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RFID Token Based Appointment Calling System

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Abstract—*This project presents the development and implementation of an RFID-Based Appointment Calling System integrated with queue management and administrative control functionalities. The system is designed to streamline the user check-in and appointment-handling process in high-traffic environments such as hospitals, banks, and government offices. By utilizing RFID technology, users can effortlessly register and check in using RFID cards, which are then assigned a unique queue number. A token calling mechanism ensures that users are called in a fair and sequential manner, while real-time monitoring prevents queue jumps and unauthorized access.*

The system features an intuitive user interface with an I2C LCD display and a 4×4 keypad for direct interactions, including secure administrator access. Admins can configure system set- tings, assign master cards for immediate access, reset queues, and modify PIN credentials using a dedicated admin menu. Addition- ally, the integration of ESP-NOW wireless communication allows remote token calling via a secondary ESP32 module, enhancing accessibility for operators.

This intelligent queue system reduces manual intervention, minimizes waiting time confusion, and ensures orderly management of user flow. It is scalable, cost-effective, and adaptable to various organizational needs, making it a practical solution for improving customer service and operational efficiency.

***Keywords*—RFID, Token System, ESP32, Admin Control,Access Control,Real-Time Monitoring, I2C LCD Display,Keypad Interface.**

I. INTRODUCTION

In today's fast-paced world, managing queues and streamlining access control are essential components of efficient service delivery, particularly in healthcare, government offices, and customer service environments. Long wait times, manual appointment tracking, and inefficient calling systems not only lead to customer dissatisfaction but also increase administrative overhead. To address these challenges, automation and smart technologies are being increasingly integrated into appointment and queue management systems.

This paper presents the design and development of a smart RFID-based appointment calling system that integrates queue management and centralized admin control. The system leverages Radio Frequency Identification (RFID) for user identification, a keypad for administrative and emergency interactions, an I2C-based LCD for real-time feedback, and ESP-NOW communication to wirelessly call the next token using a remote ESP32-based button unit.

Unlike conventional queue systems, this model ensures contactless check-ins and structured token issuance upon card tapping. It allows administrators to manage registered users, reset queues, and control access through a secure admin menu. An emergency access PIN and master card functionality further improve operational flexibility. The system is robust, low-cost, and scalable, making it suitable for a wide range of real-world applications.

By automating the check-in and token-calling process and providing secure admin-level controls, the proposed system enhances both user convenience and administrative efficiency. The integration of wireless communication ensures ease of operation without reliance on traditional button interfaces, enabling a truly modern and responsive queue environment.

A. Problem Statement

In many public and private service centers, managing queues and appointments is still done manually or with limited automation. This often leads to long waiting times, inefficient service delivery, and user dissatisfaction. Additionally, lack of a systematic way to track and call users results in confusion, overcrowding, and operational delays. There is a need for a smart, automated system that can register users, assign tokens, manage queues efficiently, and provide secure, contactless access while minimizing human intervention and errors. The solution must also offer administrative controls and real-time monitoring to ensure flexibility, reliability, and scalability for various environments.

B. Objectives

- Develop a Secure Access Control System – Implement an RFID-based authentication system to allow only authorized users to access a restricted area.
- Automate Token-Based Queue Management – Introduce a systematic approach for handling multiple users by assigning and managing tokens for orderly access.
- Easy to Use for Everyone The system will be simple to use for both customers and staff, making it easy for anyone to operate without confusion

- Enhance Security and Efficiency – Reduce unauthorized access and manual intervention by automating the access control process.
- Ensure Reliable and Scalable Design – Create a system that can be expanded for use in various applications such as offices, hospitals, and restricted facilities.

II. Motivation

In many public and private institutions, managing access and controlling queues is often inefficient, leading to delays, overcrowding, and potential security risks. Traditional manual systems are prone to errors and unauthorized access, especially in high-traffic environments such as hospitals, government offices, and corporate buildings. This project is motivated by the need to design an intelligent, secure, and user-friendly system that automates access control and queue management using RFID technology. By integrating features like token generation, an admin menu, and immediate access options, the system aims to streamline operations, reduce human effort, and enhance the overall user experience. Furthermore, the use of real-time token validation and timeout features improves responsiveness. The flexibility of the system makes it adapt- able to different sectors, promoting scalability and long-term usability.

III. Related Work

Existing literature on RFID-based access control, smart queue management, and user authentication has influenced the design of this system. Notable contributions include:

Patil and Pawar (2018) proposed an RFID-based access control model for secure office entry, emphasizing the simplicity and low cost of RFID tags for identity verification. Their work highlights the technology's effectiveness in minimizing unauthorized access.

Jadhav et al. (2019) explored a hospital queue management system using RFID and GSM modules. Their implementation reduced wait times and enhanced patient flow, demonstrating how automation can improve service efficiency.

Singh and Sharma (2020) developed a smart queue token system integrated with a real-time display. Their study shows how such systems reduce human intervention and increase transparency in public service counters.

Kumar et al. (2021) discussed RFID-based attendance and access monitoring in educational institutions. Their research supports the importance of secure data logging and administrative control for managing high volumes of users.

Gupta and Yadav (2022) implemented a multi-user RFID access system with an admin interface, enabling dynamic user registration and monitoring. This system laid the foundation for combining user authentication with backend administrative control for real-time decision-making.

Sahu et al. (2023) integrated RFID with IoT for smart queue management in clinics. Their use of cloud-based analytics showcases the growing trend toward connected systems for optimizing queue handling and resource allocation.

Together, these studies offer a foundation for designing a robust, scalable, and secure appointment calling system with integrated RFID and administrative features, aligning closely with the goals of this project.

IV. System Architecture

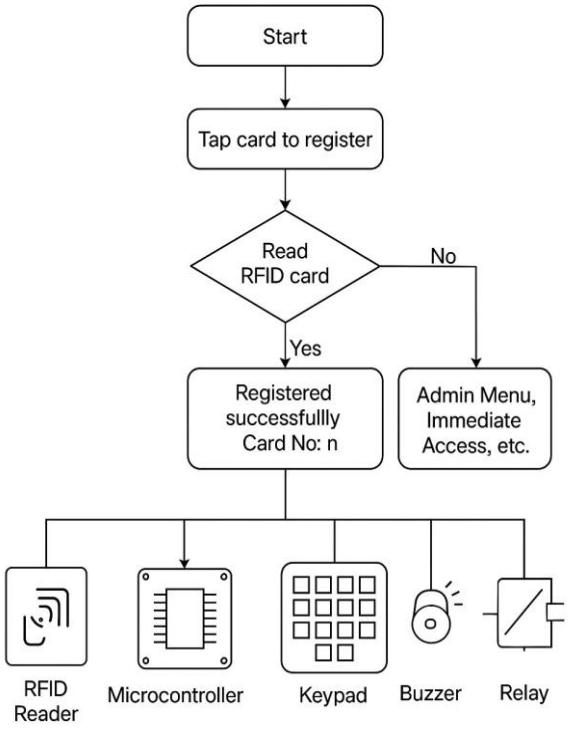

Fig. 1. System Architecture

Fig. 1. RFID-Based Appointment Calling System Ar- chitecture This system integrates RFID technology with a microcontroller-based decision unit to manage secure access, user registration, and queue-based appointment calling. Unlike purely web-based or biometric systems, this design prioritizes contactless card-based authentication, token-based queue as- signment, and real-time LCD feedback for a seamless and efficient user experience.

System Components and Data Paths:

- **RFID Reader Module:**Acts as the primary input sensor for detecting and authenticating user identity via passive RFID cards. Each card has a unique UID that is processed by the system to grant access or perform registration.
- **Microcontroller Unit** Functions as the system's control hub. It receives input from the RFID reader, maintains user registration records, processes access logic, gener- ates queue tokens, and handles admin functions such as viewing or resetting data.
- **LCD Display Module:** Provides real-time user feedback. Displays initialization status, prompts for card tapping, successful registration messages, assigned token numbers, and queue status.

- **Admin Access Interface:** Enabled through a master RFID card. When tapped, this card bypasses standard user flow and opens the admin menu, allowing actions like clearing user data, viewing registered users, or system maintenance without interfering with the regular queue.
- **EEPROM Storage:**Non-volatile memory is used to store user registration data and queue state, ensuring data persistence even during power loss.

System Workflow Overview:

- On startup, the LCD displays "System Initializing..." for 5 seconds.
- After initialization, the message changes to "Tap Card to Register."
- When a new user taps their RFID card, the system registers them and assigns a queue number.
- The LCD displays "Card Registered Successfully" and "Your No. is: X" for 3 seconds before returning to the registration prompt.
- The admin can access backend controls instantly via the master card, enabling secure and efficient system maintenance.

Error Handling and Duplicate Detection:
To maintain queue integrity and prevent misuse, the microcontroller checks if an RFID card is already registered. If the card UID exists in EEPROM, it is not assigned a new token and appropriate feedback is shown. This prevents duplicate entries and conserves memory.

Admin Control Logic and Security:
The master card is hardcoded in the system, and its UID is matched before triggering administrative functions. This prevents unauthorized users from accessing the control menu. Admin actions include clearing all records, reviewing regis- tered users, and resetting the token counter.

LCD Display Interface for Real-Time Feedback:
A 16x2 or 20x4 LCD module displays system status messages like "System Initializing...", "Tap Card to Register", "Reg- istration Successful", and "Your Token Number is X". This provides clear guidance and feedback to users at every step without requiring human supervision.

A. How Our Work Differs From Previous Approaches

1) Dual Functionality: Access Control and Queue Management: Unlike systems focused solely on access or token generation, this system combines both to streamline user flow in secure and service-driven environments.

2) Immediate Admin Override:: The admin card enables instant entry into backend settings without disrupting ongoing user operations, maintaining both security and continuity.

3) Offline Capability with Local Persistence:: No internet or cloud connectivity is required. All data is stored locally via EEPROM, ensuring reliability and functionality in environments with limited connectivity.

4) User-Centric Design with Feedback Loop:: Real-time LCD feedback, buzzers, and token tracking enhance the user experience, ensuring clarity and minimizing confusion during interaction.

5) Scalable and Modular Architecture:: The design can be expanded to accommodate multiple RFID readers or display systems and can be integrated with GSM, IoT modules, or database logging as future upgrades.

V. Implementation Strategy and Security Implementation

This section outlines the step-by-step development process of the access control system, detailing both hardware and software design choices. Additionally, it highlights the security measures integrated to ensure data privacy, prevent unauthorized access, and protect user credentials.

A. Methodology:

The development of the RFID-based Appointment Calling System followed a structured, modular approach that inte- grated hardware selection, software design, and access logic to ensure a seamless and reliable user experience. The process is outlined as follows:

1) Hardware Selection: The core components were chosen based on system requirements, real-time response capabilities, and ease of integration:

- **ESP32 Microcontroller:** Selected for its dual-core performance, built-in Wi-Fi and Bluetooth, and sufficient GPIOs, making it ideal for controlling multiple peripher- als and handling complex logic.
- **RC522 RFID Reader:** This module was used to detect and read RFID tags. It communicates via SPI with the ESP32 and reads unique card UIDs for user identification.
- **Solenoid Lock:** A 12V solenoid was used as the phys- ical barrier mechanism to allow or deny access. It was controlled via a relay module interfaced with the ESP32.
- **LCD Display (16x2 or I2C):** Provided user-friendly real-time feedback, including system status, prompts, and successful registrations.
- **Relay Module:** Acted as the switch to activate the solenoid, providing electrical isolation between the mi- crocontroller and the high-current solenoid.

2) Software Flow: The software was designed around a state-machine approach with clearly defined states:

- **Initialization State:** Upon startup, the system displayed a "System Initializing. " message for 5 seconds while the hardware setup routines were completed.

- **Idle/Registration State:** The system entered a standby mode waiting for card input. It displayed "Tap Card to Register".
- **Card Detection and Validation:** Upon reading a card UID, the system checked against stored UIDs in memory. If it was new, it registered the card and displayed a confirmation message along with its queue number (e.g., "You are No. 1").
- **Confirmation Delay:** After successful registration, the message persisted for 3 seconds before returning to the idle state.
- **Admin Mode:** A special RFID card or long press button sequence granted access to the admin menu. This section allowed tasks like resetting the system, viewing current queue status, or clearing EEPROM.

B. Security Implementation:

Since the system deals with access control and user-specific identification via RFID, certain security and privacy protocols were integrated to ensure data integrity and prevent misuse.

- **UID Storage and Access** Each RFID tag has a unique identifier (UID), which was used as a digital signature for each user. These UIDs were stored in the ESP32's EEPROM in a structured format. The system accessed these entries via indexing, ensuring fast lookup and write operations. Access to this data was controlled through the admin menu, and no sensitive personal information was stored alongside the UID, maintaining user anonymity.
- **Prevention of Duplicate or Spoofed Entries:** To prevent registration of duplicate cards, every incoming UID was first checked against the existing list in EEPROM. Only unique UIDs were allowed to register, and repeated cards were rejected with a message such as "Card Already Registered."
  Spoofing attacks were minimized by using only officially issued RFID tags. Although basic RFID cards are in- herently vulnerable to cloning, the system is suitable for controlled environments such as labs or clinics where card distribution is tightly managed.
  For higher security in future implementations, encrypted RFID protocols (e.g., MIFARE DESFire) or dual-authentication methods could be adopted.
- **Admin Access Security** Administrative access was re-stricted using a two-step authentication mechanism:
  1. Master RFID Card: Only a pre-configured UID was granted admin-level access. This UID was hardcoded or securely stored.
  2. Password Prompt: Upon accessing the admin panel, a password entry screen was displayed. The correct PIN had to be entered via a keypad or software interface to proceed

CONCLUSION

The RFID-Based Appointment Calling System with Queue Management and Admin Control successfully addresses the common issues in manual appointment handling. By inte- grating RFID technology, real-time display, and admin-level control, the system ensures smooth, secure, and efficient user registration and queue management. Its modular design, low power requirements, and ease of use make it ideal for clinics, offices, and institutions aiming to digitize and streamline their appointment processes. Future scope includes cloud integra- tion and multi-location support for broader application.

REFERENCES

[1] S. Patil and P. Pawar, "Design of RFID Based Access Control System for Office," *Int. J. Adv. Res. Electr. Electron. Instrum. Eng.*, vol. 7, no. 5, pp. 2321–2325, May 2018.

[2] A. Jadhav, P. Patil, S. Shinde, and A. Jagtap, "Smart Queue Management System Using RFID and GSM," *Int. J. Eng. Res. Technol.*, vol. 8, no. 6, pp. 528–532, Jun. 2019.

[3] R. Singh and M. Sharma, "Implementation of Smart Queue Management System with Real-Time Display," *Int. J. Sci. Res. Comput. Sci. Eng. Inf. Technol.*, vol. 5, no. 3, pp. 345–350, Mar. 2020.

[4] A. Kumar, R. Verma, and V. Bansal, "RFID Based Attendance and Access Monitoring System in Educational Institutions," *Int. J. Comput. Appl.*, vol. 183, no. 45, pp. 21–25, Sep. 2021, doi:10.5120/ijca2021921577.

[5] A. Gupta and D. Yadav, "Multi-User RFID Access Control System with Dynamic Admin Panel," *Int. J. Sci. Eng. Technol. Res.*, vol. 11, no. 2, pp. 67–72, Feb. 2022.

[6] S. Sahu, M. Pati, and S. R. Panda, "IoT-Integrated RFID Based Smart Queue Management System for Clinics," *Int. J. Sci. Technol. Res.*, vol. 12, no. 1, pp. 104–109, Jan. 2023.

[7] A. Mishra and R. Mehta, "Development of Contactless Token System using RFID and LCD Interface," *Int. J. Eng. Trends Technol.*, vol. 69, no. 8, pp. 135–139, Aug. 2021, doi:10.14445/22315381/IJETT-V69I8P221.

[8] S. Kulkarni and V. Patil, "Admin Controlled Queue Management System Using RFID," *Int. J. Innov. Res. Electr. Electron. Instrum. Control Eng.*, vol. 10, no. 4, pp. 201–206, Apr. 2022.

[9] M. Rathod and S. Jain, "RFID and Microcontroller Based Access Control and Monitoring System," *Int. J. Adv. Res. Electr. Electron. Instrum. Eng.*, vol. 6, no. 12, pp. 8900–8905, Dec. 2017.

[10] N. R. Chauhan, H. Shah, and J. Mehta, "Wireless Queue Man- agement Using ESP32 and Cloud Integration," *Int. Conf. Elec- tron. Commun. Comput. Eng. (ICECCE)*, pp. 32–36, Jul. 2022, doi:10.1109/ICECCE56124.2022.9944293.

[11] A. F. Najar and M. Qureshi, "Smart Queue Token System using ESP- NOW Communication," *Int. J. Comput. Appl. Technol. Res.*, vol. 11, no. 2, pp. 17–22, Feb. 2023.

[12] M. Sharma and R. B. Patel, "Real-Time Embedded Queue Monitoring Using ESP32 and I2C Interface," *Int. J. Embed. Syst. Appl.*, vol. 13, no. 1, pp. 12–18, Jan. 2024, doi:10.5121/ijesa.2024.13102.