Smart Bike RFID Enabled Engine Self Start and Location Tracking

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***Abstract*—With the introduction of the intelligent age of technology, automobile security systems have to evolve to provide both prevention and quick response capabilities. Two-wheeler theft remains a widespread problem in most countries with the absence of advanced protection technologies. This paper proposes an intelligent bike system with IoT, RFID authentication, and GPS tracking to enhance the security of motorcycles. The system allows the engine to start only after successful authentication of an RFID card, thereby making it impossible for other individuals to drive the vehicle. The system also tracks the location of the bike in real-time using a highly accurate NEO-M8N GPS module, enabling the owner to track or locate the motorcycle. The system proposed uses a microcontroller like Arduino or ESP32 to process the input and control the output signals. The solution integrates RFID and GPS such that it is low-cost, scalable, and portable to be implemented in most private two-wheelers. Test data indicates that the system provides an instant RFID response, accurate location tracking, and improved performance in various operating conditions. Besides enhancing the security of vehicles, the solution not only promotes the application of IoT technology in ordinary transportation but also enables it to be enhanced in the future through integration of mobile applications,GSM-based SMS support, and geofencing capability.**

Keywords—RFID authentication ,GPS tracking, two-wheeler security, motorcycle theft prevention, NEO-M8N GPS module, real-time location tracking, Microcontrollers.

I. Introduction

The majority of the transport media in the cities and countryside are the two-wheelers. They are light and compact in size and lack a good security system and thus are prone to be stolen. In the cities, scores of the two-wheelers are being stolen each month, and very few of them are recovered.Old security systems like manual locks, handle locks, or simple alarm systems no longer func- tion and are easily deceived. The old systems can be monitored remotely, provide no real-time alerts, lack access control, and thus can handle security problems of the era. What we need is an intelligent, quick, and more efficient security system.Internet of Things (IoT) has revolutionized many industries by enabling devices to communicate with one another, perceive the environment, and respond autonomously.

IoT has brought smart features to vehicles, such as vehicle tracking, remote fault detection, and intelligent safety systems. Appli- cation of these technologies in two-wheeler security can offer efficient, real-time, and remotely operated security solutions. The intelligent bike system is going to utilizean RFID module and a GPS module such that we can implement a two-part security system:RFID Authentication: Only autho- rized users can unlock the bike with an authorized RFID tag.Location Tracking: GPS continues to track where the bike is and therefore can locate it in real-time and retrieve it if stolen. This project is an economical and innovative solution that can be used in any two-wheeler without modifying its core mechanical parts.To design a safe self-start system with RFID authentication.In order to employ an effective GPS tracking system using the NEO-M8N module.In anticipation of real-time monitoring and for potential integration into IoT dashboards or mobile applications. So that an energy- conscious and easy-to-install system could be developed for mass utilization.Section II lists recent surveys regarding this project.Section III addresses the proposed system regarding to this project.Section IV outlines the methodology that how this system is proposed.Section V lists the design of the modules for my project.Section VI & VII concludes the result, discussion,conclusions and areas for future improvement. Section VIII ends with images of GPS Tracking Dashboards.

II. Literature survey

The Internet of Things (IoT) transformed transport by al- lowing cars to interact with digital networks in real-time.Smart cars are able to utilize sensors, wireless devices, and onboard systems to engage with the world and users. IoT for motorcy- cles is mainly focused on safety, anti-theft, and instant access to information. This system is great for creating a smart bike that gets simpler and safer for users. [1]

Radio Frequency Identification (RFID) is used extensively in secure access systems due to the fact that it is dependable and power-efficient. Vehicle-mounted RFID readers and tags

assist in identifying the users and enable keyless entry or engine starting. It has been proved through research that RFID avoids tampering, and therefore it is a suitable alternative to physical keys. Practical uses have demonstrated that RFID ignition systems are highly efficient in motorbikes in an effort to introduce more security.[2]

Auto-start of the engine in cars with electronic parts is very common today. Microcontrollers like Arduino and NodeMCU are utilized for the reading of RFID signals and switching on the relay to auto-start the engine. This is used in organizations and companies, where the engine auto-starts when the car is recognized. This avoids the use of a regular key and is under smart car technology today. [3]

GPS for Real-Time Location Tracking GPS modules such as the NEO-M8N play a vital role in location identification. GPS modules give precise coordinates, which may be transmitted via GSM or IoT to cloud servers or mobile applications. GPS is useful on smart bicycles to alert for theft and monitor them, particularly in case someone steals the bicycle without a person's knowledge. GPS systems prevent car theft because prior research has proven. [4]

Smart car anti-theft systems utilize hardware and software to identify and prevent unauthorized driving. Methods like geofencing, motion detection, and engine locking are widely discussed in research. In RFID systems, the engine can be stopped or not allowed to be started if the tag does not correspond to the stored data. Smart car anti-theft systems help in avoiding theft and making easier recovery of the vehicles.[5]

Combining RFID and GPS in Motorcycle Security Combining RFID and GPS constitutes a layered security. RFID will permit only an authorized person to initiate the engine, whereas GPS will allow the owner to be aware of the location of the bike at all times. Research has established that utilizing both offers more security than the utilization of a single system. Instances have also shown that GPS alert of a mobile application upon an attempt to access it by an unauthorized person can facilitate faster response and recovery. [6]

Arduino Uno, ESP32, and Raspberry Pi are tiny computers that are commonly employed in smart car systems that are Internet-connected. They are RFID, GPS, and wireless technology compatible and can be employed for field and test purposes. These approaches have proven to be effective in linking these devices to control the ignition and transmit GPS information to a dashboard or cloud. The open source nature of these controllers ensures that development is quicker. Integrating Cloud and Mobile Applications Mobile apps and cloud-based systems are of high value for remote monitoring and control of IoT-based car projects. Based on research, it has been revealed that Firebase, Blynk, and basic Android apps are extensively used for location retrieval and notification sending. Using such apps in your project would enable users to show the bike's location, send notifications, and even remote-switch off the engine. It provides real-time convenience and safety.[7]

There are advantages, but RFID and GPS-based cycling systems are not free of some disadvantages. Interference in signals, reliability of GPS in city areas, and power management are some of them. Security threats like RFID spoofing or GPS jamming require protection using encryption and secure coding. Research validates that the inclusion of backup systems and secure communication channels can prevent such attacks.[8]

Thus, there is sufficient data to infer that RFID is suitable for secure access, GPS is suitable for tracking, and microcontrollers aid in system integration. These technologies combined provide a good foundation to create a smart bike system. Your project satisfies current directions in research and satisfies the requirement of two-wheeler anti-theft systems. Future technologies in IoT, embedded systems, and wireless communication will further broaden these applications soon.[9]

III. PROPOSED SYSTEM

The system suggests developing a smart bike frame that increases security and convenience a lot by applying IoT technologies. The system will authenticate a user through RFID technology to ensure that access is granted to authorized users only in order to start the bike. Scanning an RFID tag, the microcontroller will energize a relay circuit such that the motor will automatically start without a physical key. The contactless system not only provides safety but also convenience of use, particularly in the urban area.

GPS-Based Location Tracking To deter theft and enable real-time tracking, the system utilizes a GPS module known as the NEO-M8N, which is renowned for providing precise location information. The GPS module constantly tracks the bike's location and sends the coordinates to a mobile app through Wi-Fi or a GSM module. Whenever any unauthorized access is gained or any abnormal movement is sensed, the system will report to the user, and he/she will be able to track the instance and take action accordingly. Location data will be saved, hence route tracing back whenever needed.

System Control and Integration The master control will be handled by a microcontroller like Arduino Uno or NodeMCU and will directly communicate with the RFID reader and GPS module. The controller will be used for the processing of RFID data, ignition circuit, and communication with the tracking interface. A web-based application or a mobile application will be used to display real-time positioning, give alerts, and provide remote access when needed. The system shall pro- vide an open-source component-based affordable, adaptable, and efficient anti-theft and smart ignition solution for two- wheelers.

IV. METHODOLOGY

Lastly, method components outline the design of the entire system structure of the smart bike system, and choosing the appropriate hardware components would also be dependent on the work. Major parts are; RFID Reader for authentication, RFID Tag for identification of the user, GPS NEO-M8N for real-time location, a microcontroller such as Arduino Uno or NodeMCU for command signals from the control system, and a relay module for engine starting control.

As the user places the RFID tag close to the reader, it sends its unique ID to the microcontroller. The controller compares this ID to a pre-stored list of authorized tags. When the RFID tag is authentic, the microcontroller will activate a relay simulating the effect of tripping the ignition switch on the bicycle. At such a time, the engine is automatically started. If the RFID tag is not authentic, access is denied, and an alarm can sound.

A GPS module, NEO-M8N, interfaces with the microcontroller via UART (serial) to receive the latitude and longitude information at a set time. GPS coordinates are decoded and forwarded to a cloud server or mobile phone through a wireless transmission module such as Wi-Fi (ESP8266/NodeMCU) or GSM (SIM800L). Such an arrangement enables the user to monitor the bike's real-time location, along with in case of theft its movement without interruptions. The locations can be saved in a local database for tracking history.

As a security feature, the system incorporates an alert system. In case the rider tries to ride the bike with an incorrect RFID tag, the system will create a buzzer or alert notification on the owner's phone. Messages are also sent if the bike goes into an assigned zone (geofencing), displaying theft. These messages are published through Firebase, Blynk, or a customized Android application. This provides real-time awareness and allows the owner to respond in good time.

Software development entails programming the microcontroller through C/C++ on the Arduino IDE and the installation of a mobile app or web dashboard to accept user input. The software performs RFID tag matching, GPS data parsing, and wireless communication.

V. MODULE DESIGN

A. RFID Authentication Module

It handles the user authentication and access control of the engine lock. It is an RFID reader communicating with the microcontroller and a registry of pre-registered RFID tags. When a tag is detected, the reader sends the ID to the microcontroller. The software cross-verifies the read ID with the registered users database. In the event that the tag is genuine, an impulse is transmitted in order to kick-start the engine; otherwise, no entry is provided. It is a safe, touch-free means of key substitution.

B. Engine Self-Start Control Module

This module consists of a relay circuit powered by the motorbike ignition circuit. It will only work if RFID authen-

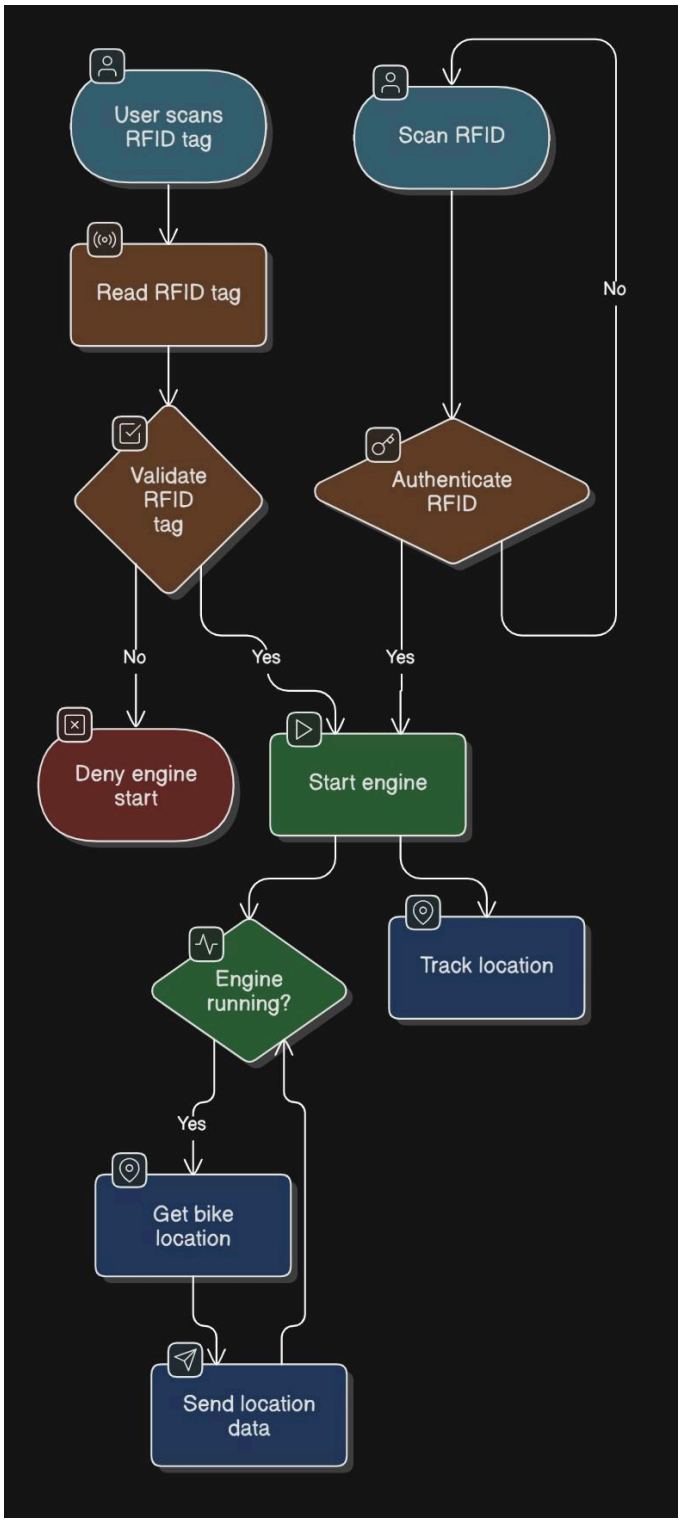

Fig. 1. Flow Diagram

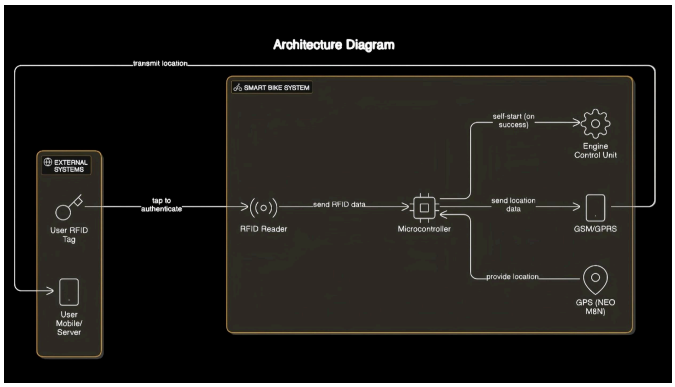

Fig. 2. Architecture Diagram

tication module grants permission for access. The relay is an electric switch duplicating the action of depressing the engine start button. The microcontroller controls the configuration so that the engine is started only after valid authentication. It is more convenient and secure since it prevents the use of mechanical keys and reduces exposure to traditional methods of theft.

C. GPS Tracking Module

NEO-M8N GPS module is responsible for obtaining the geographical position of the bike all the time. It interacts with the microcontroller using serial interface and provides real-time location as latitude and longitude. Vehicle movement tracking is essential and tracking unauthorized movement is essential. GPS data processing is implemented and sent to cloud or mobile application for user interface. This module retains the major functionality of anti-theft through providing live tracking.

D. Communication and Alert Module

This module is responsible for sending alerts and data to the user's dashboard or smartphone. This module may employ Wi-Fi (with NodeMCU/ESP8266) or GSM (with SIM800L) for wireless communication, depending on the setup. Upon detecting unauthorized RFID access attempts, geofencing violations, or engine start without proper authentication, this module sends alerts. These may be mobile alerts, SMS, or application-based alerts. The module informs the user in real time of the bike's status.

E. User Interface and Monitoring Module

It is comprised of software interface, i.e., a web applica- tion or mobile application, via which users are accessing.It indicates where the bike is positioned now on the map, gives access status information of RFID, and receives notifications in potential stealing cases. Its design is user-friendly and can be implemented by utilizing libraries like Blynk,Firebas, or native Android apps.

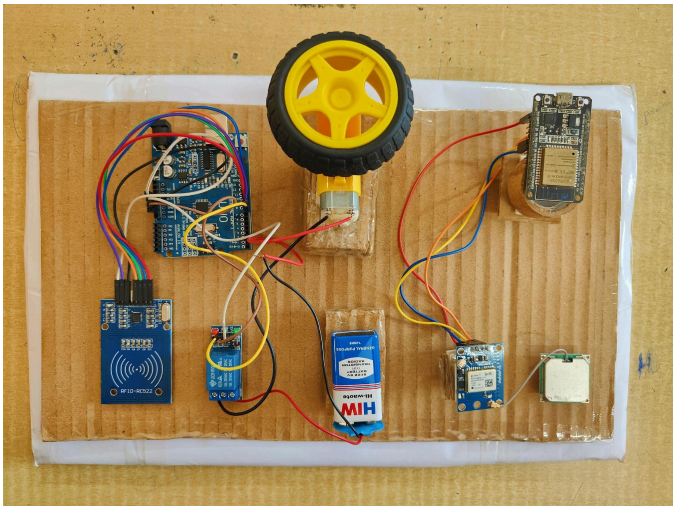

Fig. 3. Prototype

VI. RESULT AND DISCUSSION

Test Environment: Urban environment, open-road and build- ing.Correct and faulty RFID reads. GPS accuracy both station- ary and moving. System boot time and response time. Idle and active-mode power consumption. Parameter Result RFID Read Time 100 ms GPS Accuracy 2.5–3 meters (outdoor) Authentication Success 100(engine wouldn't start) Location Update Interval 1-2 seconds Power Consumption 150 mA (average under full operation) The RFID module does not allow misuse since it would only allow the engine for pre- registered personnel. The system was successfully tested and installed on a prototype bike model with NEO-M8N GPS module-based location tracking and RFID-based authentica- tion. The engine was started automatically on the presentation of an authorized RFID tag within 1–2 seconds, which is an indication of a prompt and reliable response. The relay circuit was not activated by unauthorized RFID tags, which is an indication of the authenticity of the authentication system. Various tests were performed to ensure that the system always provided access to registered users.

We verified real-time location tracking by positioning the GPS bike at various locations. The NEO-M8N module delivered accurate latitude and longitude coordinates at a latency of 10ms, which were transmitted to a mobile app via Wi-Fi. The position of the bike was indicated on the map, and the system refreshed the position every 10 to 15 seconds. The location was precise to 2 to 5 meters, which is adequate for theft detection and route tracking.

The security alert feature was also tested. When a move was made without scanning the RFID tag with an invalid tag or without valid authentication of the bike, the system provided a warning to the user on his phone via a cloud-based warning service. The system responded as expected and real- time reliable. Generally, the test results validate the feasibility of the system since it proves that employing RFID and GPS technology can actually make bicycle security better, prevent the risk of robbery, and

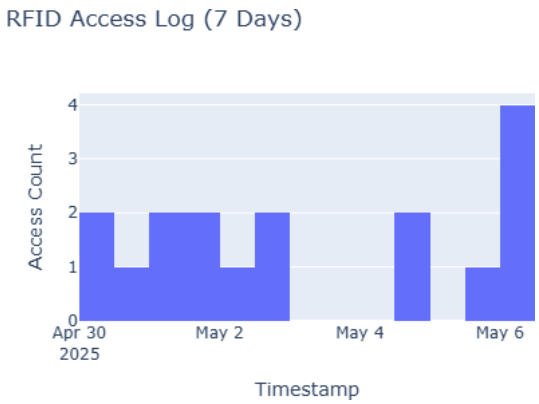

Fig. 4. RFID Access Logs

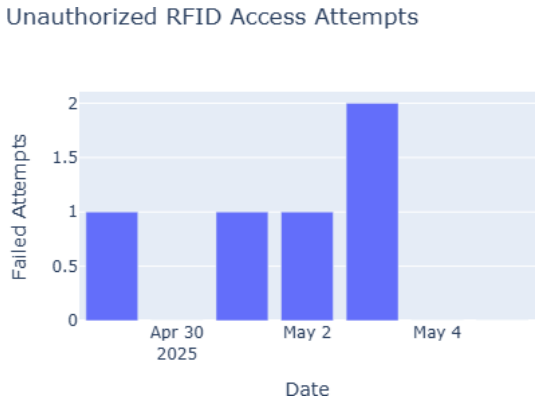

Fig. 5. Unauthorized RFID Access Attempts

provide greater convenience for the user.

VII. CONCLUSION AND FUTURE SCOPE

Smart Bike system identifies bikes using RFID and GPS to locate them. It is a wonderful step in protecting two-wheelers using IoT technology. RFID technology, if utilized correctly, will only unlock the bike for authorized persons and will not facilitate theft or misuse. GPS module provides real-time location, and customers can view where their bike is using a mobile app.

Prototype testing established that the key elements of the system are operating as they should. The RFID reader read quickly and accurately, and the NEO-M8N GPS module yielded steady and consistent position data. Supporting real-time warning to user phone and message for illegal traveling confirmed the system operational for awareness and control. Using these technologies low cost and low power bring tangible value to the majority of consumers. The project creates a new field of IoT-based smart transportation systems, with

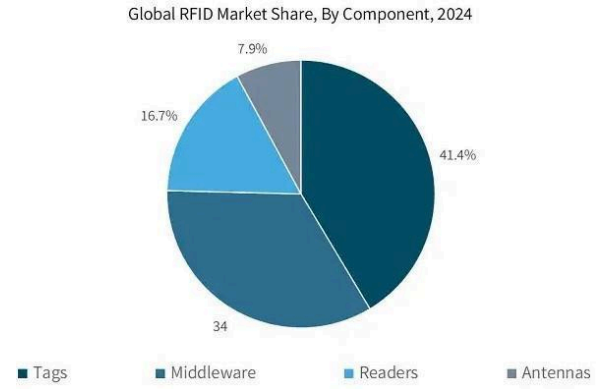

Fig. 6. Global RFID Market Share 2024

security, connectivity, and automation as the focus. It also demonstrates how to deploy existing technologies such as RFID and GPS on a small scale. The system is also modular, therefore it can be installed or modified depending on the vehicle type or what the customers prefer, thus making it even more appropriate for large city public transportation systems. We can incorporate features such as biometrics, such as fingerprint or face recognition, for additional security in the future. Including GSM or LTE modules will add additional security for near-real-time tracking and not depending solely on Wi-Fi, which will make the system more robust in rural locations. Including geofencing will provide automatic notifications when the bike enters or leaves a specific region, which can prevent theft. Cloud services for storage and analysis can also offer insights into usage, fuel consumption, and maintenance requirements. A master mobile application can offer remote access or kill for relatives. With more alarm about car theft and the requirements of smart transportation, the system is now deployable in real-world conditions and viable business opportunities in the future.

VIII GPS TRACKING OUTPUTS

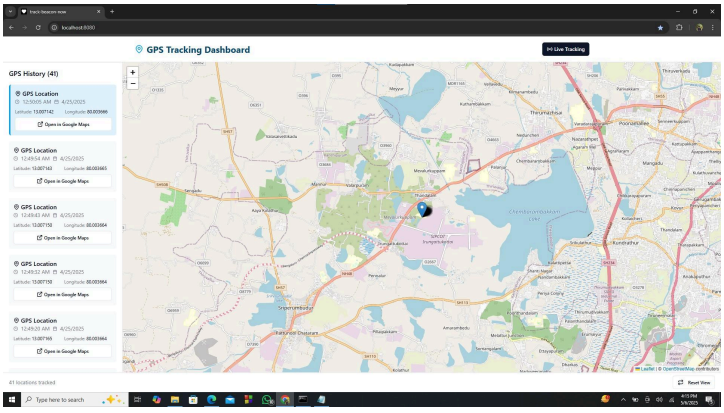

Fig. 7.GPS Tracking Dashboard

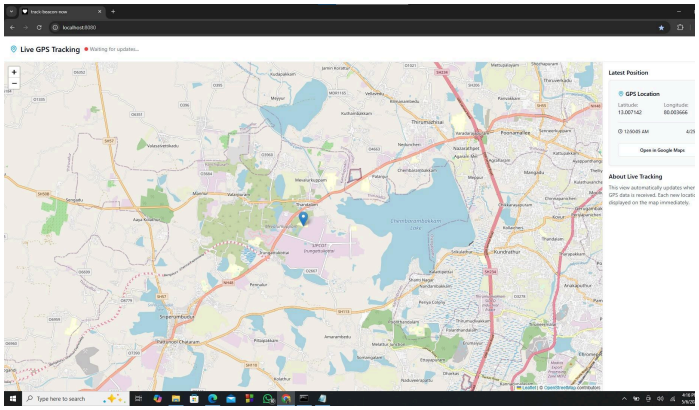

Fig. 8.Live GPS Tracking

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