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Smart Helmet based Accident Detection and Notification System for Two-Wheeler Motor Cycles

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Abstract. It's common knowledge that modern youth gravitate toward two-wheeled transportation. Drinking and driving and excessive speeding are also widespread problems today. Road accidents are responsible for the deaths of thousands of individuals every year. The primary cause of this is the tardiness of emergency aid that should have been given to the victims. Using the Internet of Things, smart helmets will be able to identify accidents and send alerts to nearby emergency services as well as medical facilities. In this case, an accelerometer module is used to detect accidents by constantly monitoring the deviations from the normal conditions. In the event of a collision, the exact location of the rider can be determined and forwarded to the relevant authorities. The primary function of this system is to transmit accurate information related to the accident in the form of text messages and phone calls to predetermined contacts.

1 Introduction

The Internet of Things (IoT) is a concept that aims to connect all of our everyday objects to the Internet. It is a fairly broad notion, with applications ranging from agriculture to health care to even common household goods such as a television and refrigerator. The IoT industry has been on the increase over the past few years, and numerous innovations are occurring in this industry. Today, it is extremely improbable that we will interact with a device that is not connected to the internet for even a single day. This technology can be used in automobiles to detect obstacles and help drivers avoid collisions. An ultrasonic sensor can be installed in the front or rear bumper of a car to detect nearby objects such as pedestrians, other vehicles, or obstacles. The sensor then sends this information to the car's onboard computer, which can alert the driver through a visual or audio warning. The use of ultrasonic sensors in automobiles can greatly enhance safe driving by providing real-time information about the environment and allowing drivers to react quickly to potential hazards on the road.

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2 Existing Methods

Jesudoss A et.al proposed a mechanism which utilises sensors such as infrared (IR) sensor, vibration sensor, and gas sensor.[1] The helmet's breathalyser uses the gas sensor to determine an individual's blood-alcohol content. MEMs control the vehicle's handlebars. The vibration sensor detects accidents. The vehicle's load is identified by the load checker. The Sensors are interfaced with the PIC microcontroller. As soon as the gas sensor detects ethanol in the user's breath, an LED indicator will show that they have consumed alcohol. If an accident occurs, the vibration sensor will detect it and send information to the hospital via GPS. If the rider engages in reckless driving, the MEME sensor will deduct a certain amount from his bank account. IR sensors are used to determine if a rider is wearing a helmet. This system is highly precise and accurate, and ambulances are automatically scheduled based on the locations. Divyasudha Net.al proposed a system consisting of a microcontroller, position sensor, Alcohol sensor, piezoelectric sensor, RF Transmitter, IOT Modem, GPS receiver, Power supply & Solar panel to avoid the accidents and check the alcohol consumption.[2] If the rider does not meet both of these criteria—whether or not he is wearing a helmet and whether or not he has drunk alcohol—the bike will not start, and a beep will sound to let him know. In the event of an accident, the IoT modem notifies a predetermined number and the local police station. When compared to other types of helmets, this one has a lower price tag. A smart helmet system based on a GSM/GPRS module was proposed by Prashant Ahuja et al. [3]. Since getting an ambulance to an accident scene might sometimes take a while, this prototype alerts the person who should be handling the situation as soon as possible so he can prepare for it. In this system, we can see characteristics like high precision, low cost, and rapid accident reporting.

Manish Uniyal et.al proposed a two-part system consisting of a helmet and a two-wheeler unit.[4] The position of the rider's helmet is transmitted to the bicycle part via an RF receiver tuned to the same frequency. Microcontrollers installed in the TW portion will continuously poll for updated data on the helmet's position. In addition to the accelerometer (used for measuring angles of tilt), Hall-effect sensor (used for measuring speeds), and GPS module (used for pointing out precise locations), the TW vehicle is equipped with a number of other sensors. Data is gathered by sensors and transmitted to a microcontroller, and eventually, if an internet connection is available, to a server. People can check the vehicle's speed at any time using this method. The device allows passengers to control the vehicle's speed. Parents can check to see if their child has actually put on the helmet. Kimaya Bholaram Mhatre al. proposed a system that includes a helmet module and a bike module in its construction.[5] IR sensors, a MQS alcohol sensor, a vibration sensor, a GSM module, a GPS module, an Arduino, and an intercom system are all part of it. If the rider has consumed alcohol and their blood alcohol level is higher than the threshold, the motorcycle will not start. If the rider's blood alcohol level is lower than the threshold, the motorcycle will start. If the vibration sensor limit is higher than the threshold, a message will be sent to the registered number about the accident. The workflow of the system is as follows: when the motorcycle starts, if the rider has consumed alcohol and their blood alcohol level is higher than the threshold, the motorcycle will not start. This technology has both a low overall cost and a high return on investment in terms of the rider's safety.

Mingi Jeong and colleagues developed a system that includes a variety of sensors, such as cameras(thermal, visible light, and drone), sensors (oxygen remaining, inertia, smartwatch, and HMD), and a command centre.[6] The goal of this system is to reduce the number of accidents that occur on the road. This framework makes it possible for IoT services to be easily integrated, controlled in an effective manner, and able to notify information in real time. Sayan Tapada ret.al has developed a prototype that measures the pace at which alcohol is ingested by the rider as well as identifying accidents using IOT modules and sensors [7]. By training the device with real-time simulation, they are attempting to make a prediction using Support Vector Machines regarding whether or not the values of the sensors correspond to an accident. The outcomes achieved by using this method are satisfactory. Both the accuracy and precision are of a very high standard.

The smart helmet approach, which can identify and report accidents, was proposed by Shoeb Ahmed Shabbir et. al.[8] They make use of a microcontroller that is interfaced with an accelerometer and a GSM module in this technique. Cloud infrastructures are utilised in order to deliver the notification and information regarding the accident. In this method, the information is sent to the emergency authority server if the level of acceleration is greater than the threshold or if an accident occurs. The server then sends the message to the assigned emergency contact through the GPS module if the level of acceleration is greater than the threshold. As a result, this system had a success rate of 94.82% in identifying incidents, and it was also successful in sending the proper coordinates 96.72% of the time. A system of a smart helmet that is integrated with a number of different features was proposed by Agung Rahmat Budiman et al. [9]. A warning notification is issued to the rider in the event that the rider is not wearing a helmet, that the rider comes with risky conditions, or that the helmet is not locked correctly in order to provide the rider with safety. The rider receives a warning from the system in the form of a notification whenever the system detects a potentially hazardous condition. The functioning test yielded a success rate of 100% in all four smart helmet capabilities, while the communication test between the two modules yielded a success rate of 98.3%. K.M. Mehata et al has proposed a technique that can ensure the safety of the workers by detecting any falls that may occur among the workers while they are at work.[10] The suggested system is composed of two different parts. The first is a wearable gadget that is constructed out of electronic and sensor components. The mobile phone is also an important element. The GSM module is what enables communication between the two different parts of the system. In addition to this, these gadgets do continual checks on the health and safety of the worker. This device provides reliable fall detection and notifies the register operator so that they can provide medical assistance.

3 Proposed Method

3.1 Problem Statement

Road accidents involving two-wheeler motorcycles are a major cause of injury and death worldwide. Despite the various safety measures taken, the number of accidents continues to rise. One of the main reasons for this is the delay in receiving medical attention due to the inability to detect accidents immediately. There is a need for a system that can quickly detect accidents involving two-wheeler motorcycles and notify emergency services to reduce the response time and improve the chances of survival for the riders. A potential solution to this problem is a smart helmet-based accident detection and notification system that can automatically detect accidents and alert emergency services.

3.2 Objectives

- Designing and implementing a hardware system to detect two-wheeler accidents involves a complex process of selecting appropriate sensors, developing software, and integrating all components into a functional system. The system must be able to accurately detect accidents involving two-wheelers, even in challenging conditions such as uneven terrains, low visibility, and unpredictable weather.

- The model must be able to process data from multiple axes, including acceleration, tilt, and impact, to accurately detect and predict accidents. It must also be able to analyse the data in real-time, so that it can quickly alert the rider or emergency contacts if an accident is predicted.
- Notifying the rider's emergency contacts of an accident involves integrating communication capabilities into the hardware and software system, so that emergency contacts can be alerted in real-time.

3.3 Architecture Diagram

When the GISMO-VI board is turned on, the MPU6050 sensor starts taking the readings of the rotation of helmet in 3 axes in degree per second. It constantly monitors the helmet's position. Based on the readings of the sensor, if the rotation of helmet is abnormal in all 3 axes, the accident detection system detects that the rider has met with an accident and sends a message and makes a phone call to the registered emergency contacts and the nearest ambulance service prov ider along with the location of the accident. If there is no sign of an accident, no notification is sent.2 minutes of the accident. In many accidents the victim's life could have been saved, if someone is informed about his accident as quickly as possible, but due to remoteness of the area of accident and unavailability of fellow citizens nearby, they lost their life. This helmet constantly monitors the rider's condition through the cloud. If any anomaly is detected an SOS message and phone call is sent to the emergency contacts registered by the rider.

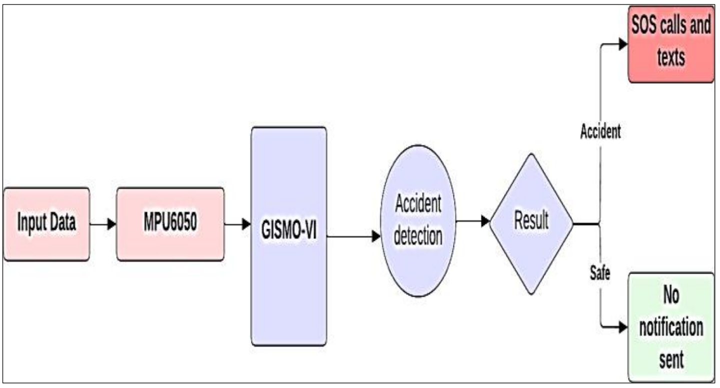

Fig. 1. Architecture diagram.

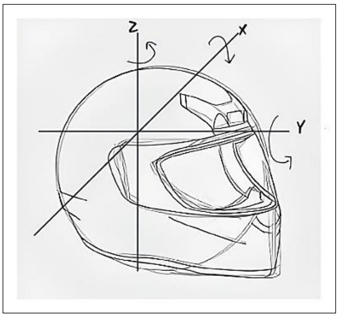

Fig. 2. Helmet**.**

When the GISMO-VI board is turned on, the MPU6050 sensor starts taking the readings of the rotation of helmet in 3 axes in degree per second. It constantly monitors the helmet's position. Based on the readings of the sensor, if the rotation of helmet is abnormal in all 3 axes, the accident detection system detects that the rider has met with an accident and sends a message and makes a phone call to the registered emergency contacts and the nearest ambulance service provider along with the location of the accident. If there is no sign of an accident, no notification is sent. The proposed solution is divided into three modules, which are as follows:

3.3.1 Data Collection Module

- Here the MPU6050 accelerometer and gyroscope sensor is used to measure the rotation in axes in a time frame.
- The MPU6050 accelerometer and gyroscope sensor monitors the rotation of the helmet in X- axis, Y-axis and Z-axis and sends the data to the firebase continuously.

3.3.2 Accident Detection Module

- If there is abnormal change in rotation of axes i.e., there is a significant change in of the axes which is greater than normal, then it is considered as an accident.

3.3.3 Notification System Module

- When a rider meets with an accident, immediately the emergency contacts and the nearest ambulance service provider registered by the rider receive a notification about the person's accident contacts. The python script uses Twilio API to perform those actions.

3.4 Modules and its Description

3.4.1 Module 1: Data collection module

The MPU6050 Accelerometer and Gyroscope Sensor is attached to the GISMO-VI Board. When the board is provided with electrical power, the sensor begins data collection. The information relates to the rotation of the helmet's axes in degrees per second. The data which is collected in this module is sent to the accident detection system which then analyses the current readings and decides if any accident has occurred or not. If any accident occurs, then the notification module gets activated which sends a phone call and a SMS to the rider's emergency contacts. A diagram representing the data being collected is shown on the serial monitor of the Arduino IDE when the GISMO Board is switched on and the sensors gets activated

3.4.2 Module 2: Accident detection module

The collected data is analysed. If there are large units of change in the rotation of the axes, which happens only in the case of an accident, the program then immediately confirms the accident and the notification system is activated.

3.4.3 Module 3: Notification system module

When the program confirms an accident, the python scripts run to call and send a SMS to the registered emergency contacts. The python script uses Twilio API to perform those actions.

```
06:08:38.428 ->
06:08:38.922 -> Rotation X: -1.14, Y: -0.21, Z: 0.79 deg/s
06:08:38.922 ->
06:08:39.443 -> Rotation X: -1.16, Y: -0.18, Z: 0.78 deg/s
06:08:39.443 ->
06:08:39.954 -> Rotation X: -1.15, Y: -0.18, Z: 0.79 deg/s
06:08:39.954 ->
06:08:40.469 -> Rotation X: -1.16, Y: -0.18, Z: 0.80 deg/s
06:08:40.469 ->
06:08:40.965 -> Rotation X: -1.16, Y: -0.20, Z: 0.80 deg/s
06:08:40.965 ->
06:08:41.452 -> Rotation X: -1.14, Y: -0.19, Z: 0.81 deg/s
06:08:41.452 ->
06:08:41.978 -> Rotation X: -1.15, Y: -0.20, Z: 0.79 deg/s
06:08:41.978 ->
06:08:42.470 -> Rotation X: -1.15, Y: -0.18, Z: 0.80 deg/s
06:08:42.470 ->
06:08:42.950 -> Rotation X: -2.28, Y: 1.12, Z: 0.92 deg/s
06:08:42.950 ->
06:08:43.459 -> Rotation X: -8.24, Y: -3.43, Z: 49.28 deg/s
06:08:43.459 ->
06:08:43.980 -> Rotation X: 34.76, Y: -10.30, Z: -134.44 deg/s
06:08:43.980 ->
06:08:44.469 -> Rotation X: -132.67, Y: 39.37, Z: -8.78 deg/s
06:08:44.469 ->
06:08:44.976 -> Rotation X: 11.54, Y: -101.82, Z: -100.05 deg/s
06:08:44.976 ->
06:08:45.481 -> Rotation X: -25.36, Y: 64.31, Z: -33.47 deg/s
06:08:45.481 ->
06:08:45.988 -> Rotation X: -86.65, Y: -121.22, Z: 35.77 deg/s
06:08:45.988 ->
06:08:46.494 -> Rotation X: 55.16, Y: 119.51, Z: -37.95 deg/s
06:08:46.494 ->
06:08:46.999 -> Rotation X: -190.47, Y: -17.74, Z: -110.06 deg/s
```

Fig. 3. Data collection module.

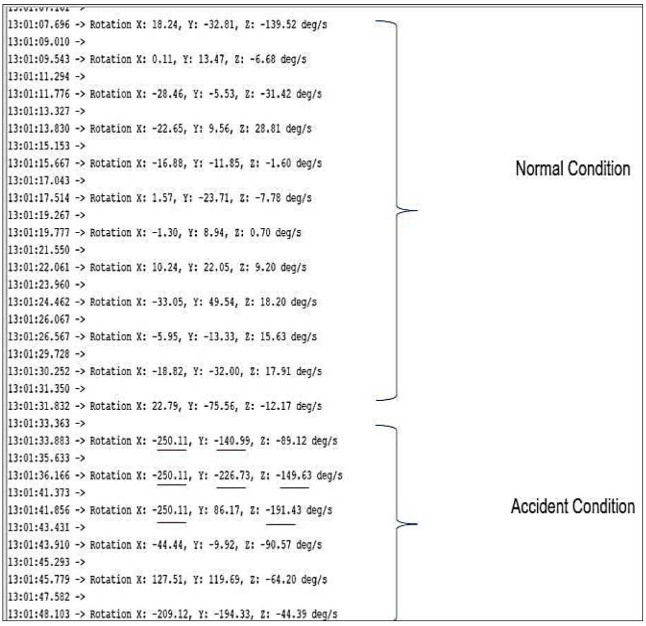

Fig. 4. Sensor Reading when accident occurred.

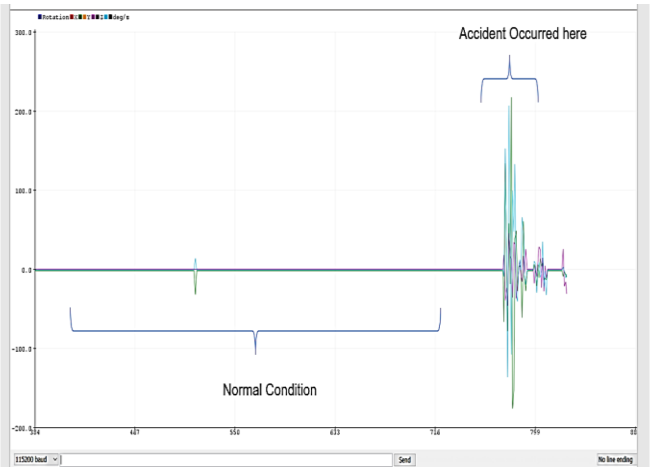

Fig. 5. Graph of sensor reading when accident occurred.

4 Results and discussions

The purpose of this sensor is to constantly measure the rotation of the helmet, and update it every second. The values recorded are then analysed for accident detection and also simultaneously uploaded on google firebase. There are three-axis accelerometers and gyroscopes included into the MPU6050 IMU. Along the X, Y, and Z axes, a gyroscope detects and registers the rotational velocity or rate of change of the angular position over time. Measurements are taken with the use of MEMS technology and the Coriolis Effect. It is in degrees per second that the gyroscope reports its readings. The output can be seen on serial monitor of Arduino IDE.

Significance of proposed method with advantages

Sales of two-wheeled vehicles in India are significantly greater than everywhere else in the world because of the country's massive road congestion and the low cost of buying and maintaining such vehicles. Despite the fact that wearing helmets is now mandatory for both the rider and the pillion, many people continue to disobey the law. This greatly raises the risk of serious or fatal injury in the event of a collision. As of the end of 2021/22, two-wheeled vehicles were responsible for 44.5% of all road accident fatalities, followed by cars (15.1%) and trucks/lorries (9.4%) [13].

In many accident scenarios, the accident happens in a remote area where the victim of the accident gets unattended for a long time and loses his life. hospitals and ambulance services are also not nearby for the victim to go by himself. The Smart Helmet solves the above problem of accident victims by sending an automatic phone call and a SMS to the emergency contacts given by the rider to inform them about his accident and helps save precious lives without wasting those crucial minutes and help decrease the death count.

5 Conclusion

The annual death toll from automobile accidents is estimated to be around 1.3 million. As a result of injuries incurred in traffic accidents, individuals, their families, and entire countries incur enormous financial damages. Automobile accidents cost most countries about 3% of their GDP every year. The alarming rate of road accidents in India and in other regions of the subcontinent has been a major cause of concern. Accidents on the country's roadways resulted in the deaths of approximately 132,000 people in 2020. Highway mishaps cost the economy between three and five percent of GDP annually. While India only accounts for roughly 1% of the world's automobile population, it is accountable for 6% of all road accidents. To bring down the loss of lives due to accidents and stop it affecting to a country’s GDP numerous measures have to be taken by all stakeholders.

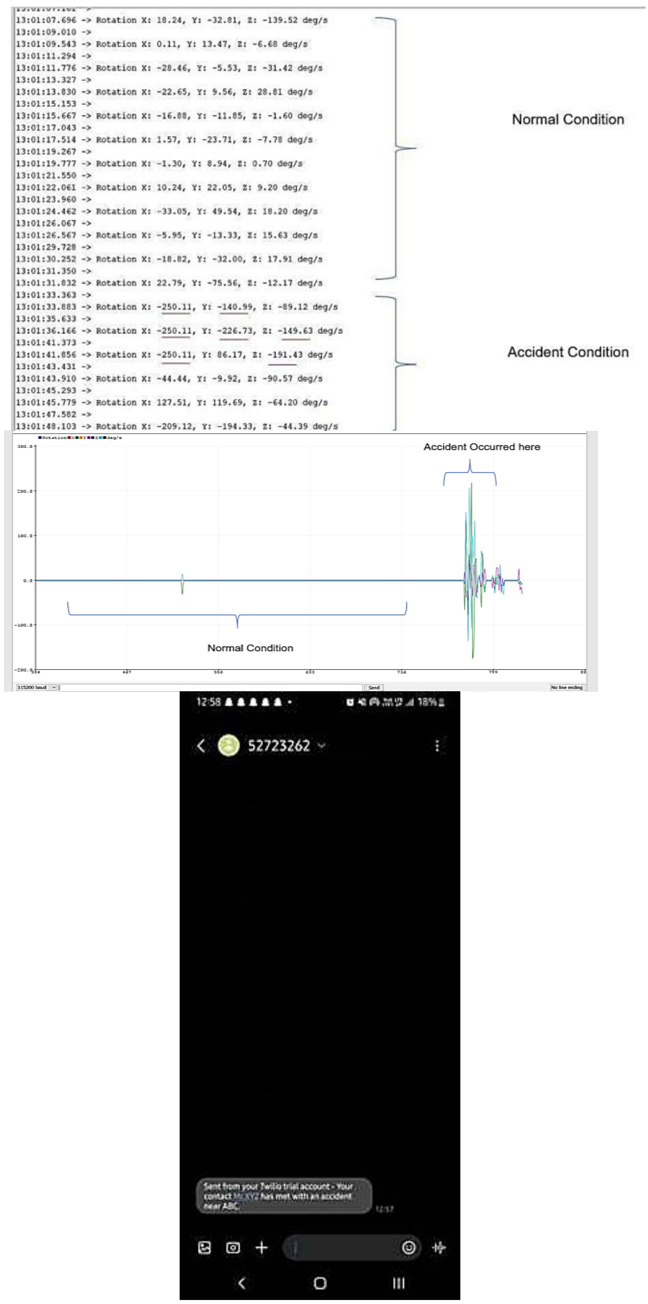

Fig. 6. Normal condition, accident condition and SMS.

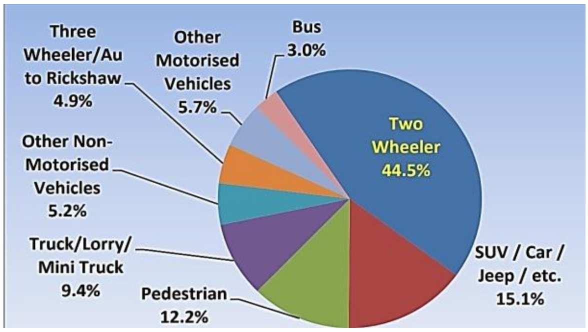

Fig. 7. Vehicle-wise road accident deaths.

With advancement in technology with time innovative solutions have come in the market which are cost efficient and exceptionally efficient of whose implementation can be seen in western and developed nations. Entrepreneurs have up come with new and smart riding accessories which includes the concept of smart helmets which can be very helpful for the riders in future. This smart helmet with capabilities of immediate accident detection and notification system can prove to be highly effective to improve the road safety conditions of riders, especially of Indian subcontinent riders.

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