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IoT-Based Smart RFID Application in Healthcare

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Abstract

The Internet of Things has become a promising technology in recent years that expands the idea of the internet and makes it more widespread, enabling smooth communication between all kinds of devices. To connect "Everything" and make it smarter, the Internet of Things plays several roles, including identification, information gathering, exchange and processing, decision-making, and security. Two important technologies that facilitate intelligent decision-making across a range of applications are cloud computing and artificial intelligence. However, the accuracy and dependability of these technologies rely on vast amounts of data from numerous sensors, which can only be accomplished with the advent of communication technologies, such as wireless sensor networks, radio frequency identification, and 5G. Radio frequency identification uses radio waves to wirelessly identify an object's properties. This project combines the power of radio frequency identification technology with real-time health monitoring in a hospital setting. Utilizing radio frequency identification tags for patient identification and asset tracking, the system seamlessly integrates with a temperature sensor, blood pressure sensor, and SpO_2 *sensor. For ongoing monitoring, the gathered data are then sent to an Internet of Things platform. 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. These data are shown on an LCD screen, providing medical practitioners with real-time patient health insights. This innovative solution enhances patient care, promotes proactive medical interventions, and exemplifies the Internet of Things in advancing healthcare.*

Keywords: Continuous monitoring, radiofrequency identification, temperature, blood pressure, oxygen saturation

INTRODUCTION

The incorporation of Internet of Things (IoT) technologies, especially Radio Frequency Identification (RFID) devices, has caused a paradigm shift in the healthcare sector in recent years. These platforms have given healthcare providers access to creative ways to improve patient care, expedite processes, and boost overall effectiveness. 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 [1–4].

The IoT has been the subject of extensive research, with the goal of using it to wirelessly and continually collecting data that is dispersed throughout the healthcare industry. With the use of IoT in the healthcare industry, which is characterized by medical sensors, computers, and communication technology for healthcare services developed by researchers. Remote monitoring has

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become a significant tool for social media corporations in recent years. RFID has gained popularity in recent years for automatic identity and data collecting [5–13]. Numerous sectors use and produce RFID technology for retail and logistics, but it has nothing to do with medical devices. The IoT and the proliferation of low-cost medical sensors, including wearable, environmental, and implanted ones, have the potential to manage and generate medical knowledge. The objective of the contemporary study is to use received electromagnetic waves to extract physical information about tags [6]. Therefore, regarding quantification, RFID offers effective means of a person interacting with their surroundings in the last meters of the IoT [5]. An RFID system with a battery-powered environment will be a wearable smart IoT gadget that supports assistance services via the reader's network. Therefore, regarding quantification, RFID offers effective means of a person interacting with their surroundings in the last meters of the IoT [5]. An RFID system with a battery-powered environment will be a wearable smart IoT gadget that supports assistance services via the reader's network. RFID, a wireless communication technology that uses electromagnetic fields to automatically identify and monitor tags attached to things, is at the heart of this revolutionary technology. This collaboration has opened the door for numerous innovative applications in the healthcare industry. Patient management is one of the most important uses of IoT-based smart RFID in healthcare. By deploying RFID-enabled wristbands or tags, healthcare facilities can accurately identify and track patients throughout their entire journey within the facility. This system guarantees effective patient flow from admission to discharge, cuts down on waiting times, and minimizes mistakes in treatment and drug delivery [7].

Additionally, IoT-based RFID devices are essential for managing and tracking assets in healthcare institutions. RFID tags can be added to medical supplies, equipment, and medications so that personnel can track their location, use, and condition 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 [9, 12].

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. System modules and streamline workflow are shown in Figure 1.

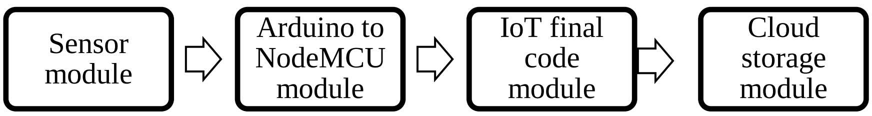

Figure 1. System modules and streamline workflow.

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 [8].

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 [10].

IoT Source Code Modules

These modules are modular components within an IoT applications codebase, each serving a 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.

Setup Module

Initializes IoT device parameters, including Wi-Fi connectivity, sensor configurations, and device registration with IoT platforms [11].

Data Acquisition Module

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

Data Transmission Module

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

Control Module

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

Cloud Storage Module

The cloud storage module in IoT systems securely stores and manages data collected from connected devices in remote servers. It makes data ingestion, persistence, and retrieval easier while guaranteeing scalability to handle increasing data quantities. By incorporating strong security mechanisms, it makes encryption and access control possible to protect sensitive data. Cloud storage enhances accessibility, allowing users to analyze IoT data from anywhere, while its scalability and reliability reduce infrastructure costs and maintenance overheads. All things considered, it offers a versatile and effective way to store and handle enormous volumes of data produced by the IoT.

LITERATURE SURVEY

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

It is now possible to connect different gadgets that may communicate with each other because of the internet's openness and sophisticated innovations. These days, smart devices fill in most gaps in a variety of fields, including medicine. RFID is essential to the technology and continuous connectivity of these smart gadgets [1].

The foundations of RFID technology based on the IoT are summed up in the study of Bouhassoune et al. By dividing RFID sensors into near-field and far-field configurations, a significant comparison is made. The working mechanism of the two groups is then examined. The use of RFID tag sensors for healthcare applications is covered in this study since RFID sensing through chip-equipped tags is currently a sophisticated technical gadget that is steadily growing in market share and application situations [2].

Based on enhanced functionality, high dependability, low cost, and ease of use, this article suggests using RFID technology in the healthcare sector. Following a brief overview of RFID technologies and their uses, the paper goes on to discuss an RFID-based system that can offer effective features that enable critical data management for emergency treatment across hospital boundaries. In addition to identifying patients using RFID technology, this system queries and retrieves medical data from a variety of current healthcare information systems and stores and provides the info that is most clinically relevant to the physicians. To offer novel, high-quality services for item mobility, the system also enables the identification and tracking of RFID-tagged objects.002E [3].

The "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 by H. Khan et al. [5].

PROPOSED WORK

This project is the implementation of RFID technology in healthcare settings and 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. The system integration block diagram is shown in Figure 2.

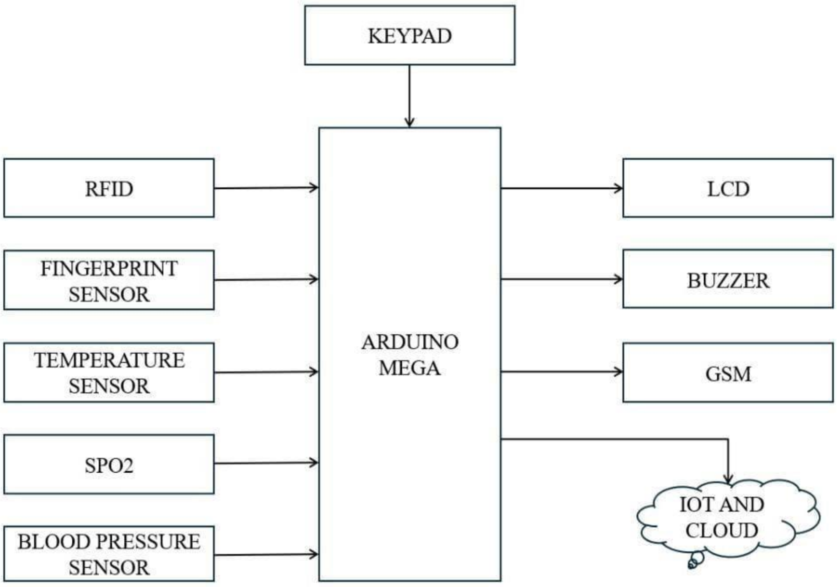

Figure 2. System integration block diagram.

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 [13].

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.

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. The prototype circuit is shown in Figure 3.

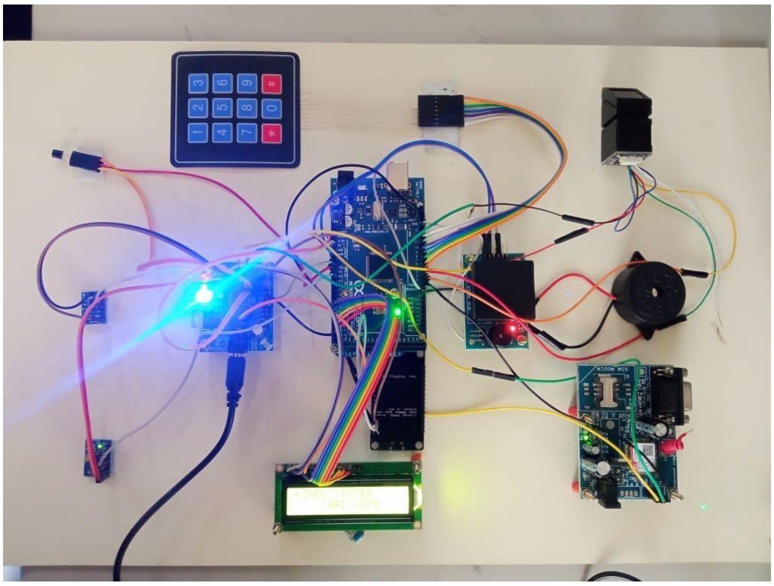

Figure 3. Prototype circuit.

The findings of this project underscore the potential benefits of integrating IoT with RFID technology in healthcare settings. The solution gives healthcare providers real-time insight into patients, assets, and workflows, which helps them make better decisions, allocate resources more efficiently, and run their businesses more effectively overall. However, several challenges were encountered during the implementation process, including interoperability issues, data privacy concerns, and the need for staff training. For IoT-based smart RFID solutions in healthcare to be widely adopted and successful in the long run, these issues must be resolved.

CONCLUSIONS

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. Healthcare institutions may improve patient care, expedite processes, and ultimately improve results for patients and providers by utilizing RFID systems and IoT technology.

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