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HemoConnect: An Intelligent Blood Request Prioritization and Emergency Allocation System

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Abstract: *Timely access to blood during emergencies remains a major challenge in healthcare systems. Although donors, hospitals, and blood banks are available, the process of connecting them efficiently is often affected by fragmented information, communication delays, and the absence of a centralized platform. As a result, patients may experience difficulties in obtaining blood when it is needed most.*

HemoConnect is a web-based blood donation management system designed to improve coordination among patients, donors, hospitals, and blood banks. The platform allows patients to submit blood requests and upload relevant medical documents, while hospitals can verify requests and monitor the allocation process. The system uses blood group information, location-based recommendations, and request prioritization to help identify suitable donors and facilitate faster response to urgent cases. Donors receive real-time notifications about nearby requests, enabling quicker communication and participation in the donation process.

To further support emergency situations, HemoConnect incorporates request tracking and priority escalation features that help ensure critical requests receive timely attention. By reducing communication gaps and improving coordination between stakeholders, the proposed system aims to make blood request management more efficient, transparent, and accessible. The platform promotes voluntary blood donation while supporting faster and more organized emergency response within healthcare networks.

Keywords: Blood donation management, emergency healthcare, request prioritization, donor recommendation, location-based allocation, real-time notifications, healthcare information systems

I. INTRODUCTION

Access to blood during medical emergencies is a critical component of healthcare. In many situations, the challenge is not the absence of donors, but the difficulty of identifying and connecting suitable donors, hospitals, and blood banks within a limited time. Delays caused by fragmented information, manual communication, and disconnected systems can significantly affect the efficiency of emergency response.

Existing blood donation platforms provide useful donor databases and registration facilities, but many of them do not support seamless coordination among all stakeholders involved in the blood allocation process. Information is often spread across multiple hospitals and blood banks, making it difficult to obtain accurate and timely details. Furthermore, urgent requests may not receive priority over routine requests, and donors may remain unaware of nearby emergencies due to limited notification mechanisms.

To address these challenges, HemoConnect is proposed as a web-based blood donation management system that brings patients, donors, hospitals, and blood banks onto a single platform. The system allows patients to submit blood requests, upload supporting medical documents, and track the status of their requests. Donors can register their availability and receive notifications when nearby requests match their blood group. Hospitals and blood banks serve as verification authorities, helping ensure reliability and transparency throughout the process.

HemoConnect incorporates location-based donor recommendation, urgency-aware request prioritization, and automated escalation features to improve response efficiency during emergencies. By centralizing information and facilitating

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communication among stakeholders, the platform aims to reduce coordination delays and support faster decision-making. The system is designed using modern web technologies, making it accessible, scalable, and suitable for real-time interaction.

The primary objective of this research is to develop an efficient and transparent blood request management framework that enhances emergency response and improves access to blood resources. The proposed system seeks to strengthen coordination among patients, donors, hospitals, and blood banks while encouraging voluntary blood donation and improving the overall management of emergency blood requests.

The major contributions of this work are as follows:

Development of a centralized platform that integrates patients, donors, hospitals, and blood banks within a unified ecosystem.

Implementation of location-based donor recommendation and urgency-aware request prioritization to improve emergency response efficiency.

Integration of real-time notifications, request tracking, and document verification features to enhance transparency and coordination.

Design of an automated request escalation mechanism to ensure that critical requests receive timely attention.

The remainder of this paper is organized as follows. Section II presents the Materials and Methods used. Section III discusses results and discussion. Section IV describes the limitations and future work.Finally, Section V concludes the paper and outlines future scope and enhancements.

II. Materials and Methods

A. System Architecture

HemoConnect follows a multi-layered architecture consisting of a React-based frontend, a Node.js/Express/Python backend, and FastAPI-based microservices. The frontend provides interfaces for patients, donors, hospitals, and blood banks, enabling users to register, submit requests, and track allocation status.

The backend manages authentication, request processing, document uploads, and communication with the database. The FastAPI microservices implement core functionalities such as donor recommendation, geospatial filtering, request prioritization, and automated escalation. MongoDB Atlas serves as the central data repository for storing user information, blood requests, hospital records, and system data. This architecture ensures efficient coordination and reliable management of emergency blood requests.

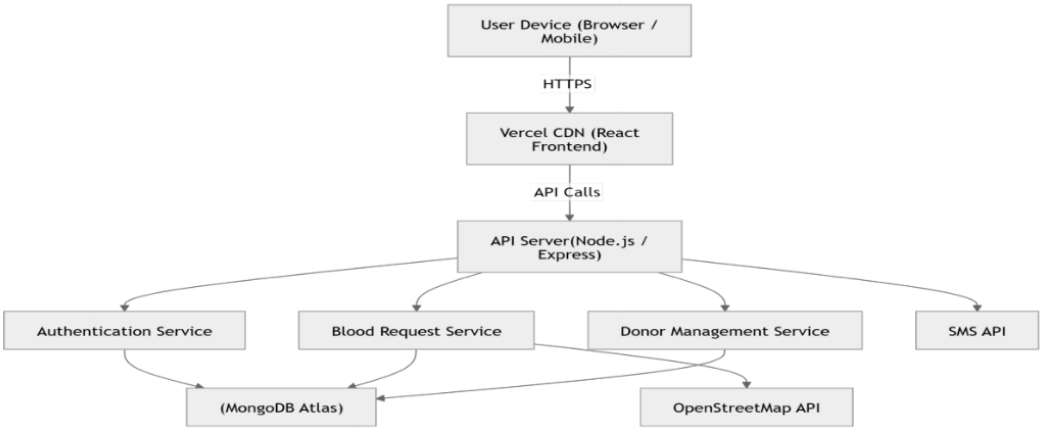

Fig. 1. System architecture of HemoConnect

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B. Donor Recommendation and Request Filtering

It identifies suitable donors based on blood group requirements, donor availability, and location information. When a blood request is submitted, the system filters registered donors to find individuals who match the required blood group and are available for donation.

To improve response efficiency, geospatial filtering is used to prioritize donors located closer to the requesting patient or healthcare facility. The filtered donor list is then ranked according to predefined criteria, enabling faster identification of potential donors during emergency situations. This approach reduces search time and improves coordination between patients, donors, and healthcare institutions.

C. Request Prioritization and Escalation Mechanism

HemoConnect incorporates a priority-based mechanism to ensure that urgent blood requests receive timely attention. When a request is submitted, the system assigns a priority score based on factors such as urgency level, request type, and submission time. Requests with higher priority scores are processed before routine requests.

To prevent critical requests from being overlooked, the system includes an automated escalation service. Pending requests are periodically reviewed, and their priority is increased if they remain unresolved beyond a predefined time threshold. This dynamic prioritization approach improves emergency response efficiency and helps ensure that urgent cases are addressed promptly.

D. Emergency Request Workflow

The blood request process begins when a patient submits a request along with the required details and supporting medical documents. The submitted request is verified by the respective hospital or blood bank before being processed further.

Once verified, suitable donors are identified through the recommendation and filtering mechanism. Notifications are then sent to eligible donors, allowing them to respond to the request. The request status is continuously updated throughout the allocation process, enabling all stakeholders to monitor progress until the request is successfully fulfilled.

Instead of evaluating single moments, the system processes frames continuously and aggregates the detected emotions over the entire response. This helps in identifying consistent behavioral patterns, providing a more reliable understanding of the user's overall emotional state during the interview.

E. Notification and Allocation Management

A notification mechanism is designed to keep donors, patients, hospitals, and blood banks informed throughout the blood request process. When a verified request is created, eligible donors can be notified based on blood group compatibility and location criteria. The proposed implementation utilizes Firebase Cloud Messaging (FCM) for real-time notifications and NodeMailerfor email-based communication.

The system also provides status updates for request tracking and allocation management. Users can monitor the progress of requests, while hospitals and blood banks can oversee verification and allocation activities. This improves communication among stakeholders and supports a more transparent and efficient allocation process.

F. Data Storage and Management

Data is stored and managed using MongoDB Atlas, which serves as the central repository for the system. The database maintains information related to users, donors, patients, hospitals, blood banks, blood requests, and notification records. This centralized approach enables efficient retrieval and management of information across different system modules.

Supporting medical documents uploaded during request submission are stored separately and linked to the corresponding request records. Proper authentication and access control mechanisms are employed to ensure that

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sensitive information is accessed only by authorized users. This approach enhances data security, consistency, and reliability throughout the platform.

G. Technologies and Tools Used

The proposed system is developed using modern web technologies to ensure scalability, reliability, and ease of maintenance. The frontend is built using React.js, TypeScript, and Vite, while the backend utilizes Node.js and Express.js for handling application logic and API requests. FastAPI-based microservices are employed for donor recommendation, geospatial filtering, request prioritization, and escalation processes.

MongoDB Atlas serves as the primary database for storing user and request information, while JWT is used for secure authentication and authorization. Multer is integrated for document upload handling. The notification module is designed to support Firebase Cloud Messaging (FCM) for push notifications and NodeMailer for email communication. APScheduler is utilized to automate request escalation and priority management tasks.

TABLE I: COMPARISON BETWEEN TRADITIONAL SYSTEMS AND HEMOCONNECT

Feature	Existing Systems	HemoConnect
Donor Registration	Yes	Yes
Blood Request Submission	Yes	Yes
Hospital/Blood Bank Verification	Limited	Yes
Location-Based DonorRecommendation	Limited	Yes
Request Tracking	No	Yes
Priority-Based Request Management	No	Yes
Automated Request Escalation	No	Yes
Centralized Stakeholder Platform	No	Yes
Real-Time Notifications	Limited	Yes

III. RESULTS AND DISCUSSION

A. Patient Module

The Patient Module serves as the primary interface for individuals seeking blood during emergencies. Through this module, users can submit blood requests by providing details such as the required blood group, quantity, hospital information, and urgency level. Patients can also upload supporting medical documents to assist in the verification process.

Once a request is submitted, users can track its progress and view updates throughout the allocation process. This helps patients and their families stay informed and reduces uncertainty during critical situations.

B. Donor Module

The Donor Module is designed for individuals willing to contribute to blood donation efforts. Donors can create and manage their profiles by providing information such as blood group, contact details, and location. The module also allows donors to update their availability status based on their willingness to donate.

When a relevant blood request is identified, eligible donors can be notified and connected to the request through the platform. This helps improve donor participation and supports faster response during emergencies.

C. Hospital and Blood Bank Module

Hospitals and blood banks play an important role in ensuring the reliability of the blood allocation process. This module allows authorized institutions to review blood requests, verify supporting documents, and monitor ongoing allocation activities.

By acting as a verification layer, healthcare institutions help maintain trust and transparency within the platform. Their involvement ensures that requests are processed through authenticated channels and that the information available to donors and patients remains accurate.

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D. Priority Management Module

Managing emergency requests effectively requires more than simply recording them in a database. This component evaluates each blood request based on factors such as urgency level and waiting time, allowing critical cases to receive greater attention.

To ensure that requests are not overlooked, an automated escalation mechanism periodically reviews pending requests and increases their priority when necessary. This approach helps healthcare institutions focus on the most urgent cases and improves the overall efficiency of the allocation process.

E. Admin Module

The Admin Module provides centralized control over the platform and its operations. Administrators can manage user accounts, monitor blood requests, oversee hospital and blood bank registrations, and review system activity.

This functionality helps maintain data integrity and ensures that the platform operates smoothly. By providing a unified view of system activities, the module supports effective management and coordination across all stakeholders.

F. Discussion

The implementation demonstrates the potential of a centralized platform in improving coordination among stakeholders involved in blood donation and emergency allocation. By combining donor recommendation, request prioritization, and tracking features within a single system, the platform reduces dependency on manual communication and fragmented records.

The proposed approach also improves transparency by allowing users to monitor request progress and enabling healthcare institutions to verify requests before allocation. These capabilities contribute to faster response times and more organized management of emergency blood requests.

IV. LIMITATIONS AND FUTURE WORK

The current system depends on accurate information provided by users and healthcare institutions. In addition, blood compatibility testing is not performed within the platform and must be verified by hospitals before transfusion.

Future work may include integration with government healthcare databases, mobile application support, and enhanced notification services. Further improvements can also focus on expanding the platform's reach and strengthening coordination among healthcare stakeholders.

V. CONCLUSION

HemoConnect is a web-based blood donation management system that connects patients, donors, hospitals, and blood banks through a centralized platform. The system supports donor recommendation, request prioritization, and emergency allocation, helping improve coordination during critical situations.

By reducing communication delays and providing a structured request management process, the platform contributes to a faster and more transparent emergency response system. Future enhancements can further improve its effectiveness and scalability in real-world healthcare environments.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICS STATEMENT

Not applicable. This study did not involve human or animal subjects requiring institutional review board approval.

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