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Smart Helmet for Accident Detection using Sensors

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Abstract: *In today's era, due to growth in population and increasing number of vehicles on the road, risk of accidents is high. Thousands lose their lives in vehicle accidents because of delayed emergency medical services. In hospital, sometimes required blood for certain blood groups is not available in time. Hence, efforts are made to avoid them by minimizing their consequences. Our main motive is to avoid the delay in aid after accidents. Smart helmet is connected to a smartphone via Bluetooth. The microcontroller in the smart helmet is used to keep track of related information of all parameters regarding accidents. Impact sensor is used to detect the vibrations of the impact on the helmet due to accident and accelerometer detects sudden changes in the X, Y and Z axes. When accidents happen, GPS is used to detect the current location of the rider and with help of Bluetooth technology, related information is sent to emergency contacts and nearby hospital through the android app.*

Keywords: *Accident detection, smart helmet, GPS, Bluetooth technology, Android app, Arduino, Impact sensor, accelerometer.*

I. Introduction

The World Health Organization, says that 1.25 million people die each year as a result of road accidents. The World Health Organization also made a survey that two-wheeler accidents are 30% but wearing a proper helmet can reduce the risk of severe injury by 72%. In a country like India, there is one death every 4 minutes due to road accidents. A survey indicates that more than 70% of the riders avoid wearing helmet without any specific reason. However, speeding and drinking and driving have become common issues. Every year, 3,00,00 teenagers are admitted to the emergency medical department because of bike injuries. By an ONEISS survey conducted by the department of health, 90% of motorcycle riders that were killed in accidents were not wearing helmet.

In India, DRINK & DRIVE case is a criminal offense of the Motor Vehicle Act 1939. According to Section 129 of Motor Vehicles Act, 1988 makes it compulsory for every single individual riding a two-wheeler to wear helmet following to the Standards of BIS (Bureau of Indian standards). In India, 377 people die every day due to road accidents which is four times more than annual death toll from terrorism was found in a survey. The impact when a rider is involved in a high-speed accident without wearing helmet is found very dangerous and can cause fatality. In 2010, MIROS (Malaysian Institute of Road Safety Research) reported that 4,067 motorcyclists died in road accidents. The helmet can detect possible accidents with the help of impact sensor and accelerometer. If the readings detected exceed a threshold, it is reported as an accident. When the accident happens, GPS can be used to detect the current location of the rider and with the help of Bluetooth technology, related information is sent to emergency contacts and nearby hospital through the android app.

This paper implemented the system on GPS for recognizing the location of vehicle of accident detection and few sensors for safety measure and to know the road condition and reason for accidents. The helmet can attach to mobile through Bluetooth, so that it can communicate with the server using the internet access. Nowadays, statistics says that the annual average road accident is estimated to be about 7,00,000 of which 10% occur in India which has overtaken China. The report of a year revealed by the World Health organization (WHO) in its Global status report on road safety says that around 80,000 people are killed on Indian roads due to rash driving and less usage of helmets. Also, almost all the countries are forcing the motor riders to wear the helmet and not to use the bike when the user is riding without helmet.

II. Literature Survey

Christian Gorges et al. [1], included in the Mechanical Systems and signal processing journal about detection of force or impact with the help of classification of a machine learning approach and experimental roughness of road. This journal gives brief description about road roughness evaluation and impact detection strategy. Road roughness, such as unpaved roads, potholes, and obstacles are analyzed to evaluate required results. Also, customer usage patterns can be studied to enhance target design of the system. The different loads on the vehicle can be classified as (1) Service loads, (2) Special events, and (3) Misuse Events. The load occurring on the vehicle due to normal usage is called as Service load. Special events on the vehicle are due to high loads induced and occur rarely.

However, it is difficult to classify between Special events and misuse events. Misuse events occur when the rider is driving against a significant obstacle. Hence, classification is done by metrics evaluation which is achieved by supervised machine learning. GPS module and vibration sensors hold on taxis where used to gather data of potholes. This was detected by change in z-axis of the accelerometer mounted on the vehicle. Tai focused on the development of mobile-based road anomaly detector, for bike-riders for machine learning, they used Support vector machines. This method proved to achieve 87% accuracy on the test tracks. Further research should be done to investigate road robustness classifier for different attributes of vehicle.

Dr. Himadri Nath Saha et al. [2], provided a methodology on proposed paper. This methodology identifies if one is wearing a helmet or not. It also detects occurrence of any accidents and overconsumption of alcohol. They made the use of components such as flex sensor, impact sensor, accelerometer, GPS module (SIM 28ML), breath analyzer (MQ3), Bluetooth module (BLE HM-10), arduino nano, and voltage regulator (9V to 5V). The helmet module consists of the arduino nano connected to sensors, GPS module, Bluetooth module and battery module. This helmet module is connected to the smartphone using Bluetooth.

The smartphone application is used for communication to perform HTTP request operations using API's. This journal also provides algorithms for functionality of modules, accident detection, alcohol detection and helmet wear detection. This journal also shows the use of buzzer when accident is detected. Sometimes the false accident detection leads to the ringing of the alarm. Successive button-click activity reported an alarm as false. This was a drawback as it let to repeatedly respond to the alarm while driving. This leads to the scope for the use of Support Vector Machines which predicts accurate results by training the device for real time simulation.

Omer Chughtai et al. [3], explained proposed paper in terms of experimental validation. In this paper they proposed Test-bed and application prototype which help to detect the accident more accurately and sends the notification to the nearby hospital quickly. Focuses on traffic management and after accident services. The major work in this paper is the implementation of collision detection using accident detection module Collision and Roll Over.

In this they use the hardware UDOO quad with I-MAX processor for computing. Inertia Measurement unit sensors (IMU-6050), which is a combination of accelerometer, triple gyroscope and micro electro-mechanical sensor for digital movement of the vehicle. Externally uses the pulse sensor for detecting the heart beats of the patient. UDOO quad and IMU provides communication with each other using the inter integrated compatibility. Use the sound sensor, if vehicle collide with another vehicle it detects the sound intensity and according to this determines the impact of accident. Here, they implement the Adafruit Ultimate GPS module to get the GPS co-ordinates of the accident location. As mentioned above their work also on the collision detection with collision and Roll Over, which are basically the algorithms woks on the inputs of the sensors.

For communication they use the VANET (Vehicle Ad-Hoc Network) implementation. Using this the client and the respective server can communicate with each other efficiently.

Fayiz Basheer et al. [4], proposed system for Intelligent Accident Detection Classification using Mobile Phones. This system basically focuses on accident detection for cars. They have used components which includes accelerometer and gyroscope sensor. They have also utilized the concept of Automatic Crash Notification (ACN) system. In mobile application, this is used for the crash detection. This leads to deploying airbags and emergency fuel shut-off. Although there are some drawbacks for the Automatic Crash Notification (ACN) system which includes subscription-based service, high cost, no absolute results and it is limited only to the modern cars.

Also, almost all smart phones come with a default gyroscope sensor and accelerometer that can be used to measure crash kinematics. This system is actually a smart phone application called *crash detect* that can detect and classifies type of collision. These collisions are classified as (1) car to non-deformable object and (2) car to human collision. This journal also introduced the terminology of false positive and false negative. Incidents such as dropping of phones, sharp turns and driving on uneven roads which includes bumps and potholes may lead to false detection of accident. This is called as false positive. Hence, the journal emphasizes on avoiding the false positive situation that is the false detection of accidents.

Yi-Cho Fang et al. [5], proposed concept of Accelerometer based fall portent identification. In this paper main focus is on the security of the workers, who works on top and buildings. The most of the accident in construction industry is due to falls. So, in this paper they trying to develop accelerometer-based fall portents identification.

Here one scenario illustrated as, worker wearing the security equipment including helmet and belt. Various sensors like accelerometer and gyroscopes, or a smart phone is attached to this equipment. These sensors continuously recognize the psychological conditions of the worker and continuously sending the data to the mobile phone and mobile to respective server. When a system detects the kind of fall portents, it is going to warn the worker as well as the respective supervisor.

The module uses for accelerometer sensors explicitly wear by the worker (ie., **S**chest, **S**waist, **S**arm and **S**hand). These four sensors continuously send the co-ordinates values to the android phone. Android phone is connected to the server using WIFI. The data sent by the sensors are getting stored in server and mobile phone simultaneously in text format. The collected data then analyze by SVM and Hierarchical threshold-based algorithm. If algorithm shows positive result, then alert goes to worker and supervisor in terms of alarm.

Daniele Bibbo et al. [6], proposed a methodology to harvest the energy coming from sun on rider's helmet. Array of Photovoltaic (PV) cells are mounted on the helmet surface. This will produce energy that can be used for various devices. This system includes PV cells, MPPT (maximum power point tracking) module, DC-DC Converter, Battery management circuit and Lithium ion battery. The input by PV cells form a non-linear I-V graph. To make the PV cells adaptive for the usage of a Direct Current converter is required. Hence the input resistance must be managed in order to keep device operating point as close as possible to the maximum power point tracking. This is a major problem due to changing environment. The generated energy can be stored in lithium batteries.

However, they have extreamly little amount of resistance and discharge faster. This leads to the use of Lithium Ion batteries. This energy can be used to provide supply to accelerometer-based device to produce an alarm in case of identification of accident. The system is connected to the PV cells using a shunt resistance to measure the current generated. "Perturb and Observe" is a technique used by commercial MPPT controllers to track the MPP. The disadvantage is that the network will be able to calculate MPP for a specific device only. Microcontrollers have limited processors only, hence emphasized on the use of NN architecture. This architecture has same precision with approximately half the computation cost. The external Lithium Ion battery acts as a buffer in case of variance, to achive cosistancy of power supply to the sensors.

This system is tested in laboratory as well as in the outside environment. That includes validation and testing of components and the system by laboratory and field tests. The output currents depend on the number of arrays and the number of cells in the PV arrays. In case of field tests, output results change due to change in alignment of the helmet under the sun's radiation. The total weight of batteries can be reduced by the use of capacitors depending on requirement. This system can be enhanced for different fields where helmet is required.

Prem Kumar M et al. [7], presented a method for proposed system. It detects if the helmet is worn or not and alcohol percent in breath of the rider. This International e-journal uses the components like Raspberry pi, cloud-based service, GPS module and sensors. This system provides accurate and quick delivery of information in real world and it's labeled as *KONNECT.* They have also utilized the Sensors, Wi-Fi, enabled processors and cloud computing infrastructure for the building whole system. At the time of sending accident notification, it also includes the blood group details along with the GPS location. They have used agile functionality while analysis. They focus on enhancing the system by enabling the rider to connect to the centralized hospital server and also by recording rider's data in cloud.

Alberto Lucchetti et al. [8], put forth the system for identification of accident and sudden treatment. In today's world, smartphone technology is utilized for the detection of road accidents in more portable and cost-effective manner than the traditional in-vehicle remedies. Smartphone have inbuilt inertial sensors such as accelerometer even though there is great difference between large range values and high precision.

The algorithm embedded in smart phone devices would alert emergency contact immediately. This survey has been using the feature of various localization sensors and inertial sensors on chip of recent mobile - phones to analyze the mobile pattern of the user and propose customized transportation remedies as well as collect the all traffic data. The advantage of this proposed system is, there is no installation as well as set-up is required. Furthermore, operational space is not bounded to instrumented spaces. Due to this reason, the notion of designing and developing false detection system is studied in a widely manner.

The research observe that the fall will go through four main steps. (a)A short period of free fall where the root-sum of squares of acceleration signals along the three axes tends to 0; (b) An impact on ground that results in an intense acceleration; (c) A bouncing phase during which no further peaks are measured; (d) A motionless period, the duration of which may increase if the person is unconscious. The concept behind those threshold-based algorithms is used for the detection for the situation by taking into consideration of value of the acceleration along the three axes of mobile phones. Even though there is no occurrence of the road accident, driving over the bump or uneven road may lead to false detection of accidents. This can be avoided by new metrics and processing methods.

Edna Elizabeth N et al. [9], forwarded a design a system for notification of occurrence of accidents. Jung includes non-intrusive active electrodes installed on seats of vehicle. White focused on using smartphone for accident detection and notification. Required components include Wi-Fi enabled processor, integrated network of various sensors and cloud computing services used for smart detection and notification. Smart helmet construction consists of the 3-axes accelerometer is used to continuously monitor the head orientation of the driver and position of the helmet and helpful for calculating the possibility of accidents and immediately alert emergency registered contacts. The technology used for implementation over HTTP using JSON or XML

via RESTful architecture is used to communicate with the cloud-based services. This system is cheap and easy to operate and develop as well as most of the systems are available in auto-mobile not only for four-wheeler but also for two-wheeler IOT provides mobile application. Future extension of this work is that smart helmet can be enhanced to detect the alcohol content in breath.

Tim Polzehl et al. [10], put forth study of fall and accident Detection with Mobile Phone (ACM 2009). In this paper they propose a mobile application which can detect the fall and automatically sending and calling emergency services. This application works on acceleration sensor which is built in the today's mobile phones.

As per theory it is stated that, using this application the elder persons can carry with to reduce risks for not getting emergency services. We can use this application in either way like for free person or mobile fall as well for any kind of emergency detection. For future scope they are trying to implement the audio messages for more specific identification. This application is implemented on iPhone 3G platform

III. Proposed System

This proposed system includes sensors such as gyroscope, accelerometer, flex sensor, etc that will be mounted on helmet surface. These sensors will provide continuous readings to arduino uno. ANDing the sensor logic will high output as their threshold value is crossed. Arduino is connected to smartphones via Bluetooth. Smartphone module consists of an android application in which user has to initially insert certain information such as name, emergency contacts, health related data, etc. As soon as accident is detected, arduino will send a signal to the smartphone. Then user details and GPS location will be sent to the emergency contacts and nearby hospitals.

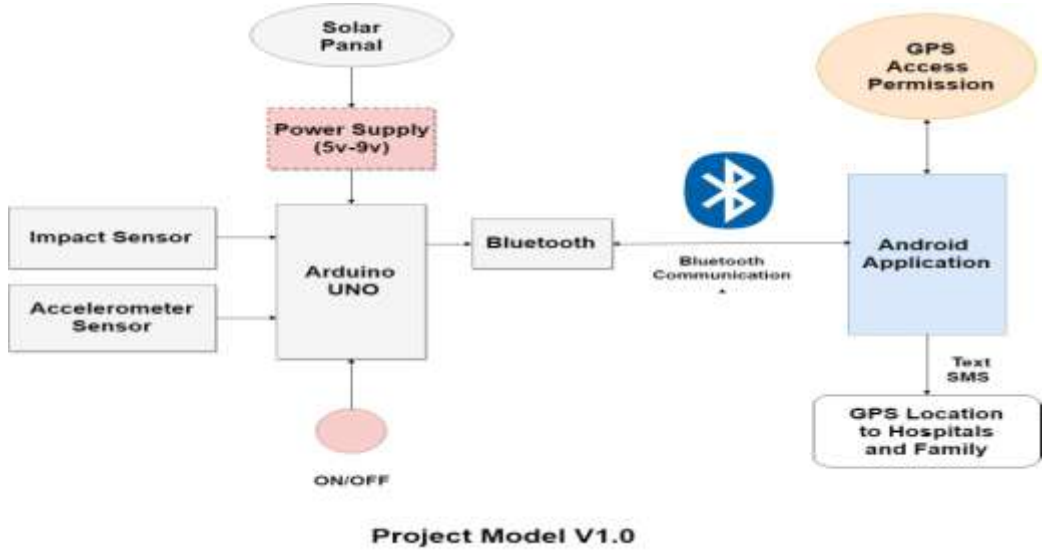

Fig. 5.1 Architectural Diagram

IV. Challenges

Based on all the concepts studied certain challenges are faced while executing them. One of the main challenges is to reduce the battery consumption. The android application in the smart phone will lead to drainage of battery. That will lead to a requirement for extra source of energy. Keeping in mind for certain applications working on the internet will drain out the battery rapidly. Also, the user will have to cost more on the usage of internet especially when the drive is long. Internet is basically used for getting GPS location and accessing cloud services. A separate GPS module may resolve this problem whereas there is no alternative for accessing the cloud services. Using cloud will not only lead to more usage of the internet but also a requirement for cloud maintenance. Considering all this there will be a huge impact on the cost of the product. High cost of the product will not be effective. Another important thing to consider is the accuracy of the system. Depending on the sensor results the further data will be processed. Hence, it is very important that the sensors detect accurate inputs and provide efficient outputs. In case of errors there will be a need of high costs for error correction.

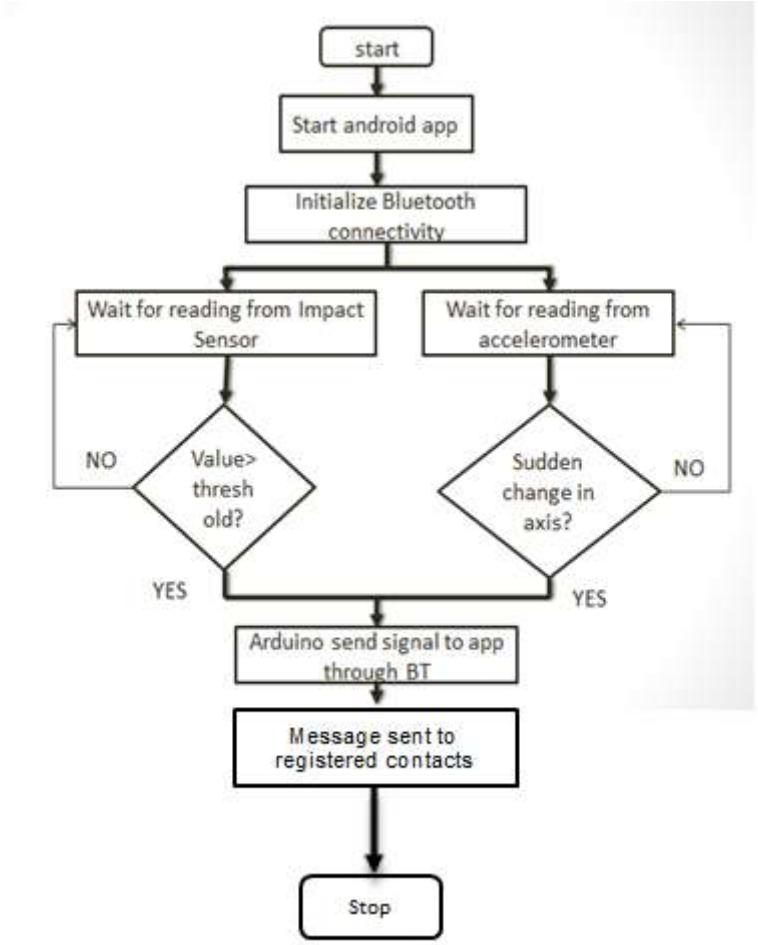

Fig. 5.2 Flow chart

V. Conclusion

Smart helmet is an effective solution to many problems. This methodology detects if one is wearing a helmet or not. It also detects occurrence of any accidents and overconsumption of alcohol. An IOT-based Smart Helmet for I Accident Detection and Notification is explained. It detects the alcohol percentage in breath of the rider. The system for Design of rapid first- I aid alert systems for 2-wheeled I vehicles via smartphones inertial I sensors.

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