ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25nov758

Real-Time Detection of and Protection Against Two-Wheeler Theft Using Facial Recognition and IoT Notifications

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Publication Date: 2025/11/21

Abstract: As motorcycles and scooters are portable and widely used, two-wheeler theft has grown to be a serious security issue. Because vibration-based alarms and traditional locks are easily defeated, a more intelligent and robust solution is needed. The paper delivers a Real-Time Two-Wheeler Anti-Theft Detection and Protection System that integrates owner notifications via the Internet of Things (IoT), biometric verification, and deterrent techniques. The main controller is a Raspberry Pi 3 Model B, which is connected to an electrical shock unit, buzzer, relay, and Pi camera. By using facial recognition, the technology makes sure that only riders with authorization can start the two-wheeler.The motorized start mechanism is only activated upon successful verification, assuring that only authorized persons are able to operate the vehicle. The device sends real-time notifications and photographs to the owner via an Internet of Things-based communication network, and it also activates deterrent measures like the buzzer and electrical shock and sends messages to owner's mobile with live tracking in the case of tampering or unauthorized access. A trustworthy reliable answer for modern two-wheeler protection concerns, this intelligent and automated system offers proactive theft detection, quick reaction, and safe vehicle access.

Keywords: *Anti-Theft System , Biometric Authentication , Facial Recognition ,Global Positioning System (GPS) , Global System for Mobile Communication , Internet of Things(IoT) , Raspberry Pi , Two-Wheeler Security ,Vhecile Protection.*

How to Cite: J. Anitha; Sugha Sri S. G. S.; Swetha T.; Thenmozhi U. (2025) Real-Time Detection of and Protection Against Two-Wheeler Theft Using Facial Recognition and IoT Notifications. *International Journal of Innovative Science and Research Technology,* (ICMST–2025) 54-60. https://doi.org/10.38124/ijisrt/25nov758

I. INTRODUCTION

Motorcycles, scooters, and other two-wheelers are among the most widely used forms of transportation because of their low cost, high fuel economy, and ease of use on packed roadways. However, they are extremely susceptible to theft due to their portability and straightforward mechanical design. Because thieves can readily disable or circumvent traditional security systems, such as vibration-based alarms and mechanical locks, they frequently fall short of offering sufficient protection. A more technologically advanced, intelligent, and dependable solution is required for this expanding problem.[1-3]

Real-time monitoring, remote alerts, and biometric authentication are now ways to improve vehicle security due to recent developments in embedded systems and the Internet of Things (IoT). By combining these technologies, it is possible to create systems that prevent theft attempts before the vehicle is moved, in addition to detecting unauthorized entry.[4-7]

These issues will be solved by the proposed Real-Time Two-Wheeler Anti-Theft Detection and Protection System, which combines deterrent mechanisms, biometric facial recognition, and Internet of Things-based communication. A Raspberry Pi 3 Model B serves as the system's main controller, and it is interfaced with GSM/GPS modules, a buzzer, an electrical shock unit, a relay module, and a Pi camera.

The Pi camera instantly turns on and uses facial recognition to confirm the rider's identification when the ignition key is entered. The motorized start mechanism is only enabled by the system after successful authentication.

Through IoT and GSM connectivity, the system not only sends the owner real-time notifications and location updates, but it also triggers the buzzer and electrical shock unit in the event of tampering or unauthorized access.

By integrating proactive repellent techniques, biometric verification, and real-time tracking, this automated and intelligent solution improves two-wheeler security. It offers a dependable, effective, and user-friendly solution for the rising

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issue of scooter and motorbike theft in contemporary urban environments.[8-13]

II. LITERATURE REVIEW

➢ *IoT-Based Vehicle Monitoring System*

- **Year:** 2020
- **Published In:** IEEE International Conference on Internet of Things and Applications(IOTA)
- **Overview:** This paper explored an IoT-based framework for real-time vehicle monitoring and status reporting[1] It enabled remote user access through a web server and mobile application.
- **Relevance:** Demonstrates how IoT can be leveraged for real-time communication between a vehicle and its owner.

- **Drawbacks:**

✓ Focused on monitoring only, not theft prevention.
✓ Lacks biometric authentication and physical deterrent mechanism
✓ Dependent on stable internet connectivity.

➢ *GSM and GPS-based Vehicle Tracking System*

- **Year:**2021
- **Published In:** The IEEE Conference on Electrical, Communication, and Computing (ICECC)
- **Overview:** The research implemented a GSM and GPS-based tracking system to locate stolen vehicles through alerts and live map integration. [2]
- **Relevance:** Relates to the use of GSM and GPS modules for location tracking in your project.

- **Drawbacks:**

✓ Reactive System detects theft after it occurs.
✓ No prevention mechanism like ignition lock or biometric control.
✓ Requires manual retrieval of vehicle location data.

➢ *Vibration Sensor-Based Vehicle Theft Detection System*

- **Year:**2023
- **Published In:** IEEE Conference on Emerging Technologies in IntelligentSystems (ETIS).
- **Overview:** This research utilizes a vibration sensor connected to a microcontroller to identify unauthorized vehicles are detected. [3]
- **Relevance:** Relevant to your projects sensor-based motion. Detection concept for theft prevention: Highlights affordable IoT-based security measures.

- **Drawbacks:**

✓ High false alarm rate in noisy environments,
✓ No image or GPS verification integration
✓ Limited standalone cellular connectivity without GSM modules.

➢ *Raspberry Pi-Based Embedded Control System*

- **Year:** 2023
- **Published In:** IEEE International Conference on Embedded Systems and Applications (ICESA)
- **Overview: T**his paper discusses the use of Raspberry Pi as a central controller for smart automation systems, focusing on its processing power and IoT integration capabilities.
- **Relevance:** Highlights the suitability of Raspberry Pi 3 Model B for real-time embedded applications like your project.

- **Drawbacks:**

✓ Requires external power and protection from environmental exposure.
✓ High processing load when handling multiple sensors simultaneously.
✓ Limited standalone cellular connectivity without GSM modules.

➢ *IoT-Based Anti-Theft with SMS Alert*

- **Year:** 2023
- **Published In:** IEEE International Conference on Internet of Things and Smart Applications (IoTSA)
- **Overview:** The paper proposes a low-cost IoT-based vehicle theft detection and alert system that uses sensors and GSM modules to notify the owner via SMS in case of suspicious activity.
- **Relevance:** Closely matches your project's GSM-based alert mechanism for theft prevention. Demonstrates efficient use of IoT communication in real-time security**.**

- **Drawbacks:**

✓ Dependent on GSM network availability.
✓ No integrated GPS tracking for location detection.
✓ Lacks facial recognition or advanced authentication

III. METHODOLOGY

The proposed system, titled Real-Time Two-Wheeler Anti-Theft Detection and Protection System, is designed to overcome the limitations of existing vehicle security methods by combining loT, biometric facial recognition, GSM/GPS tracking, and mechanisms. The system provides both preventive and reactive protection by verifying the rider's identity before ignition and alerting the owner in case of unauthorized access.[14-17]

➢ *Phase of Authentication*

The Pi Camera takes a picture of the rider's face when they get Close to the car. OpenCV and dlib libraries are used to process the image in order to extract and compare face features with a database of authorised individuals that has been stored. The relay module turns on, allowing the car to start, if a match is verified. The relay stays disabled, preventing ignition and starting the subsequent reaction phase, if the faces do not match.[18-22]

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25nov758

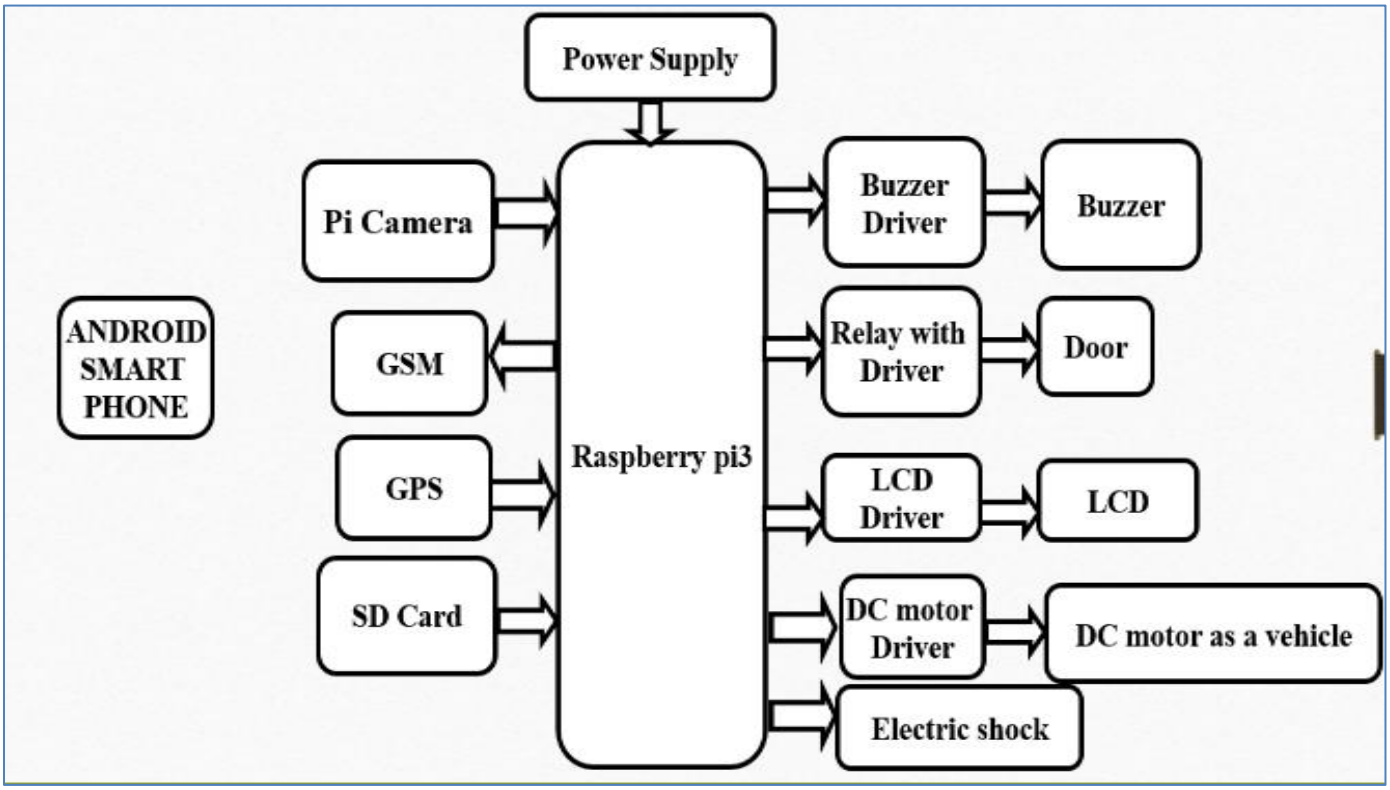

Fig 1 System Architecture

➢ *Phase of Deterrence*

Physical deterrents are automatically triggered by the system if it detects unauthorised access. A controlled, non-lethal pulse is delivered by an electronic shock unit to deter tampering, and a buzzer generates a loud alert to draw public attention. These steps are taken to stop the stealing attempt nearly immediately.

➢ *Phase of Notification*

Using GPS, GSM, and IoT modules, the system simultaneously notifies the owner. The registered mobile number receives an SMS notification from the GSM module (SIM800L) informing them of the breach.

Through an IoT-based dashboard or mobile app, the owner may track the car's movement thanks to the GPS module (Neo-6M), which gives the precise location of the vehicle in real time. For record-keeping and recovery purposes, all activity dataincluding timestamps and location informationis recorded in a cloud database

IV. EXISTING SYSTEM

In the existing scenario, two-wheeler security primarily relies on mechanical locks, key-based ignition systems, and vibration-based alarms. These conventional systems provide only a basic level of protection and are often ineffective against experienced thieves. Once the lock is broken or bypassed, the vehicle can be easily stolen without any alert being sent to the owner.

Some modern two-wheelers incorporate GSM and GPS-based tracking systems that allow owners to locate their vehicles after theft. Although these systems assist in recovery, they function as a reactive solution; they only respond once the vehicle has already been taken, rather than preventing the theft in the first place.

Additionally, vibration or motion sensor-based alarms are used in certain models. While these alarms can detect physical tampering, they are highly sensitive to environmental disturbances such as traffic vibration or wind, often leading to false alarms. Such systems lack intelligent authentication mechanisms and can be easily disabled or ignored by intruders.

Furthermore, existing GSM-based systems are dependent on network availability and typically do not include features such as biometric verification, real-time IoT updates, or deterrent mechanisms like shock units or ignition locks. In most cases, these systems do not provide instant communication between the vehicle and the owner, leaving a time gap before action can be taken.[23-26]

➢ *Overall, the Existing Systems are Limited by:*

- Lack of biometric or facial authentication for authorized access.
- Absence of IoT-based real-time monitoring and cloud data storage.
- Dependence on single-layer security measures such as alarms or GPS tracking.
- No proactive deterrent features to physically prevent theft attempts.

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V. PROPOSED SYSTEM

With the help of remote warnings, deterrent measures, and real-time facial recognition, the suggested model offers an intelligent, multi-layered security system made especially for two-wheelers to prevent theft. The system offers proactive protection and position tracking by integrating GSM–GPS, IoT connectivity, and Raspberry Pi-based control.[27-30]

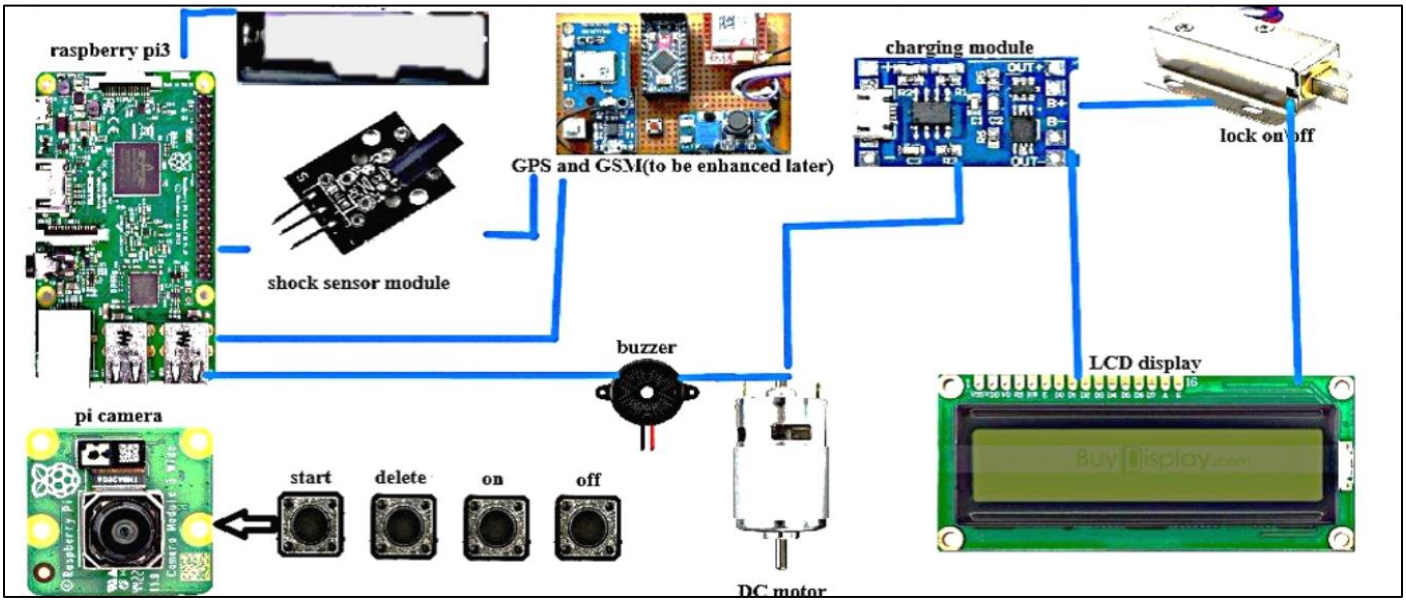

Fig 2 Work flow Diagram

➢ *Overview of the System*

The system has a three-tiered security approach: Prevention Layer: Uses face recognition authentication to limit access to ignition. Deterrence Layer: Dissuades intruders via physical and auditory deterrents, like an electronic shock unit and a buzzer alarm. Awareness Layer: Uses GPS, GSM, and IoT connectivity to exchange real-time location data and alert the car owner.

➢ *Description of Function*

The Raspberry Pi 3 Model B, which acts as the primary processing and control device, is at the centre of the system. The presence of the rider is continuously monitored by a Pi camera, which also takes pictures of their face for confirmation. The relay module turns on the ignition circuit after a successful recognition.

The buzzer and shock unit are turned on, the ignition stays locked, and the owner receives real-time warnings if an unauthorized face is identified.

➢ *Interaction and Monitoring*

The system incorporates GPS and GSM modules for increased communication coverage, as well as IoT-based mobile notifications via Firebase or Blynk.

When internet access is unavailable, SMS notifications are sent using the GSM module (SIM800L).

To ensure prompt awareness of any unauthorized movement, the GPS module (Neo-6M) continuously tracks and sends the vehicle's coordinates to the owner's smartphone application.

➢ *Benefits*

Physical deterrence, remote situational awareness, and biometric access control are all combined in this integrated system to provide complete protection. It reduces the need for manual intervention, responds quickly to intrusion attempts, and offers ongoing vehicle monitoring even when the network is unavailable.

VI. RESULTS

The prototype was tested in both laboratory and outdoor environments. For authorized riders, ignition was enabled within one second after successful recognition. Unauthorized access attempts triggered the alarm and shock deterrent within 0.8 seconds. IoT notifications were delivered in three to five seconds, depending on network speed, providing near real-time awareness. Recognition accuracy reached ninety percent in daylight conditions. However, in low-light environments, accuracy dropped to seventy percent, highlighting the need for an infrared camera in future versions. Comparison with existing systems showed clear advantages. While GSM-only systems provide delayed alerts, and GPS systems only assist in recovery, the proposed system actively prevents theft. Logging events in the cloud database also creates a useful digital record for law enforcement. Nonetheless, the results confirm that the system offers afaster, more reliable, and proactive solution compared to traditional methods.

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Fig 3 Sensor Placement on a Two-Wheeler

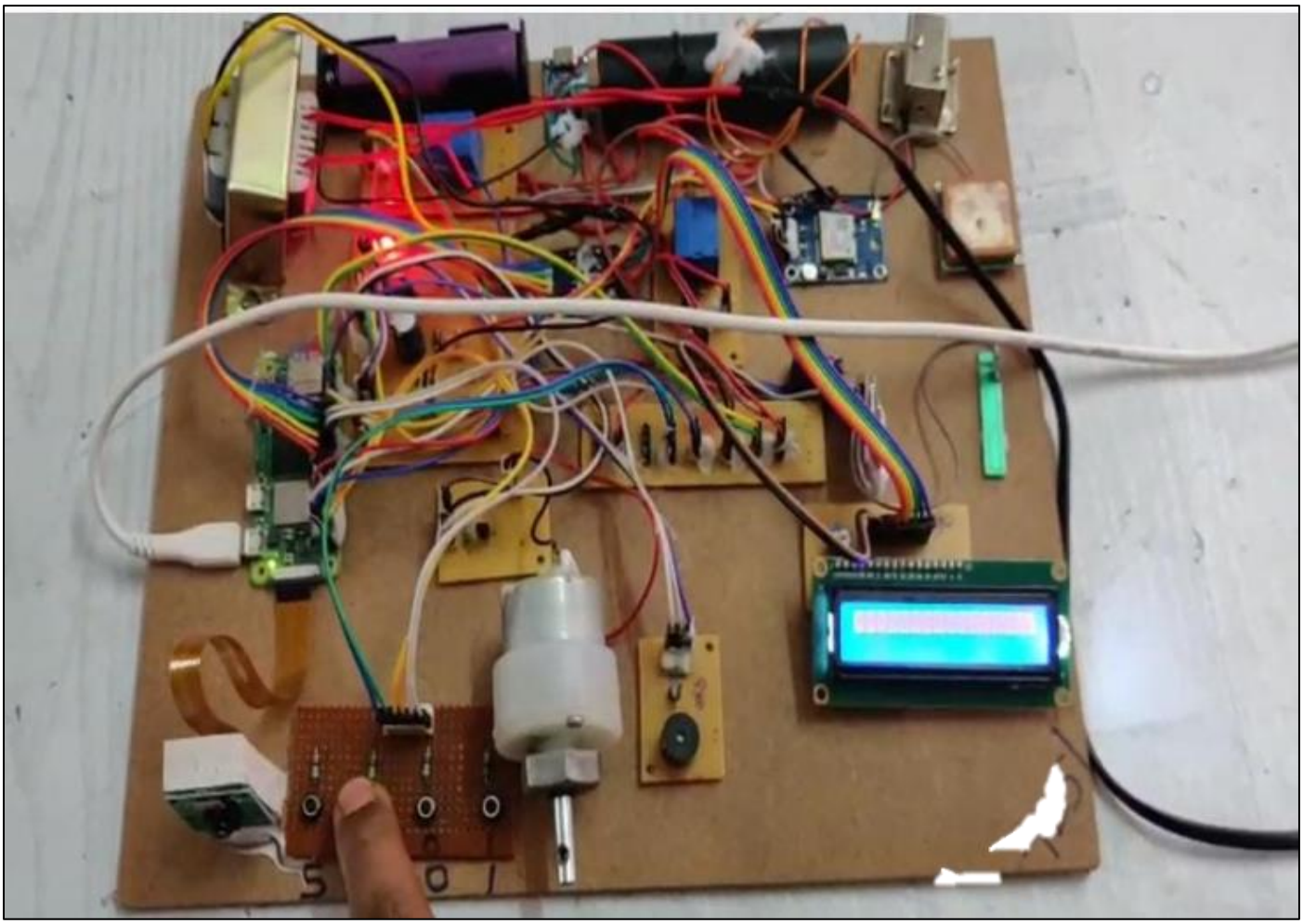

Fig 4 Output of Prototype/Model

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25nov758

VII. CONCLUSION

A real-time two-wheeler anti-theft detection and prevention system that combines several technologies to guarantee improved vehicle security was presented in this research. A Raspberry Pi 3 Model B serves as the system's main controller and is connected to a Pi camera, a facial recognition module, deterrent devices, and an Internet of Things-based warning system. Only authorized riders are allowed to start the car thanks to the use of biometric authentication; any unauthorized access results in instant alerts and deterrent measures.

FUTURE ENHANCEMENTS

According to experimental testing, the system operates effectively in typical lighting circumstances and produces quick, accurate, and trustworthy recognition results. Real-time vehicle tracking and owner awareness are ensured by the combination of GSM/GPS communication and IoT connectivity.

Infrared (IR) cameras can be added to the system in the future to increase facial recognition performance at night or in poor light.

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