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Smart Bike Security System Through Wi-Fi Using ESP32

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ABSTRACT:

The rise in bike theft incidents highlights the urgent need for a reliable and affordable security system. This project presents a **GPS-based anti-theft and ignition locking system using the ESP32 microcontroller,** designed specifically for two-wheelers. The system integrates a **NEO-6M GPS module, tilt and vibration sensors,** and a **relay module** to detect unauthorized movement, track real-time location, and control ignition remotely. When motion or shock is detected, the system automatically disables the ignition and sends an alert with GPS coordinates to the user via **Wi-Fi,** eliminating the need for GSM modules or mobile apps. The entire setup is compact, cost-effective, and can be easily installed on a bike. This solution not only enhances bike security but also provides a foundation for future smart vehicle systems with advanced features like accident detection and remote control.

Keywords: ESP32, GPS, Ignition Locking, SMS Alerts

INTRODUCTION:

Two-wheeler theft remains a common issue due to the absence of advanced, responsive security systems. Traditional methods like mechanical locks and alarms offer minimal protection and lack real-time monitoring or emergency response capabilities. As urban mobility increases, the need for intelligent and affordable vehicle protection becomes more pressing.

This paper proposes a smart GPS-based anti-theft and ignition control system using the ESP32 microcontroller. The system combines real-time GPS tracking (NEO-6M), unauthorized movement detection via tilt and vibration sensors, and ignition control through a relay. A manual override switch ensures control in critical situations, even in the event of network failure.

Unlike GSM-based solutions, this design uses Wi-Fi for communication, reducing recurring costs and simplifying connectivity. The system is compact, affordable, and well-suited for bikes and scooters, offering improved security, real-time alerts, and accident detection—making it an ideal choice for modern two-wheeler users.

LITERATURE REVIEW:

B. G. Nagaraja, Ravi Rayappa, M. Mahesh, Chandrashekhar M. Patil, proposed work on design and development of a vehicle theft control system utilizing GSM technology. [1] The system enables vehicle owners to monitor and control their vehicles remotely through mobile communication. In the event of unauthorized access or theft, the system can alert the owner via SMS and allow them to take preventive actions, such as immobilizing the vehicle. This approach offers an effective solution to enhance vehicle security by integrating GSM-based communication with theft deterrence mechanisms.

R Bavya , R Mohanamurali, presented paper on an advanced vehicle security system integrating technologies such as smart gravitational locks, touch screen ignition, GPS, GSM, and inertial navigation sensors. [2] The system enhances vehicle protection by utilizing air gesture keys and software key gestures to prevent unauthorized access. It allows owners to remotely monitor and track their vehicles, even in GPS-denied environments, using dead reckoning methods. Features like GPS fencing restrict vehicle movement within designated areas, and motion sensing subsystems detect unauthorized movements or tilts. In case of theft, the system can gradually cut off the fuel supply upon receiving a specific message, thereby immobilizing the vehicle.

S. Jeevan, Kishan Karthik S, Mohana, Minal Moharir, proposed a technique for a vehicle tracking and monitoring system that leverages GPS, GSM, IOT, and two-factor authentication to enhance vehicle safety. [3] The system provides real-time location monitoring and integrates two-factor authentication to prevent unauthorized access. By utilizing IOT technology, it offers efficient tracking and monitoring capabilities, contributing to improved vehicle security.

Veerandi Kulasekara, Pasan Dharmasiri, Pham Chi Thanh, Ilya Kavalchuk, proposed work on an intelligent anti-theft system for e-bikes that uses zigbee technology to improve usability and notify owners of the location of their vehicle. [4] The bikes position is determined by the system using Radio Frequency (RF) modules Received Signal Strength Indicator (RSSI), which allows tracking in both indoor and outdoor settings. Compared to current technologies, this method offers better personal security while using less power. With the help of performance analysis and prototype testing, the authors go over system design, network architecture, and location determination using zigbee topology.

Dhruvi K. Zala, Implemented paper on a security lock application that allows users to maintain control over bike access. [5] By activating the security locks, users can prevent unauthorized use of their bikes. The application enhances bike security by ensuring that only authorized individuals can operate the vehicle.

Vinoth Kumar Sadagopan, Upendran Rajendran, Albert Joe Francis, presented a novel anti-theft control system for automobiles, utilizing embedded systems to prevent vehicle theft. [6] The system aims to enhance vehicle security by integrating advanced technological solutions. By implementing this embedded system, the authors seek to provide an effective deterrent against unauthorized access and operation of vehicles.

M. M. Hossain, M. S. Islam, N. F. Dipu, Celia Shahnaz, proposed a cost effective anti-theft sensor for motorcycles, focusing on detecting handlebar rotation to enhance security. [7] The sensor aims to provide an affordable solution to motorcycle theft by monitoring unauthorized movements. By integrating this sensor into motorcycle security systems, owners can benefit from improved protection against theft without incurring significant costs.

K. Venkateshwara Rao, P. Sireesha, K. Suresh, presented the design and development of an advanced vehicle locking system in a real-time environment using GSM and GPS technologies. [8] The system allows for remote tracking and locking of vehicles, enhancing security measures against theft.

Abu Sabir K V, Jithin J, Mohammed Nihal, Srikanth K, presented a paper on a vehicle theft and engine lock system that integrates an Atmega microcontroller for robust vehicle security. [9] It enables users to remotely manage engine status via SMS commands and receives real-time GPS updates for accurate location monitoring.

S. S. Pethakar, N. Srivastava, S. D. Suryawanshi, presented a work on a dual function system that prevents unauthorized vehicle use by locking it ignition system and provide effective tracking through GPS and GSM technologies in case of theft [10]

PURPOSED METHODOLOGY:

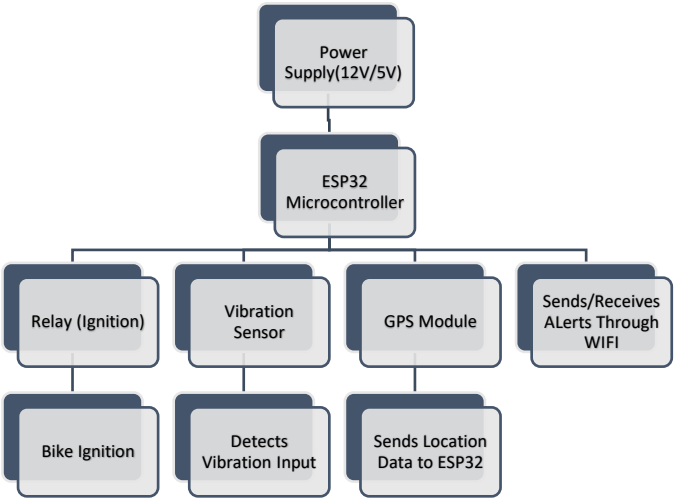


Fig 1. Block Diagram

The block diagram of the proposed system demonstrates the architecture of a Wi-Fi-based GPS anti-theft and ignition control system using the ESP32 microcontroller. The entire system is powered by a 5V supply through a USB interface or power bank, making it portable and easy to integrate into two-wheelers.

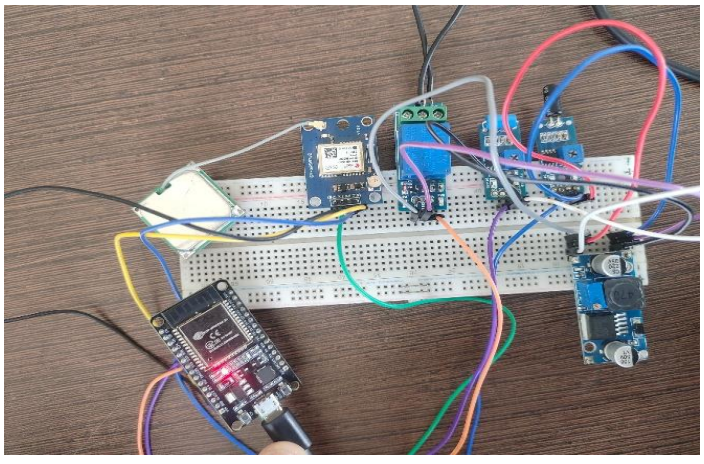
At the core of the system is the ESP32, which acts as the central controller. It receives real-time location data from the NEO-6M GPS module and sensor inputs from both the tilt and vibration sensors. When unauthorized movement or tampering is detected by these sensors, the ESP32 activates the GPS module to fetch the vehicle's live coordinates.

In response to suspicious activity, the relay module is triggered to cut off the ignition system, thereby preventing the bike from starting. Additionally, a manual override switch is included to allow the rider to bypass the system in safe or verified conditions.

Instead of GSM-based SMS communication, the ESP32 leverages Wi-Fi to send data to a local server or dashboard, where the owner can monitor the bike's location or receive alerts. This design eliminates recurring GSM costs and simplifies the communication setup.

RESULT:

Fig 2. Hardware Model



The ESP32-based GPS anti-theft and ignition locking system was tested successfully on a two-wheeler prototype. The tilt and vibration sensors reliably detected unauthorized movement, triggering the system to fetch the bike's location using the GPS module. The ESP32 then sent this data over Wi-Fi, confirming real-time tracking without GSM.

The ignition relay worked effectively, preventing the vehicle from starting during theft simulations. A manual override switch allowed safe, authorized ignition. Testing showed accurate GPS location, quick sensor response, and stable Wi-Fi communication.

Overall, the system proved to be reliable, easy to use, and cost-effective—offering real-time tracking, secure ignition control, and improved vehicle safety.

CONCLUSION:

This project introduces a smart, cost-effective security system for two-wheelers using the ESP32 microcontroller. It combines GPS tracking, tilt and vibration-based accident detection, and ignition control to deliver real-time monitoring and responsive security features. Unlike traditional GSM-based systems, this solution operates over Wi-Fi, reducing communication costs while maintaining accurate location tracking and quick alert capability. The system detects unauthorized movement, disables ignition access, and ensures emergency response through intelligent automation. Its energy-efficient and modular design makes it well-suited for personal bikes, fleet management, and public transportation, offering a reliable upgrade over conventional vehicle security methods.

FUTURE SCOPE:

Future improvements have the potential to greatly increase efficiency of system. By examining trends in vehicle movement, AI-based crash detection can improve accident identification. Users may find voice command ignition control more convenient as it enables hands free operation. Long term data for security monitoring and analysis would be stored in cloud-based tracking history. Lastly, longer operating times could result from improved battery performance, guaranteeing dependable operation even in isolated or off grid areas. This system provides a creative, scalable, and useful answer to contemporary vehicle security requirements by utilizing IoT and smart sensor technology.

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