Smart Vehicle Anti-Theft Detection System using ESP32, GPS, and Telegram Bot without GSM

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***Abstract*—Vehicle theft continues to be a serious issue due to the limitations of traditional security systems. This paper presents a smart vehicle anti-theft detection system using the ESP32 microcontroller, GPS module, and Telegram Bot without relying on GSM communication. The system uses a keypad for password-based authentication to control the engine ignition. When the correct password is entered, the relay module is activated, allowing the engine to start. If an incorrect password is entered, the system immediately disables the engine, activates a buzzer alarm, retrieves real-time location data using the GPS module, and sends an alert message with location details to the vehicle owner through a Telegram Bot using Wi-Fi. By eliminating GSM modules, the system reduces cost and improves communication speed. The proposed system offers a reliable and efficient IoT-based solution for vehicle security.**

***Index Terms*—ESP32, Vehicle Security, GPS Tracking, Telegram Bot, IoT, Anti-Theft System**

I. INTRODUCTION

In recent years, the rapid growth in vehicle ownership has led to a significant increase in vehicle theft incidents across both urban and rural areas. Despite the availability of various security mechanisms, many vehicles still rely on conventional systems such as mechanical locks and basic alarm systems, which can be easily bypassed by modern theft techniques. As a result, there is a growing need for more advanced, reliable, and intelligent vehicle security solutions.

Traditional electronic anti-theft systems often use Global System for Mobile Communication (GSM) technology to send alert messages to the vehicle owner. While these systems provide remote notification capabilities, they suffer from several limitations, including communication delays, dependency on cellular network availability, and additional operational costs associated with SMS services [5]. Moreover, GSM-based systems typically require extra hardware modules, which increase the complexity and cost of implementation.

With the advancement of the Internet of Things (IoT), modern microcontrollers such as the ESP32 have emerged as powerful alternatives for building smart and connected systems. The ESP32 offers built-in Wi-Fi and Bluetooth capabilities, enabling seamless internet-based communication without the need for external communication modules [1]. This significantly reduces both hardware complexity and overall system cost while improving performance and reliability.

In addition to communication, real-time location tracking has become an essential feature in vehicle security systems. Global Positioning System (GPS) modules, such as the NEO-6M, are widely used to provide accurate geographical coordinates of the vehicle [2]. Integrating GPS with IoT-enabled controllers allows vehicle owners to monitor their vehicle's location in real time, especially during unauthorized access or theft attempts.

Another important aspect of vehicle security is user authentication. Password-based authentication using a keypad provides a simple yet effective method to ensure that only authorized users can operate the vehicle. When combined with automated control mechanisms, such as relay modules for engine

ignition, this approach enhances system security by preventing unauthorized engine access.

In this work, a smart vehicle anti-theft detection system is proposed that integrates ESP32, GPS module, and Telegram Bot for real-time monitoring and alerting. Unlike conventional systems, the proposed design eliminates the need for GSM communication and instead utilizes Wi-Fi to send instant notifications through a Telegram Bot [3]. Telegram provides a fast, secure, and reliable platform for delivering alert messages, including location details, directly to the user's smartphone.

The system operates by verifying a password entered through a keypad. If the password is correct, the vehicle engine is allowed to start. However, if an incorrect password is entered, the system immediately disables the engine, activates a buzzer alarm, retrieves the current GPS location, and sends an alert message with location coordinates to the vehicle owner. This real-time response mechanism ensures quick detection and action in case of unauthorized access.

Overall, the proposed system aims to provide a cost-effective, efficient, and user-friendly solution for vehicle security by leveraging IoT technologies. It offers improved response time, reduced system complexity, and enhanced reliability compared to traditional GSM-based approaches, making it suitable for modern smart vehicle applications.

II. LITERATURE SURVEY

A wide range of vehicle anti-theft systems have been proposed to improve vehicle security and reduce theft incidents. These systems differ in terms of technology, cost, and efficiency.

Early vehicle security systems were mainly based on mechanical locks and basic alarm systems. Although these systems are simple and low-cost, they do not provide remote monitoring or intelligent response mechanisms.

To overcome these limitations, GSM-based vehicle security systems were introduced. These systems send SMS alerts to the vehicle owner during unauthorized access. However, GSM-based systems suffer from communication delays and require additional operational cost due to SIM usage and message charges [5].

To enhance tracking capabilities, GPS modules were integrated with GSM systems. These systems provide real-time location information along with alerts. However, they increase hardware complexity, power consumption, and cost due to the use of both GPS and GSM modules [2].

RFID-based security systems were also developed to provide authentication. These systems allow access only when a valid RFID tag is detected. While they improve access control, they do not support real-time tracking or remote alert systems.

With the advancement of IoT technology, modern systems now use microcontrollers like ESP32, which have built-in Wi-Fi capability. These systems eliminate the need for GSM modules and provide faster and more reliable communication over the internet [1].

In recent developments, messaging platforms such as Telegram are used for sending alerts. Telegram Bot API allows real-time communication between the system and the user, enabling instant delivery of alert messages along with location data. Compared to SMS-based systems, this approach is faster, cost-effective, and more reliable [3].

The system proposed in this paper combines ESP32, GPS, and Telegram Bot to create an efficient vehicle anti-theft system. It eliminates GSM dependency while providing real-time tracking and instant alert notification.

III. PROBLEM STATEMENT

Vehicle theft remains a major concern due to the increasing number of vehicles and the limitations of existing security systems. Traditional systems such as mechanical locks and alarm-based mechanisms are no longer sufficient, as they can be easily bypassed and do not provide remote monitoring capabilities.

Many modern vehicle security systems rely on GSM technology to send alert messages to the owner. However, these systems suffer from several drawbacks, including communication delays, dependency on cellular networks, and additional operational costs associated with SMS services. Furthermore, GSM-based systems increase the overall hardware complexity and power consumption.

Another limitation of existing systems is the lack of real-time tracking and immediate response during

unauthorized access. In many cases, the vehicle owner receives delayed information, reducing the chances of quick action. Additionally, some systems do not include proper authentication mechanisms, making them vulnerable to unauthorized usage.

Therefore, there is a need for a cost-effective, reliable, and fast vehicle anti-theft system that can provide secure authentication, real-time location tracking, and instant alert notifications without depending on GSM technology.

IV. OBJECTIVE

The main objectives of the proposed system are as follows:

- To design and develop a smart vehicle anti-theft system using the ESP32 microcontroller as the main controller.
- To eliminate the dependency on GSM modules by using Wi-Fi for communication.
- To implement a secure password-based authentication mechanism using a keypad.
- To control the vehicle engine using a relay module based on authentication.
- To integrate a GPS module for real-time location tracking of the vehicle.
- To send instant alert notifications, including location details, to the vehicle owner using a Telegram Bot.
- To provide an audible alert using a buzzer in case of unauthorized access.
- To develop a low-cost, efficient, and easy-to-implement IoT-based vehicle security system.

V. SYSTEM OVERVIEW

The proposed Smart Vehicle Anti-Theft Detection System is developed using ESP32 as the central controller. It integrates authentication, engine control, real-time tracking, and alert communication into a single system. The system uses Wi-Fi instead of GSM, making it faster, cost-effective, and more efficient.

5.1 System Components Overview

The system consists of several hardware components connected to the ESP32. Each component performs a specific function:

- ESP32: Main controller that processes input and controls all operations
- Keypad: Used to enter the password
- Relay Module: Controls engine ON/OFF
- GPS Module: Provides real-time location
- Buzzer: Generates alert sound
- Power Supply: Provides required voltage

5.2 Hardware Requirements

The hardware components required for the system are listed below:

- ESP32 Microcontroller
- GPS Module (NEO-6M)
- 4×4 Matrix Keypad
- Relay Module (1-channel)
- Buzzer
- Connecting wires
- 5V Power Supply / Battery

These components are selected to ensure low cost, easy implementation, and reliable performance.

5.3 Software Requirements

The software tools and libraries used in this system include:

- Arduino IDE: Used for coding and uploading program to ESP32
- ESP32 Board Package: Enables ESP32 programming
- Wi-Fi Library: For internet connectivity
- TinyGPS++ Library: For processing GPS data
- Telegram Bot API: For sending alert messages
- Embedded C: Programming language used

5.4 Block Diagram

The block diagram represents the overall working of the system.

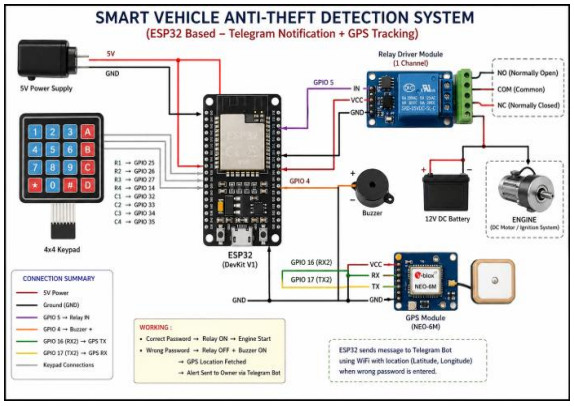


Fig. 1: Block Diagram of Smart Vehicle Anti-Theft System

- The keypad acts as the input device where the user enters the password
- The ESP32 processes the input and controls the system
- The relay module controls the engine ignition
- The buzzer provides an alert signal
- The GPS module sends location data to ESP32
- The Wi-Fi module (ESP32 built-in) sends data to the Telegram Bot
- The block diagram clearly shows the flow of data from input to output and communication.

5.5 Circuit Diagram

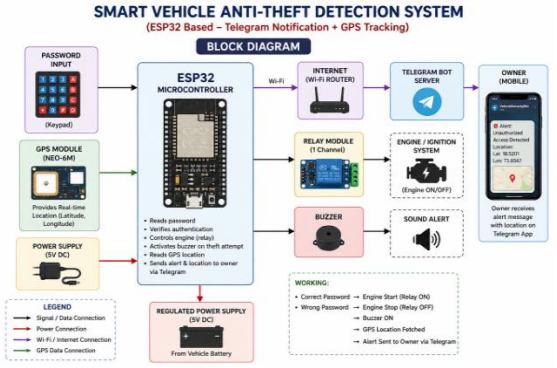


Fig. 2: Circuit Diagram of Smart Vehicle Anti-Theft Detection System

- The keypad is connected to GPIO pins of ESP32 for password input
- The relay module is connected to a digital output pin to control the engine
- The buzzer is connected to another GPIO pin for alert indication
- The GPS module is connected via UART communication (TX → RX, RX → TX)
- The power supply provides required voltage to all components
- The relay controls the vehicle battery, which ultimately controls the engine

5.6 Communication Mechanism

The system uses Wi-Fi communication through ESP32. It connects to the internet and communicates with the Telegram Bot.

When an unauthorized access is detected, the system sends an alert message with GPS location directly to the owner's mobile phone. This method is faster and more reliable compared to GSM-based SMS systems.

5.7 Authentication and Engine Control

The system uses a password-based authentication mechanism:

- If the password is correct → Relay ON → Engine starts
- If the password is incorrect → Relay OFF → Engine disabled

This ensures that only authorized users can operate the vehicle.

5.8 Alert and Tracking System

In case of unauthorized access:

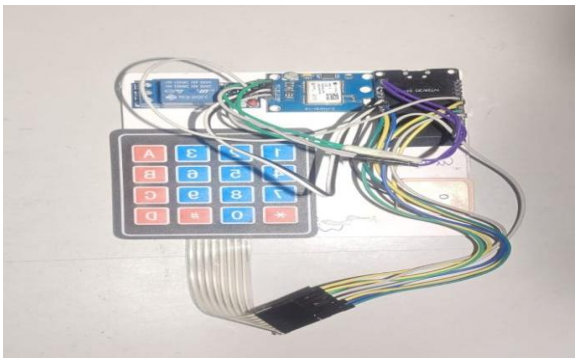
- Buzzer turns ON
- GPS retrieves location
- ESP32 sends alert message via Telegram

This provides real-time tracking and immediate notification to the vehicle owner.

5.9 Overall Working Summary

- System connects to Wi-Fi
- User enters password
- Correct password → Engine ON
- Wrong password →
  - Engine OFF
  - Buzzer ON
  - GPS location fetched
  - Telegram alert sent

5.10 Hardware implementation:



VI. FUTURE SCOPE

The proposed system can be further improved by integrating a mobile application for easier monitoring and control. Advanced authentication methods such as fingerprint or facial recognition can enhance security. Features like geo-fencing, cloud data

storage, and remote engine control can also be added to make the system more robust and suitable for real-world smart vehicle applications.

VII. CONCLUSION

This paper presented a Smart Vehicle Anti-Theft Detection System using ESP32, GPS, and Telegram Bot without relying on GSM communication. The system effectively addresses the limitations of traditional vehicle security systems by providing a cost-effective, fast, and reliable solution.

The use of ESP32 with built-in Wi-Fi eliminates the need for GSM modules, reducing both hardware complexity and operational cost. The integration of password-based authentication ensures that only authorized users can access the vehicle. In case of unauthorized access, the system responds immediately by disabling the engine, activating a buzzer, retrieving the vehicle's location through the GPS module, and sending an alert message to the owner via Telegram.

The results demonstrate that the system performs efficiently, providing real-time tracking and instant notification. Overall, the proposed solution offers a practical and modern approach to vehicle security and can be further enhanced with advanced features for future applications.

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