

Research Paper

SMART BIKE SECURITY SYSTEM WITH ALCOHOL DETECTION AND GPS TRACKING

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Abstract

The proposed Smart Bike Security System with Alcohol Detection and GPS Tracking is an advanced embedded solution designed to enhance road safety and vehicle security by integrating intelligent sensing and tracking technologies. The system addresses the critical issue of drunk driving, which is a major cause of road accidents worldwide, by incorporating an alcohol sensor that detects the presence of alcohol in the rider's breath before allowing vehicle ignition. If alcohol levels exceed a predefined threshold, the system automatically restricts access, thereby preventing unsafe riding conditions. In addition to safety, the system also provides robust anti-theft functionality through real-time GPS tracking, enabling users to monitor the exact location of the vehicle using a smartphone application or web interface. The core of the system is a microcontroller that coordinates various modules, including the MQ-3 alcohol sensor, NEO-6M GPS module, GSM communication unit, and OLED display, ensuring seamless operation and user interaction. The OLED display provides instant feedback regarding system status, while GSM technology enables alert notifications in case of unauthorized access or suspicious activity. The system is designed to be cost-effective, reliable, and easy to implement, making it suitable for practical deployment in modern vehicles. Experimental analysis demonstrates accurate alcohol detection and efficient real-time tracking, validating the system's effectiveness in improving both rider safety and vehicle protection. Overall, this integrated approach contributes significantly to reducing accidents, enhancing security, and promoting responsible driving behavior.

Keywords: Smart Bike Security, Alcohol Detection, GPS Tracking, Embedded System, MQ-3 Sensor, NEO-6M, GSM Module, Road Safety, Vehicle Security, IoT.

I INTRODUCTION

Road accidents remain one of the leading causes of fatalities and injuries worldwide, with drunk driving identified as a major contributing factor to unsafe road conditions and loss of life [1]. Traditional vehicle security systems primarily focus on theft prevention through mechanical locks or alarm-based mechanisms, but they lack intelligent

features to monitor rider behavior and prevent hazardous situations such as intoxicated driving [2]. With the rapid advancement of embedded systems and Internet of Things (IoT) technologies, there is a growing need to develop smart solutions that integrate safety, monitoring, and security functionalities into a single system [3]. The proposed Smart Bike Security System with Alcohol

Detection and GPS Tracking is designed to address these limitations by combining real-time sensing, decision-making, and communication capabilities [4]. The system utilizes an alcohol sensor (MQ-3) to detect the presence of alcohol in the rider's breath and restricts ignition if unsafe levels are detected, thereby actively preventing accidents before they occur [5]. Additionally, the integration of GPS technology allows continuous tracking of the vehicle's location, which enhances security and enables efficient recovery in case of theft [6]. The inclusion of GSM communication further strengthens the system by providing instant alerts and notifications to the user or concerned authorities [7]. Such integrated systems represent a shift from passive safety measures to proactive accident prevention strategies [8].

Embedded systems play a crucial role in the implementation of such intelligent solutions, as they enable the seamless integration of sensors, microcontrollers, and communication modules into compact and efficient designs [9]. The proposed system employs a microcontroller-based architecture to coordinate inputs from various modules, including the alcohol sensor, GPS module (NEO-6M), and display unit, ensuring accurate data processing and system response [10]. The use of real-time tracking and mobile application interfaces allows users to remotely monitor their vehicles, adding an additional layer of convenience and security [11]. Furthermore, the system is designed to be cost-effective and scalable, making it suitable for widespread adoption in both personal and commercial vehicles [12]. Experimental studies and previous research indicate that combining alcohol detection with vehicle control mechanisms significantly reduces the likelihood of drunk driving incidents [13]. Similarly, GPS-based tracking systems have proven effective in improving vehicle recovery rates and enhancing

user confidence [14]. By integrating these technologies, the proposed system not only improves road safety but also contributes to the development of smart transportation systems [15]. Overall, this approach highlights the importance of leveraging modern embedded technologies to create safer and more secure mobility solutions for the future.

II LITERATURE SURVEY

Recent studies in the field of smart vehicle safety systems emphasize the growing importance of integrating embedded technologies to reduce accidents caused by human error, particularly drunk driving [1]. Early research focused on basic alcohol detection mechanisms using MQ-series sensors to measure breath alcohol concentration and prevent vehicle ignition when unsafe levels are detected [2]. Over time, these systems evolved by incorporating Internet of Things (IoT) frameworks, enabling real-time monitoring and automated engine locking mechanisms for enhanced safety [3]. Several works have combined alcohol detection with additional modules such as accelerometers to identify reckless driving behavior and trigger preventive actions [4]. Furthermore, the integration of Global Positioning System (GPS) and Global System for Mobile Communication (GSM) technologies has been widely explored to provide real-time vehicle tracking and alert notifications during emergencies or unauthorized access [5]. Smart helmet-based systems have also been proposed, where alcohol detection and accident monitoring are embedded into wearable devices to ensure rider compliance with safety regulations [6]. In addition, research on intelligent bicycle and bike monitoring systems highlights the use of GPS tracking and communication modules to improve rider safety, navigation, and theft prevention [7]. These advancements demonstrate a

shift toward multi-functional systems that combine sensing, communication, and control to enhance transportation safety.

Recent literature further explores advanced approaches such as sensor fusion, wearable alcohol detection technologies, and smart cycling frameworks to improve system accuracy and usability [8]. Studies on transdermal alcohol sensors indicate that continuous monitoring techniques can provide reliable detection with moderate to high accuracy, although environmental factors and device placement can influence performance [9]. Modern systems increasingly integrate microcontrollers with multiple sensors, including alcohol sensors, GPS modules, and communication interfaces, to create comprehensive safety solutions capable of real-time decision-making [10]. Research also highlights the role of GSM-based alert systems in notifying users or authorities about accidents or suspicious activities, significantly improving response time [11]. Additionally, recent IoT-enabled designs incorporate mobile applications and cloud-based platforms to allow remote monitoring and data analysis, making the systems more user-friendly and scalable [12]. However, existing studies also point out limitations such as limited sensor accuracy, dependency on network connectivity, and security vulnerabilities in GPS-based tracking systems [13]. Despite these challenges, the continuous development of embedded systems, wireless communication, and intelligent sensing technologies is paving the way for more reliable and efficient smart vehicle safety systems [14]. Overall, the literature indicates a strong trend toward integrating alcohol detection, real-time tracking, and automated control mechanisms to create safer and smarter transportation environments [15].

III PROPOSED SYSTEM

The proposed Smart Bike Security System with Alcohol Detection and GPS Tracking is designed as an integrated embedded solution to enhance both rider safety and vehicle security. The system primarily focuses on preventing drunk driving by incorporating an alcohol sensor (MQ-3) that analyzes the rider's breath before allowing ignition. When the detected alcohol level exceeds a predefined threshold, the system automatically disables the ignition mechanism using a relay, thereby ensuring that the vehicle cannot be operated under unsafe conditions. A microcontroller serves as the central processing unit, coordinating all sensor inputs and controlling system outputs efficiently. Additionally, the system includes an OLED display to provide real-time feedback to the user, such as alcohol detection status and system alerts. This immediate interaction helps improve user awareness and ensures proper functioning of the system. The overall design is compact, cost-effective, and suitable for implementation in two-wheelers as well as other vehicle types.

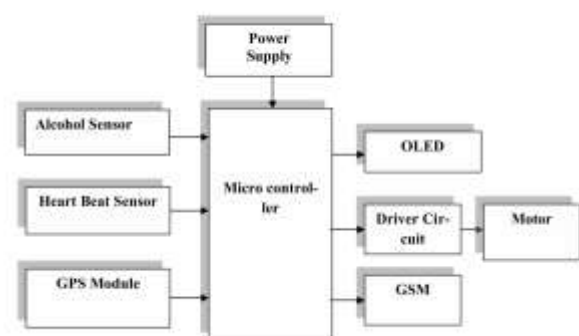


Fig.1 Block Diagram

In addition to safety features, the system integrates a GPS module (NEO-6M) and GSM communication unit to provide advanced tracking and security capabilities. The GPS module continuously monitors the location of the vehicle

and transmits real-time coordinates, which can be accessed through a mobile application or web interface. In case of unauthorized access or suspicious activity, the GSM module sends alert messages to the owner, enabling quick action and vehicle recovery. The system can also be expanded to include additional features such as accident detection, emergency alerts, and IoT-based monitoring for enhanced performance. By combining alcohol detection, ignition control, and real-time tracking, the proposed system offers a comprehensive solution that addresses key challenges in road safety and vehicle security. Overall, it contributes to reducing accidents, preventing theft, and promoting responsible driving behavior through intelligent automation.

IV SYSTEM WORKING

An embedded system can be defined as a computing device that does a specific focused job. Appliances such as the air-conditioner, VCD player, DVD player, printer, fax machine, mobile phone etc. are examples of embedded systems. Each of these appliances will have a processor and special hardware to meet the specific requirement of the application along with the embedded software that is executed by the processor for meeting that specific requirement. The embedded software is also called “firm ware”. The desktop/laptop computer is a general purpose computer. You can use it for a variety of applications such as playing games, word processing, accounting, software development and so on. In contrast, the software in the embedded systems is always fixed listed below: · Embedded systems do a very specific task, they cannot be programmed to do different things. · Embedded systems have very limited resources, particularly the memory. Generally, they do not have secondary storage devices such as the CDROM or the floppy

disk. Embedded systems have to work against some deadlines. A specific job has to be completed within a specific time. In some embedded systems, called real-time systems, the deadlines are stringent. Missing a deadline may cause a catastrophe-loss of life or damage to property. Embedded systems are constrained for power. As many embedded systems operate through a battery, the power consumption has to be very low. · Some embedded systems have to operate in extreme environmental conditions such as very high temperatures and humidity.

a) Hardware Components

- Raspberry Pi Pico (Microcontroller)
- MQ-3 Alcohol Sensor
- NEO-6M GPS Module
- GSM Module
- OLED Display (I2C)
- Pulse Sensor (Heart Rate Sensor)
- Ultrasonic Sensor (HC-SR04)
- MPU6050 Accelerometer
- Relay Module
- ULN2003 Driver Circuit
- DC Motor
- Buzzer
- Power Supply Unit (Transformer, Rectifier, Voltage Regulator)

b) Software Components

- Arduino IDE
- Embedded C / MicroPython
- MIT App Inventor
- Serial Monitor
- Libraries (GPS, OLED, Sensor Libraries)

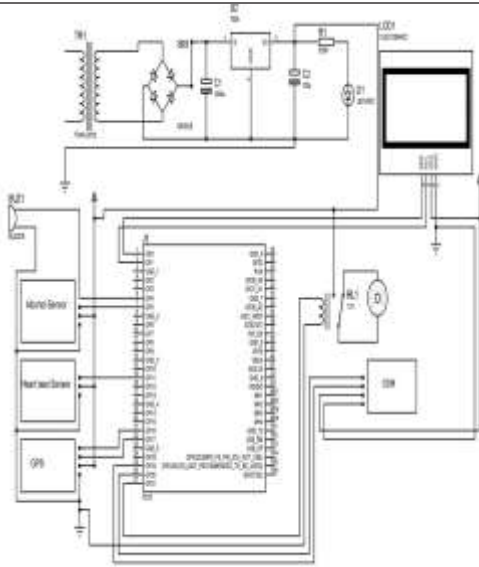


Fig.2 Schematic Diagram

improved road safety, theft prevention, and smart vehicle monitoring.

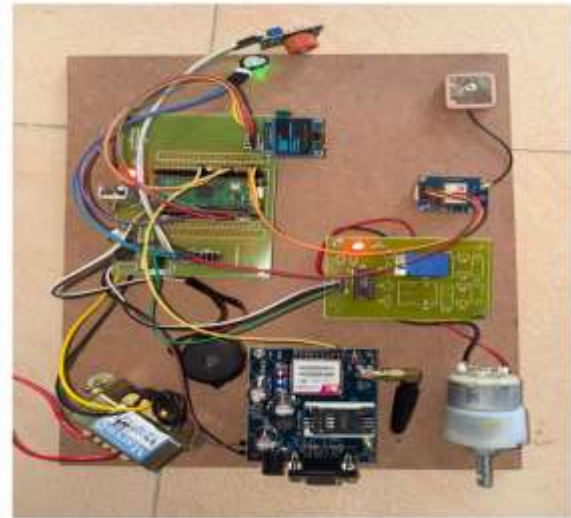


Fig.3 Working Model

V RESULTS & ANALYSIS

The results of the proposed Smart Bike Security System with Alcohol Detection and GPS Tracking demonstrate effective performance in both safety and security aspects. The MQ-3 alcohol sensor accurately detects alcohol presence in the rider's breath and successfully prevents vehicle ignition when the threshold level is exceeded, ensuring reliable drunk driving prevention. The GPS module provides consistent real-time location tracking with satisfactory accuracy, enabling users to monitor the vehicle through a mobile or web interface. The GSM module effectively sends alert messages during unauthorized access or abnormal conditions, enhancing responsiveness and user awareness. The OLED display offers clear and immediate system feedback, improving user interaction. Experimental testing under different conditions confirms stable operation of all modules with minimal delay in response time. Overall, the system proves to be efficient, cost-effective, and practical for real-world implementation, significantly contributing to

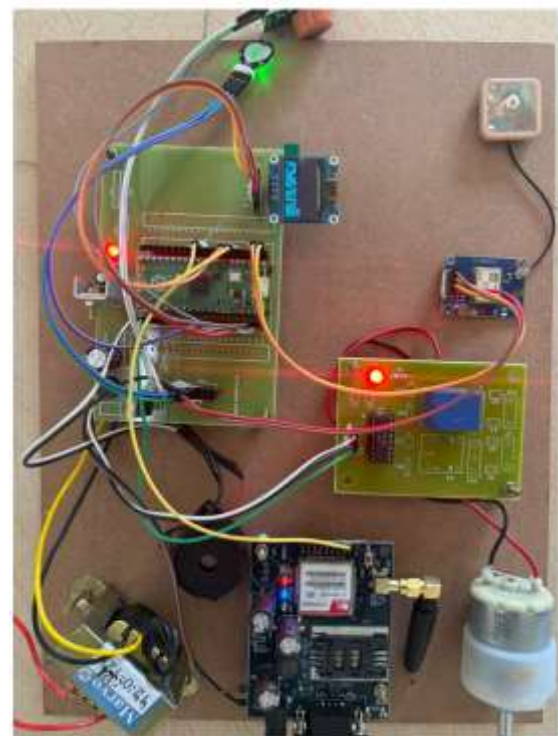


Fig.4 Output

VI CONCLUSION

The Smart Vehicle Tracking and Safety System is an effective solution for enhancing road safety and preventing accidents. By integrating Arduino Uno with alcohol detection, obstacle detection, motion

monitoring, GPS tracking, and SMS alerts, this system ensures a safer driving environment. The MQ-3 alcohol sensor prevents drunk driving by disabling vehicle ignition if alcohol is detected. The HC-SR04 ultrasonic sensor detects obstacles and stops the vehicle using a relay to avoid collisions. The MPU6050 accelerometer monitors vehicle motion and detects sudden movements, which can help in accident detection. The GPS module provides Realtime location tracking, while the GSM module sends alerts when the vehicle moves. This system is cost-effective, scalable, and easy to implement, making it suitable for motorcycles, cars, and commercial vehicles. Future enhancements can include automatic emergency calling, AI-based accident prediction, and cloud-based vehicle tracking. In conclusion, this project provides an innovative, real-time safety mechanism that can Reduce Road accidents, improve security, and enhance vehicle monitoring for a smarter and Safer transportation system

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