IOT BASED SMART BLOOD BANK SYSTEM

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Abstract—– *The unit which administers and manages the requisition is named as a blood bank. The main objectives of the blood banks are providing blood to the patients with minimal blood transfusion error. The blood is very important medical supplies so it should be managed well. As the blood bank management consists of a number of manual steps, therefore it will become difficult for the blood banks to provide a high level of accuracy, reliability, automation in blood storage and transfusion process. The system proposed is divided into three segments, the first segment consists Temperature sensor, Weight sensor nodes which is installed in rack of blood bank, and the GSM Module for sending request of blood to the donors and blood banks all these are interfaced with Arduino Uno. Second segment consists of Wi-Fi module for data transfer to the server and third segment is displaying the status of available blood stock. All the real time status relates to the available blood stock of the blood bank is are displayed on webpage, so that the blood seeker can get the blood from their nearest blood bank.*

Keywords—Blood bank, blood transfusion, Temperature Sensor, Weight sensor, GSM Module, Arduino, Wi-Fi Module, Web page.

I. INTRODUCTION

In today's healthcare landscape, the efficient management of blood resources is crucial for saving lives and ensuring timely access to blood transfusions. However, many blood banks still rely on outdated manual processes, leading to inefficiencies in blood inventory management, donor registration, and blood distribution. These challenges highlight the need for innovative solutions to modernize blood bank operations and enhance patient care.

This study addresses these challenges by introducing a comprehensive blood bank management system leveraging Internet of Things (IoT) technology and web-based interfaces. The main objective of this study is to streamline the blood banking process, and enhance donor management through a user-friendly and automated system. At the core of this study lies the integration of IoT devices, including Arduino microcontrollers and GSM modules, which enable real-time monitoring and data transmission. These devices are deployed within the blood bank infrastructure to collect and transmit data related to blood inventory levels, donor registrations, and blood distribution activities.

The scope of this study consists of several key components. First, an Arduino-based monitoring system incorporates sensors to monitor temperature, humidity, and inventory levels within the blood bank storage facilities. These sensors continuously collect data, which is then transmitted to the central server for analysis and processing. Second, GSM modules facilitate seamless communication and data transfer. The advancement offered by this study is a user-friendly web interface developed using HTML, CSS, HTTP and PHP framework, providing blood bank staff with access to real time data and management functionalities. This interface allows users to monitor blood inventory levels, register donors, schedule appointments, and track blood distribution activities. Additionally, MySQL database is employed to store and manage critical data, including donor information, blood inventory records, and transaction history, ensuring data integrity and providing a robust foundation for reporting and analytics.

By implementing, blood bank facilities can significantly enhance their operational efficiency, reduce manual errors, and improve overall healthcare delivery. The automation of key processes such as inventory management and donor registration minimizes administrative burden on staff, allowing them to focus more on patient care. Additionally, the real-time monitoring capabilities provided by this study enable proactive decision-making and ensure timely response to blood supply demands.

II. LITERATURE REVIEW

Every year the nation requires about 4 Crore units of blood, out of which only a meagre 40 Lakh units of blood are available. There are multiple blood banks around the world, however none of them offer the capability for a direct contact between the donor and recipient. A blood donation occurs when a person voluntarily has blood drawn donating blood may be of whole blood (WB), or of specific components directly.

Today in the developed world most blood donors are unpaid volunteers who donate blood for a group supply. Donor can also have blood drawn for their future use. Today web-based application has become a part of our daily life. With the revolution in technology many features were added to the field. This web application is developed to easily search the blood donor nearby at any emergency. Those who have registered in this app, their location, contact number and blood group along with other details with be displayed. The proposed work aims at servicing the persons who seek donors who are willing to donate blood and also provide it in the time frame required. This application allows donor to register their details such as their locality, weight, contact info etc. Direct involvement of the donor and the seeker saves time and life as sometimes the required blood may not be available in the blood bank and also the seeker has to purchase the blood required in the time of emergency.

Vedant Satpute, Sakshi Patil, Swaroop Taral, Viresh Kadam, the students at Vishwakarma Institute Of Information Technology Pune, in their paper, he proposed the design and implementation of a blood bank management system using a Database Management System (DBMS) and Java Database Connectivity (JDBC). The system will help in the efficient management of blood donations and blood samples. The system will also allow for tracking of donor information, blood types, and inventory records. The system is implemented in Eclipse IDE and provides an easy-to-use interface for managing blood donations and monitoring inventory levels.

Four students at Department of Internet of Things in Seshadri Rao Gudlavalleru Engineering College, Gudlavalleru, in their paper published at Journal of Emerging Technologies and Innovative Research (JETIR) traced the implementation of IOT for monitoring and preventing blood bank system crisis. Utilizing the hardware components Arduino Uno, Node MCU, GSM Module, DHT11 Temperature sensor, 2x16 LCD Display, Load Cell and the software setup for this system primarily involves the development of a web-based interface using Flask, HTML5, and CSS. This results the web page to display the number of bloodbags, donor details like name, age, email, contact number and blood group and the donor will receive the SMS alert about the availability of blood units.

M. Krishna and S. Nagaraju in 2016 at international conference of Inventive Computation Technologies (ICICT), Coimbatore, India in their paper "Design and Implementation of Short Message Service (SMS) Based Blood Bank using Raspberry pi, GSM module, data base packet count module, where blood available at blood bank then the receptor will get contact details of the bank' otherwise; he gets the contact numbers of the registered donors from the database.

Sara. A. Hashim, Afnan M. Al-Madani, Bayan S. Bashamakh, Nahla Aliojo at Computing and Information Technology in King Abulaziz University, Jeddah, Saudi Arabia in their paper 'Online Blood Donation Reservation and management in Jeddah' uses the waterfall methodology for clear objectives and goals of the system for each phase of the system development life cycle. The most important steps to build the blood bank website are: Initial stage, Design stage, Implementation stage.

III. Methodology

The development of a Smart Blood Bank Management System involves a systematic approach aimed at leveraging IOT (Internet of Things) technology to automate blood bank operations, enhance resource management, and improve donor engagement. Our work focuses on integrating various hardware and software components to create an efficient and effective system for managing blood bank facilities.

Hardware Aspects:

The Smart Blood Bank Management System utilizes key hardware components to enable efficient blood bank operations. Central to the system is the Arduino UNO R3 microcontroller, supported by modules such as GSM and Wi-Fi for communication. An LCD display provides real-time data, while sensors monitor blood inventory and storage conditions. Interconnected via jumper wires, these components ensure seamless functionality, backed by a stable power supply for uninterrupted operation. This setup forms the backbone of the system, enabling streamlined management and communication within blood bank.

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Figure 1.Arduino Uno R3

The Arduino UNO is powered through a USB connection or an external power supply, providing flexibility in deployment. Its onboard voltage regulator ensures stable operation across a wide range of input voltages, making it suitable for various power sources.

In the Smart Blood Bank Management System, the Arduino UNO is connected to essential components such as the GSM module, ESP8266 Wi-Fi module, LCD display, and sensors. It acts as the central hub for data acquisition, processing, and communication, orchestrating the interaction between these components to enable efficient blood bank management. Through its robust hardware and flexible programming capabilities, the Arduino UNO serves as the backbone of the system, facilitating seamless integration and reliable operation.

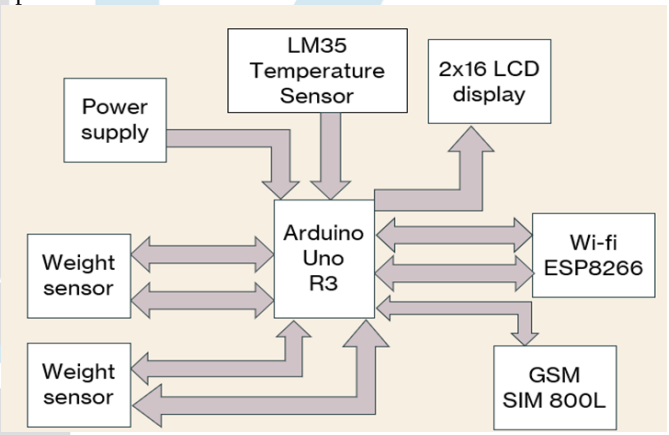

Figure 2. Hardware Integration

In 2014, an ESP8266 Wi-Fi module was introduced and developed by third-party manufacturers like AI thinkers, which is mainly utilized for IoT-based embedded applications development. It is capable of handling various functions of the Wi-Fi network from another application processor. With its built-in Wi-Fi connectivity, the module enables wireless communication between the blood bank system and external servers or devices, facilitating real-time data transmission and remote monitoring.

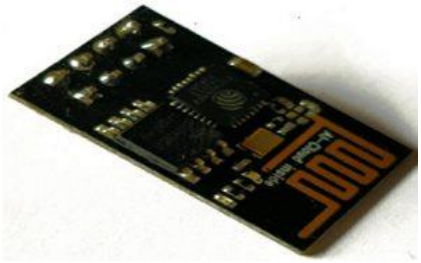

Figure 3. ESP8266 Wi-Fi Module

In the project, the ESP8266 Wi-Fi serves as the interface between the blood bank system and the internet, allowing for data exchange and cloud integration. It enables the system to communicate with online platforms for storing blood inventory data, receiving donor registrations, and providing updates to stakeholders. Through its lightweight and efficient design, the ESP8266 Wi-Fi enhances the system's

connectivity and enables advanced IOT functionalities crucial for modern blood bank management.

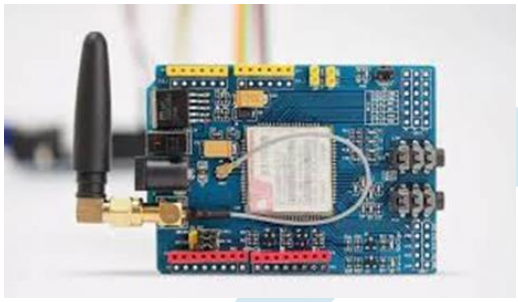

Figure 4. GSM SIM900L

The GSM module acts as a vital communication link in the Smart Blood Bank Management System, enabling SMS based notifications and alerts. Integrated with the system, it facilitates communication between the blood bank facility and donors or administrators via text messages. Through its capability to send and receive SMS messages, the GSM module ensures efficient communication for donor registration, appointment scheduling, and emergency notifications. With its compact form factor and reliable performance, the GSM module enhances the system's communication capabilities, providing an effective means of interaction between the blood bank and its stakeholders.

The LCD (Liquid Crystal Display) unit acts as the primary user interface in the Smart Blood Bank Management System, facilitating interaction between users and the system. It provides a visual display of critical information such as blood inventory levels, system status, donor registration prompts, and instructions. The LCD display enhances user experience by presenting real-time feedback and instructions, making the system more intuitive and user-friendly.

Figure 5.2x16 LCD display

Load cells are essential components utilized for accurately measuring the weight of blood bags within storage units. In the context of the blood bank management system, load cells play a crucial role in inventory management by providing precise measurements of blood bag weights. This enables the system to monitor blood inventory levels accurately, facilitating efficient resource management and inventory control. By ensuring accurate measurements, load cells contribute to the overall effectiveness and reliability of the blood bank management system.

Temperature sensors are integral to monitoring temperature variations within blood storage units. These sensors continuously measure temperature levels, allowing the system to maintain optimal storage conditions for blood products. By ensuring that stored blood remains within the appropriate temperature range, temperature sensors help preserve the quality and integrity of blood products, preventing spoilage and ensuring patient safety. As a result, temperature sensors are essential components in the Smart Blood Bank Management System, contributing to the system's ability to maintain the quality and safety of stored blood products.

Figure 6.LM35 temperature sensor

Software Aspects:

The software setup for this System primarily involves the development of a web-based interface using PHP, MySQL DB, HTTP, HTML, CSS. HTML and CSS are utilized to design and style the user interface, ensuring a visually appealing and user-friendly experience. Additionally, the system integrates ESP8266 Wi-Fi module to transmit sensor data from the hardware components to the cloud platform. Through seamless integration of these software components, the Smart Blood Bank Management System offers a comprehensive solution for real-time monitoring, management, and visualization of blood inventory data.

The front-end design of the Smart Blood Bank Management System focuses on delivering a user-friendly and accessible web interface using HTML and CSS. HTML structures the web page content, defining elements such as headers, paragraphs, and forms, while CSS styles these elements to enhance visual appeal and layout. By employing responsive design techniques, the front-end ensures compatibility across various devices, allowing users to access critical blood bank information seamlessly. CSS plays a crucial role in styling the front-end, allowing for customization of colour, typography, and spacing. Through CSS rule sets, the front-end design achieves a cohesive and visually appealing layout, prioritizing readability and ease of navigation. By adhering to best practices in web design, such as responsive grids and media queries, the front-end adapts gracefully to different screen sizes, ensuring optimal user experience on desktops, tablets, and smartphones. Overall, the front-end design of the Smart Blood Bank.

Management System aims to provide users with a straightforward and intuitive interface for accessing blood bank information and registering as donors. By combining HTML and CSS effectively, the system offers a visually pleasing and responsive web experience, contributing to improved usability and user engagement.

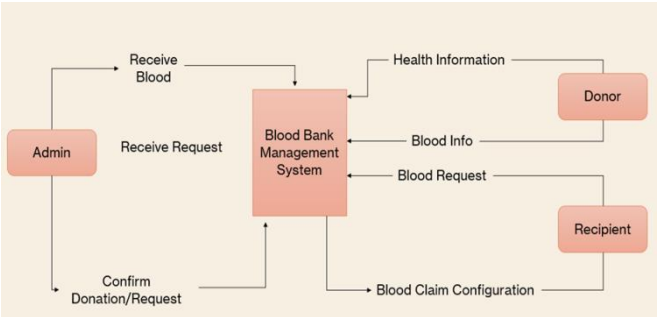

Figure 7. Web Application Flowchart

In an IoT-based blood bank, sensors and devices collect real-time data (like temperature, blood bag levels, RFID info, etc.). PHP can be used to process this data on the server. MySQL stores all data collected and used by the system like Store blood bag inventory details, Log sensor data (temperature, expiry dates), Maintain donor and receiver records, Track blood requests and availability. HTTP is used

for communication between IOT devices via Wi-Fi modules like ESP8266 and the server. User interfaces (web apps/mobile apps) and backend server.

IV. IMPLEMENTATION

The hardware integration of the Smart Blood Bank Management System involves connecting various components to the Arduino UNO microcontroller, utilizing specific pins to ensure proper communication and functionality. By carefully connecting each component to the Arduino UNO using the appropriate pins and communication protocols, the Smart Blood Bank Management System achieves seamless integration and robust functionality.

The GSM module and ESP8266-WiFi module are connected to the Arduino UNO via software serial communication using digital pins 0 and 1 for RX and TX, respectively. This setup enables communication with the GSM module for sending SMS alerts and the ESP8266 Wi-Fi module for internet connectivity. Additionally, the load cell sensor modules are connected to the Arduino UNO for precise measurement of blood bag weights. The first load cell is connected to pins A1 and A2, the second load cell to pins A3 and A4.

Furthermore, the temperature sensor is connected to pin A0, enabling temperature readings to be obtained from the LM35 sensor. The Liquid Crystal Display (LCD) unit is connected to digital pins 8 to 13. This setup enables the display of critical information such as blood group quantities and system status on the LCD screen.

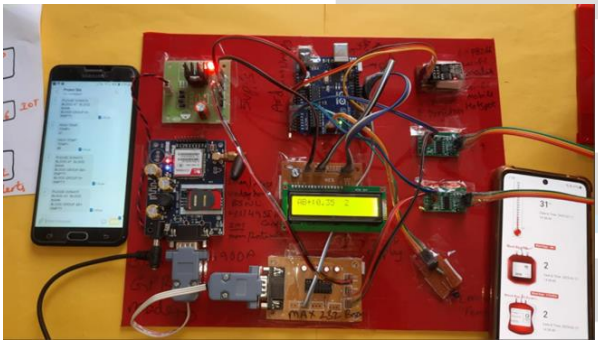

Figure 8. Hardware Integration

The software implementation of the Smart Blood Bank Management System involves the development and integration of various components to enable seamless functionality and data management.

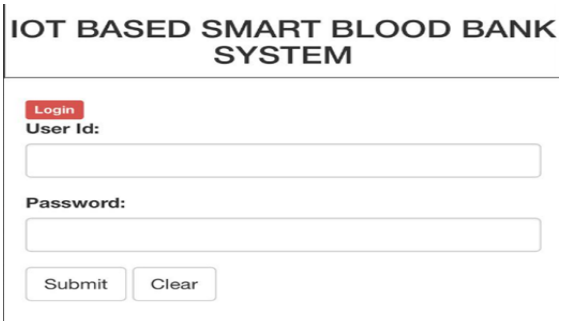

Figure 9.Webpage Overview

The integration of software components is essential for the Smart Blood Bank Management System to function effectively, providing users with timely access to blood bank information and donation registration forms. By leveraging Python , PHP, HTTP, HTML, CSS, and MySQL, the system achieves a balance of functionality, performance, and user experience, contributing to its overall success and usability.

V. RESULTS AND ANALYSIS

The implementation of the Smart Blood Bank Management System yielded promising results, demonstrating its efficacy in enhancing blood bank operations and improving donor engagement. Through rigorous testing and evaluation, several key outcomes were observed, highlighting the system's performance and functionality.

The system effectively tracked and controlled blood stock levels instantly, offering precise and current details on the amount of each blood type present in the blood bank. This up-to-the-minute monitoring enabled streamlined resource distribution and inventory control, guaranteeing a sufficient blood supply to address patient requirements.

Moreover, the integration of IoT technology enabled seamless communication between the blood bank sensors and the cloud platform, allowing sensor data to be transmitted and stored securely.

Moreover, the intuitive online platform allowed authorized users simple access to vital blood bank data, such as the number of units for each blood type, donor sign-up sheets, and facility addresses. This accessible interface enhanced donor interaction and convenience, motivating people to take part in blood donation events and support the blood bank's reserves

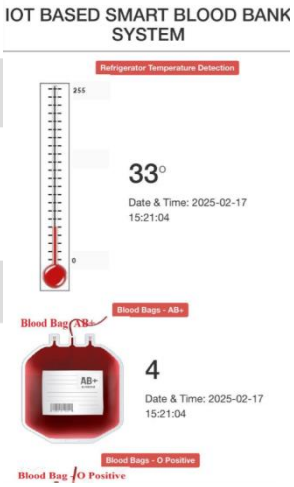

Figure 10. Webage Second Page

.Additionally, the system's alerting mechanism, implemented through SMS notifications, effectively alerted blood bank staff to low blood inventory levels and temperature deviations, enabling timely intervention and corrective actions. This proactive approach to inventory management helped prevent blood shortages and ensure the integrity of stored blood products.

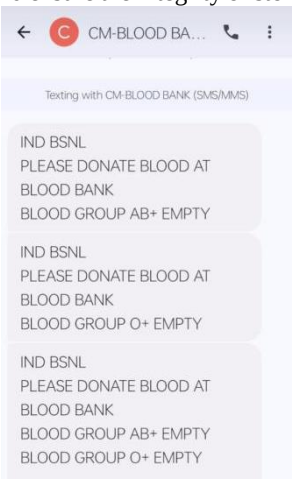

Figure 11.Receiving SMS on Phone

Overall, the results of the Smart Blood Bank Management System demonstrate its potential to revolutionize blood bank operations, streamline processes, and improve blood supply management.

VI. CONCLUSION

In conclusion, the outcomes of the intelligent Blood Bank Management System highlight its capability to significantly transform blood bank procedures, simplify workflows, and enhance the management of blood resources. The system's effectiveness and features create opportunities for further development and expansion, establishing it as a crucial asset within the healthcare industry.

VII. ACKNOWLEDGMENTS

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