VEHICLE THEFT DETECTION WITH ALARM SYSTEM

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Abstract- The rapid increase in the number of vehicles across the globe has made vehicle theft an even more concerning issue. The old security measures for vehicles, such as mechanical locks and simple alarms, lack the force to deter the thieves. The authors of the present paper brought to light a vehicle theft detection system's design and implementation with an alarm mechanism that relies on embedded and communication technologies of the modern age. The suggested system makes use of sensors to detect unauthorized access or vehicle movement, triggers an audible alarm while simultaneously sending alerts to the vehicle owner. The entire system is built around a microcontroller, which is connected to different sensors such as vibration or motion sensors, along with GSM and GPS modules for communication and location tracking. A buzzer alarm is turned on and an SMS notification with the vehicle's location is sent out as soon as a theft attempt is detected. With this approach, the security of the vehicle is further increased due to the fact that the monitoring takes place in real time and the response is quick, that is why this system is cost-effective, reliable and suitable for two wheelers as well as four wheelers.

Keywords—Vehicle theft detection, alarm system, GSM, GPS, IoT, embedded systems.

I INTRODUCTION

The rapid growth in the number of vehicles across urban and rural areas has significantly increased the problem of vehicle theft worldwide. With rising vehicle ownership, incidents of unauthorized access, tampering, and theft have also escalated, leading to substantial financial losses, emotional distress, and safety concerns for vehicle owners. Despite advancements in automobile manufacturing, vehicle theft remains a major challenge due to the limitations of conventional security mechanisms.

Traditional vehicle security systems mainly rely on mechanical locks, steering locks, and basic alarm systems. Although these methods provide a basic level of protection, they can be easily bypassed by experienced thieves using modern tools lock for vehicle immobilization. The objective is to provide an efficient, low-cost, and reliable and techniques. In many cases, conventional alarm systems fail to notify the vehicle owner in real time, making it difficult to respond quickly during a theft attempt. Additionally, such systems lack advanced features like remote monitoring, vehicle immobilization, and location tracking.

With the development of embedded systems, microcontrollers, and wireless communication technologies, smart vehicle security solutions have gained significant attention in recent years. Technologies such as Global Positioning System (GPS), Global System for Mobile communication (GSM), Internet of Things (IoT), and motion sensors have enabled real-time monitoring and alert mechanisms. These technologies allow vehicle owners to receive instant notifications, track vehicle location, and take preventive actions remotely.

Several research works have proposed vehicle theft detection systems using combinations of GPS and GSM to provide location tracking and SMS alerts. While these systems improve post-theft recovery, they often lack immediate theft prevention features such as vehicle immobilization. IoT-based vehicle security systems offer real-time data visualization and mobile application control; however, they are highly dependent on continuous internet connectivity and may suffer from latency and reliability issues. Motion sensor-based systems improve theft detection accuracy but may generate false alarms if not properly calibrated.

Despite the availability of various vehicle security solutions, challenges such as high system cost, complexity, power consumption, delayed response, and lack of integrated security features still exist. Many advanced systems are expensive and not suitable for mass adoption, especially for two-wheelers and low-cost vehicles. Therefore, there is a strong need for a vehicle theft detection system that is cost-effective, reliable, fast in response, and capable of providing multiple layers of security.

This review paper focuses on analyzing existing vehicle theft detection techniques and identifying their limitations. Based on the literature survey, an improved vehicle theft detection approach using embedded systems is discussed. The reviewed system integrates an Arduino microcontroller with an MPU6050 motion sensor for detecting unauthorized movement, GSM and ESP32 modules for real-time alerts, a GPS module for location tracking, and a relay-controlled solenoid vehicle theft detection system suitable for both two-wheelers and four-wheelers.

II LITRATURE SURVEY

Theft of vehicles is becoming a bigger issue because of the increasing number of vehicles and the high-tech methods used for theft. The use of traditional methods like mechanical locks, steering locks, and simple alarms merely gives limited security as they can all be easily tampered with. This led to making vehicle security systems that are smarter and that come with a

mix of innovative sensors, efficient microcontrollers, and wireless communication technologies.

Among others, researchers have also turned to IoT, GPS, and GSM technologies as their solutions. Ramesh et al. (2021) came up with an IoT-enabled detection system that makes use of a vibration sensor and GPS/GSM modules to detect unauthorized movement of vehicles and send alerts to the vehicle owner's mobile phone immediately through SMS. The system which was designed was both economical and effective in handling the problem at its source.

Patel et al. (2020) designed a GPS/GSM based vehicle tracking system that would notify the owner of the vehicle's location each time suspicious movement was detected. Although good for monitoring, the system was still powerless in halting the vehicle during theft.

Suryavanshi and co-workers (2022) merged the theft detection with remote engine locking using GSM commands, which raised security. The complexity of the whole system was the drawback of this method as it did so in a more effective way than before.

Pushpa and others (2021) suggested a multi-sensor approach with accelerometers, vibration sensors, and GPS, which cut down false alarms and offered precise real-time alerts. Although their system was dependable, it still needed to be calibrated carefully and consumed a little more power than the regular systems.

Another way these studies are good is that they offer great theft detection and vehicle tracking, however, the majority of systems either have high costs because of the usage of multiple sensors or depend on the network availability heavily. Thus, the market is in need of a solution that is cost-effective, reliable, and scalable and at the same time offers good detection accuracy, real-time alerting, and easy installation.

The proposed system is made up of various elements which are Arduino microcontroller, MPU6050 motion sensor, ESP32 for wireless communication, relay, solenoid lock, and Bluetooth module thus it is a low-cost and effective vehicle theft detection system. By employing sensor-based detection, immobilization, and real-time alerts, the system overcomes the disadvantages of current methods and enhances vehicle security.

Many researchers have suggested vehicle theft detection and tracking systems based on GPS and GSM technologies. Moreover, IoT-based systems have been developed which enable users to keep an eye on vehicles via mobile apps from anywhere. Some systems are dedicated to engine immobilization and others are for real-time tracking and alert mechanisms. However, most of the existing solutions come at a high price or are too complex. The proposed system, on the other hand, is simple, cheap, and reliable while still providing basic theft detection and alert functionalities.

From the literature that has been reviewed, it is clear that an efficient vehicle theft detection system has to weigh up and find a good mix of accuracy, cost, real-time communication, and ease of installation as its most important parameters. The suggested system, however, intends to integrate the already verified elements—like vibration or motion detectors, GSM alerting, and optional GPS tracking—into a single, low-cost, and multifunctional system design suitable for mass adoption. The current research, therefore, takes the existing literature's advantages and problems and combines them with an intention to enhance the reliability and accessibility of vehicle security solutions simultaneously.

Author (s)	Technology Used	Key Features	Limitations
Pushpa et al.	Arduino, GPS, GSM, Sensors	Multi-sensor-based theft detection, SMS alert to owner, real-time vehicle tracking	Higher power consumption, limited battery optimization
Ramesh et al.	GPS, GSM	Vehicle location tracking, theft notification via SMS	No vehicle immobilization, delayed response
Kumar et al.	IoT, Sensors	Real-time monitoring using mobile application, cloud data storage	Internet dependency, increased system complexity
Sharma et al.	Motion Sensors, Microcontroller	Early theft detection using vibration analysis	High false alarm rate due to environmental noise
Patel et al.	GPS, GSM, Relay	Engine immobilization with location tracking	High implementation cost, complex circuitry

III COMPONENTS AND METHODOLOGY

1. Arduino

In the project, Arduino serves as the main controller for connecting sensors and actuators. It processes the MPU sensor readings, applies the theft detection logic, and then, depending on the outcome, operates either the relay or the solenoid lock. With its easy programming and reliable communication capabilities, the Arduino makes it possible to integrate and control external modules.

2. MPU Sensor (MPU6050)

The MPU6050 is a sensor that detects motion and vibrations, which comprises a 3-axis accelerometer and a 3-axis gyroscope. It signals the controller when the car stealthily or unauthorized shaken. The detector sends information to the controller for determining theft whether or not.

3. ESP32

The ESP32 is the primary communication module. Its integration of Wi-Fi and Bluetooth within the chip allows for wireless operation and instant data transfer between the operator and the vehicle. Furthermore, the ESP32 can notify

users via the internet of things (IoT) or smartphone apps and let them surveil the car from afar.

4. Bluetooth Module

The Bluetooth interface serves to provide short-range wireless access. It has the functionality of allowing the vehicle owner to remotely activate or deactivate the security system via a mobile app. To ensure security, all unauthorized Bluetooth access attempts are automatically disregarded.

5. 12V Relay Module

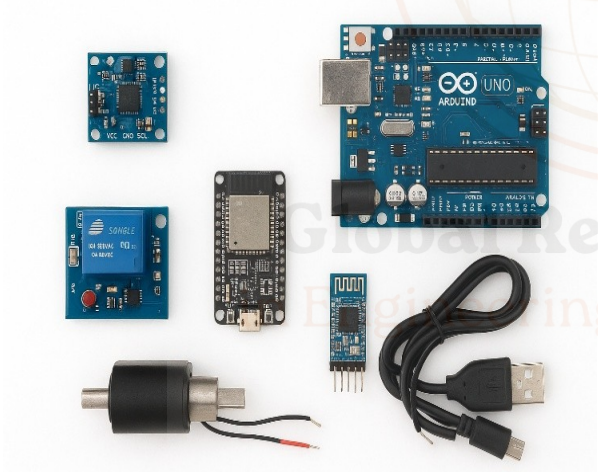
The 12V relay module is functioning as a switching device to manage the power-hungry components. It prevents the low-voltage control signals from being disturbed by the high-voltage loads and is utilized to either turn the solenoid lock or the engine control system on or off.

6. Solenoid Lock

The solenoid is used as a security system and the mechanism for immobilization. A theft attempt triggers the sensor, and then the relay activates the solenoid to lock or disable the car system so that the car cannot be moved.

7. API Key Generation

The API keys are obtained from online platforms like Firebase, Blynk, or ThingSpeak. With the help of these keys, the communication between the ESP32 and the cloud servers is made secure. The API key acts as a filter that allows only authorized users to access data.



IV SYSTEM DESIGN

The approach of the suggested vehicle theft detection with alarm system concentrates on building an efficient and economical security system employing embedded systems along with wireless communication technologies. The system works by sensing any unauthorized access or movement of the vehicle, raising an alarm and sending the vehicle owner real-time information as a notification.

1. System Design

The whole system is made up of the following components the microcontroller connected to the vibration or motion sensor, the GSM module, the GPS module, and the alarm unit. The microcontroller serves as the central processing unit that constantly oversees the flow of data from the sensors and the entire system functionalities.

2. Theft Detection Mechanism

A vehicle's unauthorized movement is monitored by a vibration or motion sensor installed in it. The sensor constantly detects vibrations and transmits signals to the microcontroller. A threshold value is decided to separate the normal vehicle vibrations from the unauthorized ones. The exceeding of the sensed value over the threshold is the sign of a theft attempt.

3. Alarm Activation

As soon as the theft is detected, the microcontroller triggers the alarm system without delay. The loud sound produced by the buzzer or siren is meant to attract the attention of people nearby and at the same time, scare off the thief.

4. Alert Notification

At the same time, the GSM module sends an SMS alert to the vehicle owner's registered mobile number. The alert message not only warns the owner about the theft attempt but also provides continuous updates.

5. Vehicle Location Tracking

The GPS module gives the vehicle's current location in terms of latitude and longitude. These coordinates can be found in the SMS alert or as a link to a map, which makes it easy for the owner to track the vehicle location.

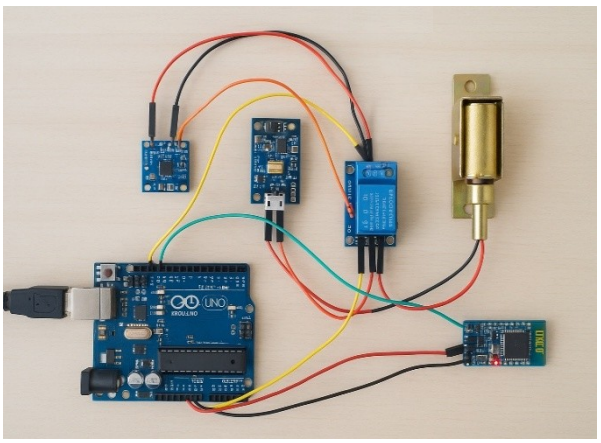
6. Software Implementation

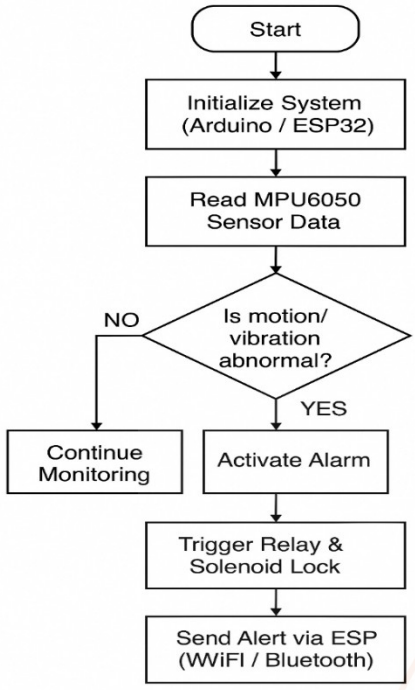
The embedded C or Arduino programming is used to create the system software. The program is designed to read the sensor's data continuously, carry out processing of the data, and in turn, control alarm and communication modules. The methodology of error handling and delays is employed to reduce the occurrence of false alarms.

7. Testing and Validation

The system goes through a number of scenarios including normal vibration, accidental shocks, and actual theft situations.

V FLOWCHART & DIAGRAMS





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VI CONCLUSION

A vehicle theft detection system using Arduino, MPU6050 motion sensor, ESP32, Bluetooth module, 12V relay, and solenoid lock was built and evaluated to make a successful proposal. The MPU6050 sensor performed well in recognizing the illegal access of the vehicle by detecting the wrong motion and vibration indoors. An alarm was triggered immediately when the preset limit was crossed, and the relay-connected solenoid lock was activated to make the vehicle immobile.

The ESP32 module, with a secure API key, was really good at alerting the user via Wi-Fi in real time. Bluetooth communication was used so that the authorized user could easily and reliably switch the system on and off within a short distance. The relay module worked without problems in switching high-voltage components and at the same time keeping low-voltage control circuitry unaffected.

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