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Intelligent Safety Solutions for Road Users in Mitigating Accidents and Promoting Responsible Driving Behavior

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Abstract

Presently, accidents pose a significant concern for all individuals. The frequency of accidents is increasing, so efforts are being made to prevent them and reduce their consequences. In our society, people frequently disregard and violate the regulations of the road, rendering them useless. Moreover, it is inherent in human nature to resist that which is imposed upon them. Therefore, by utilizing a smart helmet, we provide safety with luxurious and intelligent features from a distinct perspective. The Smart Helmet is a project that utilizes a microcontroller from the AVR family. The helmet incorporates intelligent functionalities that enhance your driving experience and ensure your safety while on the road. The intelligent helmet consists of three primary components, each serving a distinct purpose. For instance, the primary objective of the first feature is to promote or compel the rider to wear a helmet. Likewise, the second feature aims to deter the rider from consuming alcohol and operating the vehicle. Lastly, the third feature aims to maximize the preservation of lives in accidents by guaranteeing comprehensive head protection through a helmet door controlled by a servo mechanism. In order to verify that the rider is wearing the helmet, two modules, one attached to the helmet, and one attached to the bike, will function together. The ALCHO-LOCK feature is employed to mitigate instances of driving under the influence. A vibration sensor is designed to detect accidents and transmit the real-time location to authorized personnel. This strategy can be employed to mitigate major accidents and minimize both human and financial losses. Every element is connected to the Arduino microcontroller. The Arduino ATMEGA328 microcontroller is employed for input and output management through the Arduino IDE, utilizing embedded C programming. It is fueled by a regulated power source that supplies a constant 5 volts of direct current to all hardware modules.

Keywords: Internet of things, Arduino UNO controller, Alcohol sensor, Vibration sensor, DC motor, Cloud, Switch.

1. Introduction

The Internet of Things (IoT) is presently employed in many sectors such as wearables, home automation, smart appliances, smart agriculture, and more. In these domains, objects and individuals establish communication through a network. The primary function of IOT devices is to detect and transmit data to a server, which has the capacity to generate a substantial volume of data. Inferences can be derived from the generated data through the process of analyzing and assessing the received data. This offers the benefit of delivering up-to-the-minute information from the surroundings. The incidence of motorcycle accidents is increasing in contemporary times, leading to a significant number of fatalities. This can be prevented by utilizing a smart helmet. Based on the poll, the data shows that there is a mortality rate of four individuals per hour in India due to their failure to wear helmets. Over the

course of 2017, a staggering 48,746 individuals operating two-wheeled vehicles tragically lost their lives in traffic collisions. Furthermore, a significant majority of 78.3% failed to utilize a helmet. Before the bike may be operated with the smart helmet, two essential prerequisites must be verified. The initial criterion entails confirming that the biker is actively donning the helmet rather than simply possessing it. Furthermore, sensors can be employed to ascertain the presence of alcohol in the user's breath, thereby indicating whether or not the user has consumed an alcoholic substance. In less developed nations, road traffic accidents were the primary cause of injuries and ranked eleventh among the top causes of disability-adjusted life years. Expanding the road is not a viable solution within the framework of the Indian road system for alleviating traffic congestion in urban areas. There exist multiple remedies for the difficulties associated with state programs aimed at controlling drunk driving. A helmet is a form of protective gear designed to safeguard the head against harm or damage. A helmet provides additional protection to the skull, helping to safeguard the human brain in case of an accident. The objective of the initiative is to provide bicyclists with comprehensive safety measures. A significant number of accidents occur due to negligence or driving under the influence of alcohol. The traffic authorities offer multiple orders to operators of vehicles. However, a significant number of them fail to adhere to the regulations. Despite the latest mandate, a significant number of persons persist in driving without helmets. Despite efforts to increase public consciousness regarding accidents and the importance of helmet usage, a considerable number of individuals persist in violating the law. Enforcement of helmet usage by traffic police is not a sustainable solution. Due to the inability of traffic officers to be omnipresent. Consequently, an intelligent helmet equipped with a technology to avoid accidents was developed to establish the helmet as an essential requirement. The vehicle will only start if the driver is wearing a helmet and is not intoxicated by alcohol.

The most effective will adhere to certain principles: they will invest authority and responsibility in people and organizations at all levels, from local to national, because drunken driving prevention necessitates action at all levels. They will operate in the public eye, using the media to report on problems and solutions, because ultimate public support is required. They will not promise fast results based on a single activity, but will instead take small steps toward long-term progress. Moreover, rather of trying to apply one-size-fits-all solutions, they will build processes for recognizing and solving problems. As a result, road safety has become a serious concern. As a result, it becomes necessary to employ such a difficult strategy in order to circumvent the basic requirement of wearing a helmet and avoid drunk driving. In this case, we created a system that verifies the two criteria before starting the bike's engine. Our device incorporates an alcohol sensor and a helmet-sensing switch. A switch is used to detect whether or not the biker is wearing a helmet. If the cyclist is drunk, an alcohol sensor detects it and sends the result to the MCU. Both the switch and the alcohol sensor are built inside the helmet. The engine will not start if any of the two prerequisites is not met. The MQ3 alcohol sensor is used to detect the alcohol concentration in the driver's breath. Based on the concentration of alcohol, the sensor produces an analog resistive output. The MCU is the microcontroller unit that controls all of the other blocks in this system. The MCU receives or reads data from the sensors and manipulates this data to operate all of the system's functions. The alcohol sensor is linked to the MCU through an interface circuit, whereas the helmet sensing switch is directly linked to the MCU. The MCU collects data from these sensors and sends digital data to the encoder only if the two requirements are met. Finally, if a person is involved in a collision, the sensor evaluates the person's and bike's conditions and provides location information to a nearby hospital. If the person has no major injuries, the bike's button is pressed, indicating that the person's condition is good.

1.1 Objective

The goals of this project are to create a circuit that can increase motorcycle safety and to create a smart safety helmet for the entire rider. The inspiration for this project comes from the real-world issues we confront on the roads every day. Road accidents are becoming more common, and in countries like India, where bikes are more common, many people die as a result of carelessness induced by not wearing helmets. In today's world, there are numerous examples of mortality caused by two-wheeler road accidents. Despite the fact that helmets are widely available, most people do not use them. In the event of a road accident, the message is transmitted to the emergency contact through GSM.

2. Literature survey

Jesudoos [1] presented a system that employs sensors such as infrared sensors, vibration sensors, and gas sensors. The gas sensor checks the breath of a person wearing the helmet to determine how much booze he has ingested. MEMS is in charge of the vehicle's bar control. A vibration sensor detects an accident. The load checker determines the vehicle's load. The sensors are linked to a PIC microprocessor. If a user has consumed alcohol, the gas sensor will detect it and display it on the LED display. If an accident occurs, the vibration sensor will detect it and send information to the hospital through GPS. If the rider drives recklessly, the MEME sensor identifies the amount in the person's bank account. An IR sensor is utilized to determine whether or not the cyclist is wearing a helmet. The exactness and accuracy of this system are high, and ambulances are booked automatically based on ten locations. The smart helmet approach, suggested by Shabbeer [2], identifies and reports accidents. In this method, a microcontroller is linked to an accelerometer and a GSM module. The cloud infrastructure is used to enable accident notification and reporting. If the acceleration level exceeds the threshold or if an accident happens, the information is transferred to the emergency authority server, which subsequently sends the message to the nominated emergency contact through the GPS module. This method was able to recognize incidents 94.82% of the time and send the right coordinates 96.72% of the time.

P. Roja [3] presented a system made up of six components: a remover sensor, an Infrared sensor, an air quality sensor, an Arduino UNO microprocessor, GPRS, and GSM. This helmet warns employees about dangerous chemicals in mining locations and also sends information to the server if the helmet is removed. This data communication is carried out via IOT technology in this case. Bher et al. [4] presented a smart mining helmet detection system that identifies three sorts of hazards: toxic gases, helmet removal, and impacts. Several sensors are used here, including infrared sensors, gas sensors, and accelerometers. Chandran et al. [5] has proposed Konnect, a smart helmet system. To detect and prevent accidents, they deploy an integrated network of sensors, WIFI enabled processors, and cloud computing infrastructures. If the speed exceeds the threshold level, the information is also sent to the provided contact by text message. Aatif et al. [6] devised a method that used an Arduino Nano, a Bluetooth module, a push button, and a 9-volt battery. If an emergency occurs, the smart helmet with Bluetooth is connected to the cell phones, and a push button is employed. Archana et al. [7] devised a solution to reduce accidents; the system comprises of a sensor that detects human touch when the bike key is inserted. When he puts on the helmet, the sensor automatically locks it, and he can only remove it when the bike is stopped.

To provide workers with safety, Lee et al. [8] presented a system based on three sensors: an acceleration sensor, an ultrasonic sensor, and a carbon monoxide sensor, as well as an Arduino MCU (Micro Controller Unit) with a Bluetooth module. Budiman et al. [9] designed a system of smart helmets with several features. If a rider is not wearing a helmet, is in risky conditions, or the helmet is not properly locked to offer safety to the rider, a warning notification is issued. A warning to the rider is generated

in the form of a notification in this system to advise him of the risky condition. There is a 100% success rate in four smart helmet features in the functioning test and a 98.3% success rate in the communication test between the two modules. Tapadar et al. [10] also developed a prototype that uses an IOT module and sensors to identify the rate of alcohol consumption by the rider as well as accidents. They are attempting to use support vector machines to forecast whether or not the sensor values correspond to an accident by training the device using real-time simulation. This system produces acceptable outcomes. The precision and accuracy are likewise quite excellent.

Ahuja et al. [11] presented a smart helmet system that makes use of GSM and GPRS modules. Because we all know that the ambulance may arrive late at the scene, this prototype assists in informing the appropriate person about the accident so that he may take the necessary procedures. This system has features such as high accuracy, cost effectiveness, and providing accident information within a minute. To avoid mishaps, Jeong et al. [12] presented a system that includes sensors such as a thermal camera, a visible light camera, a drone camera, an oxygen remaining sensor, an inertia sensor, a smartwatch, an HMD, and a command center system. This framework enables the easy integration, effective management, and real-time notification of IOT services.

3. Proposed system

The rider must wear the helmet since there is a switch in it. When the switch is pressed, the ignition starts. The helmet also checks if the rider is drunk and driving. If the rider is drunk, then the ignition of the bike is avoided, hence not letting the rider ride the bike. In this system, we use an Arduino microcontroller interfaced with an alcohol sensor, which is used to monitor the user's breath and constantly send signals to the microcontroller. The microcontroller encounters an alcohol signal from the sensor and sends the data to the motor using UART communication, which stops the DC motor to demonstrate engine locking. If alcohol is detected, the system locks the engine. It also uses a Vibration Sensor to detect an accident and the system also sends a message to a server by displaying the status of the helmet switch, alcohol level, and vibration of the rider's behavior, including the latitude and longitude location of the incident using GPS.

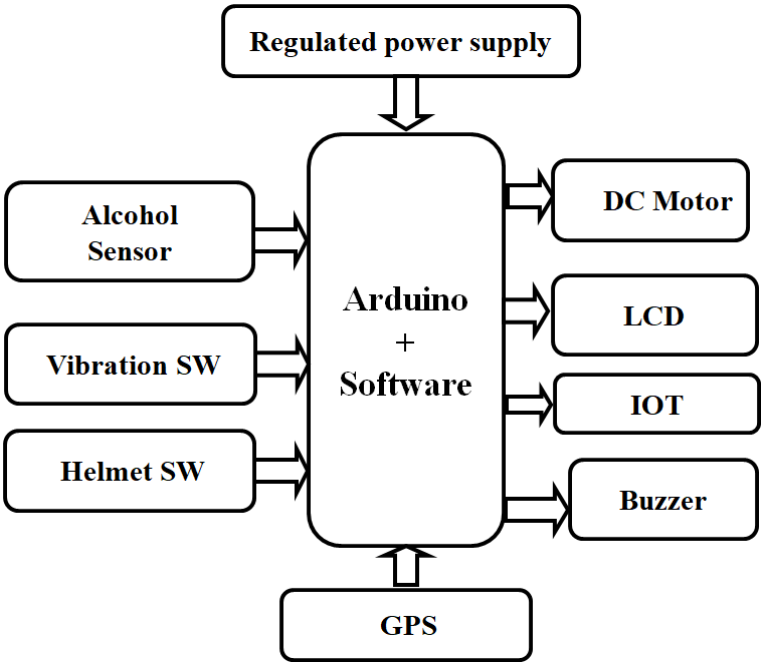

Figure 1: Proposed smart helmet block diagram.

Working operation

The system uses an RPS module to convert the 230 AC volts into 5V DC, which is the power supply for all the components. The inputs of the system include a Helmet switch, Alcohol sensor, Vibration sensor, and GPS module. The Helmet switch is used to detect whether the rider is wearing a helmet or not. The Alcohol sensor measures and detects the alcohol content in the rider's breath. The Vibration sensor detects vibrations caused by the bike's movement, such as a fall or accident. The GPS module determines the location of the bike and rider. The system has several output components, including a DC Motor (used as the bike's engine), an LCD (Liquid Crystal Display) that displays various information such as the status of the inputs, a Buzzer that generates warnings to the rider, and an IoT module. The IoT module connects the helmet to the internet and allows data to be transmitted to a website or mobile app.

The Arduino microcontroller contains the software programming code in Embedded C. It controls the data flow and processing in the system. When the kit is switched on and the mobile hotspot is set, the system waits until it receives GPS data. Once the data is received, the LCD displays the status of the helmet switch, alcohol sensor, and vibration sensor. The system checks if the helmet switch is ON (indicating the rider is wearing a helmet). If the helmet switch is ON and the alcohol sensor is OFF (indicating no alcohol consumption), the DC motor runs, starting or stopping the bike's engine. If the rider doesn't wear a helmet or has consumed alcohol (alcohol sensor is ON), the DC motor stops running, and the buzzer emits a warning sound. The system continuously monitors the vibration sensor. If the sensor detects sudden impacts or an accident, it generates an alert using the buzzer and LCD. The GPS module helps determine the location of the bike and rider, which can be used to alert emergency services in case of accidents. The IoT technology is utilized to transmit sensor data, such as location, alcohol status, helmet status, and vibration sensor status, to a website or mobile app through a Wi-Fi module. By connecting to the hotspot and logging in, users can easily check the updates and status of each input module on the website or app.

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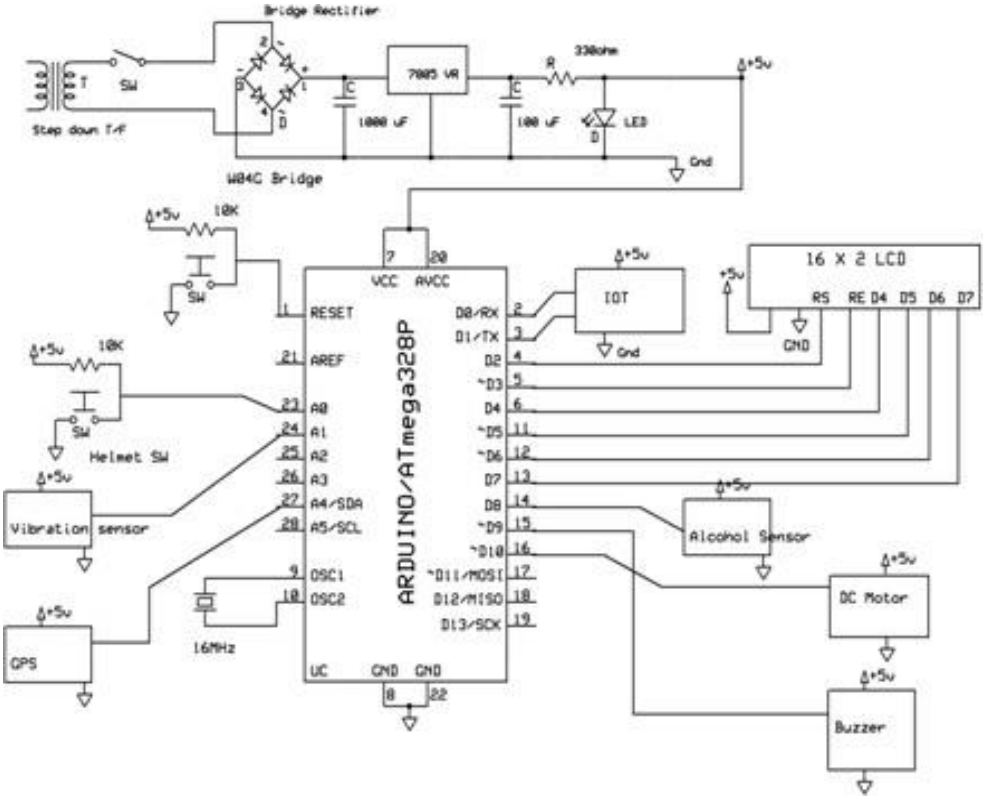


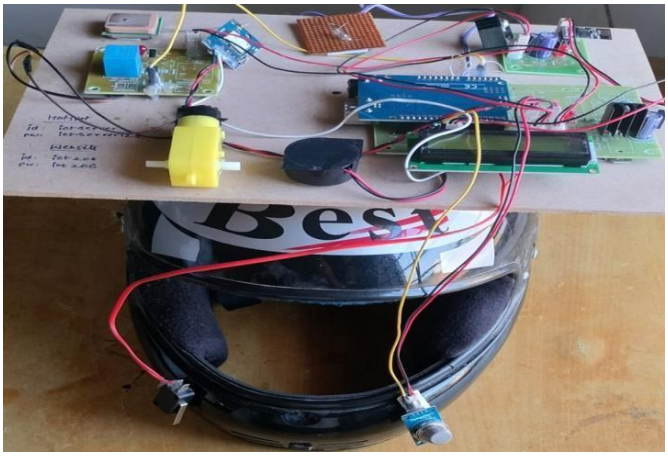
Figure 2: Schematic diagram of proposed smart helmet.

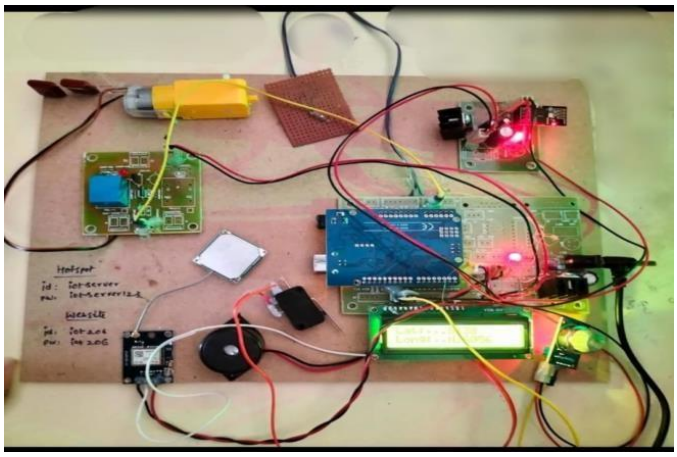
In this project, we are using an Atmega328p microcontroller. It has a total of 28 pins. With these 28 pins, we are using only 20 pins. D0-D13 are the digital pins (14) and A0-A5 are the analog pins (6). Here, D0 and D1 are connected to the IOT for transmitting and receiving the data. D2-D7 pins are connected to a 16*2 LCD display, and D8 pins are connected to the alcohol sensor, which detects whether alcohol is consumed or not. The D9 pin is connected to the buzzer, which gives a beep sound as a warning to the rider. The D10 pin is connected to the DC motor; it is used to start or stop the bike engine based on the status of the inputs. The A0 pin is connected to the helmet switch, which acts as a toggle switch; if it is pressed, then the bike starts; otherwise, it does not. The A1 pin is connected to the vibration sensor, which detects the sudden impacts or falls of the rider. The A4 pin (serial communication) is connected to the GPS module, which detects the location of the rider. The 230-volt AC is converted into 5 volts of DC, and that is given to the circuit through pin 7. Reset is given to pin 1, which is used to reset the circuit for connecting to the IOT module. The oscillator is connected to pins 9 and 10, and GND is connected to pins 8 and 22.

4. Results and discussion

We attempted to build a smart helmet using an innovative approach. Because our smart helmet differs from traditional helmets. All of our circuits have been put outside the helmet fabric for ease, so they do not come into touch with the head. The image above depicts our smart helmet. A receiver circuit device is to be installed on the bike. We made every effort to keep the receiver circuit as small as feasible. The helmet is the same size as any other helmet and is quite comfortable to wear. The entire helmet is referred to as the transmitter circuit since it will communicate data to the bike's reception unit (DC motor). The data will be transmitted using UART communication. We have positioned the MQ-3 alcohol sensor in front of the rider's lips at a safe distance so that it can analyze the driver's breath and

determine whether or not he or she is drunk. The helmet switch determines whether or not the helmet is worn. There is a vibration sensor (Mercury Switch) that detects the rider's fall. Sensors must meet specified requirements. If these conditions are met, the data will be sent via communication. An Arduino Uno is used to link all of these sensors.





Here the circuit is turned on by using the regulated power supply of 12 volts, which is then converted to 5 volts of DC current. The LED is the indication for 5 volts of current, so if there is 5 volts of current, then automatically the LED glows. The generated 5 V DC current passes to every hardware component in the circuit.

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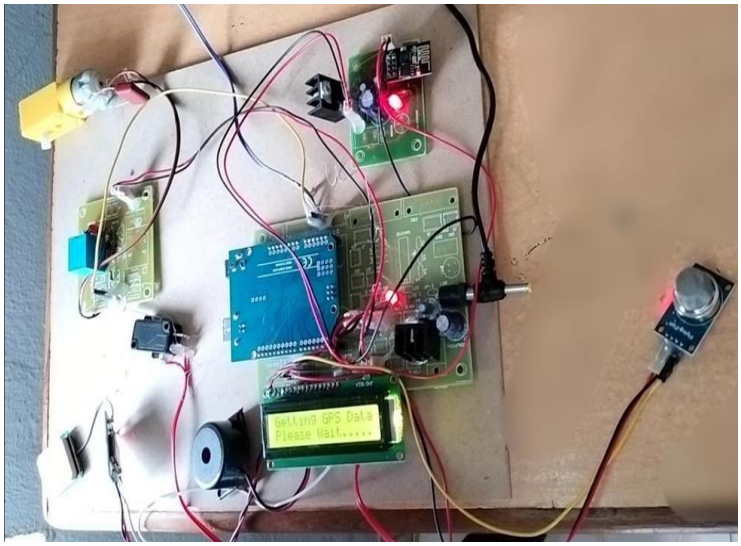

Once power is received by all the components in the kit, wait until it gets the GPS data. It means detecting the location of the rider. After getting GPS data, when we press the reset button, the LCD displays the title “IOT Smart Helmet”. The output may be seen in the following image after we have connected the IOT module via a Wi-Fi connection. Here, the LCD displays the output based on the status of the inputs.

The above figure is about detecting the rider's status and displaying it on the LCD. The system is proposed to detect whether the rider wears a helmet or not (on or off) and, based on his consumption of alcohol, whether he is drunk or not (on or off). If he falls down or not (on or off), all these statuses are displayed on the LCD. If the helmet is not worn and alcohol is consumed, if an accident happens (falls), then it displays alert on the LCD (ON) and gives a beep sound through the buzzer.

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S.No	Alcohol	Vib_Accident	Helmet	Location	Date	
1	OFF	OFF	NO_Wear	Location	Location	2023-03-19 11:21:56
2	OFF	OFF	NO_Wear	Location	Location	2023-03-19 11:21:07
3	OFF	OFF	NO_Wear	Location	Location	2023-03-19 11:18:31
4	OFF	OFF	Wear	Location	Location	2023-03-19 11:18:10
5	ON	OFF	Wear	Location	Location	2023-03-19 11:17:06

This website shows the status of the rider (whether he or she consumed alcohol or not, wore a helmet or not, had an accident or not), and the location of the rider. Every minute, the information and exact location of the rider are updated on the website with the date and time.

5. Conclusion

The IOT smart helmet to avoid accidents project is a novel solution to the problem of motorcycle accidents caused by drunk driving and a lack of suitable safety equipment. Using the vibration sensor and GPS module, the project ensures that the rider is wearing a helmet, prevents the bike from starting if alcohol is detected, and detects accidents. The inclusion of a Wi-Fi module allows data to be transferred to a server for monitoring and analysis, hence strengthening safety regulations. Finally, the Internet of Things smart helmet project has the potential to increase motorcycle safety and reduce accidents caused by human mistake. The initiative emphasizes the need of combining technology into safety equipment and supports the use of creative solutions to societal problems. The idea may be expanded and scaled out to benefit a bigger community of riders, making it a wonderful example of how technology can be used to make the world a safer place.

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