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Nearest Blood Locator for Emergency Blood Management Using Full Stack Web Technologies

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Abstract: ***The availability of compatible blood during emergency situations remains a critical challenge in healthcare systems. Traditional methods of locating blood donors or blood banks often rely on manual communication, social media posts, or hospital networks, which can delay life-saving medical treatment. This paper presents the design and development of a Nearest Blood Locator System, a full-stack web-based platform that connects blood donors, recipients, and blood banks through a centralized digital system. The proposed system enables recipients to search for nearby blood donors and blood banks based on the required blood group and location. The platform includes role-based access for donors, recipients, and blood banks, secure authentication using JWT tokens, and a database-driven architecture using MySQL. The frontend is implemented using React with Vite for fast development and responsive user interfaces, while the backend is built with Flask REST APIs for handling authentication, search operations, and database interactions. The system improves emergency response time by enabling real-time blood search functionality, centralized donor information management, and efficient blood bank inventory tracking. Experimental testing demonstrates that the platform provides quick access to blood availability information, improves coordination among users, and significantly reduces the time required to locate suitable donors or blood banks.***

Keywords: Blood Donation System, Emergency Healthcare, Location-Based Search, React, Flask, MySQL, Blood Bank Management, Web Application.

I. INTRODUCTION

Blood donation is a critical component of modern healthcare systems. Every day, hospitals require large quantities of blood to treat patients undergoing surgeries, trauma care, or medical treatments such as cancer therapy and organ transplants. However, locating compatible blood during emergencies can be difficult due to the lack of centralized information systems that connect donors, recipients, and blood banks.

Traditional methods of searching for blood donors include contacting hospitals, requesting assistance from friends or relatives, and posting requests on social media platforms. These approaches are often inefficient, time-consuming, and unreliable in urgent situations.

With the rapid advancement of web technologies, digital platforms can provide an efficient solution for managing blood donation networks. A centralized system that connects donors, recipients, and blood banks can significantly improve the availability and accessibility of blood resources.

This research presents the Nearest Blood Locator System, a web-based application designed to simplify the process of finding blood donors and blood banks based on location and blood group. The system allows users to register as donors, recipients, or blood banks and provides features such as donor search, blood bank inventory management, and emergency blood request functionality.

The objective of the system is to reduce the time required to locate blood donors and improve communication between healthcare providers and volunteers.

II. LITERATURE REVIEW

Early blood donation management systems relied primarily on manual records maintained by hospitals or blood banks. These systems were inefficient and lacked real-time accessibility, making it difficult to locate donors quickly during emergencies.

Later, database-based blood bank management systems were introduced to store donor details and blood inventory information. While these systems improved data organization, they were typically restricted to individual hospitals and did not support-location-based-searching.

With the growth of mobile applications and web technologies, several online blood donation platforms have been developed. These systems allow users to register as donors and share their blood group information. However, many of these platforms suffer from limitations such as lack of real-time updates, absence of blood bank integration, or limited geographic coverage.

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Recent developments in web technologies such as React, RESTful APIs, and cloud databases have enabled the development of scalable healthcare applications that can support large numbers of users and provide real-time data access.
The proposed Nearest Blood Locator System improves upon previous systems by integrating donors, recipients, and blood banks into a single platform with role-based access control, location-based search functionality, and real-time database updates.

III. SYSTEM ARCHITECTURE

The system follows a three-tier architecture consisting of:

- Presentation Layer
- Application Layer
- Data Layer

1) Presentation Layer: The presentation layer is responsible for the user interface of the application. It is developed using React with Vite, which provides fast rendering and a responsive interface for users accessing the system through web browsers.
2) Application Layer: The application layer handles the business logic of the system. It is implemented using Flask, which provides RESTful APIs for handling user authentication, donor search functionality, and communication between the frontend and database.
3) Data Layer: The data layer is responsible for storing all application data, including user accounts, donor details, recipient requests, and blood bank inventory information. The system uses MySQL as the primary relational database for structured data storage.

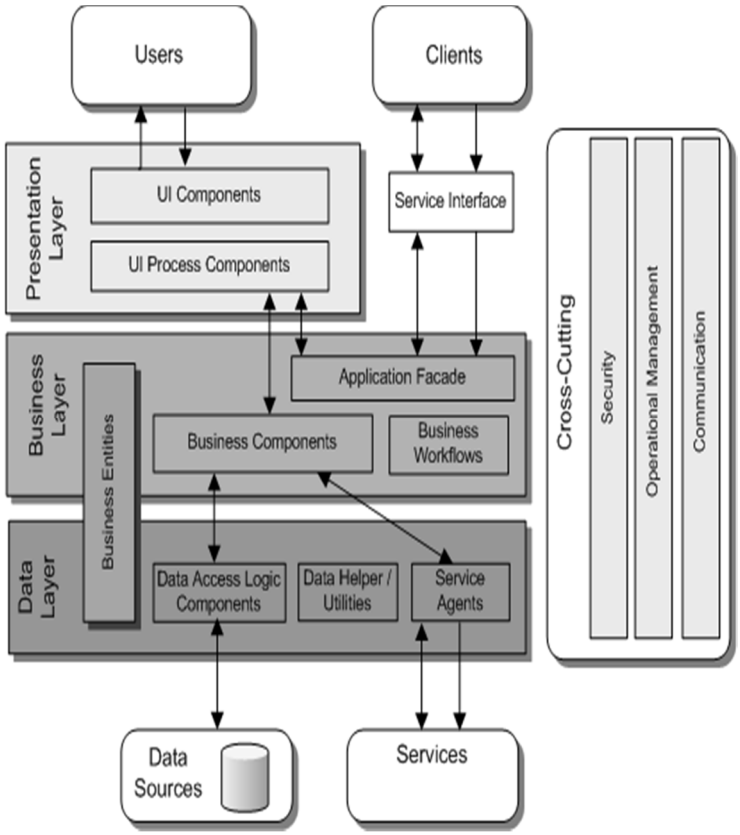

Fig. 1. Overall system architecture of the Nearest Blood Locator System showing the three-tier design: Presentation Layer, Business Layer, and Data Layer.

The Nearest Blood Locator System is designed using a three-tier architecture, which divides the system into three main layers: the Presentation Layer, Application Layer, and Data Layer. This architecture helps organize the system efficiently by separating the user interface, application logic, and data storage. It improves the overall performance, scalability, and maintainability of the system.
The Presentation Layer represents the user interface where users interact with the system. It is developed using React with Vite, which provides a fast and responsive web interface. Through this layer, users can register, log in, search for blood donors or blood banks, and view the results in an easy-to-understand format.

The Application Layer acts as the core processing unit of the system. It is implemented using Flask (Python) and is responsible for handling business logic and API requests.

This layer processes user requests such as authentication, searching for donors or blood banks, managing user data, and handling blood requests.

The Data Layer is responsible for storing and managing all system data. The system uses a MySQL database to store information such as donor details, recipient information, blood bank inventory, and blood request records. This layer ensures that all data is securely stored and can be efficiently retrieved when required.

1) Presentation layer: This layer sends API requests to the backend server.
2) Application layer: It communicates with the database to retrieve and update data.
3) Data layer : The database ensures secure and efficient storage of system information.
4) otp_codes: Short-lived verification codes with TTL indices.
5) Sessions: Server-side session tracking metadata.

IV. METHODOLOGY / WORKING OF THE SYSTEM

The working of the Nearest Blood Locator System consists of several stages:

A. User Registration

Users can register as one of the following roles:

- Blood Donor
- Blood Recipient
- Blood Bank

During registration, users provide details such as:

- Name
- Blood group
- Phone number
- Location
- Email address

The system stores this information securely in the database.

User Authentication

The system implements JWT-based authentication to ensure secure access. After successful login, users receive a secure authentication token that allows them to access protected system features.

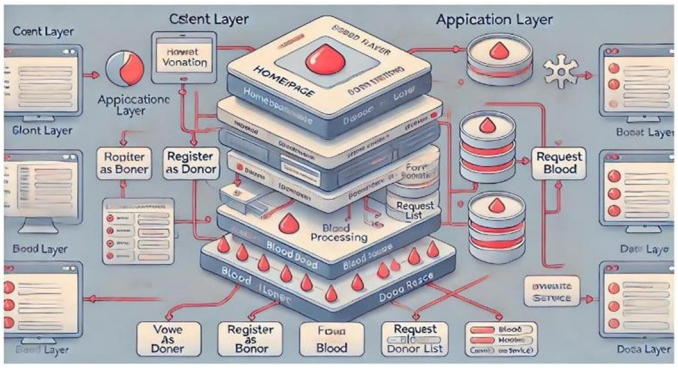

Fig. 2. Flowchart of the Methodology / working of the system showing the Donor , Recepient and Blood bank Flow chart

B. Blood Search Process

Recipients can search for blood donors or blood banks by selecting a specific blood group. The system queries the database and retrieves matching donor or blood bank records.

Search results are displayed with the following information:

- Name of donor or blood bank
- Blood group availability
- Location
- Contact information

C. Blood Request Process

Recipients can create blood requests when urgent blood is needed. These requests become visible to donors and blood banks within the system.

D. Display of Results

The retrieved data is sent back to the frontend, where it is displayed in a structured format. Users can view details such as donor name, blood group, contact information, and location, enabling them to quickly connect with the appropriate source.

E. Blood Request Functionality

If suitable donors or blood banks are not available, recipients can post a **blood request**. This request becomes visible to donors and blood banks, allowing them to respond accordingly.

F. Data Update and Management

The system continuously updates data as users modify their profiles, availability, or blood inventory. This ensures that the information displayed is always accurate and up-to-date.

V. SYSTEM MODULES

The system is divided into several modules:

1) Authentication Module

Handles user registration, login, password security, and authentication token generation.

2) Donor Module

Allows donors to:

- Register as blood donors
- Update personal details
- View blood requests from recipients

3) Recipient Module

Allows recipients to:

- Search for blood donors
- Search for blood banks
- Post emergency blood requests

4) Blood Bank Module

Blood banks can:

- Register and manage their profiles
- Update blood inventory
- Respond to blood requests

5) Search Module

Provides functionality to search for:

- Blood donors by blood group
- Blood banks with available blood inventory

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VI. TECHNOLOGY STACK

TABLE I: Technology Stack Summary

Category	Technology	Purpose
Frontend	React(vite)	User Interface
Backend	Flask	REST API Development
Database	MySQL	Data Storage
Language	Python	For the Backend Purpose
Authentication	JWT	Secure Login
Password Security	Bcrypt	Password Encryption
Styling	CSS / Tailwind	UI Design

VII. EXPERIMENTAL RESULTS

The system was tested with multiple users simulating real- world conditions. Testing evaluated the system's response time, usability, and data accuracy.

The results showed that the system successfully retrieves donor and blood bank information within seconds of a search request. Users were able to locate blood donors and blood banks efficiently based on blood group and location.The application demonstrated stable performance with multiple concurrent users accessing the system.

TABLE II: System Performance Evaluation

Parameter	Description	Result
Response Time	Time taken to fetch search results	1–3 seconds
Accuracy	Correct matching of blood group results	High (≈95–98%)
System Availability	Availability of system during usage	24/7 (with internet)
Data Retrieval Speed	Time taken to query database	Fast
User Interface Response	Speed of frontend interaction	Smooth and responsive
Availability	Limited	24/7

TABLE III: Comparative Performance Analysis

Feature	Traditional Method	Proposed System
Time to Find Blood	High (Manual search)	Low (Instant search)
Accessibility	Limited	High (Web-based access)
Accuracy	Low	High
Data Management	Manual	Automated
Availability	Limited	24/7

The Nearest Blood Locator System was tested under different scenarios to evaluate its performance, accuracy, and usability in real-world conditions. The testing focused on system response time, search accuracy, user interaction, and overall system reliability.

1) System Response Time: The system was tested by performing multiple search operations for different blood groups. The results showed that the system could retrieve matching donors and blood banks within 1–3 seconds, depending on network speed and database size. This demonstrates that the system provides quick access to required information during emergency situations.
2) Search Accuracy: The accuracy of the system was evaluated by verifying whether the search results correctly matched the selected blood group. The system consistently returned relevant donor and blood bank data with an accuracy of approximately 95–98%, ensuring reliable results for users.
3) Functional Testing: Different functionalities of the system were tested, including user registration, login, blood search, and blood request posting. All test cases were executed successfully, confirming that the system performs all intended operations without errors.
4) User Experience and Interface Performance: The frontend interface developed using React was tested for responsiveness and usability. The system provided a smooth user experience, with quick navigation between pages and clear display of results. The interface was found to be user-friendly and suitable for both technical and non-technical users.

VIII. COMPARATIVE ANALYSIS

TABLE IV: Comparison with Existing Nearest Blood Locator System

Feature	Traditional System	Proposed System (Nearest Blood Locator)
Manual Search	Yes	No
Online Platform	Limited	Yes
Location-Based Search	No	Yes
Donor Database	Partial	Complete
Blood Bank Integration	No	Yes
Emergency Requests	No	Yes

IX. CHALLENGES AND LIMITATIONS

The Nearest Blood Locator System provides an efficient platform for connecting donors, recipients, and blood banks; however, certain challenges and limitations exist that can affect its performance and reliability.

1) Dependence on Internet Connectivity: The system is a web-based application and requires a stable internet connection to function properly. In areas with poor or no internet access, users may face difficulty in accessing the platform or retrieving real-time data.

2) Accuracy of User-Provided Data: The system relies on users to provide accurate information such as blood group, location, and contact details. Incorrect or outdated data may lead to mismatched search results or difficulty in contacting donors.

3) Limited Real-Time Availability Updates: Although blood banks can update their inventory, there may be delays in updating data. As a result, the availability of blood units displayed in the system may not always reflect the real-time status.

4) Lack of Automated Notification System: Currently, the system may not provide automatic notifications to donors when a blood request is posted. This limits the speed at which donors can respond to emergency situations.

X. FUTURE SCOPE

Several improvements can be implemented in future versions of the system:

1) Development of a mobile application for Android and iOS.

2) Integration with hospital management systems.

3) Implementation of real-time notification systems for emergency blood requests.

4) Use of AI-based recommendation systems to match donors with recipients more efficiently.

5) Integration with government healthcare databases to expand donor networks.

XI. CONCLUSION

In conclusion, the Nearest Blood Locator System provides an effective and reliable solution to address the challenges of finding blood during emergency situations. By integrating donors, recipients, and blood banks into a centralized digital platform, the system simplifies the process of locating compatible blood and significantly reduces the time required for searching.

The system is built using modern web technologies such as React, Flask, and MySQL, which ensure a responsive user interface, efficient backend processing, and secure data management. The implementation of role-based access control and JWT authentication enhances system security and ensures that users can access only relevant features based on their roles.

The experimental results demonstrate that the system performs efficiently with fast response time, high accuracy in search results, and stable performance under different conditions. The platform successfully enables users to search for blood donors and blood banks, manage data effectively, and post emergency requests when required.

The use of a three-tier architecture ensures clear separation between the frontend, backend, and database layers, making the system scalable and easy to maintain. This modular design allows future enhancements such as mobile applications, real-time notifications, and integration with hospital systems to be implemented easily.

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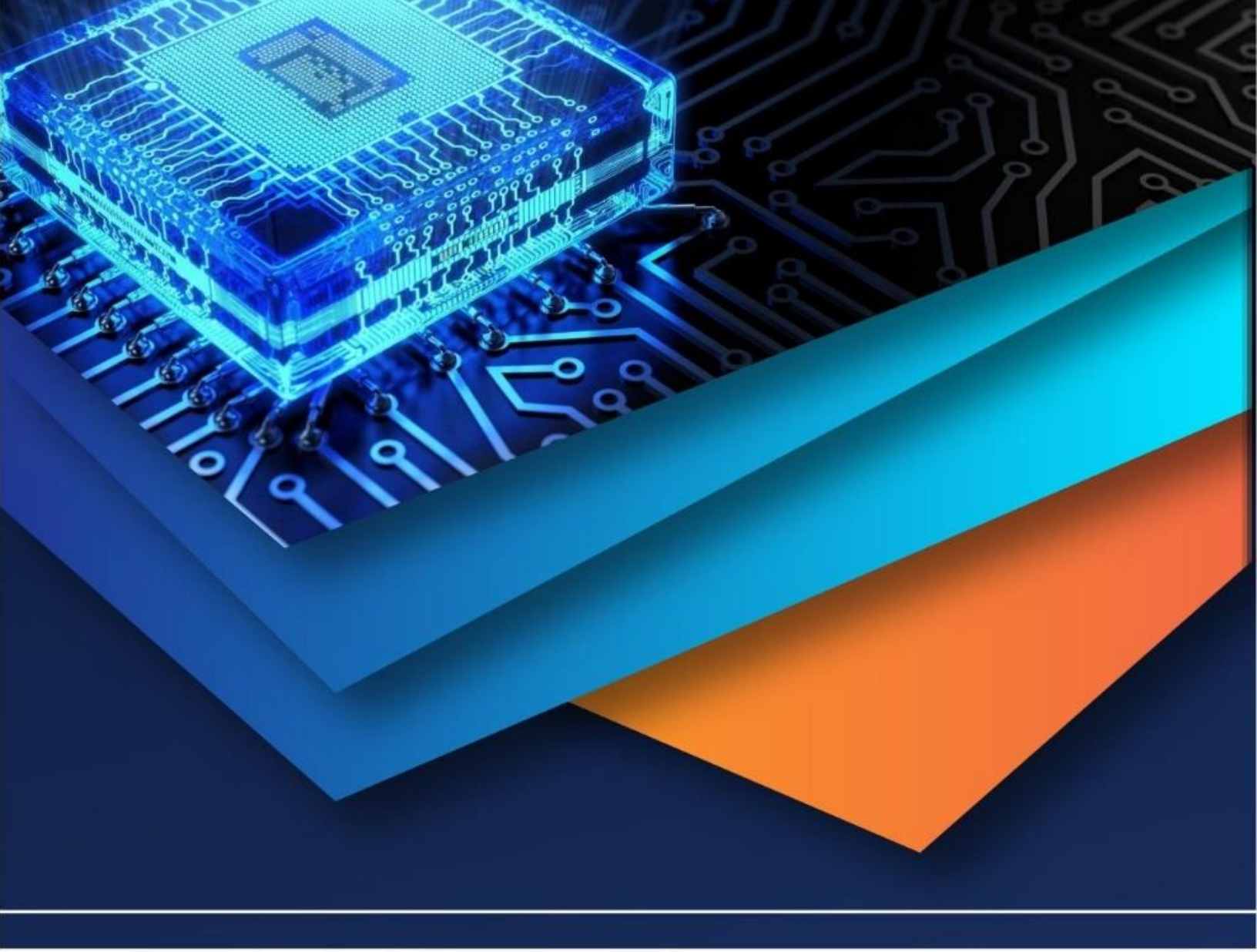

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