

Analysis of Smart helmets and Designing an IoT based smart helmet: A cost effective solution for Riders

Divyasudha N, Arulmozhiarman P
School of Electrical Engineering
VIT University, Vellore
Tamil Nadu, India- 632014

Rajkumar E.R

Senior Architect at Robert Bosch engineering and solutions
Bengaluru, Karnataka, India- 560103

Abstract - In this paper, we have reviewed the recent trends in developing Smart Helmet system. The smart helmet system is used to prevent the accidents in motor bikes and to identify the bike accidents on time for wellness of human being. Also, the smart helmet system analyzed in this paper is used in mining industry for safeguarding the miners from hazardous events in the mine and to alert the miners from hazardous gas emissions inside it. The research also helps to understand the smart helmet system evolved over the period and currently by using emerging technology like Internet of Things (IoT). This work also addresses the intelligent motor bike helmet system which is used to inform the rider about rear big trucks/buses for avoiding collisions.

Key Words – Smart Helmet, Internet of Things, and Wi-Fi enabled processor, Support vector machine.

I. INTRODUCTION

In every aspect of our life safety and security are the major important areas. Now-a-days the scenario that we come across in many cases of human deaths and severe injuries to people is because of two-wheeler road accidents. And it is a crucial issue that requires everybody's attention, for every four minutes there is one death being reported in India. As per World Health Organization (WHO) we have identified that 40% of the deaths and 70% of severe injuries can be reduced if bike rider wears the helmet [1].

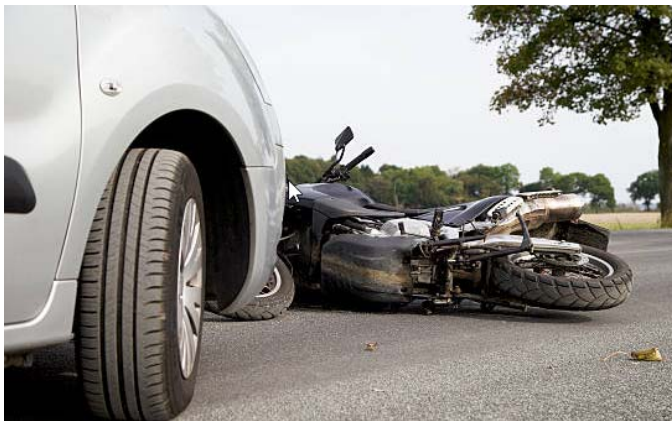


Fig. 1 Indian road accident safety report

Now a day's wearing helmet is compulsory for every two wheeler riders and also it is equally important for pillion riders too to wear the helmet, but the discomfort or inconvenience caused due to wearing conventional helmet makes the rider to avoid using the helmet and finally it leads to death of the rider.

In spite of the fact that helmets are being available to everybody, people are just not wearing them and the main reason behind it is that the conventional helmets are generating unconditional temperatures inside it which makes inconvenience to the person.

Currently in the existing system, when the person met with an accident we are not in a position to ensure the immediate first aid treatment; due to this late medication the person may die. With the help of proposed system in this paper, it triggers an automatic alert message to the concerned person or to the ambulance in case of any emergency situation like an accident. The alert message consists of the details such as location of the accident and time of accident, which will help to speed up the first aid service to the casualty.

The Internet of Things (IoT) can provide an infrastructure which integrates the smart services with situational responses, and also allows mutual communication between smart things or devices and people over a network. So we have come up with this idea of IoT based smart helmet which ensures the safety of the rider while riding.

The idea of proposing this system has mainly come from the social responsibility towards the society. The proposed system allows the rider to start a bike only on wearing the helmet. This system will not allow driver to ride if he had consumed alcohol. This system identifies the bike accidents with accuracy and gives information to the nearby hospital and relatives of the rider who met with an accident. It also tracks the location details of the rider and alcohol consumption of the rider and will be stored in the cloud/server.

II. RELATED WORK

In the process of literature survey, we have found a lot of smart helmets with different approaches and with different methodologies.

C. J. Behr et al [2] had proposed a smart helmet for mining industry in order to identify hazardous event detection and air quality. This system can identify the concentration level of the harmful gases such as CO, SO₂, NO₂, and particulate matter by using electro chemical sensor and also detects the removal of Helmet by using an IR sensor. It also identifies an incident when miners are struck by an object in contradiction to their head with a high force exceeding a value of 1000 by using the Head Injury Criteria. An accelerometer was used to calculate the acceleration of the head after hit and the HIC was calculated in software.

III TECHNOLOGIES USED

Edna Elizabeth et al [3] had developed a smart helmet device for detecting and reporting bike accidents. Smart helmet system comprises of various sensors, and it identify the accident by evaluating uneven or irregular variations obtained from sensor system, and a trigger will be sent to Pager Duty from the microcontroller. Pager Duty will then triggers a call to the phone number registered by the motorist. If the driver does not respond to it for a period of 5 minutes after the first call is initiated, then the emergency contacts will be informed with the details about the accident. The emergency contacts will be alerted through text message, e-mail, and phone call until they acknowledge the incident. In real time, this system assures a reliable and quick delivery of information relating to the accident.

Rashmi Vashisth et al [4] had proposed a methodology which uses Piezo electric buzzer in order to identify over speeding bike and it also equipped with a feature called velocity limiter, which restricts the speed limit of the bike. It also has a feature which prevents the drunk and drive scenarios of the rider called as ALCHO-LOCK and an accelerometer to identify accidents, upon detecting accidents it automatically send a message to concerned person. A fog sensor has been used in this system in order to improve the visibility for the rider in case of fog or smog. It also features automatic deduction of required or needed amount from the riders registered virtual wallet in wireless to helps the rider to stop and do the payment. Selvathi et al [5] had designed a system which automatically detects if the rider is wearing a helmet and also checks whether the rider has consumed alcohol before starting the ride. The relay attached to the engine will turn ON if and only if both the conditions are met. The Microcontroller in the system controls the functioning of relay and thus the ignition. This system also identifies the bike accident at any place and alerts the concerned person about the accident.

Archana D et al [6] had proposed a system which will not allow driver to start the engine without wearing the helmet. When rider wore the helmet, helmet will be locked and engine will be switched ON. This system also identify the approaching vehicle's speed on both sides of the bike while riding by using ultrasonic sensor and alert the rider by generating vibrations in bike's handlebar.

Sayan Tapadar et al [7] had proposed a methodology for smart helmet which can detect whether rider is wearing the helmet or not, and detect whether the person has over-consumed alcohol and can also detects about the accident. This system gathers the data generated from the accelerometer and pressure sensors and the same will be sent to cloud server via an online application programming interface (API) to train a support vector machine (SVM). SVM can help in detecting accident precisely so in the future enough data will be gathered and analysed to provide more accuracy about event detection. The proposed system (smart helmet) can be connected to any smart phone via Bluetooth in order to communicate with the online API, by using the smart phone internet connection.

It is observed that various sensors are integrated with the helmet with safety features in the system incorporated using emerging technologies have been used across the world.

C. J. Behr et al [2] had developed smart helmet used for miners in mining industry which consist of network of sensors attached to the helmet. It consist of air quality sensor which is the electro chemical sensor to identify hazardous gases like CO, SO₂, and NO₂ from SGX Sensor Tech. IR beam based sensor to detect the helmet removal from miner head and ADXL377 an accelerometer sensor to detect the collision. These sensors have been used to detect removal of helmet and air quality in the surroundings and to detect whether the miner had experienced an object collision to his head. All the three sensors are fixed on the helmet and connected to a ZigBee unit. ZigBee module collects the data from all the sensors and processes it and finally acts as a wireless communicator between the helmets connected in the whole network through the Contiki operating system (OS). This complete system was analyzed and designed in such a way that to have minimal power consumption by helmet as the whole system is running on battery as shown in Fig.2. The advantages ZigBee over blue tooth is that to be less power, low data rate and less-cost and it is more suitable to create larger mesh networks compared to Bluetooth. ZigBee has all the same advantages as a Wi-Fi system. It is based on the IEEE 802.15.4 standard. ZigBee module is selected as a wireless chip as it has very good signal penetration inside the walls of mine. Wireless or more specifically Wi-Fi, can be used in mines, but Wi-Fi requires calibrating throughout the mine to the routers. System designers had an idea to use a Raspberry Pi as the main processor in parallel a ZigBee terminal for wireless communication between nodes. The sensor network and the ZigBee module will be connected to the Raspberry Pi. The Raspberry Pi will collect data from sensors and control the ZigBee module. But problems rose due to the more power consumption by Raspberry pi and it had issues with interfacing to connect it. Hence designers decided to use ATZB-24-A2 a ZigBee device as a wireless terminal. It has adequate amount of processing power along with in-built EEPROM(Electrically Erasable Programmable Read-Only Memory).



Fig. 2. Smart helmet device prototype [2]

Edna Elizabeth et al [3] had developed a smart helmet to detect and report the accidents. This system makes use of sensors network, Wi-Fi enabled processor and cloud computing or server based infrastructure connected through Internet of Things. IoT applications introduce several benefits like the ability to monitor remotely, manage and control

embedded devices or things, and to get new perception and important information from large set of real-time data. IoT application-specific framework is capable in reading data streams from sensors or sensor networks directly. It also does transparent and scalable data processing and when events of interest are identified, the programmed set of actions shall be triggered by utilizing the several cloud computing applications. This smart helmet system integrated with the accelerometer to the Wi-Fi enabled processor, which monitors for uneven or abnormal variations in the data continuously. When an accident occurs, the relevant information has been sent to the concerned persons by utilizing a cloud based service. GPS is used to extract the vehicle location. This smart helmet system framework highlighted in this work as shown in Fig.3. The proposed smart helmet system ensures reliable and fast delivery of information about the accident in real time through IoT.

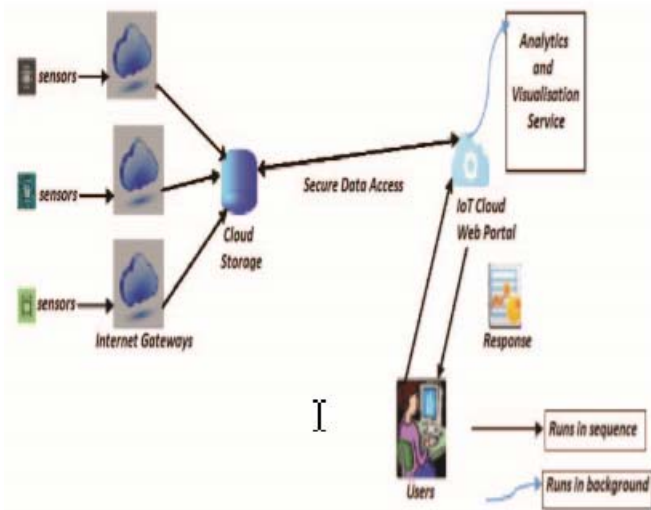


Fig. 3 Communication model between several components in cloud centric IoT frame work [3]

Rashmi Vashisth et al [4] had proposed a methodology which has separate circuitry for both helmet and bike module. Radio frequency modules at 434 MHz are used for wireless transmission between bike and helmet section. Magnetic chip has been used in the system to detect if rider is wearing helmet or not. Gas sensor had used to detect the alcohol consumption of the rider. Only if the rider is sober and wearing a helmet then bike starts. A LDR (light detection resistor) has been used to identify the presence of fog in air. An accelerometer was used to identify the bike accidents by measuring the tilt of the helmet to its regular position. The data from the sensor was transmitted to the Arduino microcontroller. GSM modem in the system communicates with Arduino through USART (Universal Synchronous Asynchronous Receiver Transmitter) and microcontroller evaluates the data and gives command to GSM modem known as AT (Attention) commands to send message to emergency contact of concerned authority as shown in Fig. 4.

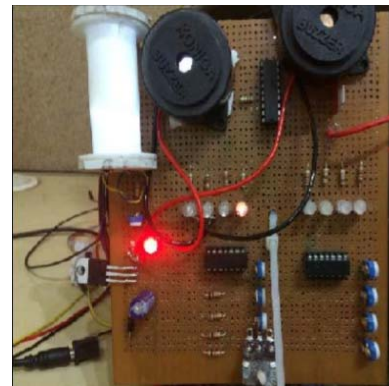


Fig. 4 Helmet unit prototype [4]

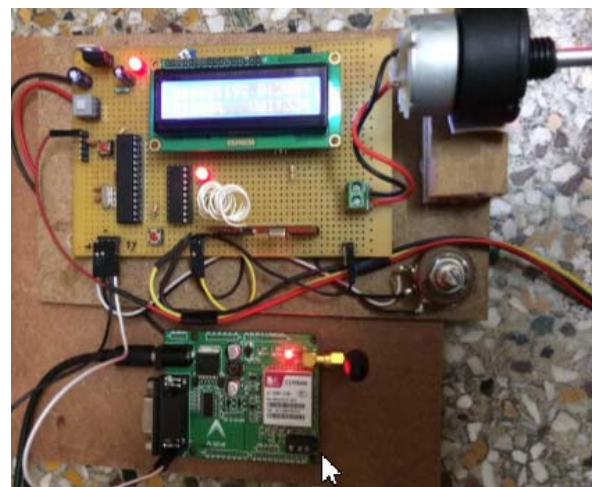


Fig. 5. Bike unit prototype[4]

Sayan Tapadar et al [7] had used on board sensors like flex sensor, Impact sensor, accelerometer (ADXL355), breath analyser (MQ3) to identify the alcohol consumption by rider and to detect the accidents. Fig.5 shows the bike unit prototype which integrates with the Bluetooth module (BLE HM-10) available in smart helmet will transmits the x, y, and z positions data from the accelerometer to a server through Application interface program Interface (API) via online. Support vector machines (SVM) are extensively used in the means of supervised machine learning. This is a learning algorithm that analyses the data and recognize the patterns. SVM will take the set of data and it maps the data into space and tries to derive a hyper plane that divides the space in to positive data and negative data.

During evaluation of data if data lies on the positive plane treats it as positive event detection and if it lies on negative plane treats it as false event detection. As this system makes use of SVM it can optimize the accident detection with reliable accuracy and it has ability to connect to the smart phone makes this system powerful and made to yield good results.

V LIMITATIONS OF EXISTING SYSTEM

Naturally four wheeler segments incorporated various safety features like ABS, Air bag and automated guidance system over the periods. But in two wheeler segments very little has been done to protect the two wheeler drivers by various manufactures. There were prototypes proposed with more features causing more components to be implanted on the helmet which can lead to add more weight to the helmet and also more cost involved in developing it. There was no discussion on the protection of human head when it exposed to severe accident which results in electronics are being embedded to the human head. There was no prototype available or designed with solar energy as power source to the smart helmet.

VI PROPOSED METHODOLOGY & DESIGN

IoT based Smart Helmet is a cost effective assistive technology to provide security and safety of the biker against road accidents. The proposed IoT based helmet that prevents road accident and detects alcohol consumption and this will be able to track the biker and sends GPS coordinates periodically to pre-defined number. Also, it detects crash and will be able to send notification to the predefined number and also the nearby police station.

This system consists of micro controller, position sensor, Alcohol sensor, piezoelectric sensor, RF Transmitter, IOT Modem, GPS receiver, Power supply & Solar panel as shown in Fig.6.

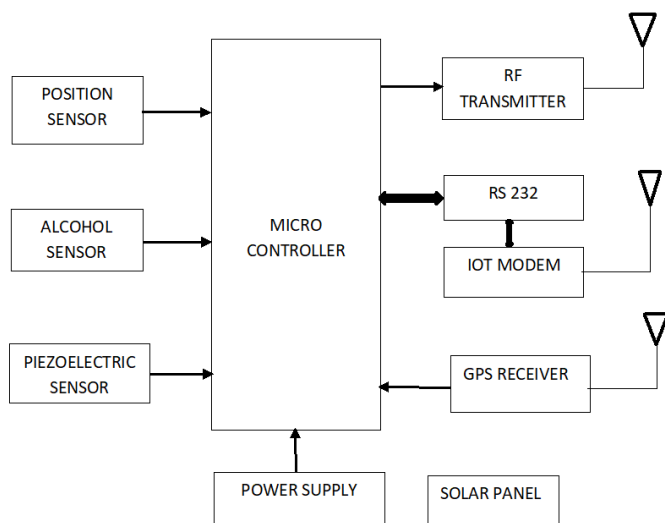


Fig. 6 Block diagram of proposed Smart helmet system

Here we design a system which always checks two conditions before rider starts the ignition of the bike. The first condition is whether the rider wearing a helmet or not and it is detected by position sensor. The second condition is detection of alcohol content in rider's breath with the help of alcohol sensor. Micro controller unit in the helmet collects and process the data by using radio frequency transmitter to the bike section. RF receiver unit in the bike section will receive

the data and a relay is placed in the bike section to control the engine ON – OFF. If either of these conditions mentioned above are not met then the bike engine will not start and this will be indicated by a beep sound. If the rider is wearing a helmet and the alcohol content is not detected then ignition of the engine starts.

Once Biker starts the bike, during the ride the attached GPS receiver fetches the current (longitude & latitude) location and update it to the pre-defined number with the defined periodicity. If any accident occurs then a piezoelectric sensor detects the crash then an alert message will be sent to pre-defined number and also to nearby police station using IoT modem. Solar panel will be mounted on the helmet to charge the battery of circuitry board as self -powered feature.

VI CONCLUSION

Currently we are in the process of finding an appropriate design for the helmet. The proposed helmet should accommodate all the needed facilities in a compact manner. In parallel, the selection of microcontroller and sensors are being taken care. The proposed design will give a solution in terms of cost effective and updated technology front for all kinds of helmets.

The aim is to target the two wheelers segment and then bi cycle users with lighter version. This cost effective solution can be integrated with engine start and other needed safety aspects.

REFERENCES

- [1] Prudhvi Raj R, Sri Krishna Kanth, BhargavAdityaBharath K, (2014) "Smart-tec Helmet" Electrical and Electronics Engineering, GITAM University,Rushikonda, Visakhapatnam, India. Advance in Electronic and Electric Engineering 4: 493-498.
- [2] Behr, C.J., Kumar, A., Hancke, G.P " A Smart Helmet for Air Quality and Hazardous Event Detection for the Mining Industry" Proceedings of the IEEE International Conference on Industrial Technology 2016-May,7475079, pp. 2026-2031
- [3] Sreenithy Chandran, Sneha Chandrasekar, N Edna Elizabeth "Konnect: An Internet of Things(IoT) based smart helmet for accident detection and notification" 2016 IEEE Annual India Conference (INDICON)
- [4] Rashmi Vashisth, Sanchit Gupta, Aditya Jain, Sarthak Gupta, Sahil, Prashant Rana "Implementation and analysis of smart helmet" 2017 4th International Conference on Signal Processing, Computing and Control (ISPCC)
- [5] D. Selvathi, P. Pavithra, T. Preethi "Intelligent Transportation System for Accident Prevention and Detection" 2017 International Conference on Intelligent Computing and Control Systems (ICICCS)
- [6] Archana D, Boomija G, Manisha J, Kalaiselvi V. K. G. "Mission On! Innovations in Bike Systems to Provide a Safe Ride Based on IOT " 2017 2nd International Conference on Computing and Communications Technologies (ICCT)
- [7] Sayan Tapadar, Shinjini Ray; Himadri, Nath Saha; Arnab, Kumar Saha, Robin Karlose " Accident and alcohol detection in bluetooth enabled smart helmets for motorbikes" 2018 IEEE 8th Annual Computing and Communication Workshop and Conference (CCWC)