# Development of a Smart Wireless System for Safety of Bike Riders

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## ABSTRACT
Existing systems for safety of bike riders do not check drunken driving and wearing of helmet prior to bike start. In this paper, the authors propose a novel system that uses human pulse detection to ensure that the bike rider is wearing helmet. A breath alcohol sensor is used to detect the possibility of drunken riding. The proposed system is designed such that the vehicle can start only when permission signal is received from intelligent helmet node via RF receiver. The system also has a vehicle fall detection feature implemented using vibration sensors. By integrating the system with GPS for vehicle live location and connecting it via cellular mobile network with emergency contact numbers, we increase the chances for timely aid to bike rider. The system ensures that messages carrying the live location of the vehicle fall are immediately sent to emergency contact numbers programmed in the proposed system via GSM module. The emergency messages (such as SMS) are sent continuously until an acknowledgement is received to ensure on-time medical assistance. The system was successfully tested and found to be an effective solution for improving rider safety and thus contributes immensely towards safer riding.

## Keywords
Internet of Things, RF Transceiver, cellular mobile, GPS, ArduinoMega

## 1. INTRODUCTION
Road safety is a major concern in dense traffic scenarios as well as for long drives along highways and adverse weather conditions. Traffic related fatalities amount to 1.35 million people worldwide, of which 93% are in low and middle-income countries. While the majority of these fatalities occur due to distractions (27.38%) and speeding (16.34%), driver intoxication (14.6%) is also a key factor [1]. In this regard, networks of intelligent sensor nodes can be harnessed for many new applications for road transportation. Several recent research papers propose the development of advanced driver assistance systems with features like lane keeping, automatic brake control, adaptive speed control etc. [2]. Connectivity of vehicles over long distances enable automatic reporting of weather hazards, road anomalies, suggestion of optimal route [3], [4]. These nodes also aid driver monitoring applications like drowsiness detection, driver misbehaviour detection and notification.

Technological advances in safety systems for bike riders are primarily focused on analysis of rider behaviour for identifying safety risks and alerting the driver. Generally, vehicles identify safety risks by analysing the rider's physical behaviour, which include drowsy driving detection [5], [6], eye blink frequency, nodding, bike yawing [7], monitoring of the vehicle position with respect to the lane markings [8], monitoring of the vehicle position with respect to obstacles and other approaching vehicles [9], steering wheel movements [10] and fall detection [11]. These systems trigger alarms when a dangerous driving behaviour or situation is detected. The literature survey conducted by the authors of this paper suggests that no work has so far been done which involves a proactive approach to curb drunken driving and riding without helmet. Existing systems do not check drunken driving / riding and wearing of helmet prior to bike start which reduces the efficacy of these systems.

This paper presents the development of a novel intelligent wireless system that proactively checks if the bike rider is wearing helmet using pulse detection sensor and also measures alcohol content in rider's breath to detect the level of intoxication prior to vehicle start. When human pulse is identified and measured breath alcohol levels are negligible, a signal is sent via RF transceiver to enable bike start circuit. The proposed system also has a vehicle fall detection feature implemented using vibration sensor and an integrated GPS for automatic identification of vehicle live location. This feature immediately messages live location of accident to emergency contact numbers programmed in the intelligent helmet node via GSM module. The emergency messages with live location are sent continuously through SMS to the predefined emergency contact numbers until an acknowledgement is received, to ensure on-time medical assistance at the destination. The location measured by the GPS module integrated with intelligent helmet is also displayed in real-time at u-center map interface. The developed system is tested and results obtained have been presented in this paper.

The paper is organized as follows: Section II describes the overall architecture of the proposed system. Sections III and IV give the hardware and software details of the system, respectively. Sections V and VI report the experimental results and conclusions, respectively.

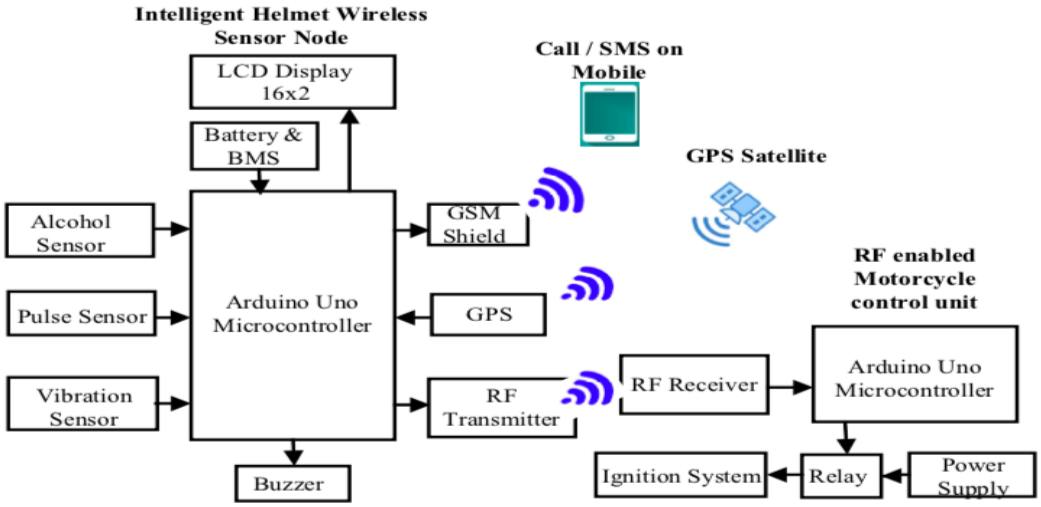


**Fig. 1. Architecture of the Smart Wireless System for Safety of Bike Riders**

## 2. SYSTEM ARCHITECTURE

The architecture of the proposed smart wireless system for safety of bike riders is shown in Fig. 1. This system has also been implemented in this work and essentially consists of two main nodes: (i) GSM connected Intelligent Helmet Wireless Sensor Node, and (ii) RF enabled bike control node.

### 2.1 GSM connected Intelligent Helmet Wireless Sensor Node

This unit comprises of sensors, a microcontroller, GPS module, GSM and RF transceiver for communication. The microcontroller is programmed to sample alcohol and pulse sensor. The sensor data is processed to identify that the driver is not drunk and has worn the helmet. When the measured sensor data detects human pulse signal and alcohol is not detected in driver's breath, a signal is sent via RF transceiver of the helmet node to the RF receiver connected to bike control circuit to enable the start of the vehicle. In case of a fall detection, the intelligent helmet sensor node immediately sends the real-time location of the vehicle to emergency numbers saved in it via SMS till an acknowledgement is received.

### 2.2 RF enabled bike control node

An RF receiver unit is connected to the vehicle start circuit and comprises of an RF receiver and a microcontroller to receive the signals from the intelligent helmet node and actuate the vehicle. This unit disables the start of the vehicle unless a start signal is received from the intelligent helmet node.

## 3. SYSTEM IMPLEMENTATION

### 3.1 GSM connected Intelligent Helmet Wireless Sensor Node

The intelligent helmet wireless sensor node developed in this work uses an Arduino Uno microcontroller based on ATMega328P. The board requires a power supply of 7V. It operates at frequencies of up to 1 MHz It has 32 kB flash memory, 2 kB SRAM, SPI, I2C interface, 2 UART serial ports, 14 digital input-output pins of which 6 are PWM pins and 6 analog input pins [12]. The pulse sensor SEN-11574 used in the node uses an optical heart rate sensor and amplification and noise cancellation circuit to measure pulse rate. Besides, it is low power and draws a low amount of current [13]. The MQ3 gas sensor is used for alcohol detection. It is highly sensitive to alcohol and less sensitive to benzene. The sensing range of the sensor is 0.04 mg/L to 4 mg/L. The sensor consumes less than 150 mA at 5V. The sensitive material in MQ3 is SnO2 whose conductivity is proportional to alcohol, and has good resistance to gasoline, smoke and vapour [14].

The vibration sensor module used in the sensor node for fall detection is based on vibration sensor SW-420 and comparator LM393. It is a high sensitivity non-directional vibration sensor which gives high output when still. When vibration occurs, the circuit is disconnected and sensor output goes low [15]. NEO-6M GPS Module is used for identifying the latitude and longitude coordinates in case of a fall. It operates at a baud rate upto 115200 Bauds. It is based on Ublox NEO-6M, the latest technology from Ublox for the best possible positioning information. It includes a built-in 25mm x 25mm active GPS antenna with a UART TTL socket. For configuring Ublox GPS receivers and also remotely visualize their GPS locations on windows operating system, a GUI tool U-center is used [16]. For communicating the start signal to the bike control unit, RF hybrid transmitter module TX-ASK is used. It operates at transmission frequency of 433 MHz and can transmit and receive the data and transmission is possible even in case of obstruction. It draws 4.5mA at a 3V power supply and is not very costly [17]. GSM Shield SIM800L is used to enable communication of the developed sensor node with remote server [18].

The sensor node was programmed in embedded C language via Arduino IDE (Integrated Development Environment). The program follows the logic in the flowchart indicated in Fig. 2.

### 3.2 RF enabled bike control node

In the prototype developed in this work, the RF Receiver unit controlling the bike start circuit comprises of an RX–ASK Hybrid receiver module and a microcontroller connected to the bike start circuit. The vehicle can start only when the permission signal is received from the Intelligent Helmet sensor node. The flowchart of the program for RF enabled bike control unit is shown in Fig. 3.

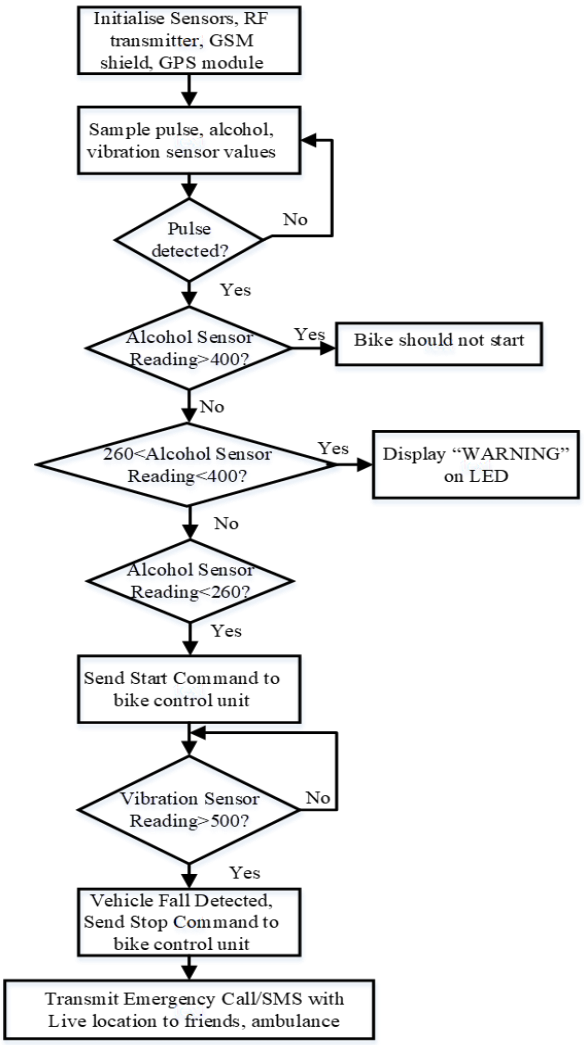


**Fig. 2. GSM connected Intelligent Helmet wireless sensor node program flow.**

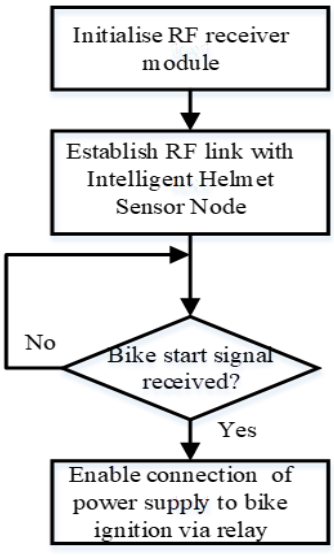


**Fig. 3. RF enabled bike control unit program flow.**

## 4. SYSTEM WORKING AND RESULTS

The prototype of the implemented system is shown in Fig. 4. The developed system was successfully tested for rider pulse detection and alcohol detection in the breath. The breath alcohol, pulse rate and vibration sensor measurements displayed on Arduino IDE software are shown in Table 1.

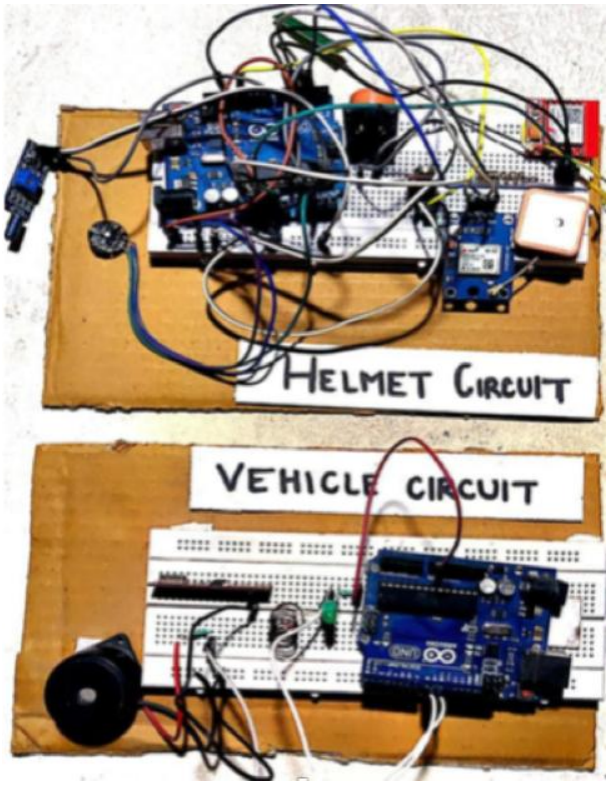


**Fig. 4. Implemented System prototype**

**Table 1. Readings of sensors displayed on serial monitor of Arduino IDE software**

| S. No. | Pulse rate (bpm) | Alcohol (ppm) | Vibration |
|---|---|---|---|
| 1 | 72 | 493 | 144 |
| 2 | 73 | 493 | 139 |
| 3 | 72 | 493 | 139 |
| 4 | 72 | 493 | 134 |
| 5 | 72 | 492 | 136 |
| 6 | 72 | 251 | 133 |
| 7 | 72 | 250 | 134 |
| 8 | 72 | 250 | 140 |
| 9 | 72 | 249 | 139 |
| 10 | 72 | 249 | 138 |
| 11 | 83 | 249 | 530 |
| 12 | 83 | 248 | 530 |
| 13 | 84 | 248 | 528 |
| 14 | 84 | 249 | 528 |

Alcohol sensor values above 400 ppm indicate that the driver is drunk and the system is designed such that the vehicle does not start. Similarly, alcohol sensor measurements between 260

ppm and 400 ppm display a warning on LED. For alcohol measurements less than 260 ppm, the signal is sent to the RF receiver for completing the bike start circuit. Similarly, when vibration sensor measures successive values more than 500, a vehicle fall is detected and location of the vehicle is measured using GPS module and warning message is sent, automatically. The SMS alert containing live location of the vehicle received on the mobile phone, sent by GSM connected intelligent helmet wireless sensor node when a fall is detected is shown in Fig. 5. The live location of intelligent helmet / vehicle measured by 6M-NEO GPS MODULE as displayed on u-center GUI is shown in Fig. 6.

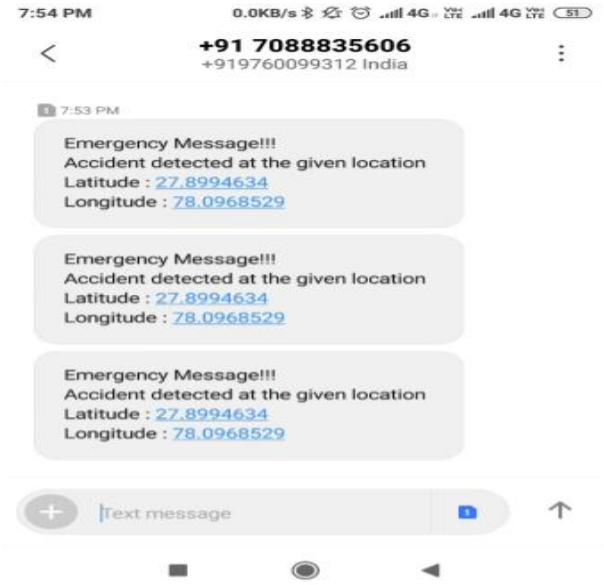


**Fig. 5. SMS alert with live location received on mobile phone when vehicle fall is detected.**

| LOCATION OF VEHICLE | | | |
|---|---|---|---|
| Date | Time | Latitude | Longitude |
| 09/09/19 | 07:52 p.m. | 27.8994632 | 78.0968528 |
| 09/09/19 | 07:53 p.m. | 27.8994634 | 78.0968529 |
| 09/09/19 | 07:54 p.m. | 27.8994634 | 78.0968529 |
| 09/09/19 | 07:55 p.m. | 27.8994634 | 78.0968529 |


**Fig. 6. Vehicle Live Location displayed on u-center GUI**

## 5. CONCLUSIONS

Several recent statistics have highlighted that road safety is an issue of concern particularly in developing countries for bike, motorcycle drivers. This work has studied the limitations of present driver safety systems for bikes. This paper has presented details of a successful implementation of a novel system for safety of bike riders as a solution to identified limitations in existing systems. This system monitors and analyses the human pulse rate and alcohol sensor data variations and hence makes intelligent inference whether to allow the bike to start. The bike start circuit is controlled via RF transceiver module. More importantly, this system is also capable of quickly detect vehicle fall and sending alert messages with live location to the phone numbers programmed in the microcontroller via cellular network. This feature enables timely medical help to the concerned persons. Also, the use of vibration sensor for fall detection makes the response of the system more reliable with reduced false positives compared to accelerometer-based approaches for fall detection. A large-scale adoption of such integrated intelligent communication system presented in this paper can considerably improve driver/ rider and road safety.

## 6. ACKNOWLEDGMENTS

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