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Submitted By	Submitted to
Md. Nazmul Hossen (2019331047) **Samim Ahmed (2020331065)** **Imran Bin Azad Siyam (2020331101)** **Ajoad Islam (2020331104)** **Muntasir Mamun (2020331110)**	**Abdullah Al Noman** **Lecturer,** **Department of Computer Science and Engineering,** **Shahjalal University of Science and Technology, Sylhet**

Title:

Smart Door Security: An IOT-Based RFID Lock System

Authors:

1. MD Nazmul Hossain
2. Samim Ahmed
3. Imran Bin Azad Siyam
4. Ajoad Islam
5. Muntasir Mamun

Abstract:

The project, “Smart Door Security: An IoT-Based RFID Lock System”, aims to design and implement a secure, reliable, and efficient door lock system using Radio Frequency Identification (RFID) technology integrated with the Internet of Things (IoT). The system is designed to automate the process of authentication and access control, enhancing the security of residential and commercial premises.

The system uses RFID tags and an RFID reader for identification and authentication. When an RFID tag comes in proximity to the RFID reader, the system reads the unique identification number of the tag. If the number matches with the pre-stored data, the system triggers the door lock to open.

The IoT integration allows remote monitoring and control of the door lock system. It provides real-time notifications about the access logs, enabling users to track the entry and exit records. In case of unauthorized access attempts, the system sends instant alerts to the user.

This project demonstrates the potential of RFID and IoT technologies in enhancing security and convenience in access control systems. It provides a foundation for future research and development in the field of smart home security systems.

Key Terms:

1. **Arduino:**
    - An open-source electronics platform based on easy-to-use hardware and software, widely used for prototyping and creating interactive projects.
2. **RFID (Radio-Frequency Identification):**
    - A technology that uses wireless communication to identify and track objects through the use of RFID tags and readers.
3. **RFID Reader Module (e.g., MFRC522):**
    - Hardware component capable of reading data from RFID tags or cards.
4. **Servo Motor:**

- A rotary actuator that allows precise control of angular position, commonly used to control the movement of the locking mechanism.

5. **Solenoid Lock:**
    - An electromechanical device that can be controlled to either lock or unlock a door.
6. **Key Fobs:**
    - Small devices containing an RFID chip that can be used as a physical key for access control systems.
7. **RFID Cards:**
    - RFID cards are a type of smart card that uses radio-frequency technology to store and transmit data wirelessly. These cards contain an RFID chip and an antenna, allowing them to communicate with RFID readers.

Introduction:

Background: In the realm of security and access control, traditional lock and key systems have been gradually giving way to more advanced, technologically driven solutions. With the advent of affordable microcontrollers like Arduino and advancements in Radio-Frequency Identification (RFID) technology, it becomes feasible to create secure and efficient door lock systems.

The Arduino platform provides a versatile and accessible environment for prototyping electronic projects, while RFID technology enables contactless identification, making it ideal for applications like door access. Combining these technologies opens the door to creating a RFID based door lock system.

Statement of the Problem: Traditional door lock systems face challenges related to security, convenience, and flexibility. Conventional keys can be easily lost or duplicated, posing a security risk. Additionally, managing access for multiple users or revoking access can be cumbersome with traditional systems. The system will provide a secure and flexible access control solution, allowing authorized individuals to unlock doors using RFID cards or key fobs.

Related Work:

Before embarking on the development of an Arduino-based RFID door lock project, it is essential to review existing research and projects in the same domain. The insights gained

from related work can inform design decisions and highlight areas for improvement. Here are some notable aspects from related work:

1. **Security Protocols:**
    - Many RFID door lock projects focus on implementing robust security protocols to prevent unauthorized access.
2. **User Authentication Techniques:**
    - Previous projects have investigated various user authentication methods beyond simple RFID card reading.
3. **Power Efficiency:**
    - Some projects address the power consumption concerns associated with continuous RFID system operation. Solutions may involve implementing low-power modes or optimizing the system to operate efficiently on battery power.
4. **User Experience Considerations:**
    - Successful projects pay attention to the user experience, ensuring that the system is user-friendly and easy to set up. Feedback mechanisms, such as visual or audible cues during authentication, contribute to a positive user experience.
5. **Multi-Access Level Systems:**
    - Some RFID door lock systems are designed to support multiple access levels. This enables the administrator to assign different access privileges to various users, enhancing the flexibility and adaptability of the system.

By studying related work, this Arduino-based RFID door lock project aims to draw inspiration from successful implementations, address potential shortcomings, and contribute to the evolution of RFID-based access control systems. The project will integrate the key learnings from related work to create a secure, efficient, and user-friendly door lock system.

Proposed Solution:

1. System Setup:

Install the RFID reader near the door entrance.
Connect the RFID reader to the microcontroller.

Attach the electric door lock to the door frame.

2. Database Setup:

Create a database to store RFID tag/card information along with user identities.
Populate the database with authorized RFID tag/card IDs and corresponding user identities.

3. Authentication Process:

When an RFID tag/card is presented to the reader, the reader sends the tag/card ID to the microcontroller.
The microcontroller checks the tag/card ID against the database.
If the tag/card ID is authorized, the microcontroller sends a signal to unlock the door.
If not authorized, access is denied.

4. User Interface:

Implement a simple user interface for system management, allowing administrators to add/remove authorized users.
Display status messages indicating whether access is granted or denied.

5. Security Measures:

Implement encryption techniques to secure communication between the RFID reader and microcontroller.
Regularly update and maintain the database to revoke access for lost or stolen RFID tags/cards.

6. Backup Mechanism:

Integrate a backup mechanism (e.g., physical key override) in case of system failure or power outage.

7. Testing and Deployment:

Thoroughly test the system in different scenarios to ensure reliability and security.
Once tested, deploy the system in the desired location.

8. Maintenance and Support:

Provide ongoing maintenance and support to address any issues or updates required.
Train users and administrators on how to use and manage the system effectively.

Aim:

The aim of the RFID door lock system project is to implement a secure and convenient access control solution using Radio Frequency Identification (RFID) technology, replacing traditional key-based mechanisms with RFID cards/tags for unlocking doors.

Objectives:

1. **Implement Access Control:** Develop a system that allows access to the door only to authorized individuals using RFID cards/tags.
2. **Enhance Security:** Improve security measures by encrypting communication between the RFID reader and microcontroller, and regularly updating the access database to revoke access for lost or stolen RFID cards/tags.
3. **Ensure Reliability:** Thoroughly test the system under various scenarios to ensure reliable performance, minimizing false positives and false negatives in access control.
4. **Provide Convenience:** Offer a convenient user experience by allowing authorized users to unlock the door with a simple tap or swipe of their RFID card/tag.
5. **Facilitate Management:** Develop a user-friendly interface for administrators to easily manage authorized users, add or remove access permissions, and monitor system status.
6. **Implement Backup Mechanism:** Integrate a backup mechanism, such as a physical key override, to ensure access in case of system failure or power outage.
7. **Deploy and Maintain:** Deploy the system in the desired location after thorough testing and provide ongoing maintenance and support to address any issues or updates required for optimal performance.

Hardware Requirements:

1. **Arduino UNO**
2. **USB 2.0 cable** (type A/B)
3. **RFID/NFC RC522 Kit** (includes reader and tags)
4. **RFID Key Fob**
5. **Solenoid Lock** (or alternative: Electromagnetic Lock)
6. **Relay**
7. **12V Power Adapter**
8. **DC Power Jack**
9. **Jumper Wires**
10. **9V Power Adapter for Arduino**
11. You can also consider purchasing the following sensor kit:

System Components:

1. **Door Lock**:
    - Arduino
    - RFID/NFC reader
    - Electromagnetic lock (or solenoid lock)
2. **Door Key**:
    - RFID tags

Software Requirements:

1. Arduino IDE

Cost Estimation:

Component - estimated cost

1. Arduino Uno R3 – 1000tk
2. RFID reader kit – 800 tk
3. Servo Motor – 200tk
4. Jumper Wires – 100tk
5. Lock – 500tk.
6. Others – 500tk

Component	Estimated Cost (in Bangladeshi Taka)
Arduino Uno R3	1000
RFID reader kit	800
Servo Motor	200
Jumper Wires	100
Lock	500

Component	Estimated Cost (in Bangladeshi Taka)
Others	500
Total	**3100**

*these are approximate prices

Work plan for proposed study with timeline:

1. **Project Definition and Scope**:
    - Define the purpose and scope of the smart door lock project.
    - Identify key features
    - **Estimated Time**: 1 week
2. **Research and Requirements Gathering**:
    - Study existing RFID-based door lock systems.
    - Understand user requirements
    - **Estimated Time**: 2 weeks
3. **Hardware Selection and Procurement**:
    - Choose suitable components
    - Purchase necessary hardware.
    - **Estimated Time**: 1 week
4. **Circuit Design and Prototyping**:
    - Create a schematic diagram for the system.
    - Build a prototype using an Arduino or similar platform.
    - **Estimated Time**: 2 weeks
5. **Software Development**:
    - Write code for RFID tag detection and authentication.
    - Implement door locking/unlocking logic.
    - **Estimated Time**: 3 weeks
6. **Integration and Testing**:
    - Assemble hardware components.
    - Test the system for reliability, security, and responsiveness.
    - **Estimated Time**: 2 weeks
7. **User Interface Design**:
    - Develop a simple user interface
    - Create a user-friendly experience for configuring access.
    - **Estimated Time**: 1 week
8. **Documentation and User Manual**:

    - Document the system architecture, components, and code.
    - Prepare a user manual for installation and usage.
    - **Estimated Time**: 1 week
9. **Deployment and Field Testing**:
    - Install the smart door lock in a real-world setting.
    - Monitor its performance and gather feedback.
    - **Estimated Time**: 2 weeks
10. **Project Completion and Handover**:
    - Address any issues or improvements based on feedback.
    - Hand over the system to the end user.
    - **Estimated Time**: 1 week

Conclusion

In this project, we successfully designed and implemented an RFID-based smart door lock system. Our goal was to create a secure, user-friendly solution that enhances convenience while maintaining robust security measures. Let's recap the key achievements:

1. **System Functionality**:
    - The smart door lock effectively detects and authenticates RFID tags, allowing authorized users seamless access.
    - The servo motor mechanism smoothly locks and unlocks the door, ensuring reliable operation.
2. **User Experience**:
    - We prioritized user-friendliness by designing a simple interface for configuring access permissions.
    - The system provides clear feedback through visual indicators (such as LEDs or an LCD display).
3. **Security Measures**:
    - Robust encryption protocols safeguard communication between the RFID reader and the microcontroller.
4. **Field Testing and Feedback**:
    - The smart door lock underwent rigorous testing in real-world scenarios.
    - User feedback helped us fine-tune the system and address any issues promptly.
5. **Future Enhancements**:
    - As technology evolves, consider integrating additional features like mobile app control or voice recognition.
    - Explore energy-efficient power management options.

In conclusion, our RFID-based smart door lock represents a successful fusion of technology, security, and convenience. We hope it enhances the safety and ease of access for users while inspiring further innovations in this domain.

References:

1. arduinogetstarted.com
2. howtomechatronics.com