

Keyless Security

The Smart Solution for Home with a Smart Door Lock

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Abstract— This research paper introduces a novel approach to improve security and access control in smart door lock systems. The proposed system incorporates multi-factor authentication, combining a numerical keypad, mobile app, and RFID sensor. Each authentication method is associated with a specific lock, offering differentiated access control. Notably, the system requires the simultaneous use of the mobile app and RFID sensor to unlock a designated lock, adding an extra layer of security. To assess the system's effectiveness, a comprehensive study was conducted, considering security, usability, and user satisfaction. The study involved simulated attacks, user surveys, and usability tests, with data analysis providing insights into the system's resilience and user acceptance. This research contributes to the field of smart door lock systems by offering an innovative approach to enhance security through multi-factor authentication. The findings provide valuable insights for designing advanced access control mechanisms, empowering users with increased confidence in their security measures while maintaining a user-friendly experience.

Keywords- Internet of things, RFID, Solenoid lock, Security, Remote management.

I. INTRODUCTION

A keyless smart door lock is a security device that eliminates the need for traditional keys by using Radio Frequency Identification (RFID) technology. The RFID system uses tags or cards that have an embedded microchip and antenna, which transmit a unique identifier to a reader located on the door. The reader then verifies the information and grants access to the user if the data is correct. This technology has gained popularity due to its convenience, flexibility, and security benefits. Several studies have been conducted to design and implement keyless smart door locks using RFID technology. For instance, Islam et al. [1] developed an electronic protection system using RFID to prevent question paper leakage, while Hou et al. [2] proposed a highly secure authentication module for a smart door lock with temporary key function. Sikiru et al. [3] conducted a review of intelligent lock systems, and Makanjuola et al. [4] designed an RFID-based access control system with an intruder alert system. Christianah et al. [5] developed a biometric access control system using voice and fingerprint, and Garg et al. [6]

experimented with RFID-based clinical medicine dispenser. Furthermore, several studies have explored the use of the Internet of Things (IoT) to enhance the functionality of keyless smart door locks. Gunawan et al. [7] evaluated the performance of a smart home system using IoT, while Qasim et al. [8] designed and implemented a home security system using wireless sensor networks and IoT. Djupsjö and Almosawi [9] applied IoT security to a smart door lock application, while Clark et al. [10] used Bluetooth proximity sensing to determine the location of office workers. Kavde et al. [11] developed a smart digital door lock system using Bluetooth technology. In summary, the keyless smart door lock using RFID technology is a reliable and secure way of controlling access to homes, offices, and other restricted areas. The technology has a wide range of applications and has attracted the attention of researchers and developers worldwide.

II. LITERATURE REVIEW

Researchers had tried to proposed a approach of a Smart Door & Lightning System using IOT for smart home. By doing this project they tried to control two major aspects 1) Door Lock & 2) Lightning System. A remotely control door lock is made which can be control with internet from any corner of the world & same goes with the lightning system. They faced issue of connectivity which we cannot maintain as the system relies on Wi-Fi connection. Also, a danger on any device that connects to the internet can be vulnerable to cyber-attacks. It is not cost effective [11]. The simplest method of door lock system using IOT. This project was developed with the help of Arduino and a biometric sensor use in smartphone. They face drawback's that biometric sensors which can be affected by factors such as dirt, moisture, or changes in lighting, which could affect their accuracy [12]. The goal of the article is to eliminate manual door lock control in favor of a method that provides remote access and control. Door locks have been operated by biometrics such as fingerprint, iris scanning, and facial recognition [3]. the application of RFID technology to offer a solution for user tracking and safe entry to an area. For managing and transactional processes, a centralized system is being implemented. Technology improves safety, but RFD tags must be physically worn. When a reader is nearby, false detection might happen [14]. The article demonstrates developing a simple home automation application on a Raspberry Pi using an algorithm created in the Python environment by scanning the subject of emails [15]. With the help of IOT technology they use a app which can control the door lock with software programmed installed in smartphone which can be control with the help of voice command. EWELINK app and IFTTT app are used because available on the most popular platforms [16]. The project presents the Smart home controller which uses Bluetooth to control the security of door system. Firstly, Android app was developed using JDK and SDK. The phone and door lock are connected with the help of Bluetooth connection for transferring the data. And a Arduino is use to control the lock [17]. There has been a growing interest in developing advanced security systems utilizing Internet of Things (IoT) and Radio Frequency Identification (RFID) technologies. Researchers have proposed smart lock systems using IoT, emphasizing the integration of IoT technologies to enhance the functionality and security of the lock system [18]. The application of IoT in centralized smart locker systems has also been explored, utilizing RFID technology for secure and convenient storage [19]. RFID technology has been widely applied in various domains, including smart parking systems that offer efficient and secure parking management [20]. Additionally, prototypes of RFID-GSM-based lock systems have been developed, showcasing the potential of combining these technologies for enhanced security [21]. Other studies have investigated the use of Raspberry Pi-based systems for

interactive home automation, providing flexible and convenient solutions [22]. The application of active RFID technology in tool tracking on construction job sites has also been explored, highlighting its potential in improving efficiency and accountability [23]. Furthermore, a review of multifactor door locking systems has emphasized the importance of integrating multiple security measures to enhance overall security [25].

III. DOMAIN MODEL SPECIFICATION

A. Microcontroller

Symbols for residential locks include a solenoid lock and a relay. An ESP-connected relay controls it. When the user enters the pertinent IDs into the ESP, the relay is switched to push the solenoid lock's head up to lock it or bring it down to open it. Using a green LED, the lock's condition is displayed. Microcontroller checks whether entered key value is correct or incorrect.

B. Power Supply

The ESP requires a 12V power supply. The general-purpose input/output (GPIO) pins or the USB can be used to supply this. A power bank, a direct plug connection, or lithium-ion batteries may be used to supply the energy. The pins of the Module are linked to all other components' power inputs, allowing them to draw power from them. Since the module's maximum output voltage is 5V, the solenoid lock used for demonstrations needs 12V power, which it cannot obtain from the module. We utilize a Adapter to convert AC 230V to output 12V. Through the solenoid lock's positive and negative terminals, they can be linked. The 5v power is given to servo motor for unlocking keypad actuated lock.

C. Working Operation

Figure 3.1 illustrates the system workflow. As per case, a single locker is intended to be used by two consumers within an organization. To unlock the locker, both consumers must have their respective access systems enabled. Additionally, an appointed supervisor is granted a separate access system. For the first access, when an RFID card is tapped for scanning, the scanner will scan the card and pass the information to the interpret module. If the scanned card or token matches a pre-set ID, the interpret module will proceed to the second step, which involves verification. Access from the mobile application will be sent as a signal to the module, and upon successfully completing two verification steps, the first lock will open.

The relay, which is powered by a battery supply, will then activate the solenoid lock. The LED indicator will display the status of whether access has been granted or denied. The third step involves verification through a keypad, which is exclusive to the supervisor. After each access

permission, a buzzer will emit a predetermined tune to indicate the successful completion of the access process.

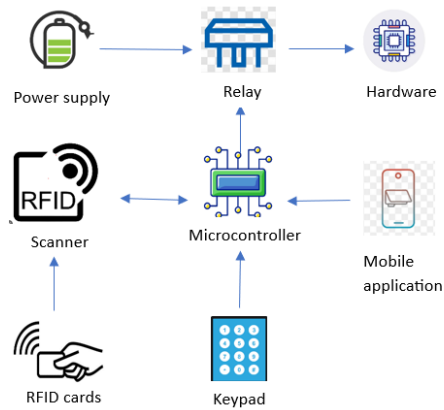


Figure 3.1 Project Layout

D. Remote operation model

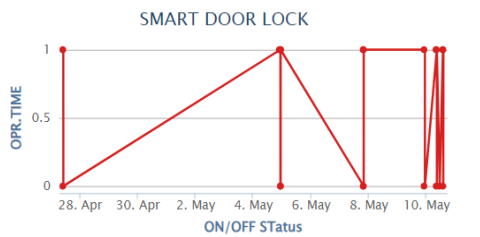


Figure 3.2 Door lock operation status graph

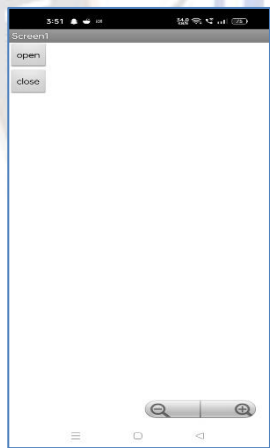


Figure 3.3 Mobile application (a) User interface

The figure 3.2 shows the status of accesses, the module's connectivity to Thing Speak enables it to analyse the date and time of door operations, specifically whether it is open or closed. This information is graphically represented by '0' and '1' values, indicating the door's status. Such a feature enhances the safety of the system, allowing users to keep track of who enters or exits a particular area, and at what time. This option also provides users with a level of control over their security, making it an essential aspect of any door monitoring system. As such, the module's integration with Thing Speak is a

valuable tool for those who seek to improve their security measures

The Fig.3.3 shows user interface of mobile application which has option for accessing lock.

IV. RESULTS

TABLE 4.1 RESPONSE TIME ANYALSIS

Start	Sequence	Operation	Operation time	Total time
1.Scenario: Unlocking				
Correct RFID trial	1(a)	Scanner detects	0.5 S	20s
	1(b)	Data interrupt in module		
	1(d)	Buzzer sounds		
	1(E)	Mobile accesses	Depend on internet speed	
	1©	Lock open	Almost instantly	
Correct Key pass	1(a)	Entering key	5s	5s
Incorrect Key pass	1(a)	Entering key	5s	10s
	1(b)	Buzzer sounds	5s	
Incorrect RFID trial	1(a)	Scanner detects	Almost instantly	6s
	1(b)	Data interept in module		
	1©	Lock didn't open		
	1(d)	Scanner ready for scanning	0.2s	
	1(F)	Double tap require for correct ID for next attempt	0.4s	

TABLE 4.2 FIALURE SCENARIOS AND REASON

Operations	Outcome	Reason
Scenario: Failure occurs		
Solenoid goes in locks state	Lock does not move	Insufficient supply
Scanning not performing correctly	Lock not opening	Poor visibility of card and reader

GRAPH 4. 1 DISTANCE VS DETECTION RANGE

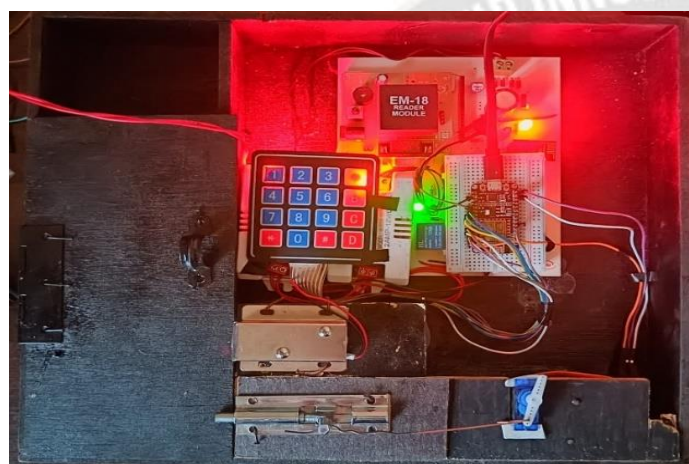
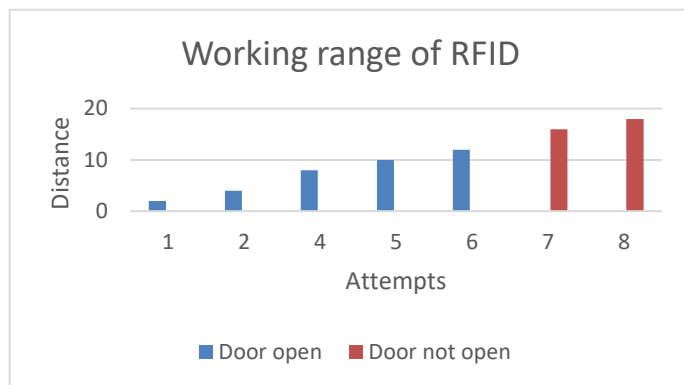


Figure 4.1 Prototype modelling image

As in graph 4.1 the used RFID in our System works up to 12 mm from scanner. RFID-based smart lock systems offer many benefits over traditional lock and key systems for securing homes. They eliminate the need for physical keys, making it easier and faster for users to enter their homes while also reducing the risk of lost or stolen keys. These systems also allow homeowners to grant and revoke access to specific users, providing greater control over who can enter their homes. Additionally, RFID-based systems can track and log all access attempts, giving homeowners detailed records of who has entered their home and when. One of the key advantages of RFID-based smart lock systems is the integration of mobile applications and Num. key lock for 3 step verification. Mobile applications can also allow users to remotely grant or revoke access, even when they are not physically present at the lock's location. It is important to note that not all RFID-based smart lock systems are created equal. Homeowners should carefully consider the features of each system and select the one that best fits their individual needs. Some systems may have more advanced features, such as voice control or integration with smart home devices, while others may have a simpler, more straightforward design. In conclusion, RFID-based smart lock

systems provide an effective solution for enhancing home security. They offer convenience, enhanced security features such as access control and tracking, and the integration of mobile applications for two-step verification. As technology continues to evolve, it is likely that RFID-based smart lock systems will continue to be a popular choice for homeowners who seek a better way to secure their homes.

REFERENCES

- [1] Islam, Md. Ariful & Mashiat, Lamisa & Sayeed, Md & Kabir, Engr. Md & Himu, Sheik & Abrar, Fahim & Chowdhury, Moinul Kabir & Hayat, Md. (2022). Design and Implementation of A Low Cost Electronic Protection System To Prevent Question Paper Leakage.1-5. 1109/CONECCT55679.2022.9865777.
- [2] Hou, Dongkun & Cheng, Shiyuan & Zhang, Jie & Dong, Yuji & Ma, Jieming & Zhu, Xiaohui & Man, Ka. (2022). A Highly Secure Authentication Module for Smart Door Lock with Temporary Key Function. 228-235. 10.1109/CW55638.2022.00053.
- [3] Sikiru, Anaza & Jiya, Jibril & Shu'aibu, Ya'U. (2017). A Review of Intelligent Lock System. 9-15.
- [4] Makanjuola, Philip & Shokenu, Emmanuel & Araromi, Haonat & Idowu, Peter & Babatunde, Joshua. (2022). An Rfid-Based Access Control System Using Electromagnetic Door Lock and an Intruder Alert System. Journal of Engineering Research and Reports. 7-17. 10.9734/JERR/2022/v22i117574.
- [5] Christianah, Boluwatife & Araromi, Haonat & Shokenu, Emmanuel & Idowu, Peter & Babatunde, Joshua & Monsuru, Adeagbo & Oluwole, Itanrin. (2022). Biometric Access Control Using Voice and Fingerprint. Engineering and Technology Journal. 07. 2456-3358. 10.47191/etj/v7i7.08.
- [6] Garg, Ridita & Bhatt, Isha & Eashwer, K & Jindal, Sumit. (2022). Experimental Design and Implementation of RFID based Clinical Medicine Dispenser.33.36.1109/PCEMS55161.2022.9807886.
- [7] T. S. Gunawan, I. R. H. Yaldi, M. Kartiwi, and H. Mansor, "Performance evaluation of smart home system using internet of things," International Journal of Electrical and Computer Engineering, vol. 8, no. 1, pp. 400-411, 2018, doi: 10.11591/ijece.v8i1.pp400-411.
- [8] H. H. Qasim, A. E. Hamza, H. H. Ibrahim, H. A. Saeed, and M. I. Hamzah, "Design and implementation home security system and monitoring by using wireless sensor networks WSN/internet of things IoT," International Journal of Electrical and Computer Engineering, vol. 10, no. 3, pp.2617-2624, 2020, doi: ijece.v10i3.pp2617-2624.
- [9] K. Djupsjö and M. Almosawi, "IoT security applied on a smart door lock application," Unpublished M. Sc Thesis, KTH, tockholm, 2018.
- [10] B. K. Clark, E. A. Winkler, C. L. Brakenridge, S. G. Trost and G. N. Heal, "Using Bluetooth proximity sensing to determine where office workers spend time at work," PLOS One, vol. 13, no. 3, p. e0193971, 2018, doi: 10.1371/journal.pone.0193971.
- [11] S. Kavde, R. Kavde, S. Bodare and G. Bhagat, "Smart digital door lock system using Bluetooth technology," 2017 International

- Conference on Information Communication and Embedded Systems (ICICES), 2017, pp. 1-4, doi: 10.1109/ICICES.2017.8070788.
- [12] Rahul Satoskar "Smart Door Lock and Lighting System using Internet of Things"(IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 9 (5) , 2018, 132-135
- [13] Patil, Karthik & Vittalkar, Niteen & Hiremath, Pavan & Murthy, Manoj. (2020). Smart Door Locking System using IoT. International Journal of Engineering and Technology. 7. 2395-0056.
- [14] Gadupu, Harshith & Mokharji, Osa & Kankaria, Raunak & Kumar, Shrey & Jayavel, Kayalvizhi. (2021). ACCESS - IoT enabled smart lock. International Journal of Reconfigurable and Embedded Systems (IJRES). 10. 176. 10.11591/ijres.v10.i3.pp176-185.
- [15] Jain, Sarthak et al. "Raspberry Pi based interactive home automation system through E-mail." 2014 International Conference on Reliability Optimization and Information Technology (ICROIT) (2014): 277-280.
- [16] Rahman, Abdel & Al Moaiad, Yazeed & Farea, Mazen & Mohamed, Rajina & Al-Abiary, Yousef & Jusoh, Julaily & Iryani, Syarilla & Saany, Ahmad & Ts, Assoc & Baker, Yousef & Assoc, El-Ebiary & Ts,. (2023). A Different Vision Of Automated Door System Based On Smartphone Apps And Voice-Controlled. Journal of Pharmaceutical Negative Results. 14. 10.47750/pnr.2023.14.S02.154.
- [17] Kamelia, Lia & Noorhassan, S.R. & Sanjaya, W. S. Mada & Mulyana, W.S.. (2014). Door-automation system using bluetooth-based android for mobile phone. 9. 1759-1762.
- [18] Bhattacharya, Sourav & Basak, Swarnajoy & Chakraborty, Ritwik & Dey, Upalabdi & Chowdhury, Niladri & Hegde, Roopa. (2022). Smart Lock Using IoT. 1-4. 10.1109/IRTM54583.2022.9791563.
- [19] Bharatiraja, C. & Chittoor, Prithvi & Bhargava, Yash. (2023). An IoT based centralized smart locker using RFID technology. AIP Conference Proceedings. 2427. 020098. 10.1063/5.0101139.
- [20] Sadaat, Hamza & Shoukat, Omer. (2022). RFID Based Smart Parking. Dharmale, Gulbakshee & Katti, Jayashree & Waghere, Sandhya & Patankar, Tanuja & Ati, Kartik. (2022). Door Lock using RFID and Arduino. 1-5. 10.1109/ICCCNT54827.2022.9984396.
- [21] Anaza, S & Jiya, Jibril & Shu'aibu, Ya'U. (2020). DEVELOPMENT OF A PROTOTYPE RFID- GSM BASED LOCK SYSTEM. 77-84.
- [22] S. Jain, A. Vaibhav and L. Goyal, "Raspberry Pi based interactive home automation system through E-mail," 2014 International Conference on Reliability Optimization and Information Technology (ICROIT), 2014, pp. 277-280, doi: 10.1109/ICROIT.2014.6798330.
- [23] Goodrum, P., McLaren, M., Durfee, A., "The application of active radio frequency identification technology for tool tracking on construction job sites." Automation in Construction, 15 (3), 2006, pp 292-302
- [24] R. Weinstein, "RFID: a technical overview and its application to the enterprise," IT Professional, vol. 7, pp. 27 - 33, May-June 2005
- [25] Motwani, Yashraj & Seth, Saambhavi & Dixit, Devang & Annasamy, Bagubali & Rajesh, R. (2021). Multifactor door locking systems: A review. Materials Today: Proceedings. 46. 10.1016/j.matpr.2021.02.708.
- [26] Motwani, Yashraj & Seth, Saambhavi & Dixit, Devang & Annasamy, Bagubali & Rajesh, R.. (2021). Multifactor door locking systems: A review. Materials Today: Proceedings. 46. 10.1016/j.matpr.2021.02.708.