

Hospital Management System using RFID Technology

Mrs. Nishaat Fatima¹, Dr. Kumaraswamy K L², Mrs. Sumaya Fathima³, Mrs. Lubna Afza⁴
Mrs. Jabeena Banu⁵

^{1,4,5} *Assistant. Professor, Department. of ECE, KNS Institute of Technology, Bengaluru*

² *Assistant. Professor, Department. of ME, KNS Institute of Technology, Bengaluru*

³ *Assistant. Professor, Department. of AIML, Impact College of Engineering and Applied Science, Bengaluru*

Abstract—The efficient management of hospitals is crucial to improving patient care, minimizing administrative errors, and enhancing staff productivity. With the increasing demand for smart healthcare solutions, Radio Frequency Identification (RFID) technology provides a promising approach for automating hospital operations. This paper presents a comprehensive RFID-based hospital management system designed to automate patient data management, staff access control, secure pharmacist access and medical equipment data management. Utilizing passive RFID tags and readers, along with a microcontroller-based control unit and a web-based interface, the system enables seamless management of hospital resources. The results demonstrate improved operational efficiency, reduced manual work, and enhanced security within the hospital premises.

Index Terms—RFID, Hospital Management, Patient Tracking, Healthcare Technology, IoT in Healthcare, Access Control, Smart Systems

I. INTRODUCTION

Hospitals are dynamic, high-pressure environments where the efficient management of patients, staff, and resources is paramount to ensuring the delivery of high-quality healthcare services. In traditional hospital settings, management systems rely heavily on paper-based records, manual tracking, and direct human interaction, which can often lead to inefficiencies, errors, and delays in critical healthcare processes. These traditional methods create bottlenecks in patient care, hinder operational workflows, and make it difficult to ensure real-time tracking of hospital resources.

The complexities of hospital management, which

include tasks like patient admission, discharge, inventory management, staff access, and medical equipment data management, have traditionally been handled through fragmented, siloed systems. These systems are prone to human error, data duplication, and slow information flow, all of which contribute to delays and inefficiencies in service delivery. The introduction of technology into healthcare management systems is no longer just an innovation but a necessity for streamlining operations, reducing errors, and improving the overall efficiency of healthcare services.

Radio Frequency Identification (RFID) technology has emerged as a powerful solution to automate identification, tracking, and data management tasks within hospital settings. RFID offers several advantages over traditional manual tracking systems, including real-time tracking of patients, staff, and hospital assets with minimal human intervention. The system integrates patient data management, allowing seamless tracking of patient identification and history, improving care delivery and reducing errors.

Moreover, RFID facilitates staff access control, ensuring that only authorized personnel can access restricted areas and sensitive patient data. The system also enhances secure pharmacist access to prescriptions, allowing pharmacists to securely retrieve medication orders and patient prescriptions, minimizing the chances of errors. Additionally, equipment data management allows for the tracking of medical equipment usage and maintenance, ensuring that necessary devices are available when needed and in optimal working conditions.

This paper explores the development and

implementation of a hospital management system that leverages RFID technology to optimize operations such as patient data management, staff access control, secure pharmacist access to prescriptions, and equipment data management, thereby improving both operational efficiency and the quality of healthcare services.

II. RELATED WORK

[1] Anagha Gharat and Dr. Gargi Phadke (2022) proposed a smart medical health card system in their paper titled Smart Medical Health Card for Hospital Management. The system uses RFID-based cards embedded with a patient's medical history to reduce paperwork and improve healthcare accessibility. Their implementation focused on using these cards for faster data retrieval during emergency cases. The research demonstrated how a smart RFID health card could be integrated with hospital databases. This solution also emphasized the need for standardization in hospital ID systems. The study validated RFID as a reliable medium for fast, secure patient identification.

[2] Vinicius Uchoa Oliveira (2022), in Applying RFID Technology to Improve Hospital Logistics, discussed how RFID enhances inventory control, asset tracking, and staff management in healthcare environments. The paper highlighted the integration of RFID with logistical operations such as drug delivery, equipment usage, and bed occupancy. Their work demonstrated how RFID could reduce operational costs and improve traceability within hospitals. The system also helped manage stock levels and reduced time spent locating critical assets. RFID was shown to improve the transparency of internal hospital workflows and logistics.

[3] Francis Ivan D. Consigma et al. (2023), in their paper Enhancing Patient Healthcare Management through RFID Technology, focused on using RFID for real-time patient tracking, medication dispensing, and movement monitoring. Their study addressed issues such as patient misidentification, treatment delays, and inefficient workflow. By introducing tag-based movement logs and automated alerts, the system improved patient safety. The research demonstrated significant improvements in reducing manual errors and communication gaps. Their model showed that RFID significantly improves service delivery in healthcare.

[4] Mahesh Babu Ammisetty and Krishna Veni Sahukara (2021) proposed COVID-SAFE, an IoT-based health monitoring solution using RFID, designed specifically for pandemic response. The system provided contactless health data tracking, minimizing physical interaction and reducing virus transmission risk. RFID tags were used to record health status, movement logs, and quarantine compliance. The model was especially useful in hospitals, isolation wards, and vaccination centers. The paper highlighted how RFID systems could support public health safety and efficient pandemic monitoring. The research illustrated how RFID could integrate with other IoT devices for scalable, real-time applications.

These studies collectively highlight RFID's versatility in healthcare—from logistics to real-time monitoring—supporting the design and implementation of our proposed hospital management system.

III. SYSTEM ARCHITECTURE

The proposed Hospital management system using RFID comprises four main modules: patient data management, staff access control, secure pharmacist access to patient's prescription and equipment data management.

A block diagram of the system shows RFID readers connected to the ESP32, which communicates with a central server to verify identities and control actions such as gate access or patient record retrieval.

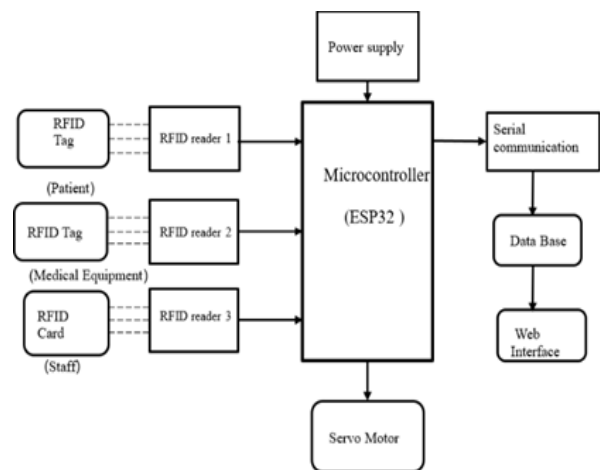


Fig: Block diagram of proposed model

A) Hardware Components:

- 1) ESP32 MICROCONTROLLER: The ESP32 is a Wi-Fi and Bluetooth-enabled microcontroller that offers higher processing power than Arduino UNO. This is used in this system for wireless data transmission to the web interface. With built-in Wi-Fi, it connects to the hospital's local network, allowing real-time updates without requiring serial cable communication. It has multiple GPIO pins, supports SPI/I2C protocols, and provides sufficient memory to handle multiple RFID reader inputs simultaneously. Its compact size and dual-core processor make it suitable for fast, scalable IoT-based hospital systems.
- 2) RFID READER (RC522): This module reads 13.56 MHz RFID tags and communicates with Arduino through SPI protocol. It detects passive tags within 3–5 cm and transmits their ID for authentication. Used at entry points for staff and patient identification.
- 3) PASSIVE RFID CARDS: These are contactless tags containing unique IDs, assigned to hospital staff, patients, and pharmacists. When scanned, their IDs are used to determine user roles and permissions.
- 4) SERVO MOTOR: The servo motor simulates gate operation. The motor rotates on valid tag detection to allow physical access.
- 5) POWER SUPPLY & BREADBOARD: A regulated 5V supply powers the components via a breadboard. The breadboard allows modular connections for prototyping and testing the circuit layout.
- 6) PERSONAL COMPUTER (PC): The PC runs the Visual Studio-based application that receives RFID data from Arduino. It displays dashboards for staff, patients, pharmacists, and equipment monitoring through a GUI interface.

B) Software Components:

- 7) ARDUINO IDE: Used for writing and uploading embedded C code to Arduino UNO. It handles tag reading, access logic, motor control and includes a serial monitor for debugging.
- 8) VISUAL STUDIO: Hosts the graphical dashboard. The interface built using Python, HTML, and CSS, receives RFID data via serial communication and displays relevant hospital

data.

- 9) PYTHON: Used for backend logic to process serial data from Arduino, compare tag IDs, and trigger GUI updates. Python also manages access logging and prescription data display.
- 10) HTML & CSS: HTML structures the web dashboard content while CSS styles the interface. Together, they form an intuitive interface for displaying login, access status, and patient prescription panels.

IV. METHODOLOGY

The proposed Hospital Management System using RFID was developed through a structured multi-phase approach that integrates hardware interfacing, embedded programming, and software dashboard development.

In the initial phase, hardware components such as the ESP32, RFID readers (RC522), passive RFID tags, servo motor, and power supply circuits were assembled on a breadboard. Each RFID tag was uniquely assigned to hospital personnel, including staff, patients, and pharmacists. The ESP32 facilitated wireless communication with the hospital's local network, while it was also responsible for real-time tag detection and control of the servo motor.

The RFID readers were strategically placed at key access points, allowing the scanning of RFID cards. Upon scanning, the unique tag ID was processed by the ESP32, and access was either granted or denied based on predefined roles (staff, patient, pharmacist, etc.). The servo motor was used to simulate physical gate movement for staff entry, ensuring only authorized personnel could access restricted areas.

On the software side, the Arduino IDE was used to upload embedded C code to the ESP32. Visual Studio was used to build a graphical user interface, with Python as the backend and HTML/CSS for frontend design. The dashboard received data from the microcontroller via serial or Wi-Fi communication, processing and displaying patient information, access logs, and equipment status.

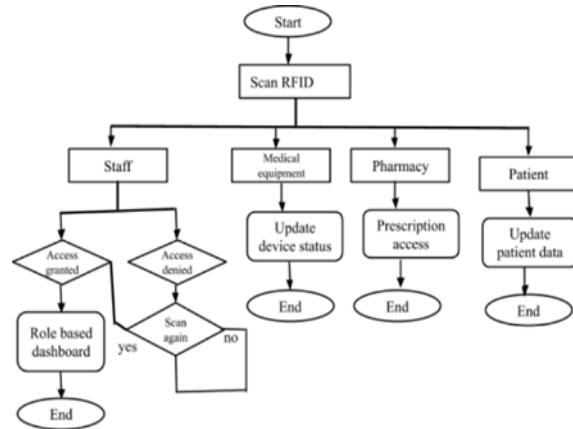
- Patient Data Management: Each patient was assigned an RFID tag, which contained essential personal and medical data linked to their unique

ID. When the patient's RFID tag is scanned, the system displays their medical history, ensuring healthcare providers have instant access to vital information for decision-making.

- **Staff Access Control:** The RFID system controls access to restricted areas based on staff roles. Authorized staff members are granted access when their RFID tag is scanned, and unauthorized access attempts are logged and monitored. The servo motor ensures that physical gates are unlocked only for valid entries, thus enhancing security.
- **Secure Pharmacist Access to Patient Prescriptions:** RFID tags are also issued to pharmacists, allowing them secure access to prescription data. Only authorized pharmacists can retrieve prescription orders linked to patients, minimizing the risk of medication errors. This ensures that medications are dispensed correctly according to the patient's medical needs.
- **Equipment Data Management:** Medical equipment in the hospital is tagged with RFID labels to track their usage and status. The system displays real-time equipment availability, ensuring that staff can easily locate and manage devices like infusion pumps or wheelchairs. Additionally, the system tracks equipment maintenance schedules, alerting staff when routine checks or repairs are due.

To ensure system robustness, a series of test cases were executed, simulating both valid and invalid access attempts, patient record retrieval, and pharmacist login. The system performed consistently under stress conditions with minimal latency. These tests confirmed that the integration of RFID hardware with real-time data display on a local interface improved operational transparency. Furthermore, the modular nature of the system allows for scalability, enabling future integration with cloud databases, biometric security, or mobile platforms. This methodology ensures reliable hardware-software synchronization, promoting smart healthcare automation.

V. FLOW CHART



VI. IMPLEMENTATION

A prototype model was developed to validate the Hospital Management System using RFID technology. The setup focuses on patient data management, staff access control, secure pharmacist access to prescriptions, and equipment data management.

The central component of the system is the ESP32 microcontroller, which interfaces with three RC522 RFID readers via the SPI communication protocol. These readers are responsible for scanning RFID tags on patients, staff, and equipment. The servo motor is used for staff access control, unlocking doors when authorized RFID tags are detected.

The RFID system also handles patient data management by tracking patient identification and medical history stored on RFID tags. For secure pharmacist access to prescriptions, only authorized RFID tags allow access to prescription data, reducing the risk of medication errors. Equipment data management is achieved by tagging hospital assets with RFID, enabling real-time tracking of equipment location and usage.

The system is connected to a laptop hosting the web application interface, which allows real-time monitoring of patient data, staff access, prescription logs, and equipment status. The application provides an interactive platform for managing hospital operations efficiently and securely.

The complete experimental setup is illustrated in the figure below

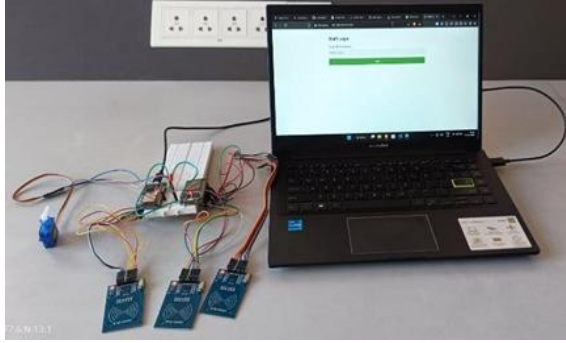


Fig: Experimental setup of Hospital Management System using RFID

VII. RESULTS AND FUTURE SCOPE

The system was rigorously tested under various scenarios to evaluate its performance. The RFID readers successfully identified authorized tags, leading to servo motor actuation and granting access. Unauthorized tags were denied access, ensuring system reliability and security. The developed web dashboard efficiently captured and displayed real-time data including staff login credentials, patient information, and entry-exit logs.

Key observations include:

- Successful RFID authentication within 1–2 seconds of scanning.
- Real-time updating of staff attendance and patient data.
- Reliable servo motor actuation for entry control without noticeable delay.
- Pharmacists were provided with RFID-based access to patient prescriptions through the web dashboard.
- Equipment data was managed through RFID tags, indicating whether a device was operational or under maintenance.

Representative screenshots of the developed web interface are shown below:

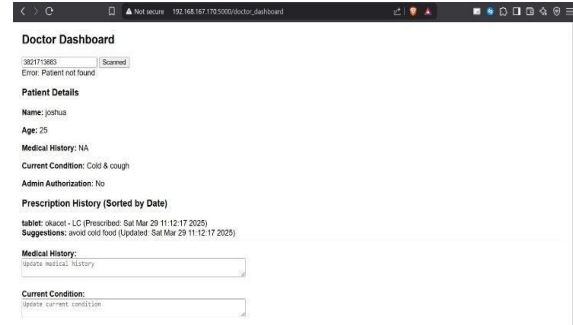


Fig: Patient information dashboard showcasing real-time retrieval of registered patient details upon RFID tag scanning.

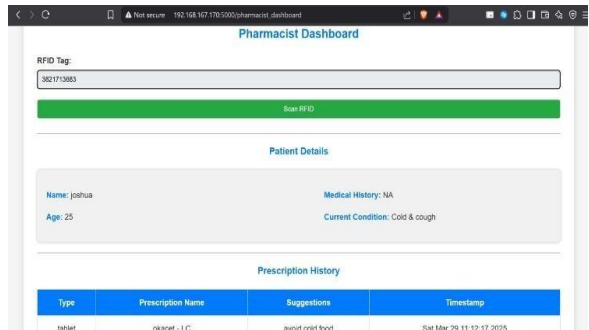


Fig: Pharmacist Dashboard displaying patient prescription upon RFID authentication



Fig: Serial Monitor output displaying staff access status based on RFID tag (Access Granted/Denied)

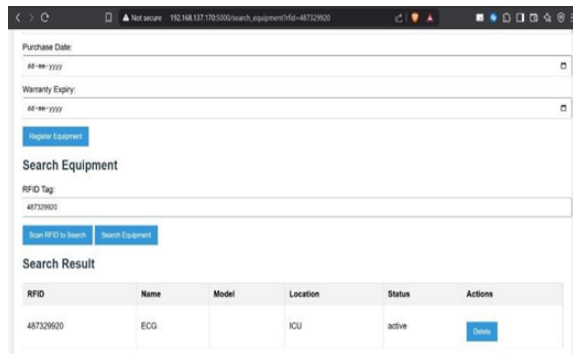


Fig: Equipment Data Dashboard displaying usability status and service history of medical devices

VIII. FUTURE SCOPE

The proposed Hospital Management System using RFID Technology offers several opportunities for future enhancement and scalability:

- **Cloud Integration:** Future versions can integrate cloud-based storage to allow secure, centralized access to patient records and logs across multiple hospital branches.
- **Mobile Application Support:** A dedicated mobile app can be developed for staff and administrators to view real-time data, receive alerts, and manage hospital operations remotely.
- **Biometric Authentication:** Combining RFID with biometric verification (e.g., fingerprint or facial recognition) can further strengthen access control and identity validation.
- **AI-Based Predictive Maintenance:** Using AI algorithms, equipment data can be analyzed to predict maintenance needs before failures occur, improving hospital efficiency and safety.
- **Integration with National Health Portals:** Linking with government or insurance health databases could streamline patient record management and facilitate automated billing.

IX. CONCLUSION

This paper presents the design and implementation of an RFID-based hospital management system aimed at enhancing operational efficiency, security, and real-time resource monitoring within healthcare environments. By leveraging low-cost passive RFID tags and a microcontroller-based architecture, the system effectively automated critical hospital

functions such as staff access control, patient information retrieval, and medical equipment status tracking.

Experimental validation demonstrated that the system performs reliably under real-world scenarios, with fast and accurate RFID authentication and seamless integration between hardware and software. The inclusion of a Visual Studio-based admin dashboard enabled real-time visibility into hospital operations, including pharmacist access to patient prescriptions and equipment usability data, ensuring that essential resources are properly tracked and managed.

The solution stands out for its simplicity, affordability, and adaptability to various healthcare settings, particularly in small to mid-sized hospitals seeking a smart yet economical management system. Future work may explore enhancements like cloud data synchronization, role-based access control, biometric integration, and mobile accessibility to increase scalability, security, and usability even further.

REFERENCES

- [1] Anagha Gharat, Dr. Gargi Phadke, "Smart Medical Health Card for Hospital Management", 2022 2nd Asian Conference on Innovation in Technology (ASIANCON)
- [2] Vinicius Uchoa liveira, "Applying RFID Technology to Improve Hospital Logistics" 2022 IEEE 12th International Conference on RFID Technology and Applications (RFID- TA)
- [3] Francis Ivan D. Consigma, Arnold C. Paglinawan and Charmaine C. Paglinawan, "Enhancing Patient Healthcare Management through Radio Frequency Identification (RFID) Technology", 2023 IEEE 15th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM)
- [4] Mahesh Babu Ammisetty, Krishna Veni Sahukara, "COVID-SAFE: lot Based Health Monitoring System using RFID in Pandemic Life", 2021 IEEE International Conference on RFID Technology and Applications (RFID- TA)
- [5] A. Abugabah, N. Nizamuddin and A. Abuqabbeh, "A review of challenges and barriers implementing rfid technology in the healthcare sector", *Procedia Computer Science*, vol. 170, pp. 1003-1010, 2020.

- [6] M. Rajak and K. Shaw, "An extension of technology acceptance model for health user adoption", *Technology in Society*, vol. 67, pp. 101800, 2021.
- [7] M. Haddara and A. Staaby, "Rfid applications and adoptions in healthcare: a review on patient safety", *Procedia computer science*, vol. 138, pp. 80-88, 2018
- [8] N. S. Sworna, A. M. Islam, S. Shatabda and S. Islam, "Towards development of iot-ml driven healthcare systems: A survey", *Journal of Network and Computer Applications*, vol. 196, pp. 103244, 2021
- [9] A. Nath, M. Ashraf-Ur-Rahman, M. A. Kader, K. M. H. Muttaqui, M. E. Alam and Y. Arafat, "Development of a wireless Automotive Health Monitoring System for Doctor's Chamber", 2019 10th International Conference on Computing Communication and Networking Technologies (ICCCNT), pp. 1-5, 2019.
- [10] MM Islam, A Rahaman and MR Islam, "Development of Smart Healthcare Monitoring", *Computer Science*, 2020.