

Smart RFID and IoT-Based Patient Monitoring Systems in Modern Healthcare

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ABSTRACT

Radio Frequency Identification (RFID) is used to identify the characteristics of an object wirelessly using radio waves. This project combines the power of RFID technology with real-time health monitoring in a hospital setting. Utilizing RFID tags for patient identification and asset tracking, the system seamlessly integrates with temperature sensor, blood pressure sensor and SpO2 sensor. The collected data is then transmitted to an Internet of Things (IoT) platform for continuous monitoring. The system not only ensures accurate patient identification and efficient asset management, but also provides real-time oxygen saturation, blood pressure rate and temperature data. This information is displayed on the LCD screen, offering healthcare professionals immediate insights into patient health. This innovative solution enhances patient care, promotes proactive medical interventions, and exemplifies the IOT in advancing healthcare.

Keywords-- Continuous Monitoring, Radio frequency Identification, Temperature, Blood Pressure, Oxygen Saturation

At the core of this transformative technology lies RFID, a wireless communication technology that utilizes electromagnetic fields to automatically identify and track tags attached to objects. In the context of healthcare, this synergy has paved the way for a myriad of groundbreaking applications. One of the most significant applications of IoT-based smart RFID in healthcare is patient management. By deploying RFID-enabled wristbands or tags, healthcare facilities can accurately identify and track patients throughout their entire journey within the facility. From admission to discharge, this technology ensures efficient patient flow, reduces wait times, and minimizes errors in medication administration and treatment procedures.

Moreover, IoT-based RFID systems play a vital role in asset tracking and management within healthcare facilities. Medical equipment, supplies, and medication can be equipped with RFID tags, allowing staff to monitor their location, usage, and maintenance status in real-time.

This not only prevents loss and theft but also optimizes inventory levels, ensuring that essential resources are always available when needed. Additionally, RFID-enabled tracking of surgical instruments and implants enhances patient safety by ensuring the correct items are used during procedures, minimizing the risk of errors and complications.

I. INTRODUCTION

In recent years, the healthcare industry has witnessed a paradigm shift with the integration of Internet of Things (IoT) technologies, particularly Radio Frequency Identification (RFID) systems. These systems have empowered healthcare providers with innovative solutions to streamline operations, enhance patient care, and improve overall efficiency. Among these advancements, IoT-based smart RFID applications stand out as a beacon of progress, offering unparalleled benefits in patient management, asset tracking, and beyond.

II. SYSTEM ARCHITECTURE

The system architecture for our RFID application in healthcare project is a sophisticated integration of IoT and multiple modules to ensure robust functionality and seamless integration across various components.



Figure 1: System Modules and Streamline Workflow

2.1 Sensor Module

A sensor module is a compact unit that integrates various components necessary for sensing and measuring specific physical parameters. These modules are designed for easy integration into electronic systems, devices, or equipment, simplifying the process of incorporating sensing capabilities into a product.

2.2 Arduino to NodeMCU Module

The term "Arduino to NodeMCU module" typically refers to a communication interface or adapter that allows Arduino-compatible shields, sensors, or modules to be easily interfaced with a

NodeMCU board. This module may include voltage level shifters, pin mappings, and other circuitry to ensure compatibility between the different hardware platforms. It simplifies the process of integrating Arduino-compatible hardware with NodeMCU-based projects, enabling developers to leverage the strengths of both platforms in their IoT applications.

2.3 IoT Source Code Modules

These modules are modular components within an IoT applications codebase, each serving specific function to facilitate device operation, data handling, and communication with other systems. Here's a concise overview of key modules typically found in IoT source code:

2.3.1 Setup Module

Initializes IoT device parameters, including Wi-Fi connectivity, sensor configurations, and device registration with IoT platforms.

2.3.2 Data Acquisition Module

Collects sensor readings and input data from connected devices, processing and preparing them for transmission.

2.3.3 Data Transmission Module

Sends collected data to cloud services, IoT platforms, or remote servers using various communication protocols such as MQTT, HTTP, or CoAP.

2.3.4 Control Module

Facilitates remote control and actuation of connected devices based on received commands or predefined rules, enabling interaction with the IoT system

2.2 Cloud Storage Module

The cloud storage module in IoT systems securely stores and manages data collected from connected devices in remote servers. It facilitates data ingestion, persistence, and retrieval, ensuring scalability to accommodate growing data volumes. Integrating robust security measures, it enables access control and encryption to safeguard sensitive information. Cloud storage enhances accessibility, allowing users to analyze IoT data from anywhere, while its scalability and

reliability reduce infrastructure costs and maintenance overheads. Overall, it serves as a flexible and efficient solution for storing and managing vast amounts of IoT-generated data.

III. LITERATURE SURVEY

This paper showcase review according to reach of paper and will understand ability research paper with recent technologies implementation and top listed here.

[1]A Review of RFID-based Internet of Things in the Healthcare Area, the New Horizon of RFID Ibtissame Bouhassoune, Hasna Chaibi, Abdellah Chehri, Rachid Saadane Procedia Computer Science 207, 4151-4160, 2022 .This research summarizes the fundamentals of the Internet of Things (IoT) based RFID technology. RFID sensors are critically compared by separating them into near-field and far-field configurations. The two categories are then analyzed for their operating mechanism. RFID sensing via tags equipped with chips is now a sophisticated technological device that continuously increases its presence in the market and several application scenarios; therefore, adopting RFID tag sensors for healthcare applications is discussed in this work.

[2]IoT based on secure personal healthcare using RFID technology and steganography Haider Ali Khan, Raed Abdulla, Sathish Kumar Selvaperumal, Ammar Bathich International Journal of Electrical and Computer Engineering 11 (4), 3300, 2021, the "Internet of Things (IoT) enables the connection of smart objects to the internet, revolutionizing the medical field by using sensors like RFID technology for health monitoring. Researchers are exploring more IoT applications in healthcare using RFID to collect real-time data". A two-level secured platform using RFID and Steganography enhances data security for user health analysis. Privacy concerns are addressed through this technology. A smart healthcare medical box with health measuring sensors has been developed for real-time data analysis.

[3]Rfid based smart healthcare system: A survey analysis,RKAR Kariapper, MS Suhail Razeeth, P Pirapuraj, ACM Nafrees Test Eng. Manag 83, 4615-4621, 2020 -The advanced enhancements in innovation and the openness of the Internet make it conceivable to connect distinctive devices that can communicate among them. Nowadays smart devices close most of the gaps in different domains including medicine too. Radio Frequency Identification (RFID) adds essence for uninterrupted communication to these smart devices as well as the technology too.

[4]Rfid-based solutions for smarter healthcare Cristina Turcu TurcuarXiv preprint arXiv:1705.09855, 2017- This paper proposes the application of RFID technology in healthcare industry based on its increased

functionality, high reliability, easy-to-use capabilities and low cost. After a brief presentation of RFID technologies and their applications, the paper describes an RFID-based system that can provide efficient facilities to allow essential information management for emergency care across hospital boundaries. This system performs RFID-based identification of the patients, querying and retrieving medical data from various existing healthcare information systems, as well as storing and giving the most clinically significant information to the clinicians. Also, the system allows identifying and tracking RFID- tagged objects in order to provide new quality services for the mobility of objects.

IV. PROPOSED WORK

This project is the implementation of RFID technology in healthcare settings offers numerous benefits, including the assignment of unique RFID tags to patients. These tags, which contain patient identifiers, can be embedded in wearable devices or attached to medical equipment for easy tracking and identification. Furthermore, the integration of RFID-enabled temperature sensors, blood pressure sensors, and pulse oximeter sensors allows for the continuous collection of vital health data. By deploying RFID readers in healthcare facilities or patient environments, data can be wirelessly captured from RFID tags on wearable devices or medical equipment, providing healthcare professionals with real-time information to improve patient care and outcomes.

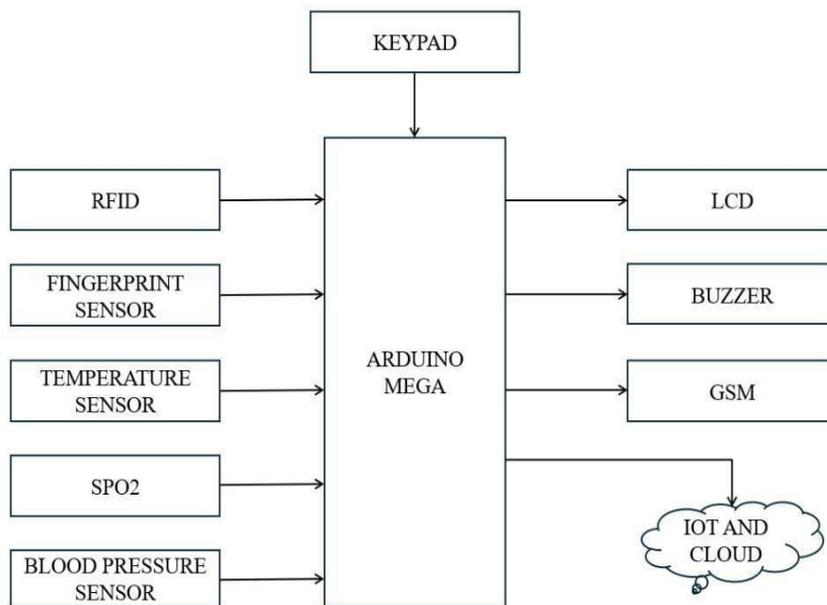


Figure 2: System Integration Block Diagram

The transmission of the collected data wirelessly from RFID readers to a centralized IoT platform using protocols such as Wi-Fi, Bluetooth, or cellular connectivity is a crucial aspect of modern healthcare technology. This process allows for the secure storage of transmitted data in the cloud, enabling centralized access and analysis by healthcare providers.

By leveraging this technology, healthcare professionals can remotely monitor patients' vital signs in real-time through a web-based dashboard or mobile application connected to the IoT platform. This level of connectivity and data accessibility enhances patient care and enables timely interventions to improve health

outcomes.

V. RESULTS AND DISCUSSIONS

The results of the study indicate significant improvements in several areas following the implementation of the IoT-based smart RFID application. Moreover, the real-time data provided by the system facilitated proactive maintenance of medical devices, reducing downtime, and ensuring their availability when needed.

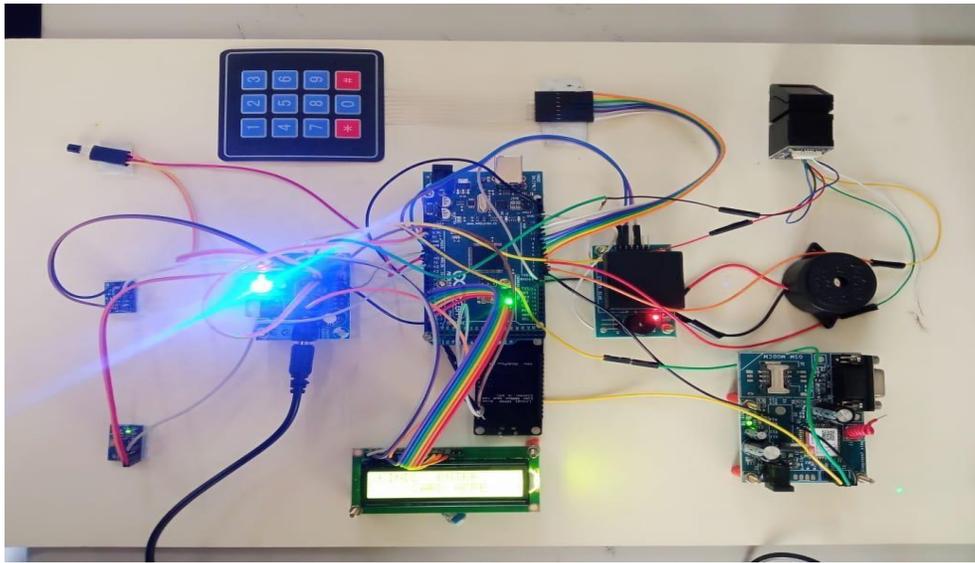


Figure 3: Prototype

The findings of this project underscore the potential benefits of integrating IoT with RFID technology in healthcare settings. By providing real-time visibility into assets, patients, and workflows, the system enables healthcare providers to make informed decisions, optimize resource allocation, and improve overall operational efficiency. However, several challenges were encountered during the implementation process, including interoperability issues, data privacy concerns, and the need for staff training. Addressing these challenges will be crucial for the widespread adoption and long-term success of IoT-based smart RFID applications in healthcare.

VI. CONCLUSION

In conclusion, the results of this study demonstrate the effectiveness of an IoT-based smart RFID application in improving various aspects of healthcare delivery. While challenges exist, the potential benefits justify further investment and research in this area. By leveraging IoT technology and RFID systems, healthcare facilities can enhance patient care, streamline operations, and ultimately, improve outcomes for both patients and providers.

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