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Bio Lock License and Fingerprint-Enabled Bike Security System

S.Kayathri Assistant Professor
Computer Science and Engineering
P.S.R Engineering College
Sivakasi,Tamil Nadu
kayathrijaikumar87@gmail.com

A.Ishwarya Assistant Professor
Computer Science and Engineering
P.S.R Engineering College
Sivakasi,TamilNadu
ishwariya8888@gmail. Com

J.Jusvanth Raja
Computer Science and Engineering
P.S.R Engineering College
Sivakasi,Tamil Nadu
jusvanth175@gmail.com

R.Gokul
Computer Science and Engineering
P.S.R Engineering College
Sivakasi,Tamil Nadu
rgokul3112@gmail.com

G.Chandrabose
Computer Science and Engineering
P.S.R Engineering College Sivakasi,Tamil Nadu
bossc0724@gmail.com

Abstract*— The increasing number of motorcycle thefts necessitates improved security systems. This research focuses on developing a biometric and RFID-based ignition system to ensure only authorized individuals can access and start motorcycles. Integrating fingerprint recognition as the primary authentication method and RFID-based license verification offers a dual-layer security mechanism, replacing traditional key-based systems. It significantly reduces theft risk and enhances user convenience. Additionally, to prevent under age riding, the system verifies the rider's age through RFID license data, ensuring only individuals aged 18 and above can start the motorcycle. Rigorous testing demonstrated the system's superior security compared to conventional methods, proving to be a reliable and cost-effective solution. The innovative system sets a new standard in motorcycle security, offering enhanced protection through biometric and RFID verification while promoting safe riding practices.

Keywords: RFID, Fingerprint, dual-layer security system.

I. INTRODUCTION

The increase in motorcycle theft incidents has underscored the urgent need for enhanced security systems tailored to protect motorbikes effectively. Traditional key-based security mechanisms, while widely used, are proving increasingly vulnerable to theft, prompting the exploration of advanced, technology-driven solutions. This research proposes an innovative, dual-layered security system that integrates biometric authentication and RFID-based license verification to limit motorcycle access exclusively to authorized users.

The system employs fingerprint recognition as the primary method of rider authentication. This approach ensures that only the registered fingerprint can unlock and start the motorcycle, providing a robust layer of security. To further solidify this mechanism, an RFID component is embedded for license verification. Each rider must possess an authorized RFID-tagged license, enhancing the system's security by verifying not only identity but also the age of the rider. In this way, underage access is effectively prevented, as only riders aged 18 and above, validated through the RFID license data, can engage the ignition.

This dual-layered security setup marks a significant departure from traditional systems by eliminating reliance on keys, reducing the likelihood of theft, and improving user convenience. Rigorous testing has shown that this biometric and RFID-based security system performs reliably under varied conditions, proving to be both efficient and cost-effective. Through a comparative analysis, it is evident that this system provides superior security in contrast to conventional methods, setting a new standard for motorcycle security. Additionally, this system not only safeguards the vehicle but also promotes safe riding by preventing underage operation.

By implementing this dual-authentication method, this study introduces a new paradigm in motorcycle security that leverages both biometric and RFID verification, offering enhanced protection and promoting responsible riding practices.

II. RELATED WORK

In recent years, the development of motorcycle security systems has been fuelled by the rise in theft cases and an increased demand for reliable safety mechanisms. A range of studies has examined advanced technologies that can improve motorcycle security, providing essential strategies to enhance vehicle protection.

One major focus has been on biometric technology, particularly fingerprint recognition, as a method for controlling vehicle access and ignition. Studies have shown that fingerprint-based security systems can significantly reduce the risk of unauthorized access. For instance, research

by Prabhakaran et al. (2018) demonstrated that biometric authentication offers stronger protection than traditional key-based systems. Since fingerprint patterns are unique to each individual, these systems add a high level of difficulty for unauthorized use, making them a preferred choice for motorcycle security.

Facial recognition has also emerged as a potential security measure for vehicles. This technology uses cameras and advanced algorithms to verify authorized users, offering a combination of security and real-time surveillance. For example, Iqbal et al. (2020) proposed a solution that integrates facial recognition with continuous monitoring to quickly identify unauthorized users. However, while promising, facial recognition presents challenges in terms of privacy concerns and sensitivity to environmental factors, which must be addressed for widespread adoption.

Radio-Frequency Identification (RFID) technology has also gained traction in vehicle security. By embedding RFID tags within user licenses or on the vehicle itself, RFID enables seamless access control. Zhang et al. (2019) demonstrated that RFID is effective for anti-theft applications, particularly when paired with GPS tracking for vehicle recovery. This combination showcases the potential for comprehensive security systems that tackle multiple aspects of vehicle protection.

Multi-factor authentication, which uses multiple security methods, is another approach gaining momentum. Sharma et al. (2021) introduced a multi-factor vehicle security system combining biometric authentication, RFID, and PIN codes, showing that multi-layered security can provide superior protection by requiring several forms of identification. This reduces the risks associated with relying on a single authentication method.

Furthermore, the integration of smartphones in vehicle security systems has become increasingly popular. Many modern vehicles now come equipped with mobile apps that allow users to control and monitor their vehicles remotely. Khan et al. (2022) explored smartphone applications that offer features like location tracking, remote ignition control, and instant alerts, emphasizing that user convenience and real-time monitoring are critical in today’s security solutions.

Overall, current research in motorcycle security emphasizes the role of advanced technologies like biometrics, RFID, and mobile apps in creating comprehensive protection mechanisms. The proposed biometric and RFID-based ignition system aims to build on these findings, addressing the problem of motorcycle theft and supporting safe riding practices. By combining these technologies, the system not only enhances security but also provides a more user-friendly experience, setting a new benchmark in vehicle safety.

III PROPOSED SYSTEM

The objective of this proposed methodology is to design, implement, and evaluate a biometric and RFID-based ignition system for motorcycles to improve security and prevent unauthorized access. This systematic approach includes key phases: system design, component selection, implementation, and testing and evaluation.

A.System Design

The first phase involves establishing the overall system architecture. The ignition system will incorporate two main components: a biometric authentication module and an RFID-based license verification module. The design will prioritize effective integration of these components to achieve secure and reliable operation.

- Biometric Module: This module will use a fingerprint scanner to capture and process fingerprint images. Advanced algorithms will extract and match unique features from fingerprints to accurately identify authorized users. The design will account for various environmental factors, such as lighting and moisture, which could affect fingerprint recognition reliability.

Fig No: 3.1 Fingerprint Sensor

- RFID Module: The RFID component will consist of RFID readers and tags. Each motorcycle will be fitted with an RFID reader, which will interact with a tag embedded in the rider's license. The design will prioritize fast and precise tag reading, allowing the system to confirm both the rider's identity and age.

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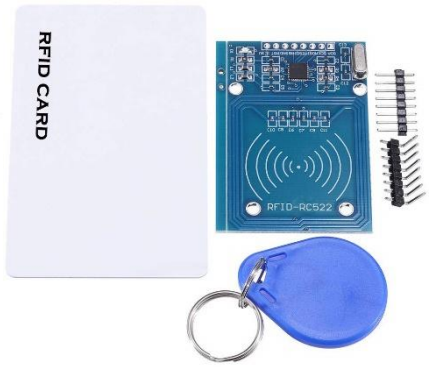

Fig No:3.2 RFID Reader

B.Component Selection

Selecting the right components is essential for achieving optimal system performance. This phase involves choosing a suitable fingerprint scanner, RFID reader, and microcontroller to serve as the system's central processing unit.

- Fingerprint Scanner: Key selection criteria include accuracy, speed, durability, and resistance to environmental factors. Various scanners will be evaluated to select one that performs well under real-world conditions.
- RFID Technology: The RFID reader should support a reasonable reading range to facilitate efficient access, while the tags must be durable and secure, minimizing risks of tampering or duplication.
- Microcontroller: The choice of microcontroller will depend on its processing capabilities, compatibility with sensors, and ease of programming. This microcontroller will integrate the biometric and RFID modules into a unified system.

Fig No: 3.3 Arduino

C. Implementation

After finalizing the design and selecting components, the system will be implemented by assembling hardware and programming the microcontroller.

- Hardware Assembly: The biometric and RFID modules will be installed within the motorcycle's ignition system, ensuring secure mounting and protection against environmental influences.
- Software Development: The microcontroller will be programmed to handle fingerprint matching and RFID tag verification. User interfaces will allow enrollment and management of authorized users, making updates and maintenance straightforward.

D.Testing and Evaluation

The final phase involves extensive testing to confirm that the ignition system meets all security, reliability, and performance standards.

- Functional Testing: Both the fingerprint and RFID modules will be thoroughly tested for speed and accuracy under various conditions to ensure they perform as intended.
- Security Assessment: A detailed security evaluation will be conducted to identify any vulnerabilities. This may include penetration testing and simulations to assess the system's resistance to theft scenarios.
- User Testing: Real-world testing will collect feedback on usability and overall performance, enabling adjustments to enhance the user experience.
- Final Evaluation: After testing, a detailed report will be created to summarize system performance, security features, and user feedback. This report will serve as a basis for future improvements and commercialization potential.

FUNCTIONAL DIAGRAM

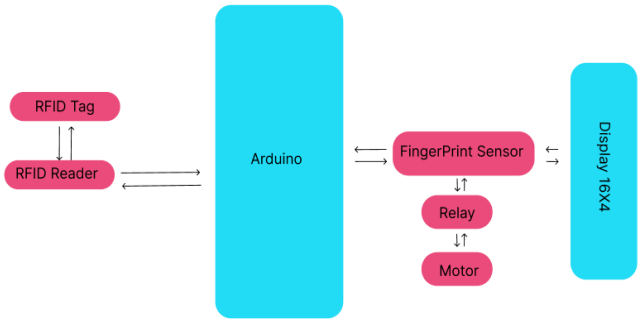

Fig No:3.4 Functional Diagram

DIAGRAM EXPLANATION

In the functional diagram, the RFID reader detects the RFID tag and transmits the data to the Arduino. The system then performs biometric authentication by comparing the RFID information with the fingerprint data. If both match, the Arduino processes the confirmation and activates the motor to start the bike.

VI Literature Survey

1)Title & Year:
Fingerprint & Pascode Based Anti Theft Vehicle System (July 2022).
Author:
Mr.Prashanth
Description:
Vehicle security system uses fingerprint, GPS, GSM, and panic button for real-time theft detection.

2)Title & Year:
Motorcycle fingerprint safety system
(August 2022)
Author:
Kiran CS
Description:
Motorcycle anti-theft system uses fingerprint ignition for owner-only access, enhancing security and convenience.

3)Title & Year:
A Review Bike security system using fingerprint and GPS (March 2020).
Author:
K. Dinesh kumar
Description:
Anti-theft vehicle system uses fingerprint, GSM, and GPS for secure, remote monitoring and control.

4)Title & Year:
Automatic Bike Locking System Through Fingerprint Sensor (2021)
Author:
Dr.Rekha Chakravarthi
Description:
Fingerprint-based ignition system aims to reduce motorcycle theft, enhancing security and ignition convenience.

5)Title & Year:
A Review on fingerprint oriented lock and unlock identification system (March 2023)
Author:
Chandrakant Naikodi
Description:
Fingerprint-based locker systeenhances,security,preventing unauthorized access and eliminating reliance on passwords.

V EXISITING SYSTEM

The existing motorcycle security systems primarily rely on traditional key-based or mechanical lock mechanisms, which offer limited protection against theft. These conventional systems are often vulnerable, as keys can be easily duplicated or stolen, and mechanical locks can be bypassed by experienced thieves. Due to these vulnerabilities, motorcycles are frequently at risk of unauthorized access, resulting in high theft rates, especially in urban areas. Consequently, there has been a growing interest in integrating advanced technologies to strengthen motorcycle security, moving beyond simple key-based systems.

A.Traditional Key-Based and Mechanical Lock Systems

Most motorcycles still rely on traditional key-based ignition systems or mechanical locks for security. While these systems are straightforward and inexpensive, they offer limited protection as keys can be easily duplicated, lost, or stolen. Additionally, experienced thieves can bypass mechanical locks with relative ease, which has led to a rise in motorcycle thefts, especially in urban areas.

B.Electronic Key Fobs and Immobilizers

One step forward from traditional locks, electronic key fobs and immobilizers add an extra layer of security. Immobilizers disable the ignition system unless they detect a specific electronic code from the key fob, preventing the motorcycle from starting without it. Although immobilizers are more secure than mechanical locks, skilled thieves with technical knowledge and tools can sometimes bypass these systems. Thus, while they improve security, they do not fully protect against all theft methods.

C.RFID (Radio Frequency Identification) Systems

RFID technology offers a contactless security method by requiring the motorcycle to read a specific RFID tag carried by the rider. When the correct tag is detected by the RFID reader, the ignition system is unlocked. RFID systems offer more security than traditional key systems because they are difficult to duplicate and can contain unique identifying information. However, basic RFID systems can still be vulnerable to “spoofing,” where electronic devices replicate the RFID signal to trick the reader into granting access.

D.Biometric Security: Fingerprint Recognition

Biometric security, particularly fingerprint recognition, has shown promise for motorcycle security systems. By using unique fingerprint patterns for identification, these systems provide a high level of security since they require the physical presence of an authorized user. Unlike RFID or keys, fingerprints cannot be stolen or duplicated easily. However, biometric systems can be affected by environmental conditions (e.g., moisture, dirt) and physical factors (e.g., cuts or injuries on fingers), which can reduce scanner accuracy. Not all biometric systems are equipped to handle such variables, which can affect their performance and reliability.

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VI OUTPUT AND RESULT

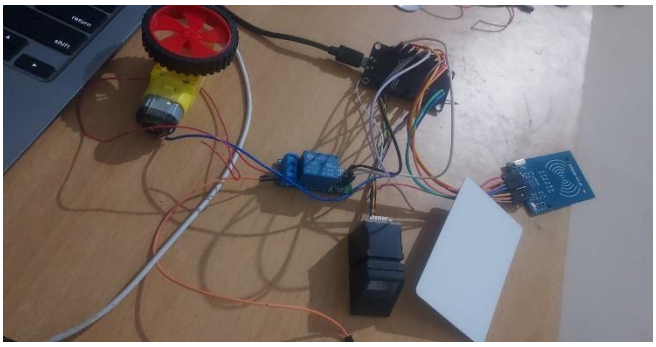

Fig No: 6.1 Connection Circuit

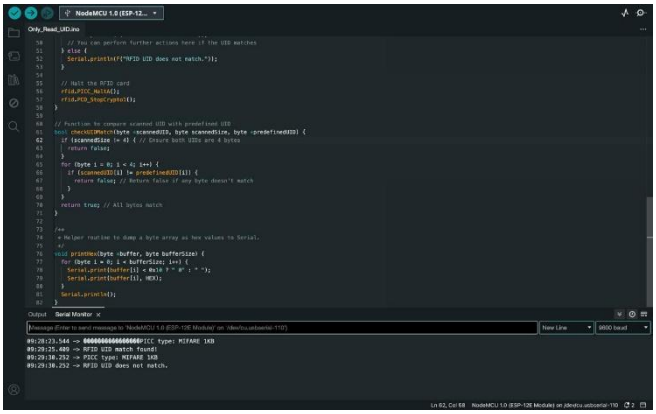

Fig No: 6.2 RFID Validation

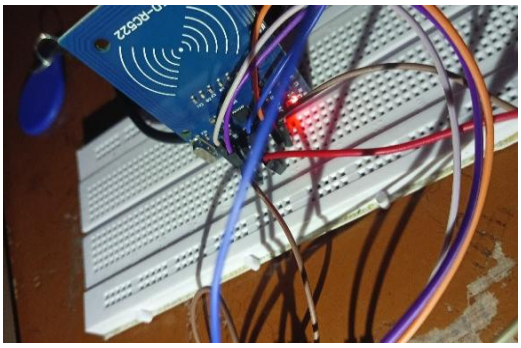

Fig No: 6.3 RFID Reader

TABLE I. Table for Components Requirement

S.NO	Name of the Components	Quantity	Price
1.	Arduino Uno	1	Rs.1500
2.	RFID Reader and Tag	1	Rs.1000
3.	Fingerprint sensor	1	Rs.1000
4.	Dc Motor	1	Rs.50
5.	Wires	required	Rs.100

Fig No: 6.1.1 Table for Components Requirement

VI ACKNOWLEDGMENT

we wish to express our sincere appreciation to all those who contributed their time and expertise to this project our profound gratitude goes to our advisor for their exceptional guidance insights and unwavering encouragement which greatly enriched our research experience we also recognize the invaluable support from our institution which provided essential resources and facilities that were vital for the successful execution of this study additionally we are thankful for the collaboration of the technical team and our colleagues who shared their expertise and assisted with the practical components of our project their commitment and teamwork were instrumental in navigating the challenges encountered during the development process finally we would like to extend our heartfelt thanks to our families and friends for their constant support and motivation throughout this journey

VII CONCLUSION

The biometric and RFID-based ignition system is an innovative and effective approach to motorcycle security, providing both enhanced safety and convenience for users. By integrating fingerprint recognition technology, the system ensures that only authorized individuals can access the motorcycle, adding a significant layer of security against unauthorized use. This technology is combined with RFID-based license verification, which allows for real-time validation of the user's license information. Only individuals who meet age requirements, typically 18 years and older, are granted permission to start the motorcycle, thereby promoting responsible and safe riding practices. This dual-layered security system goes beyond the traditional key-based ignition. Unlike physical keys, which can be easily duplicated or stolen, fingerprint recognition provides a unique identifier that is nearly impossible to replicate. RFID license verification further strengthens the system by confirming the user's identity and age, making it highly unlikely for underage or unauthorized individuals to operate the vehicle. In addition to enhanced security, the system offers convenience for users by eliminating the need for physical keys, making it quicker and easier to start the motorcycle. The overall setup is designed to be cost-effective and reliable, making it suitable for widespread adoption. By addressing the risks of theft and promoting safe riding practices, this biometric and RFID-based ignition system represents a significant advancement in motorcycle security, catering to both safety-conscious and tech-savvy riders.

VIII REFERENCES

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