driving can cause discomfort and distraction. Therefore, this is not safe either. Thus, we are currently trying to use Support Vector Machines to predict if the values of the sensors correspond to an accident or not, by training the device using real-time simulation.

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