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IoT-Based Smart Helmet

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***Abstract* - With the increased use of motorcycles and bikes, there has been an alarming increase in road accidents in various countries each year. Some countries are among the most densely populated in the world, with roads and streets that are narrower in comparison. Although the government makes sufficient rules and regulations to prevent road accidents, the accident rate is increasing daily. Motorcycle riders cause serious road accidents that result in fatalities while not wearing helmets and riding motorcycles while intoxicated. However, wearing a helmet significantly reduces the risk of an accident. This paper describes a highly effective and technologically advanced Smart Helmet implementation based on the Internet of Things. A smart helmet is a type of protective headgear used by the rider which makes bike driving safer than before. The main purpose of this helmet is to provide safety for the rider. This can be implemented by using advanced features like front night vision object monitoring, rear blind Spot monitoring accident identification, location tracking, fall detection, head protection airbag. In case of an accident, it will send a message through GSM along with location with the help of GPS module. The distinctive utility of the project is fall detection; if the rider falls from the bike, it sends a message.**

Keywords: GSM Module, Accelerometer, Raspberry Pi.

I. INTRODUCTION

In recent years, the number of motorcycle accidents has increased to over 5000 every day. A smart helmet is a type of protective headgear worn by cyclists that makes biking safer than before. This helmet's primary objective is to keep the rider safe. We used vision-based on-road nighttime vehicle identification and tracking system with taillight and headlight features in the proposed strategy. Vehicle detection and tracking with taillight and vehicle detection and tracking with headlight are the two key processes in the suggested technique. Using computer vision and image processing techniques, we took the input as a video sequence from the camera and extracted only the red component for taillights and the white component for headlights and Using the Internet of Things (IoT), smart helmet makes the journey of rider safer and more comfortable. It provides complete safety measures which include the important feature of detecting the accident and informing the users friends and family (or specified emergency contact) about the impact along with user's current location so that user can get the immediate medical help and death can be avoided and it's equipped with an airbag attached to the helmet to popup in case of an accident and tosave the life of rider from any serious injury.

II. LITERATURE SURVEY

According to statistics, most road accidents involve two-wheelers, such as motorcycles and scooters.

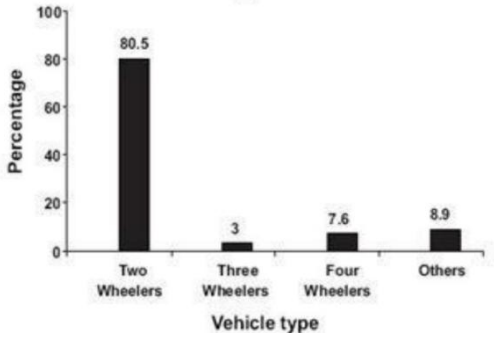

Figure 1

Helmets provide basic protection to two-wheeler riders. However, it does not ensure that the rider strictly adheres to traffic laws. Most two-wheeler accidents are caused by riders breaking traffic laws. This was discovered during our internet-based literature survey, and the statistics are as stated in the following figure 2.

Causes of road accidents	%
Fault of the driver	78.5
Fault of the pedestrian	02.2
Defect of motor cycle	01.8
Defect of the road	01.3
Fault of the cyclist	01.2
Weather condition	00.8
All other causes	14.2

Figure 2

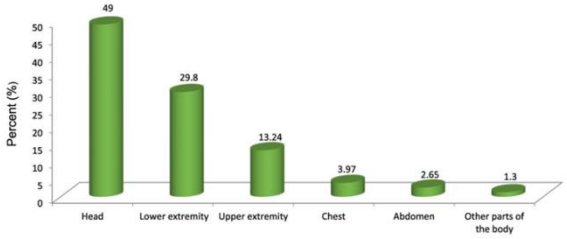

Figure 3

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III. TECHNOLOGIES

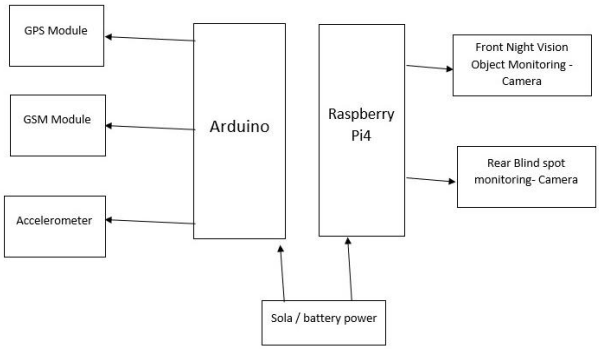

Figure 4

A) Raspberry Pi4

The ultra-fast connectivity of Raspberry Pi provides it with the ability to act as an internet gateway. Raspberry pi 4 for IoT projects is fairly easy when you include it with other sensors. Raspberry Pi 4 for IoT (Internet of Things) is widely employed in projects due to the incorporation of a microcontroller for processing data, the use of WiFi to transmit that data to the cloud, and the integration of actuators for control purposes.[1]

Figure 5

B) Arduino

Arduino IoT Cloud is an application that helps makers builds connected objects in a quick, easy and secure way. You can connect multiple devices to each other and allow them to exchange real-time data. You can also monitor them from anywhere using a simple user interface. Arduino IoT Cloud is fully integrated in the Arduino Create ecosystem, you will be able to generate a template code in Arduino IoT Cloud and then edit and upload it to your board using the Arduino Web Editor.[2]

C) Accelerometer

Accelerometer with resolution of 13 bit. The output of accelerometer is digital and uses 16 bit 2's complement data. It can be connected via Serial Peripheral Interface (SPI 3-4 wire) or I2C interface. ADXL345 is used for both measurement of static and dynamic acceleration. In this project we use accelerometer, which measures the static acceleration of gravity. Free-fall sensing unit senses if the bike is falling. And Bike unit take decision that accident is occurred or not.

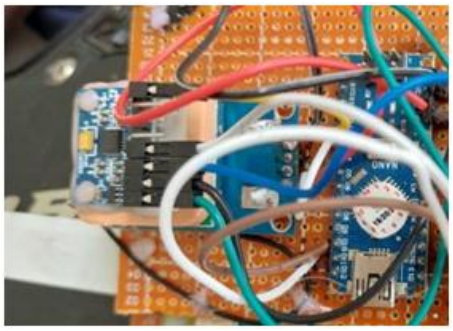

Figure 6

D) GSM Module

GSM (Global System for Mobile Communications) is an open, digital cellular technology used for transmitting mobile voice and data services. Here we are using it only for transmitting and receiving messages. GSM wireless data module is used for remote wireless applications, machine to machine or user to machine and remote data communications in many applications.

E) GPS Module

GPS (Global Positioning System) is based on the known position of specialized satellites and time. The satellites are equipped with extremely stable atomic clocks that are synchronized with one another and with the ground. Any deviation from the true time kept on the ground is corrected daily. Similarly, satellite locations are known with great accuracy. GPS receivers also have clocks, but they are usually not synchronized with true time and are less stable. GPS satellites transmit their current time and position in real time. A GPS receiver tracks multiple satellites and solves equations to determine the receiver's precise position and deviation from true time. Four satellites must be visible to the receiver for it to compute four unknown quantities.

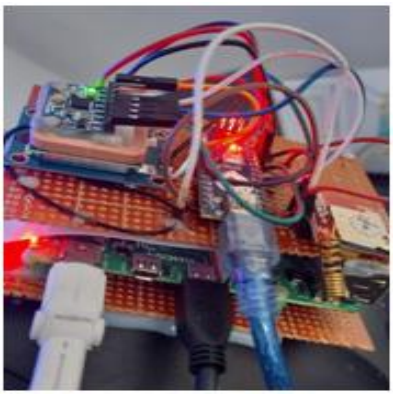

Figure 7

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IV. METHODOLOGY

A) Front Night Vision Object Monitoring

Detect the obstacles and calculate the distance between the obstacle and rider, if the obstacle exceeds the allowed space limit an alert will be sent to the rider. A night vision camera, buzzer and Raspberry Pi4 is used for this function, This function is added to make it safer and easier for the rider to drive during night times even though the bike is equipped with headlight, the driver cannot ensure the front path is 100% visible to him, through the headlight the rider can only a view a limited amount of road or path only, So that's why we have added this function to the smart helmet, In this function we have used a front night vision camera, a buzzer, a light and Raspberry Pi4 as components for this function, through the night vision camera we will be taking the input using video processing and if an obstacle or an object is detected in front of the rider, it will be alerted using a buzzer and a light.

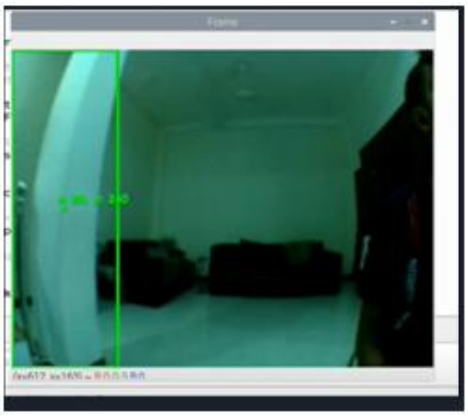

Figure 8

Figure 9

B) Emergency accident alert with SMS location share

When a rider meets with an accident through the SOS system the rider's remote location will be shared to the emergency contact point. Arduino, GSM Module is used for this function During a journey, the system will collect accelerometer data (every second) and try to determine if it represents an out-of-the-ordinary condition or not; if so, an accident may have been spotted (the word might is used, in this context, because various factors like bumps in the road, and no one, have to be considered). When a crash is detected, the user can reply to determine whether the accident occurred (on the helmet, through the button). One click and the data is used to re-model the crash detection system (no crash), two clicks and it requests assistance (if a crash occurs, an SOS message is sent, along with the location, to the user's designated emergency contacts, which may be configured in the programmed). In terms of crash detection, if the user does not answer in 305, an automated SOS message is sent to the user's emergency contacts. In the programmed, the user can also respond in the event of crash detection and whether or not to send an SOS message. We'll send an SMS or a push notification with your ride details to your Emergency Contacts if you hit the I need the Police/Ambulance button during your ride booking and slide to call. You can add up to three Emergency Contacts manually or by choosing them from your Contacts. An SMS will be sent to your Emergency Contacts informing them that they have been added as an Emergency Contact.

C) Rear Blind spot monitoring

Detect the rear blind spot objects and calculate the distance between the obstacle and rider, if the obstacle exceeds the allowed space limit an alert will be sent to the rider. A camera, buzzer and Raspberry Pi4 is used for this function, A motorized vehicle accident usually involves the rider attempting to switch from one lane to another, either to the left or to the right. Due to the rider's negligence in checking the lane for other vehicles or impending vehicles as well as their unobserved Rear blind spot, this could result in the motorcyclist's fatality". That's why we decided to include this feature in the smart helmet. For this feature, we used a camera, a buzzer, a Raspberry Pi4 and LED light as the components for this function. This function detects the rear blind spot objects and calculates the distance between the obstacle and rider, if the obstacle exceeds the allowed space limit in between Two line an alert will be sent to the rider using buzzer".

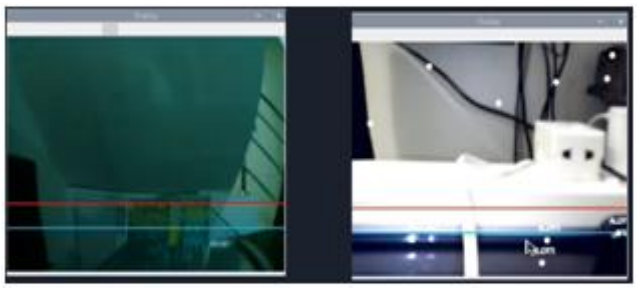

Figure 10

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Figure 11

D) Head Protection Airbag

An innovative expandable smart helmet with an integrated airbag system was introduced in order to investigate the potential synergistic effects of an expanded airbag and a typical commuter-type EPS helmet. Performance in preventing traumatic brain injuries from the suggested expandable helmet was compared to that of a typical conventional helmet. The number of fatalities involving vulnerable bike riders on the road is far too high. Over 5,000 bikers die on the roads each day around the world, and more than half of these deaths are directly related to head injuries. The bikers' only available piece of safety gear to guard against traumatic brain injury (TBI) and other head injuries, including facial injuries, is a helmet. So, we designed the helmet with an air bag.

Environments, techniques, requirements, tools, and technologies that will be needed will be discussed in this section. Here, the procedures that must be followed to conduct the study will be covered.

If the speed of the bike that we are examining is higher than the given speed, we can find out the normal wheel slip angle of the bike. So, we found out the slip angle. The balloon would pop out only if the slip angle and the speed matched. The reason which we did not consider the angle only is because, when the helmet is on hand, and if the angle is changed, then the balloon will pop out. So that will be an error. In the process, we used 2 sensors for the air bag. Those are the accelerometer sensor and the GPS module. First, we must get the speed. To get the speed, we use the GPS module. Using GPS module to calculate speed.

Speed is defined as the distance traveled divided by the travel time, commonly written as x = d/t. The distance traveled may be determined using two GPS points (locations). To determine how long it took to travel between those two sites, we may utilize the GPS device's internal clock (a very precise clock that routinely synchronizes with the atomic clocks on the GPS satellites). Latitude and longitude, or lat/lon, are recorded by the bike's GPS unit at Point A. Additionally, the time is noted. One minute after that; it records its location once more. B Point, these figures may then be used to calculate the speed of the vehicle via the GPS receiver.

E) Equation to calculate speed on GPS module

Speed is defined as the distance traveled divided by the travel time, commonly written as x = d/t. The distance traveled may be determined using two GPS points (locations). The GPS module gives us coordinates, as x1, y1 and x2,y2. get one coordinate and another coordinate which is 1 second after the first coordinate. Then we must find out the difference between the two coordinates. So, we can find out the distance travelled by the vehicle within one second. Then we should divide that distance by 1 second by converting it into hours. Then we can have the speed of the vehicle. In that way we can find out the speed using the GPS module. We do not add the speed function manually to the GPS module as it is an in-built function in the module. Then, the angle is given by the accelerometer.

F) Angle

Accelerometers measure acceleration. That is acceleration brought on by both movement and gravity.

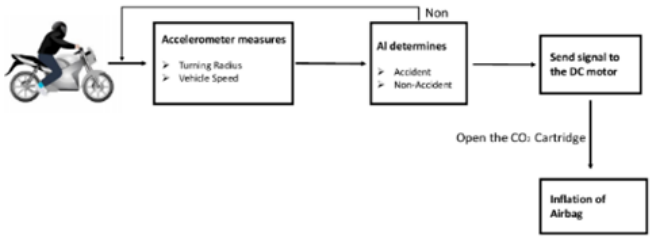

Figure 12

A tilt angle can frequently be calculated using accelerometers. They can only successfully perform this when they are stationary and not in motion. The x, y, z coordinates were taken supposing an accident was going to happen while the rider was wearing the helmet. We get many angles by considering the usual slip angles which the bikes have when accidents occur. We have taken the minimum angles of those as our coordinates. Then we came up with the condition of, if the speed is higher than 40, and the x level of the angle is in between 289-205, and y level of the angle is between 198-330, and the z is larger than 380, in the console, it will be printed as "accident "and the airbag is pop out. The angles are taken in degrees.

V. RESULTS AND ANALYSIS

Nowadays riding a bike safely is a tough task with the high amount of traffic so we need to ensure that our travelling

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by bike is a safe journey, so how can we do it? So for this only the smart helmet comes in action, through the wearing the smart helmet the riders can ensure a safe and easy ride, this helmet give the rider the features of rear blind spot monitoring, front night vision object monitoring system, When a rider meets with an accident, riders' remote location to be shared to the emergency contact point. And an airbag to be popped out in case of an accident.

All these above-mentioned functions are implemented to the smart helmet and are tested by considering all the functional, Nonfunctional and safety requirements.

VI. CONCLUSION

The designed smart helmet ensures the rider by making him easy and safe to ride specially when the rider is riding in night or in places with less human contact, through this smart helmet it ensures to detect the blind spots, detect obstacles in night, and to contact to a person in case of an emergency/accident and as its equipped with an airbag,this helmet will be a lifesaving tool for riders as well.

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