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Comparative Analysis on Smart Helmet and Intelligent Biking System

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Abstract-- Asmart helmet is a form of head protection that makes cycling safer than before. This smart helmet's main purpose is to ensure safety for rider. Due to rapid growth of two-wheeler motor-bikes, Activas, etc., many researchers have been implemented different high-profile features like detection of alcohol, accident identification, tracking of the location, solar powered, fall detection, etc. in their bikes. This not only makes your helmet smart, but it also adds some innovative functionality to your smart bike. While comprehensive surveys of related problems in bikes such as helmet detection, alcohol detection, fall detection, etc. can be found, the problem of smart helmet and intelligent biking systems is not well surveyed. This review article discusses various schemes proposed earlier for detecting smart helmet and intelligent biking system. Significantly, this paper also provides a fundamental comparison of several existing systems by discussing the key features, advantages and limitations of the systems in the field of smart helmet.
Keywords: Smart Helmet; Intelligent Biking; Alcohol Detection; Accident Identification; Tracking

1. Introduction

According to the United Nations World Health Organization's 2013 survey of motor vehicle accidents, India suffered a death rate of 16.6 per 100,000 people in 2013. The World Health Organization (WHO)'s "Global Status Report on Road Safety" described the main causes of traffic collisions as driving over speed limits, stress, fatigue, driving under pressure and not using helmets and seat belts [1]. The International Road Federation (IRF) reported in 2012 that motor vehicle accidents in India accounted for $ 20 billion (INR 1 trillion cumulative loss). Recently report data collected from the state police and transport branches shows that in 2017, about 98 two-wheeler un-helmet users lost their lives every day in road accidents [2]. In 2016, the number of deaths from 10,135 and two-wheelers not wearing helmets has increased to 36,000 last year. Recently helmets have been made mandatory by the Government of India. In recent times, traffic accidents have increased year after year in India. Many people have lost their lives due to late reporting of accidents; they were unable to monitor the exact global positioning system (GPS) coordinates of the accident areas [3,4]. Despite traffic rules and regulations, many accidents occur without careless driving, drunk driving and using a cell phone. The main reason is that many people are injured. Ed because they don't wear a helmet. Many riders refuse to wear a helmet because they feel uncomfortable and suffocated while wearing it. In compliance with Section 129 of the Act on Motor Vehicles, 1988 allows a two-wheeler driver to have head protection as per Bureau of Indian Standards (BIS) standards. In India, the drunken drive case is a criminal offense under the 1939 Motor Vehicles Act, which specifies that a motor cyclist will be prosecuted [5-8]. The bike rider in life will easily escape the law. In 2013, more than 1, 37, 000 people's life was claimed in road accidents, which according to a report by NDTV [9] exceeded the

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number of casualties in all our wars. These are the three main issues that prompted us to do a comparative analysis of all existing systems:

a) The road accidents are increasing in numbers , estimating at over 2 millions.
b) Many violate traffic rules, such as driving drunk, not wearing head-gears and unauthorized driving licenses or in sometimes driving motorcycles while not having a license.
c) Scarcity of proper time and care of injured.
d) In some situations, driving at night increases accidents.

The major challenges from two-wheel bikes on the road to detecting helmets, driving license detection, alcohol detection, distance detection between automobiles, accident and fall are roughly five types Can be classified into:
a) Helmet detection: - Helmet detection is mainly to ensure road safety. Wearing a helmet is mandatory, without a helmet ignition switch cannot be turned on.
b) Check the driver by viewing the valid driver's license: - This is obtained by use of the RFID module tested on the front panel of the bike along with the driving license and RFID scanner.
c) To check whether alcohol or non-alcohol has been consumed: - The sensor can detect whether the person is drinking alcohol or not. If the rider turns intoxicated, the bike's ignition switch will automatically lock and the current location's message will be automatically sent to their register number.
d) To track the distance between vehicles: - To reduce noise pollution, V2V communication is used by wireless communication with nearby vehicles and avoid collision instead of using horn.
e) Accident and fall detection: - When an accident occurs or the bike rider falls from the bike, the Global System for Mobile Communication (GSM) automatically send message to registered GPS module number with its current location.
The main objectives of this paper is to study and analyze various smart helmet and intelligent biking systems along with strength and weakness. The rest of the paper is organized as follows: A detailed review in the field of smart helmet-based systems, as well as their strengths and weaknesses, is provided in section 2. Finally, conclusions and future promising research directions are given in Section 3.

2. Related work

A lot of effort has been put up by many researchers for smart helmet and intelligent biking systems. In 2014, Manjesh et al. [1] developed a smart helmet for accident detection and reporting system using GSM and GPS module (**Fig. 1**). The architecture of system consists of P89V51RD2 micro-controller, multiplexer 4052, GSM modem SIM 300, GPS receiver, alcohol sensor, vibration sensor, temperature sensor etc. The main feature of the project are that it provides information about the driver whether putting the helmet on his head or not, whether the rider has taken intoxication or not, and also that he/she has experienced an accident that gives information about where he/she is encountered with an accident by means of a GSM device to family members with registered mobile numbers. It also has solar power so that its supply can be either solar power or battery.

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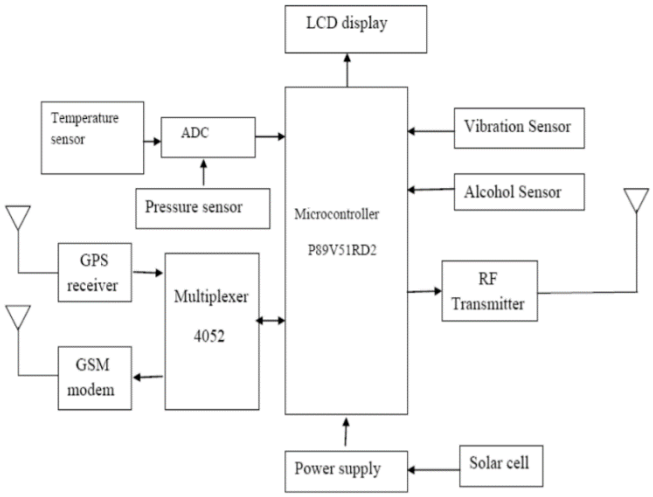

Fig. 1: Block diagram of smart helmet for accident detection and reporting system

In 2015, Ramaiya et al. [2] designed a smart helmet solar gadget system (**Fig. 2**). The architecture of this system includes GPS, GSM modem, emergency switch, helmet with Bluetooth set, ignition control, microcontroller, RF transceiver, vibration sensor. The main features of this helmet are Bluetooth headset, cooling mechanism, emergency alert system, cell phone charging unit and ignition control unit, which are lacking in traditional helmets. In particular, the smart helmet is designed to provide safety, security, and comfort for the wearer. The smart helmet design showed good results, and it works well by harvesting solar energy. Smart helmet design has shown acceptable results, and it works well by capturing solar power. The main drawback of the system is that it does not have alcohol detection and does not detect rider fatigue.

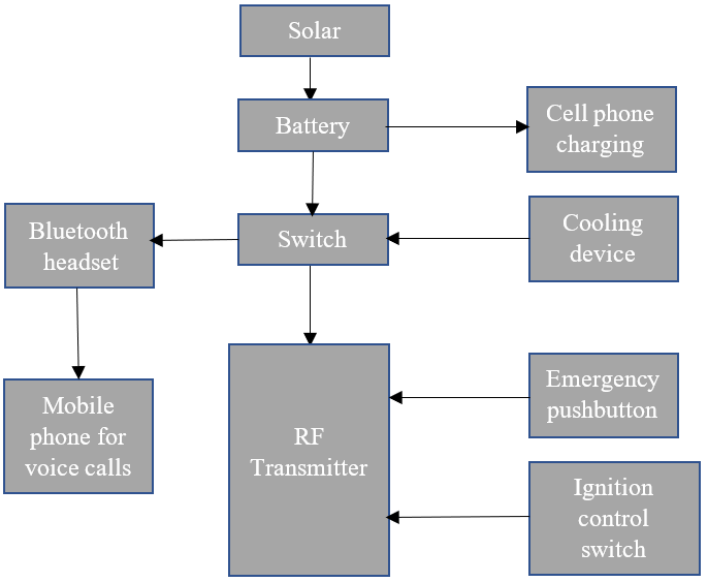

Fig. 2: Blockdiagram of smart helmet solar gadget system

In 2016, Kumar et al. [3] suggested a smart helmet system by installing it on a bicycle that operates with a helmet worn to make the driver wear a helmet before riding the bike. The architecture constitutes of helmet module, voice module and bike module. Its components are micro controller- Arduino nano, radio transceiver- NRF24L01, ultrasonic sensor- HCSR04 and speech synthesizer. The project's main goal is to get the driver to use the helmet throughout the riding. Using this project makes your bike safe at crucial times, especially

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when you are away from the bike and somebody's trying to steal it or, in other words, if there's any theft chances that can happen. The block diagram of the proposed method is shown in **Fig. 3**.

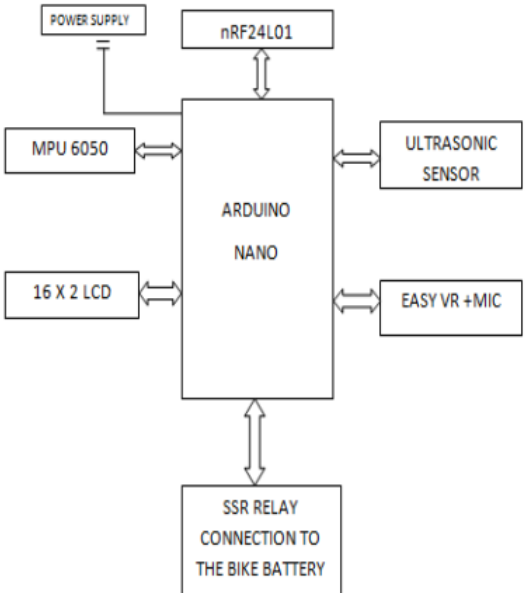

Fig. 3: Block diagram of the smart helmet system

Bonnells et al. [4] formulated a smart helmet mounted motorcycle proximity sensor with helmet display (**Fig. 4**). The architecture of model consists of Arduino, visual display, Bluetooth module, proximity sensor SMT 6500, solar panels etc. The main features of the project are Heads-Up Display (HUD) that will communicate with the bike, and provide the rider with bike information, so they will never have to look off the road. When the rider is signalling to merge, the HUD will be designed to give the rider a visual proximity warning, but this not clear. When the rider is signalling to merge, the HUD will be designed to give the rider a visual proximity warning, but this is not clear. If the rider is not clear to merge, an audible tone will also sound, alerting the driver even more to prevent an accident. Moreover, it is of reasonable cost.

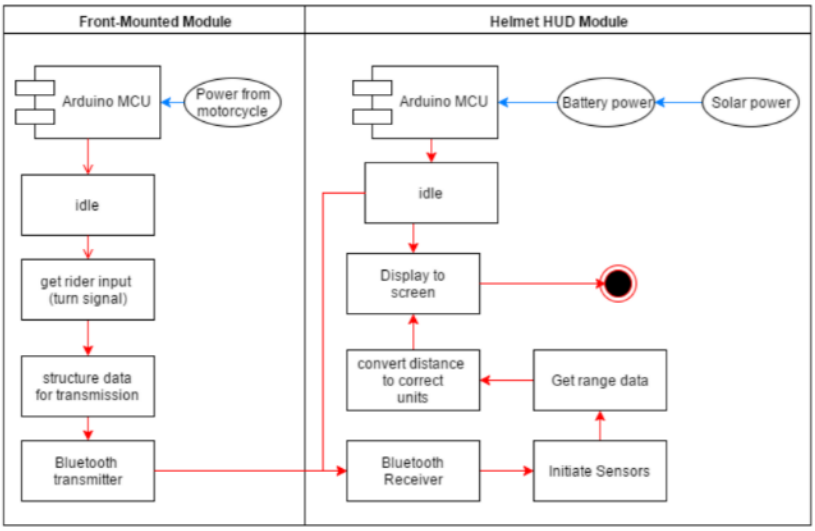

Fig. 4: Block diagram of proximity sensor mounted helmet

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In 2017, Manzoor et al. [5] explored a simple FAAZ smart helmet system that allows the prompt medical attention of a motorcycle accident victim. This smart helmet comprises of the integrated electronic system that uses some of the elementary components in the electronics world. The GPS, GSM, WiFi and the detectors are controlled by the microcontroller. When an accident meets the subject, or precisely the motorcycle rider. After a certain value that can cause significant damage to the motorcycle rider, the vibration sensor, pressure sensor and accelerometer triggers. Once the sensors have been triggered above the given value. Together with time, the GPS coordinates are sent via WiFi element and GSM to the family members and the database. The outcome of this system is that we could give the SMS to the victim's family member and the User Interface (UI) provided the victim's family member with a simple way to contact the nearest hospital. The block diagram of FAAZ smart helmet is shown in **Fig. 5**.

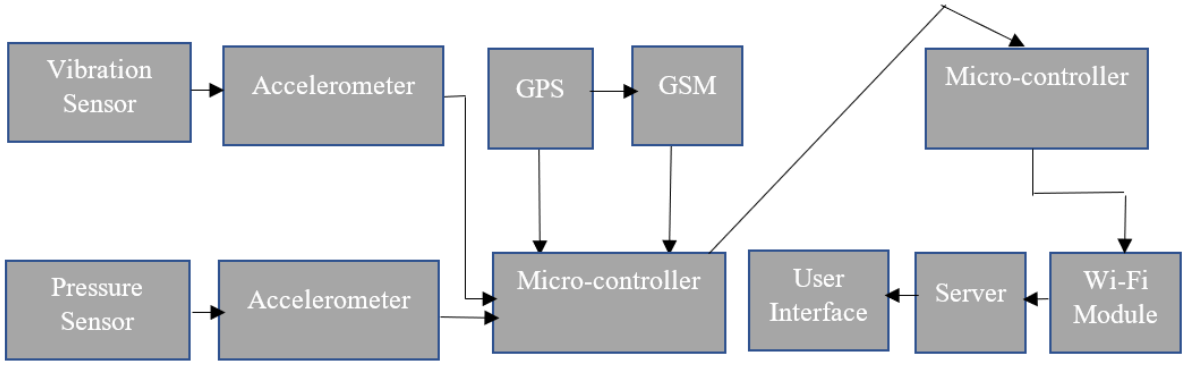

Fig. 5: Block diagram of FAAZ smart helmet system

Anjum et al. [6] formulated embedded based smart helmet for bike rider safety. The architecture of model consists of Arduino, micro-controller at mega 162, LCD, GSM module SIM900, GPS module, accelerometer, object sensor, RF transmitter and receiver, and relay. The special features of this project are helmet detection, breath analysing and alcohol detection. It can also detect an accident and send message immediately to the registered mobile number. The main drawbacks of this project are it cannot detect many other features like biker dizziness detection, over speed detection, etc.

In 2018, Rao et al. [7] presented a highly secured smart helmet system that uses Internet of Things (IoT). This smart helmet works on the WiFi-based raspberry pi 3 controller, acting as a networking system station. The cloud-based services linked up with Bluetooth and raspberry pi 3. The architecture of system consisting of IR sensors, alcohol sensors, temperature sensors, GSM and clouds, GPS, speed limit sensor, mobile sensor and traffic light follower. The main features of this system are detection, prevention and notification of accident. It has the feature of tracking accurately the GPS location of an accident area. The flowchart of high security smart helmet system using IoT is given in **Fig. 6**.

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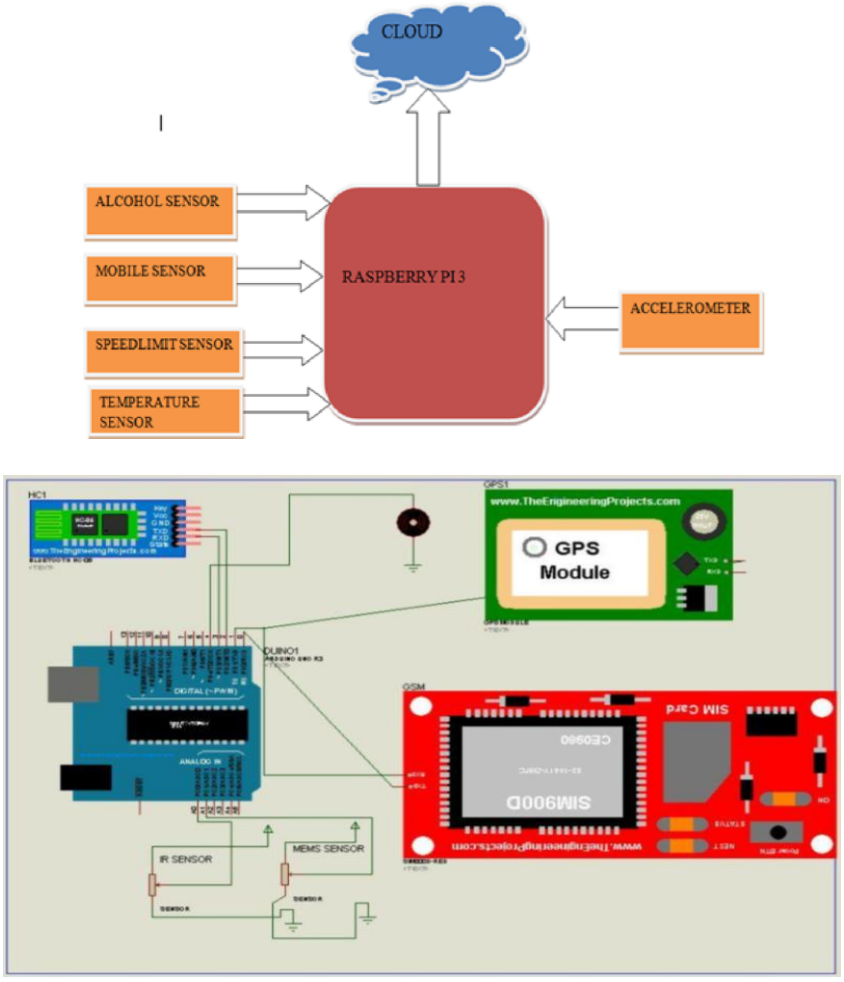

Fig. 6: Flowchart of high security smart helmet using IoT

Vinod et al. [8] proposed a smart helmet system using GPS and GSM technology (**Fig. 7**). The architecture of the system constitutes of micro-controller, GPS, GSM, LCD connection, motor, RF technology, alcohol sensor and vibration sensor. The limitation of the project is people ride the bike even in areas where there is a lack of mobile network, so it takes GSM network to send SMS. It is costly. When the helmet is accidentally knocked, it is regarded as an accident by the process.

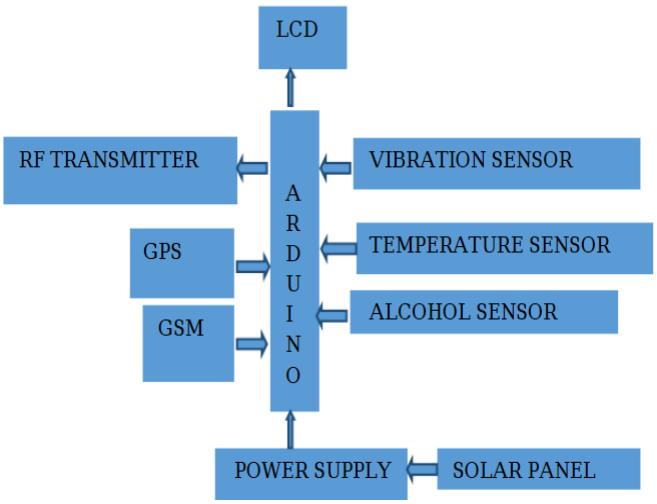

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Fig. 7: Block diagram of smart helmet system using GPS and GSM technology

Kar et al. [9] designed a smart bicycle helmet of high quality (**Fig. 8**). The architecture of system consists of Arduino, Accelerometer, GSM module, Bluetooth module, Passive Infrared (PIR) sensor, power supply, Light Dependent Resistor (LDR), etc. The main features of the project consist of very good quality helmet using a hybridized Fibre Reinforced Plastic (FRP) and carbon fibre and automated accident detection, navigation, audio tuning etc. All this at a least possible cost than the current high-end helmets on the market. Also, the other feature is audio unit i.e. bone-conducting earphones which will be attached to the back of the wearer's ear to play music or listen to directions. Such earphones transmit sound through the auditory channel bone, so that the ears are free to record ambient noise.

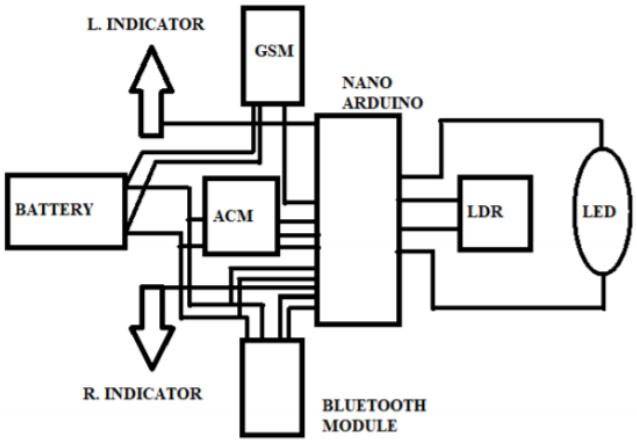

Fig. 8: Bock diagram of smart bicycle helmet

In 2019, Kabilan et al. [10] proposed a smart helmet- accident detection system based on IoT. The architecture of system consists of Raspberry pi module, GPS module, vibration sensor, accelerometer and they have also implemented a mobile application and created web interface. The main features of the project are accident detection and reporting, and it could also check the speed of the vehicle and if over speed is detected, it turns off the vehicle. The special feature of the system is to identify the victim and report the accident to ambulances and the people concerned with the rider to provide the victim with rapid medical assistance with the relevant information. A raspberry pi module is used to accomplish this feature and a special code is embedded in this module. Vibration sensors are interacted with the accident vibration frequency in raspberry pi module. The raspberry pi is connected to the GPS module and all of these are embedded in the helmet. The block diagram of smart helmet- accident detection system work is shown in **Fig. 9**.

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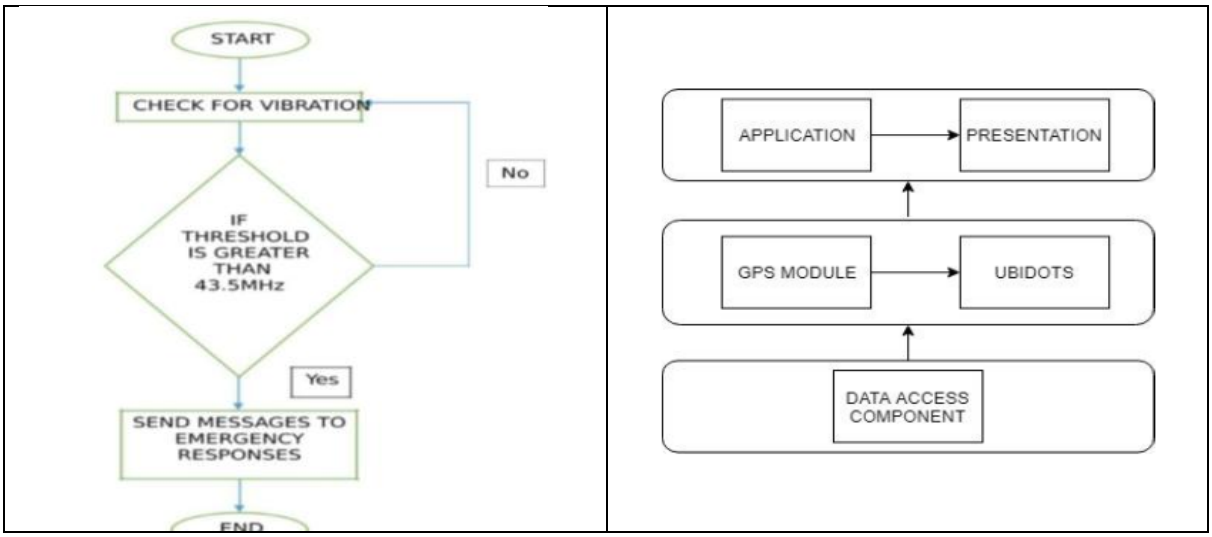

Fig. 9: Block diagram featuring smart helmet- accident detection system

Shravan et al. [11] suggested a safety protection system in the bike rider's helmet for safe driving. The architecture of the system includes Arduino, vibration sensors, RF communication circuits, accelerometers, MQ-3 alcohol sensors. Sensor. The main feature of the system is that the bike will not start until it meets the following two conditions: a) the driver is wearing a helmet; B) There is no indication of alcohol detection from the driver. If an accident occurs, the vibration sensor is activated and the location information is sent to the registered mobile number. The block diagram of the safety protection system in the bike rider's helmet is shown in **Fig. 10.**

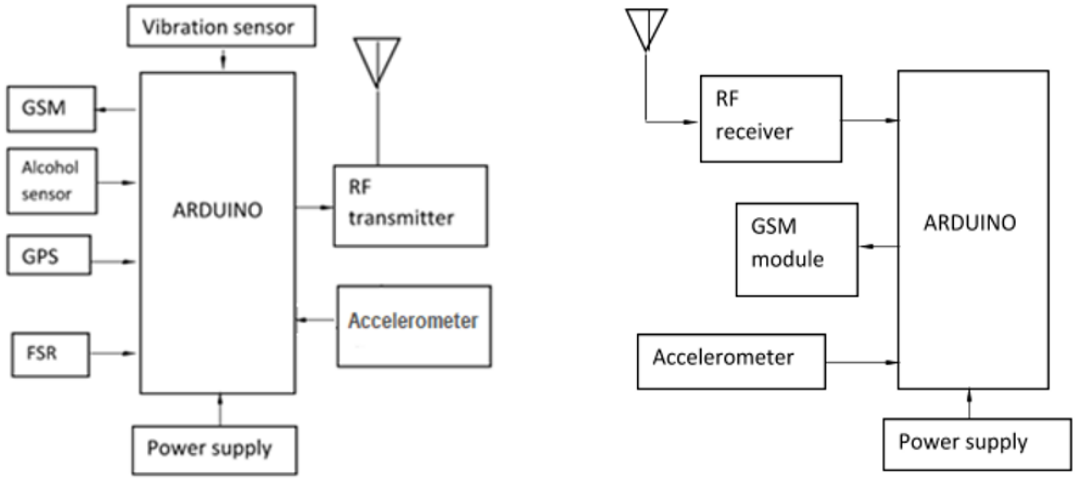

Fig. 10: Block diagram of security protection system in a bike rider's helmet

The comparative analysis of existing systems is shown in **Table 1**.

Table 1: Comparative analysis of existing systems

Author	Year	Technology	Advantages	Disadvantages
Manjesh et al. [1]	2014	Micro-controller P89V51RD2, multiplexer 4052, GSM modem SIM 300, GPS receiver, alcohol sensor, vibration sensor, temperature sensor	Alcohol detection, helmet detection	No over speed detection

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Ramaiah et al. [2]	2015	Emergency switching, GPS tracking, GSM modem usage, Bluetooth enabled helmet, ignition control, micro-controller, RF transceivers, vibration sensors	Helmet detection	No alcohol detection and riders fatigue detection
Kumar et al. [3]	2016	Micro controller- Arduino nano, Radio Transceiver- NRF24L01, Ultrasonic sensor- HCSR04 Speech synthesizer	Prevents bike from being stolen, automatic on/off through helmet detection	Lack of real-life implementation
Bonnells et al. [4]	2016	Arduino, visual display, Bluetooth module, proximity sensor SMT 6500, solar panels	GPS system: Live visual feed to user so that he/she can see what is behind him	No alcohol detection and helmet detection
Manzoor et al. [5]	2017	Microcontroller, GSM module, GPS module, accelerometer vibration Sensor	Helmet detection, over speed detection	Time delay of sending message to the registered mobile number
Anjum et al. [6]	2017	Arduino, micro-controller Atmega 162, LCD, GSM module SIM900, GPS module, accelerometer, object sensor, RF transmitter & receiver, relay	Alcohol detection, helmet detection, over speed detection	Cost is more and no eye blink movement detection
Rao et al. [7]	2018	Raspberry pi, Bluetooth module, GSM and GPS module, alcohol sensor, vibration sensor accelerometer	Alcohol detection, Violation of traffic rules detection, Speed limit, etc	No eye blink movement detection
Vinod et al. [8]	2018	Micro-controller, GPS technology, GSM, LCD connection, motor, RF technology, alcohol sensor, vibration sensor	Sends GPS location of an accident area, helmet detection	System treats it as accident even if helmet drops off accidentally
Kar et al. [9]	2018	Arduino, accelerometer, GSM module, Bluetooth module, PIR sensor, LDR	Smart phone app which have features like alarm timer, online navigation, emergency number setting for calling	No alcohol detection
Kabilan et al. [10]	2019	Raspberry pi module, GPS module, vibration sensor,	Accident detection, over speed	No helmet detection and eye

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		accelerometer, mobile application	detection, mobile application, web interface	blink detection
Shravya et al. [11]	2019	Arduino, vibration sensor, RF communication circuit, accelerometer, alcoholic sensor-MQ3	Detection of accident in remote area, drunk and drive detection	No helmet detection

3. Conclusion

In this paper, a comprehensive survey on smart helmet models is provided. Even though a large number of models have been implemented in the literature, no single model can provide satisfactory challenges in all applications. Smart accident prevention and detection in two-wheelers have been proposed using various sensors such as recent advanced Tech such as RFID reader, Vehicle2Vehicle (V2V) communication, Raspberry Pi, eye blinking detector, alcohol, vibration. Accidents. This smart helmet system prevents any casualty by looking for various conditions such as detection of red-light, driving license validation, measuring and alarming for over speeding , drunk driving case detection, and much of other situations. By this method, we ensure the safety of our loved ones by tracking them of their locations . It also solves traffic maintenance problem to protect the person and fellow riders. It is highly efficient in terms of performance as well as both parameters.

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