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IOT BASED SMART HELMET WITH BIKE SECURITY

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Abstract: The objective of this paper is to address the safety concerns that parents have when their child is riding a two-wheeler. To achieve this, this topic includes two units, the Helmet Unit (HU) and the Motorbike Unit (MU), which communicate with each other via radio frequency. The HU is equipped with sensors that measure the rider's pulse rate, alcohol content in their breath, and intensity of vibration. The pulse rate sensor detects whether the rider is wearing the helmet or not. The MU has a GPS and GSM module that sends location messages to emergency contacts in case of an accident. The accelerometer on both units detects accidents, and the MU's sensor ensures that the rider is sitting correctly, driving safely, and not over sspeeding. If the alcohol level is too high or an accident is detected, the MU turns off the ignition, sends an emergency message with location, and displays emergency contact details on the OLED screen. A rider safe push button is also provided. The LIDAR sensor on the MU alerts the rider of vehicles approaching from behind. Force-sensitive resistors are installed on the handle grip and footrest to ensure proper seating. The accelerometer in the MU detects tilt along different axes, and if it exceeds the threshold, the buzzer starts beeping and a safety message is displayed on OLED. Finally, the MU's ESP8266 Wi-Fi module sends bike speed and tilt information to the Thing Speak server, which allows parents to monitor their child's safety.

INTRODUCTION: Bike accidents are on the rise and causing a significant loss of life. Wearing a helmet can reduce the likelihood of these accidents. Unfortunately, an estimated 1.5 million people lose their lives to road accidents each year. There are numerous accidents occurring in day-to-day life that require immediate solutions. Despite ambulance services being provided, the death rate remains high. To address these problems, smart helmets are equipped with two important criteria that must be verified before a bike ride. Firstly, an IR sensor checks if the user is wearing the helmet and not simply carrying it. Secondly, a gas sensor detects the presence of alcohol in the user's breath. If the user has consumed a significant amount of alcohol, the sensor will detect it. In case of an accident, the helmet will identify the bike's condition and send the user's location to nearby hospitals through GPS to the hospital's main server. If the accident is minor, the user can press a button on the bike to signal that they are not injured and start the bike.

Module Design: The topic is comprised of two units - the Helmet unit (HU) and the motorbike unit (MU). These units communicate via RF using the NRF24L01 module. The HU has a pulse rate sensor that measures the pulse rate of the rider. The pulse rate sensor is not easy to be falsely triggered and is more compact. The MU has a LiDAR sensor which checks the distance of the vehicles behind the bike and alerts the rider. There are Force-sensitive resistors on the handle grip and footrest of the bike which detects the position of the hands and legs of the rider. This ensures a safe sitting position of the rider. Each unit has its accelerometer, so that independent accident detection can bedone of the rider as well as the bike**.**

1. Helmet Design

The helmet unit has Arduino Nano which has ATmega328 as the microcontroller. The block diagram of the helmet unit is shown in Fig.1. Arduino Nano is a compact board and the whole assembly of the sensors is very lightweight. So the weight of the helmet does not increase much after the board and the sensors are embedded on the helmet. The circuit diagram of the helmet unit is shown in Fig 3. The pulse rate sensor is fitted in the helmet as seen in Fig. 3. An MQ-3 sensor fitted near the chin of the helmet is used for alcohol detection. The buckle has a micro switch that switches on only when the rider locks the buckle. The NRF module along with the antenna is placed outside the helmet as shown in Fig.3. A buzzer is placed inside the helmet which is used for alerting the rider. Accelerometer fitted in the HU helps in detecting accidents if the rider is away from the bike. The whole HU is powered by a rechargeable 9V battery.

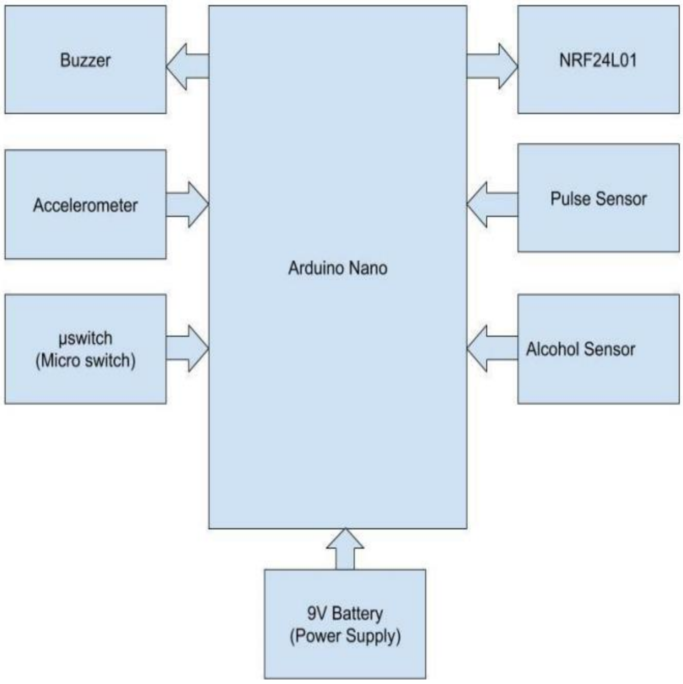


Fig. 1. Block Diagram of Helmet unit.

2. Motorbike Unit Design

Arduino Mega which has ATmega2560 as its microcontroller is used in the motorbike unit (MU). The block diagram of the motorbike unit is shown in Fig 2. The MU has an NRF module that receives all the sensor data transmitted from the HU. A Hall Effect sensor with a bar magnet assembly is measuring the speed of the motorbike. Force-sensitive resistors help in detecting the position of the hands and legs of the rider. The MU has a GSM and GPS module that is used for sending messages with the location of the rider. The OLED screen is used for displaying messages in different cases. The buzzer near the OLED is used for alerting the rider. The LiDAR sensor in MU is fitted for distance monitoring of rear vehicles. The push-button switch is a rider safe button which when pressed shows that rider is safe in case of a minor accident. The relay is connected to the ignition system. The accelerometer is used for measuring the tilt of the bike in different cases and also in identifying accidents.

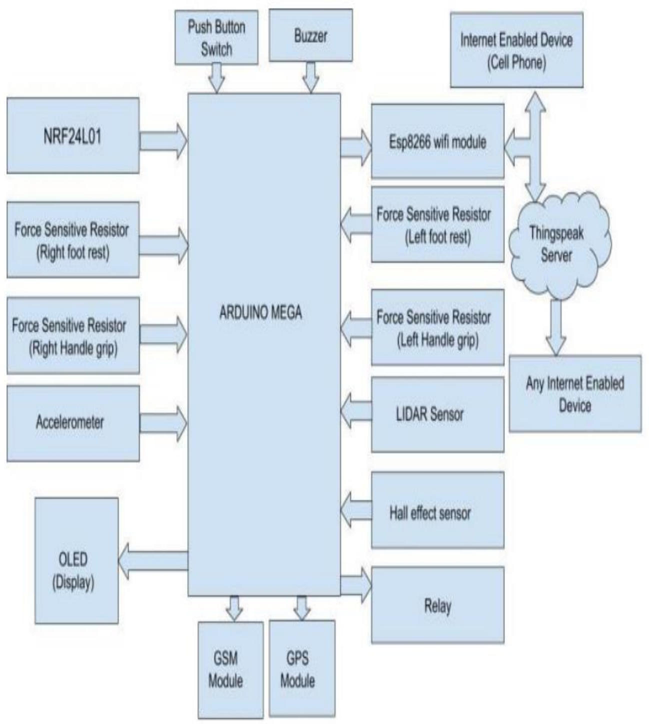


Fig 2. Block Diagram of Motorbike unit.

METHODOLOGY TO DEVELOP THE SYSTEM:

The system revolves around the bike unit, which serves as the central hub for all protocols and actions required. The microcontrollers housed in the main rider and pillion rider helmets establish serial communication with the microcontroller in the bike unit via HC-05 Bluetooth modules, which are configured using "AT" commands. The Bluetooth module in the bike unit is set to "AT+ROLE=1" to act as the master, while those in the helmets are set to "AT+BIND=slave address" to act as slaves. This allows for seamless serial communication between the bike and helmet units. Additionally, the bike unit communicates simultaneously with the GSM module, which is also configured using "AT" commands. To send a text message, the GSM module is configured to "AT+CMGF=1" and to send a message to a specific mobile number, it is set to "AT+CMGS=77XXXXX209" (where "X" represents the designated phone number). Finally, to receive incoming text messages, the GSM module is set to "AT+CNMI=1".

1.1. Assurance of main rider wearing helmet:

Once the main rider wears the helmet, the switch present over-head is active, and the main rider helmet unit is powered on by the rechargeable battery. The battery is charged manually with charging adapter or with the help of solar power panel. After powering on the helmet unit, the serial communication between the bike and main rider helmet unit is accomplished via HC-05 Bluetooth module. When the connections of the Bluetooth are established, it detects and assures the main rider helmet worn and the ignition switch will be active to start the bike. In case the helmet is removed, the over-head switch is inactive and ignition switch is disabled.

1.2. Alcohol consumption test of the main rider using MQ-3 gas sensor:

The alcohol consumption test is carried by MQ-3 gas sensor. This sensor pins are connected to Arduino Nano microcontroller in the main rider helmet unit. The sensor is present inside the main rider’s helmet near the mouth. Once the main rider wears the helmet the gas sensor monitors for any alcoholic gases from the mouth of main rider[3]. The threshold of the MQ-3 gas sensor is set to 0.04mg/L. If the rider is drunk and crosses the threshold, the signals are sent to bike unit through Bluetooth and ignition switch is disabled

1.3.Assurance of Pillion rider wearing helmet:

If the pillion rider is present, the detection of pillion rider is done by the detection switch present at the rear seat of the bike. Once the pillion rider presence is detected, pillion rider helmet worn assurance is required to start the bike. This assurance is obtained when the over-head switch inside the helmet is turned on when it is used. This whole unite is powered on by the rechargeable battery. The Battery can be charged manually or with the help of solar power panel. Once the unit is powered on, the Bluetooth connection is established between the pillion rider helmet unit and the bike unit. Therefore, the ignition switch is active to start the bike. Only when section A, B and C follows the protocols, the ignition switch turns ON. When any one protocol fails, the ignition switch turns OFF.

1.4. Accident alert system using accelerometer, GPS and GSM modules:

This working takes place inside the bike unit. The accident detection is initiated by MEMS accelerometer sensor (ADXL35). The accelerometer monitors the change in the axis of the bike during the fall of the bike. If the speed of the bike is above 30kmph and if there is change in the axis of the bike beyond 600 (which indicates the fall), accident of the bike is hence sensed at that speed[12]. Once the accident is detected, the GPS module fetches the current co-ordinates of the location and GSM module will send atext message to the concerned members of the rider and emergency service as registered in the GSM module. The text message contains the GPS location of the rider's accident spot.

1.5. Detection and audio alerting system using IR sensors and speakers:

The speed of the bike is monitored by the IR sensor, placed near the rotating wheel. If the speed of the bike exceed above 80 kmph, a signal is sent to the main rider helmet unit, the main rider hears an audio alert inside the helmet as 'bike is speeding up please slow down' for three times. The frequencies of the audio are captured by the Arduino Nano microcontroller in the main rider helmet unit. The same frequencies are transferred to the speakers present in the main rider helmet unit, hence cautioning the rider on over speeding. While transferring frequencies of audio to the speakers, the pulse code modulation technique is used.

1.6. Bike tracking using GPS and GSM:

In case the bike is lost or not found, the provision for tracking the bike is provided. The rider can send the bike tracking text message to the GSM module present in the bike. On receiving the tracking message in the bike unit, the GPS module fetches the current co-ordinates of the bike and sent to the rider's mobile number through the GSM module in the form of a text message. This way, the rider tracks his bike in case of theft or lost.

1.7. Alternate method to start the bike using the GSM module: In case the helmet is lost or tampered, the need to use the bike and start the bike using an alternate non smart helmet is still possible. This is achieved by using the GSM module. The rider sends a text message from his phone to the GSM module in the bike unit to unlock the bike. On receiving the unlock text message by the GSM module, the ignition switch is made active to start the bike. This provision is allowed by giving limited access to avoid the misuse of the system.

WORKING MODEL AND RESULT:

The system was tested on a motored-wheel. The results were observed on a 16x2 LCD display. The LCD display is also u

sed as an instruction set for the riders. The responsive text message is received from the bike unit to the mobile phone.

2.1. Unlocking the bike by wearing helmet

Before starting the bike, instructions for wearing the helmet is displayed on the LCD screen to the main and pillion rider (if present) as shown in the Figure 3. Unless, the rider wears the helmet, the ignition switch is inactive and the bike is locked. Once the helmets are worn by the riders, the bike will be unlocked as shown in Figure 4 and the ignition switch is made active.

Fig.3. Instructing the riders to wear the Helmet

Fig.4. Indicating the main rider to start the bike

2.2. Alcohol consumption test of the main rider The MQ-3 gas sensor is placed near the mouth of the main rider inside the helmet as shown in Figure 7. If the main rider is drunk, the sensor detects the alcoholic gases and the bike is locked and the ignition switch is inactive as shown in Figure 5.

Fig.5.MQ-3 gas sensor inside the helmet near the mouth.

Fig.6. Indicates the main driver is drunk and locks the bike

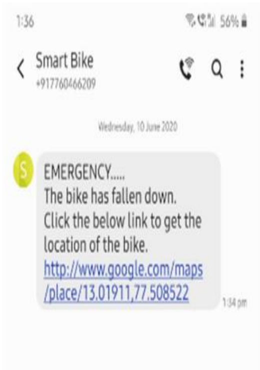
Fig.7. Cautioning the main rider on speeding

2.3. Speed check and audio alert

The speed check performed on a motored wheel where the audio warning alert inside the helmet as well as the display provided on the LCD screen as shown in Figure 7 when the speed of the vehicle exceeds 80kmph.

2.4. Accident alerting system

The concerned members of the rider are alerted on the accident occurrence once the system detects the change in the axis of the bike above 600 and speed of the bike above 30kmph. The concerned members of the rider receives a text message with real time location of the accident spot.



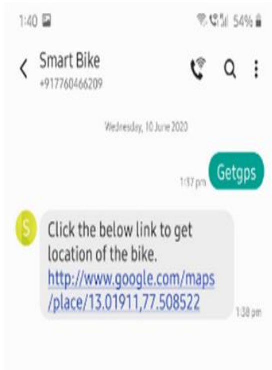


Fig.8. Accident alert message text

Fig.9. Bike tracking message with real time location

2.5. Bike tracking system

For tracking the bike, rider sends a text message 'getgps' from his phone to the GSM module present in the bike unit. A real time location of the bike is sent back to the mobile phone of the rider from the GSM and GPS module in the bike unit.

2.6. Alternate method to start the bike

The 'unlock' text message is sent from the rider's phone number to the GSM module. On receiving the unlock message, the bike will be unlocked, and the ignition switch is active to start the bike. The LCD displays the unlock status of the bike.

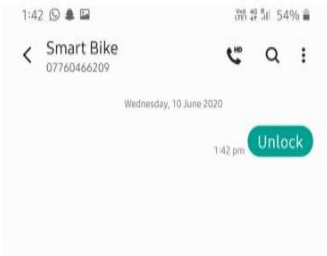


Fig.10. Text message to the
after GSM module to unlock the
message bike.
GSM module.

Fig.11 LCD display
sending 'Unlock'
to the

FUTURE WORK AND DEVELOPMENTS:

Many additional features can be added to this smart system. This prototype can be brought to the market as a product and implemented on any bike. Internet of things can be introduced to this system along with mobile applications developed for live tracking the bike. The rain sensing wipers can be added to the helmet system for the visibility during riding in the rain. The voice assistance for locations can be added inside the helmet of the main rider for assisting the rider on directions while riding for hassle free and avoid distractions from the road.

CONCLUSION:

The smart helmet system ensures the safety of bike riders by equipping them with protective gear before starting their ride. It includes a feature to detect if the main rider is under the influence of alcohol, promoting responsible driving and reducing accidents caused by impaired driving. Additionally, the system helps prevent accidents caused by speeding by alerting the rider through an audio warning system. In the unfortunate event of an accident, the system tracks the location and immediately alerts medical services to minimize casualties. To eliminate the danger of using a phone while riding, an integrated hands-free push-button Bluetooth system enables riders to receive emergency calls. If the smart helmet is lost or tampered with, the system provides an alternative method for a limited time until a new helmet is obtained. Overall, this smart helmet system reduces fatal accidents by 80% and provides prompt medical assistance, ensuring a safer riding experience.

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