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Innovative Applications of Smart Sensors for the Bike Helmet to Reduce the Accidents & To Enhance Safety of the Rider

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***Abstract*—The conceptual thinking to use smart sensors for the two-wheeler helmet is the result of social responsibility to reduce the number of accidents in India. The road accidents in India are common due to which there are fatal injuries and loss of lives. According to report published by Ministry of Road Transport, Transport Research Wing New Delhi, in 2017 a total of 4,64,910 road accidents have been reported in India, Claiming 1,47,930 lives and many fatal injuries. The road accidents which involves two wheelers have the highest share of 33.9% in total accidents and of 29.8% in total fatalities. The road accident is one issue and lack of treatment on proper time is the additional reason for deaths in India. According to the survey nearly half of the injured people are being succumbed to injuries due to lack of treatment on proper time. In this project this issue to reduce number of road accidents and in case of accident, provide all the necessary help and treatment has been addressed. This project aims at design and development of Smart Helmet which provides and ensures safety to the biker. The system proposed here helps the rider to follow all the safety regulations while driving and in case of emergency sends the signals to the concern authority. This system is specifically mechatronic system which consist of conventional helmet embedded with multiple sensors. The Sensors incorporated in the helmet are Capacitive Sensor, Strap Switch and Alcohol sensor. The capacitive sensor has the ability to sense the contact pressure and ensures that biker wears the headgear. Strap switch ensures fastening of strap belt and alcohol detection sensor prevents the rider to drive when he consumes alcoholic drinks. These three sensors have been designed to work in sync with two modules fitted on the bike viz GPS/GSM module, accelerometer. The system has been designed and tested keeping in view the Indian road conditions and economic feasibility. This System provides the future solution to tackle the global menace of road accidents at economic cost.**

Keywords*— *Smart Helmet, Capacitive Sensor, Strap and Abort Switch, Accident Detection and Alert System, Alcohol Detection, Accelerometer.

I. INTRODUCTION

Traffic accidents in India have been increasing year by year and most of the states have made it mandatory to wear a protective gear while driving the two-wheelers. As per Section129 of Motor Vehicles Act, 1988 makes it required for every single riding a two-wheeler to wear protective headgear following to standards of the BIS (Bureau of Indian Standards). In India drunken-drive case is crime of The Motor Vehicle act 1939. Which states that the bike rider will get penalize. In reality bike rider easily gets escaped from law.

These are the three main issues which motivates us for developing this project. The first step is to detect the helmet is wear or not. If helmet is worn, then ignition will start otherwise it will remain off till helmet is not wear. For these we use capacitive sensor and strap switch. The second step is alcohol detection. Alcohol sensor is used as breath analyser which detect the presence of alcohol in rider breathe if it is exceeds permissible range ignition cannot start. It will send the message to register number.

TGS-822 sensor is used for these. When these three conditions are satisfied then ignition of bike will start. The third main issue is accident and late medical assistance. If the rider met accident with him, he cannot receive medical help instantly, it's big reason for deaths. Around every second people die due to late medical assistance or the accident take place at unmanned. In fall detection, we place accelerometer at the bike module. Due to these mechanisms we detect the accident occurs or not.

Chinmay Kulkarni et.al. [1] designed a system with GPS and ZigBee communication to geolocalize the drivers. Both works are presenting interesting implementation and infield testing of the system. The authors [2] designed a smart helmet that is able to detect of hazardous events in the mines industry. In the development of helmet, Air quality, helmet removal and cooling effect have been considered. 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 problem of work noise and environmental condition while designing helmet for miners [3]. A smart helmet has been designed [4] that is able to detect of hazardous events in the mines industry. In the development of helmet, they considered the four main types of hazard such as air quality, helmet removal, fire and mercury sensor. The first is the concentration level of the hazardous gases such as CO, SO2, NO2, and particulate matter. To detect whether the biker has worn the helmet, detect accidents the mechanism has been proposed which includes IR sensor and GPS-GSM during the accident [5,18].

The framework to access concentration of dangerous gasses in the mine using Raspberry-pi with Wi-Fi have been proposed [6]. An intelligent helmet to assist the miners working in the mining industry to detect harmful events using Zigbee wireless module network are used to collect sensor data and transmit them [7]. The authors [8,15,16] have advanced the two wheelers system by the sensors that monitors and control the speed. The sensor used to control the

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speed is the speed sensor. Here ultrasonic sensor is also placed in order to maintain the distance between the vehicles to avoid collision between the vehicles. ZigBee based wireless mine supervising system with voice over ZigBee (VoZ) have been design , which enable the helmet as a mobile sensor node of ZigBee wireless sensor networks, gathering parameters such as temperature, humidity and illumination level of underground environment and will alert the central management unit in case of abnormal condition [9]. An accident avoidance prototype using IoT which consists of two units namely helmet unit and vehicle unit [10]. The authors [12] have described a helmet which is made smart using latest IOT technologies. This helmet for the comfort of riders provide various functions such as Listening to the music on the go, sending SOS messages in case of emergency, use navigation services.wireless sensor network for monitoring real time situation of underground mines from base station and to provide real time monitoring of harmful gases like CO, CH4 and LPG and temperature has been proposed [13].

A Smart helmet which can monitor the traffic behind the two-wheeler rider in real time and will alert the driver of motorcycle in case of any safety issues using computer vision has been presented[14].The helmet with the capability of wireless communication between the Ignition switch and helmet has been designed to make it sure that biker has worn the helmet[17]. The authors [18] designed Helmet using GSM and GPS Technology for Accident Detection and Reporting System. In this paper GPS and GSM as is core technologies, Vibration Sensors are placed are used. The system to ensure whether the person is wearing the helmet and has Non-Alcoholic breath while driving. IR-Sensor used to ensure that whether rider has worn the helmet on the head or Not[19].To detect alcohol consumption, receives the cell-phone calls with the wireless communication install in the helmet[20]. Usage of Mobile phones while driving. In this we are insisting that every bike rider must wear the helmet. The authors [21] present a unique design and prototype of a helmet capable of providing a comfortable and salubrious experience to the Delhi-NCR riders. In this design Gas sensors, Microcontroller, Internet of Things (IOT), THP2-Filter, Peltier Effect, etc. are used.

The main aim of this project is to make a protection system for a helmet to ensure safety of bike rider. The helmet proposed here is fitted with number of sensors to ensure biker has worn the helmet, not consume alcoholic drink and fasten the strap belt. Two different microcontrollers have been used in the design of the proposed system which are mounted on two different modules, bike and helmet. For bike module Arduino Mega-2560 and for helmet module Arduino Nano AT MEGA-328 have been used. Signal transmission between the helmet module and bike module is using an NRF module has been proposed.

II. THE PROPOSED SYSTEM

First, In this work attempt has been made to use the existing and advanced technology to design head protection gear.

The system consists of two modules viz. bike module and headgear module. The headgear module consists of capacitive touch sensor, strap switch and alcohol sensor. The bike module consists of accelerometer, GPS-GSM module and abort switch. The two modules have been designed in such a way to work in sync with each other using wireless communication. Capacitive Sensor is placed inside the helmet where the actual human touch can be sensed. This sensor works on the principal of capacitance and has excellent ability to monitor the change in capacitance. If biker attempts to start the bike without wearing the helmet it sends the signal to bike module which prevents the ignition The output capacitance increases, if a conductive object touches or approaches the sensor electrode. The measurement circuit detects the change in the capacitance and converts it into a trigger signal. The principle of capacitive sensor and actual pin configuration have been shown in fig.1 and fig.2. The Strap switch to ensure fastening of strap belt of helmet has been used here. This also ensures that the helmet will not be fallen during the ride or sudden impact. Also, the ignition of bike of engine cannot be affected without locking of the strap belt will not be started.

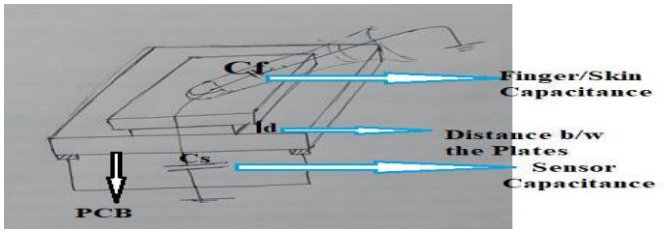

Fig -1: Principal of capacitive sensor

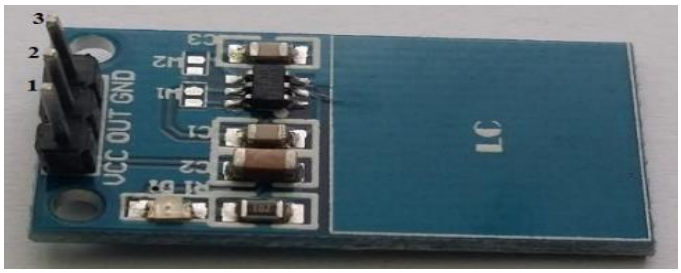

Fig -2: Pin configuration of capacitive sensor

The TGS-822 gas sensor is right for identifying the alcohol content from breath. It can be positioned just front of the face. The sensor is responds to various gases. It determines by helmet module that weather the rider is drunk or not. TGS-822 sensor has potentiometer to adjusting different concentration of gasses. the detector has been calibrated for 0.4mg/L of Alcohol concentration in the air and used value of resistance is 200 KΩ. TGS-822 can support for both analog and digital framework. TGS-822 has 4 pins namely GND, VCC, Aout, Dout. Digital output of this sensor is in the form 0 or 1. Zero means low output i.e rider has not consumed the alcoholic drinks and viceversa. The basic circuitry of alcoholic sensor is shown in fig.3 and pin configuration is shown in fig.4

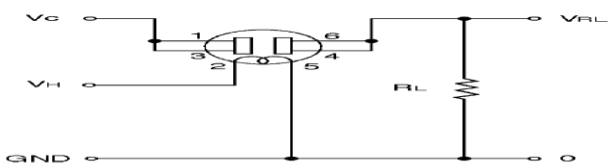

Fig-3: Basic Measuring CKT of Alcohol Sensor

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Fig -4: Alcohol Sensor

To monitor the bike acceleration ,the accelerometer has been mounted on the bike module. It is well known fact bike acceleration varies during the ride and can be monitored to ensure the safety of biker. Accelerometer is an electromechanical device that measures the force of acceleration due to gravity in g unit. It can be used in applications requiring tilt sensing. The ADXL335 measures acceleration along X, Y and Z axes and gives analog voltage output proportional to the acceleration along these three axes. This signal is processed by microcontroller using analog to digital converter. The ADXL335 is tiny, tri axial accelerometer which is used for both measurement of static and dynamic acceleration. In this project accelerometer has been used to measure the static acceleration by gravity and free-fall sensing if the bike is falling. If accident or sudden impact is experienced by the bike, the microcontroller immediately sends the signal to the receiving unit. In this project ADXL335 has been interfaced using I2C digital interface technique.

Fig -5: Interfacing ADXL335 Accelerometer Module with Arduino

GPS module gets the location information from satellites in the form of latitude and longitude. The microcontroller processes this information and sends it to the GSM modem. The GSM modem then sends the information to the Relatives, Police Control room or ambulance. The System is equipped with accident detection sensor installed on the bike, which will be able to detect accident and in case of accident happened it will quickly notify to the police control room, relatives and ambulance with help of GPS-GSM modem. If the accident is minor, rider can abort message by pressing the abort switch.

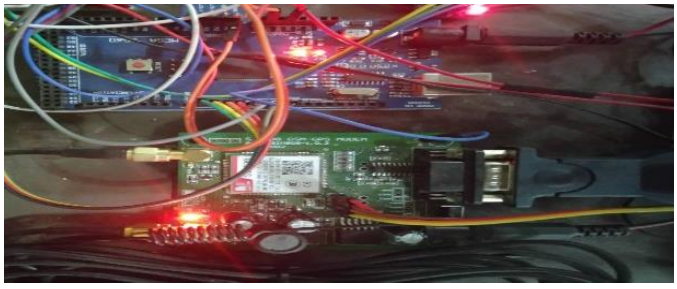

Fig -6: Interfacing GPS-GSM Modem with Arduino

NRF module uses the 2.4GHz band and it can operate with baud rates from 250kbps up to 2Mbps. It is used in open space and with lower baud rate its range can reach up to 100 meters.

Helmet module and Bike module are connected by wireless link of NRF24L01. NRF communication circuit contains encoder and decoder circuit. Encoder is on helmet module which is used to convert parallel data into serial data. The encoder is capable of encoding massage. Decoder is on bike module ; it is used to decode serial data. It converts this serial data in to parallel. The decoders are capable to receive the data that are send by an encoder and understand it.

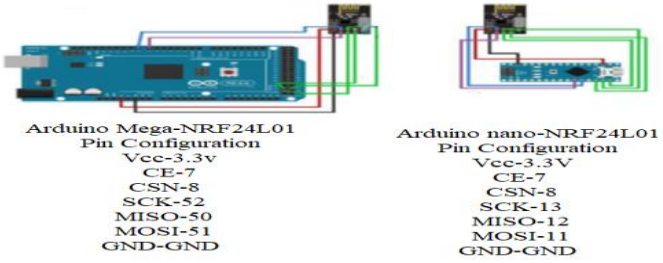

Fig -7: Interfacing NRF24L01 module with Arduino

III. CONSTRUCTION

In this work two modules i.e. helmet module and bike module have been designed and fabricated. In helmet module, the capacitive sensor is placed inside at upper part of the helmet where head can easily touch with sensor surface. Alcohol Sensor is placed in front of rider's mouth as shown in fig.8. It is located in such way that it can sense the breath of a rider very easily. In case rider is found to be consumed alcoholic drink it generates the warning signal. The Battery, Regulator Circuits, Microcontroller, Strap switch and NRF transmitter are fixed inside the helmet. The detail construction and circuitry are shown in fig.8 and 9 and block diagram of helmet module and bike module are shown in fig. 10 and 11 resp.

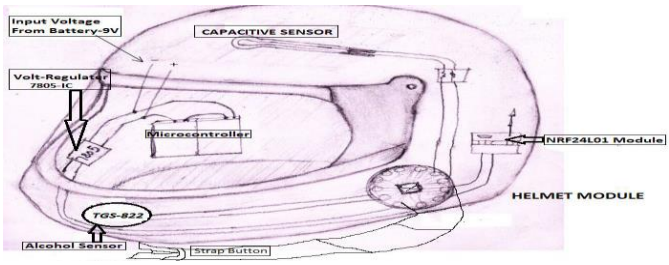

Fig-8: Construction of The Helmet module

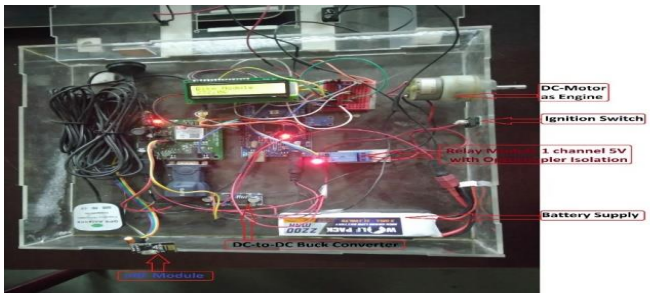

Fig-9: Construction of Bike module

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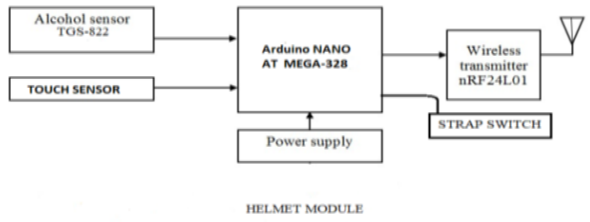

Fig-10: Block Diagram of The Helmet module

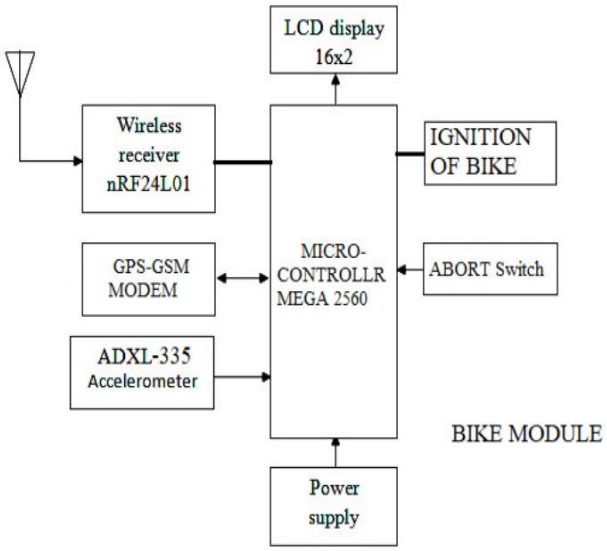

Fig-11: Block Diagram of Bike module

The bike module is mounted on actual bike. Accelerometer was fixed on bike module, for the fall detection. Our main controller, GPS-GSM modem and decoder are positioning into storage case of bike. also stick an LCD on the bike module. So, we can easily read the message.

PROGRAM FLOW CHART

In order to ensure the proper functioning of the smart sensors used in the design of system the logical flow of information and processing have been prepared. The detailed sequences and process flow are given in the fig.12. the system initialization is carried out initially when the biker inserts the key to start the engine ignition. While starting the ignition the system detects the signal of accelerometer to ensure that any mishap has not been encountered. At in this stage if bike is not encounter any accident and it will go to the next step . In the third step, sensors which are fully activated detect the biker proximity by capacitive sensor, Strap switch and alcohol consumption. The NRF module which is mounted on the helmet and working in sync with bike module sends the information. If the biker has not put on the headgear then it displays the message on LCD display mounted on the bike module. If the strap belt in not fasten it displays the message please fasten the strap belt. If the rider is found to have consumed the alcoholic drink above the limit then it displays the message you are drunk. If any of this condition found to be true the ignition of bike will not be started and GPS+GSM modem will be activated. The GPS modem which is used here to track the location of the biker immediately and send the text message to the concern person with help of GSM modem. The last step, while riding if biker encounter any accident the accelerometer detects the unusual acceleration and sends the signal to the GPS+GSM modem which in turn send the message to the concern person. The detail program flow chart as shown in fig.12.

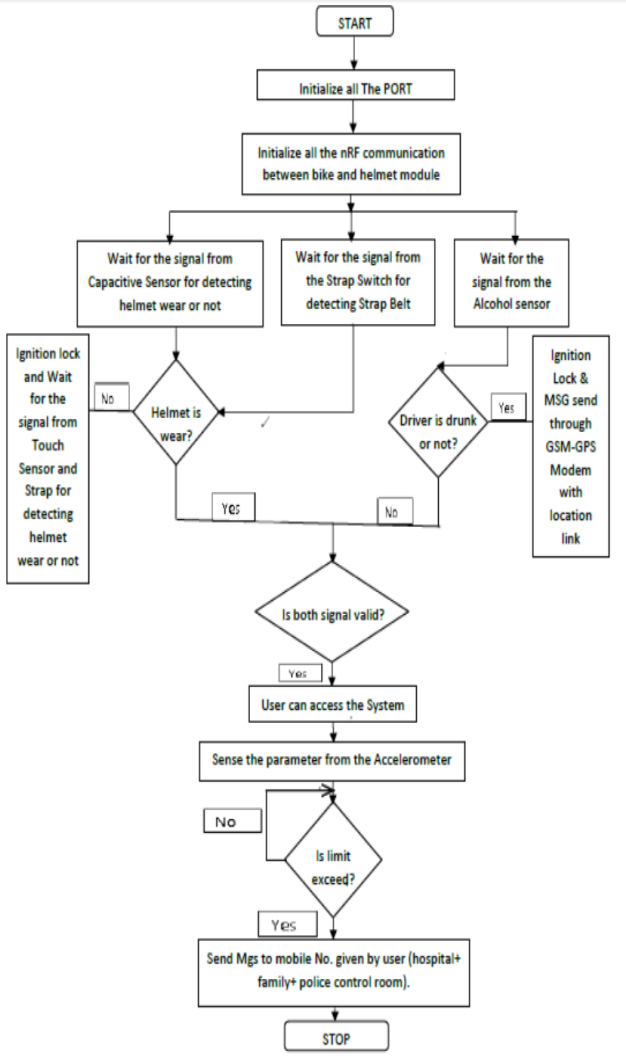

Fig-12: Flow chart of the system

IV. TESTING OF HELMET & BIKE MODULES AND EXPERIMENTAL VALIDATION

The functional testing of the retrofitted helmet having two modules has been conducted on Indian road near Pune. The test has been conducted systematically to monitor functional aspects of the various modules. Three different bike riders have been instructed to test the proposed system. The bikers have been instructed to follow the instruction manual specially prepared to test this headgear. Specifically, four different conditions have been tested by the bikers viz. 1) Not to wear the helmet and insert the key for bike ignition. 2) Wear the helmet but not to fasten the Strap Switch. 3)Wear the helmet and Fasten the strap belt. 4)Wear the helmet, fasten the strap belt and consume the alcoholic drink. The result of these four conditions have been given in following figures. If the rider attempts to break any of the rules or condition as mentioned earlier, instant message has been displayed on the LCD display unit fitted on the bike module. Also warning message

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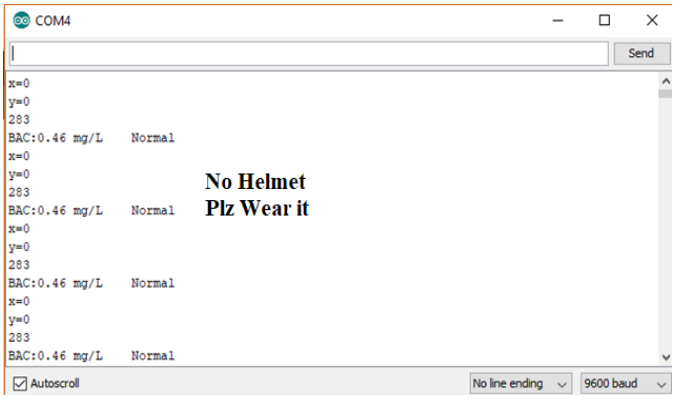
relating to the particular mistake sent to the concerned people which are already recognized by the rider. The module fitted on the bike has the accelerometer which detects static and dynamic acceleration of the bike. This unit is mainly used for detecting an accident and coordinating with helmet module. In case of an accident the message is sent to the concerned people as well as to the concerned traffic control unit. Some of the results of testing as in the table1.



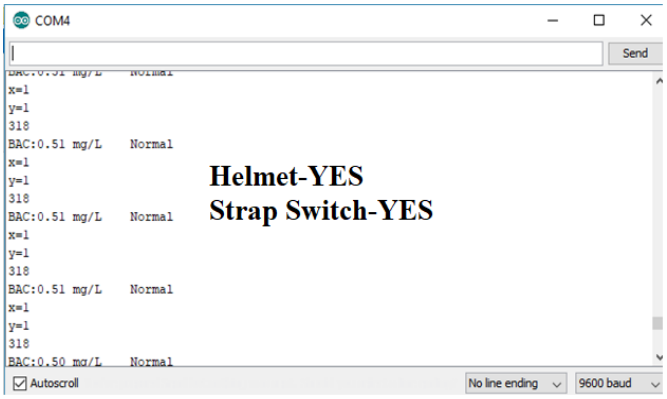
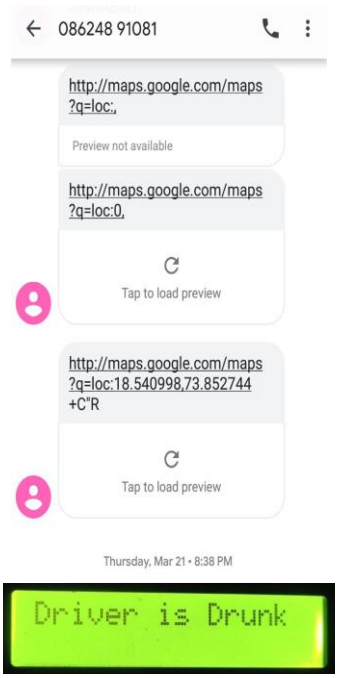
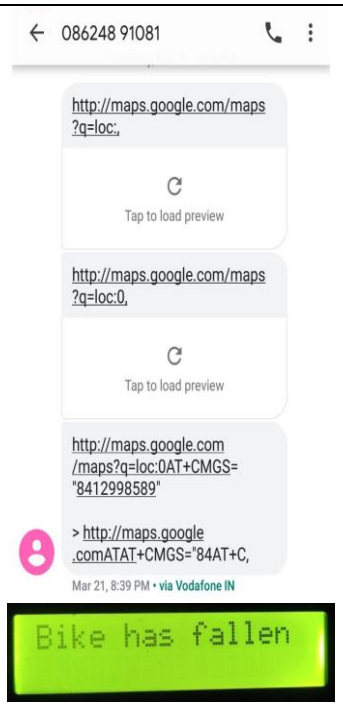


Table 1.

1) If rider is not ware helmet, then it displays the message of "No Helmet Pls Wear it".	
2) If alcohol concentration present in human breath then it displays the message on LCD and it sends the SMS to register Number. with their current location.	
3) If accident occurred, then bike is fallen. It displays the message on LCD. And it sends the SMS to register Mobile Number. with their current geographical location.	

V. FEATURES OF PROPOSED SYSTEM

This work attempts to address the critical issue of large number of accidents and there after Severe injury and death. Here the conventional helmet has been retrofitted with the

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smart sensors and simple electronic circuitry. With the additional unit fitted on the bike the system has all the features which makes it smart. This system provides the high level of safety and control at very nominal cost. The system is able to guide the rider and warn the rider for possible mishaps. The system is designed to detect the accident. In case of an accident it sends an emergency message to the concerned people and helps to provide medical services in short time. It is observed that many accidents cause due to negligence on the part of rider. The negligence in many cases are due to consumption of alcoholic drinks which makes the rider rampant. To avoid these menaces of drink and driving system is fitted with alcohol detector . It simply bars the rider to drive the bike when he consumes the alcohol. Thus system tries to reduce the probability of accidents by barring the rider.

VI. CONCLUSION

In this work attempt has been made to design the smart helmet which is helpful for Indian bike riders. Two modules that is helmet module and bike module have been made which facilities the co-ordination between rider and bike. The helmet module has the sensors viz. touch sensor, alcohol detector sensor and strap switch sensor. These three sensors ensure that the rider has worn the headgear, not consumed the alcohol and fastened the strap belt. The bike module has accelerometer, GPS-GSM modem and communication modem. The accelerometer measures the real time acceleration and generates the signal (warning) in case of unusual acceleration. GPS-GSM modem tracks the biker location and sends the emergency message in case of an accident. Communication between the bike module and helmet module takes place with the help of NRF module. This system has been tested on Indian roads and results have been tabulated. The result analysis shows system works well with on Indian roads and is found to be suitable. This system provides utmost safety to the rider with nominal extra cost. The system can be improved by installing vision system for recording the activities of the bike rider. The recorded information can be used by the controlling authority for monitoring the traffic and safety rules. The system can further upgraded by mounting the wireless transmitter on bike module which is helpful for enhanced communication bike vehicle to vehicle. Also, solar panel can be fitted on helmet module which will helpful to charge the battery of the system.

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