LifeLink-Unified Blood and Organ Donation Matching Platform

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Abstract—**Blood and organ donation play a critical role in modern healthcare systems, particularly in emergency and life-threatening situations where timely access to compatible donors can determine patient survival. Despite advancements in medical infrastructure, the process of identifying and coordinating suitable donors remains inefficient in many regions. Existing systems largely depend on manual communication, static donor databases, or basic digital platforms that lack real-time validation of donor availability and medical eligibility. These limitations often lead to delays, unnecessary communication with ineligible donors, and reduced chances of successful donor matching during emergencies.**

This paper presents LifeLink, a unified mobile-based platform designed to enhance the efficiency and reliability of blood and organ donor matching through intelligent real-time processing. The proposed system integrates multiple critical parameters, including donor compatibility, geographic proximity, urgency of the request, real-time availability, and medical eligibility constraints. A key feature of the system is the enforcement of a mandatory recovery period after blood donation, ensuring that donors are not contacted until they are medically fit to donate again. Additionally, the platform utilizes location-based services to determine whether donors are within a reachable distance, thereby eliminating delays caused by contacting out-of-station individuals.

The LifeLink system is built using a layered architecture that includes user interface, authentication, processing and matching, data management, and communication modules. The core matching engine applies rule-based filtering and prioritization techniques to identify the most suitable donors for a given emergency request. Real-time notifications are then sent only to eligible and available donors, enabling faster response and confirmation. The system also maintains a centralized database to store donor profiles, donation history, consent records, and request data, supporting continuous updates and efficient coordination between donors, patients, and healthcare providers.

Experimental evaluation through simulated emergency scenarios demonstrates that the proposed system significantly reduces the time required to identify appropriate donors compared to traditional methods. By minimizing unnecessary communication and ensuring that only relevant donors are contacted, the system improves overall response efficiency and reliability. Furthermore, the integration of both blood and organ donation services into a single platform addresses the fragmentation seen in existing solutions, providing a more comprehensive approach to donor management.

In addition to improving operational efficiency, the proposed system emphasizes donor safety and ethical considerations. Automated eligibility checks prevent medically unsuitable donations, while consent-based handling of organ donation data enhances transparency and user trust. The platform is also designed to be scalable and adaptable, allowing for future integration with hospital information systems, government databases, and advanced technologies such as machine learning for predictive donor availability.

Overall, LifeLink demonstrates how mobile technology combined with intelligent filtering and real-time communication can transform traditional donor coordination processes. The proposed solution offers a practical, efficient, and scalable framework for improving emergency healthcare response, with the potential to save lives by enabling faster and more accurate donor matching.

Index Terms—**Keywords— Blood donation, Organ donation, Mobile application, Emergency healthcare, Real-time donor matching, Donor availability, Location-based services, Healthcare information system.**

I. Introduction

Blood and organ donation are essential components of modern healthcare systems, particularly in emergency and critical care situations. Patients suffering from trauma, undergoing major surgeries, or experiencing organ failure often depend on the timely availability of compatible donors. Despite advances in medical technology, the process of identifying and contacting suitable donors remains a significant challenge in many regions. Hospitals frequently rely on manual donor lists, telephone communication, or fragmented online platforms, which can lead to delays during life-threatening emergencies. Existing digital donation systems mainly focus on donor registration and basic searching based on blood group. However, they rarely provide real-time information about donor availability or location. In addition, medical guidelines require a recovery period of approximately three months after blood donation before a donor becomes eligible to donate again. Most current platforms do not automatically enforce this rule, which may result in medically ineligible donors being contacted. Another limitation is that registered donors may be out of station or unreachable when an emergency request is raised, further reducing the effectiveness of donor coordination. With the widespread use of smartphones and mobile applications, there is an opportunity to develop a more intelligent and responsive donation management system. A mobile-based solution can support real-time communication, location-based filtering, and automated eligibility checks. Such a system can significantly reduce the time required to identify suitable donors and improve coordination between donors, patients, and hospitals.

This paper proposes LifeLink, a smart blood and organ donation matching application designed to address these challenges. The proposed system integrates donor compatibility, geographic proximity, emergency urgency, real-time availability, and medical eligibility into a unified platform. By ensuring that only eligible and currently available donors are contacted, the system aims to improve response time, enhance donor safety, and support ethical and efficient healthcare delivery during emergencies.

II. System Architecture

The LifeLink system is designed using a layered architecture to ensure secure data handling, real-time donor verification, and efficient communication between donors, patients, and hospitals. The architecture integrates a mobile application interface with cloud-based processing and database services. Each layer performs a specific function while maintaining seamless interaction with other components.

A. User Interface Layer

The User Interface Layer consists of the mobile application used by donors, patients, and hospital authorities. Donors can register, update their availability status, and manage their medical details, including last donation date. Patients or hospital staff can submit emergency requests by specifying required blood group or organ type along with their current location. The interface provides real-time request status and notification updates.

B. Authentication and Security Layer

This layer ensures secure login and role-based access control. Each user is authenticated before accessing system services. Sensitive medical and personal data are protected through secure communication protocols, preventing unauthorized access and ensuring privacy compliance.

C. Processing and Matching Layer

The Processing Layer contains the core logic of the system. It performs compatibility verification based on blood group or organ type, checks donor eligibility by enforcing the mandatory recovery period, and evaluates geographic proximity using GPS data. Donors who satisfy all conditions are prioritized based on urgency and distance before receiving emergency notifications.

D. Data Management Layer

All donor profiles, donation history, consent records, and emergency requests are stored in a centralized cloud database. The database supports real-time updates so that changes in donor availability or location are immediately reflected in the system.

E. Communication and Notification Layer

This layer manages real-time alerts and response handling. Once suitable donors are identified, notifications are sent through the mobile application. Donor responses are recorded and transmitted back to the requester to confirm participation.

F. Architecture Diagram

The overall architecture of the proposed LifeLink system is illustrated in Fig. 4. The diagram shows the interaction between users, mobile application, processing unit, database, and notification services.

III. Methodology

The proposed LifeLink system follows a structured and systematic methodology to ensure accurate donor identification, eligibility enforcement, and efficient emergency coordination. The methodology integrates data acquisition, validation, intelligent filtering, and real-time communication mechanisms. The entire workflow is designed to reduce response time while maintaining donor safety and system reliability.

A. User Registration and Data Acquisition

The initial stage of the methodology involves collecting relevant data from users. Donors register by providing personal details, blood group, organ donation consent status, medical information, last blood donation date, and current geographic location. Hospitals or patients submit emergency requests specifying the required blood group or organ type, urgency level, and exact location of need.

All collected data is securely stored in a centralized cloud-based database. The system ensures that donor profiles remain dynamically updated, especially availability status and location information. This real-time data collection forms the foundation for accurate matching and filtering.

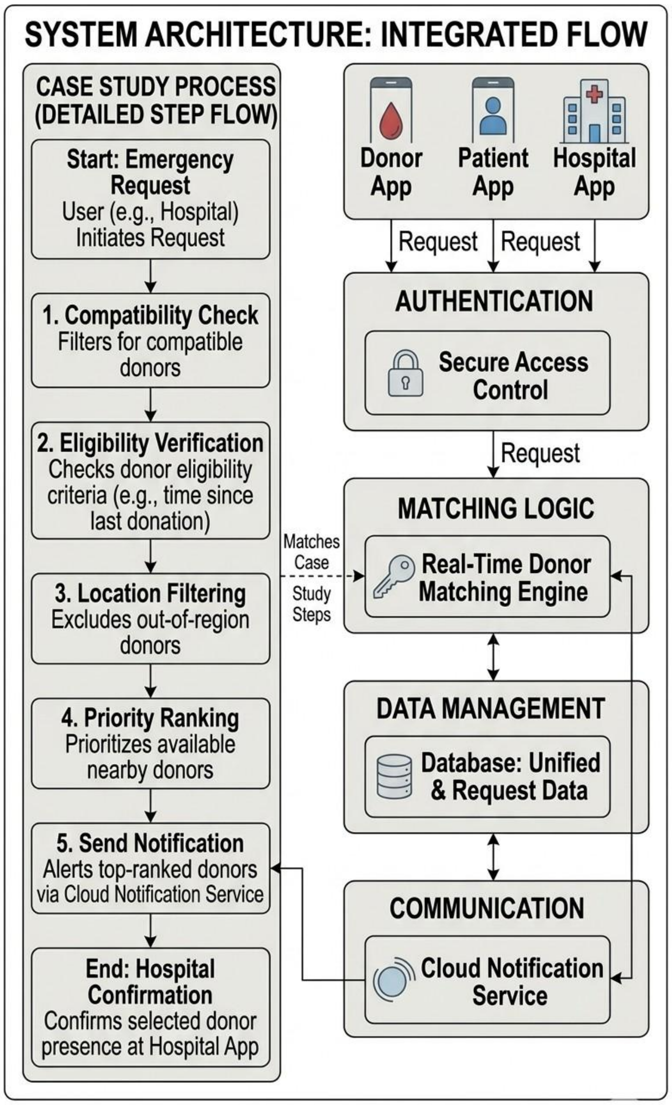

Fig. 1. LifeLink System Architecture

B. Medical Eligibility Verification

After an emergency request is generated, the system performs medical eligibility verification. For blood donation, the donor's last donation date is evaluated to ensure compliance with the mandatory recovery period of approximately ninety days. If the donor has donated within the restricted period, the system automatically marks the donor as ineligible and excludes them from further consideration.

For organ donation, the system verifies consent status and checks compatibility constraints. This automated enforcement mechanism protects donor health and ensures adherence to medical guidelines.

C. Location-Based Filtering

Once eligibility is confirmed, the system performs geographic filtering. Using GPS-based location services, the distance between the donor and the emergency location is calculated. A predefined service radius is applied to eliminate donors who are too far from the request location.

This step ensures that only physically reachable donors are considered, thereby minimizing delays during critical emergencies. Continuous location updates allow the system to dynamically adjust donor availability status.

D. Compatibility and Matching Process

After eligibility and location checks, compatibility verification is performed based on blood group or organ type. Donors who satisfy compatibility requirements are shortlisted for the next stage.

The system then applies a priority-based ranking mechanism. Emergency urgency, geographic proximity, and previous response reliability are used as ranking parameters. Donors closer to the emergency location and those with a strong response history are given higher priority. This structured matching logic ensures optimal donor selection.

E. Notification and Response Handling

Selected donors receive real-time notifications through the mobile application. The notification contains request details, including urgency level and location information. Donors can accept or reject the request through the application interface.

Upon acceptance, the system updates the request status and immediately informs the hospital or patient. If the donor declines, the system automatically proceeds to notify the next eligible donor in the priority list. All interactions are logged in the database for monitoring and future performance analysis.

F. System Monitoring and Data Logging

Every stage of the methodology generates transactional logs. These logs include donor eligibility verification, filtering decisions, response time, and final request outcomes. The stored data supports future analytical improvements, performance optimization, and potential integration with predictive models.

Through this structured methodology, the LifeLink system ensures rapid donor identification, improved coordination efficiency, and enhanced donor safety during emergency situations.

IV. Data and Visualization

The LifeLink system manages multiple categories of structured data to support real-time donor matching and efficient emergency coordination. The primary data entities include donor profiles, hospital or patient request records, donation history logs, location coordinates, and response status information. Each of these entities plays a crucial role in ensuring accurate system operation and timely response during critical situations.

Donor profiles form the core of the system and store comprehensive information such as blood group, organ donation consent, last donation date, availability status, contact details, and geographic location obtained through mobile-based GPS services. These attributes enable the system to evaluate both medical compatibility and physical proximity. Additionally,

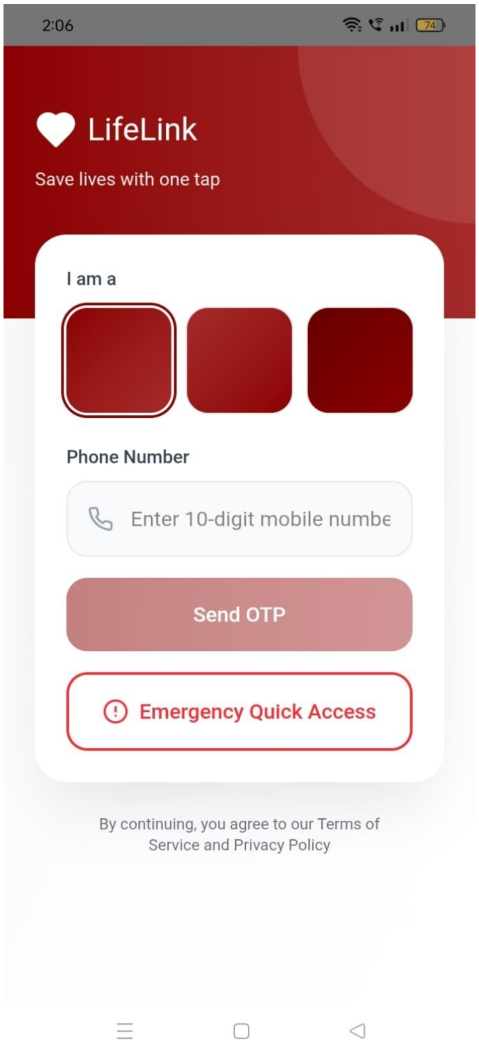

Fig. 2. Login page.

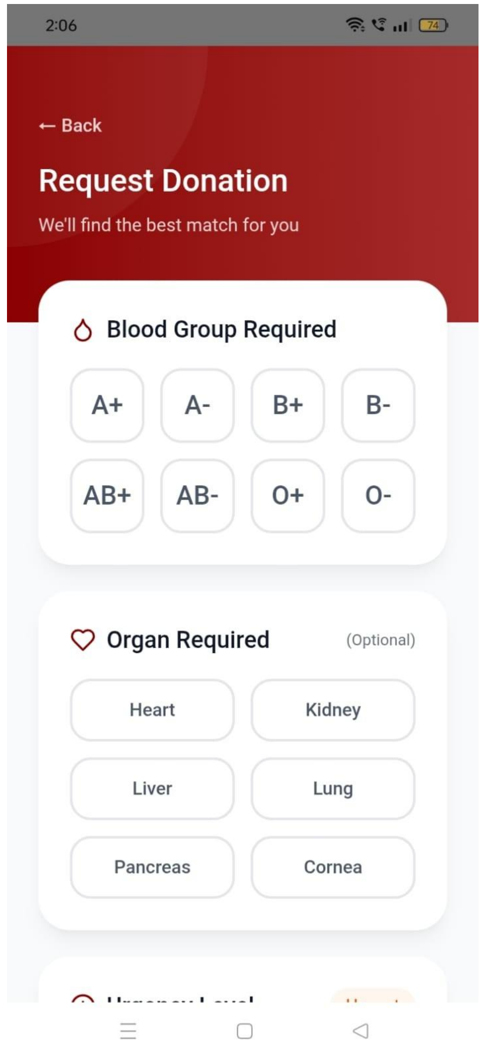

Fig. 3. Request donation.

donor availability is dynamically updated based on user interaction and system-triggered conditions, ensuring that only active donors are considered during emergency matching.

Emergency request data is generated by patients or hospital authorities and includes parameters such as required blood group or organ type, urgency level, timestamp, and request location. The urgency level is used to prioritize requests, allowing the system to handle critical cases with higher importance. Time-sensitive processing ensures that high-priority requests are handled with minimal delay. All request data is continuously monitored and updated to reflect the latest system state.

All data is stored in a centralized cloud database designed to support real-time synchronization and high availability. The database architecture ensures consistency and reliability through structured data models and indexing techniques, enabling fast retrieval of donor information during emergencies. Secure access control mechanisms are implemented to protect sensitive medical and personal data, ensuring that only authorized users can access or modify system records.

Data processing plays a critical role in maintaining system reliability and efficiency. Donation history logs are analyzed to determine donor eligibility by comparing the current date with the last donation date, thereby enforcing the mandatory recovery period required for safe blood donation. In addition, location data is processed using distance calculation algorithms to determine whether a donor falls within the predefined service radius. Donors outside this range are automatically excluded from the matching process.

The system also maintains response status information, which tracks whether a donor has accepted, rejected, or not responded to a request. This information is continuously updated in real time and is used to refine the matching process and avoid redundant notifications. By integrating response tracking with eligibility and availability checks, the system minimizes unnecessary communication and improves overall efficiency.

Furthermore, the interaction between these data entities en-

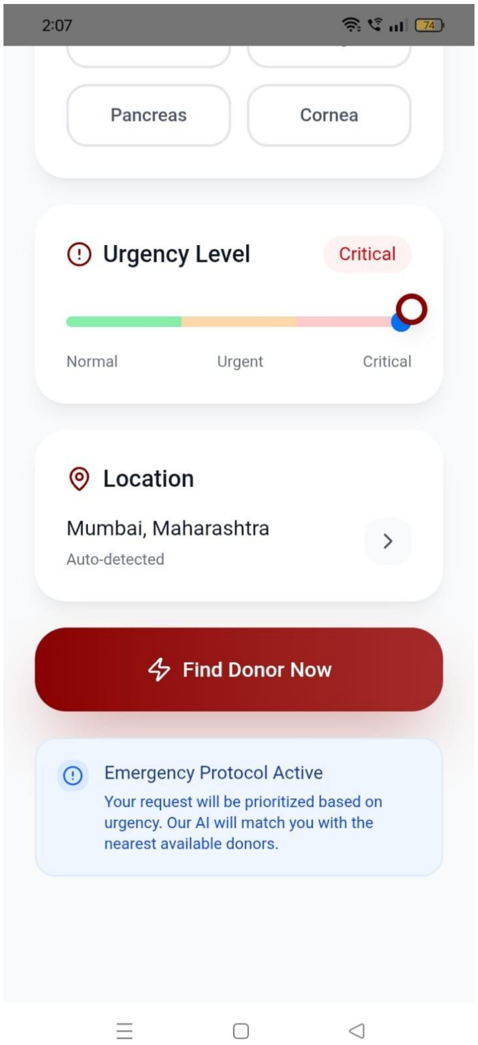

Fig. 4. Find donars.

ables intelligent filtering and prioritization. The system applies rule-based logic to shortlist donors based on compatibility, eligibility, proximity, and availability. This multi-level filtering approach significantly reduces the search space and ensures that only the most suitable donors are notified. As a result, the LifeLink system enhances coordination between donors, patients, and healthcare providers while improving the speed and accuracy of emergency response. To enhance system monitoring and administrative oversight, visualization mechanisms are incorporated within the platform. Analytical dashboards provide graphical representation of donor distribution by blood group, emergency request frequency, response rates, and average donor confirmation time. Time-series charts help identify peak emergency periods, while geographic maps illustrate donor density across service regions. These visual tools assist healthcare authorities in analyzing trends, optimizing service coverage, and improving emergency preparedness strategies.

By integrating structured data management with real-time visualization capabilities, the LifeLink platform not only facilitates efficient donor matching but also supports informed decision-making and long-term healthcare planning.

V. Results and Discussion

The LifeLink system was evaluated using simulated emergency scenarios involving multiple donors and request cases. The results demonstrate that the automated matching process significantly reduces donor identification time compared to manual coordination methods. Eligibility verification successfully excluded donors within the restricted recovery period, ensuring medical compliance and donor safety. Location-based filtering improved response efficiency by targeting only geographically reachable donors. The priority-based ranking mechanism enhanced the probability of rapid donor confirmation during high-urgency cases. Real-time notifications minimized communication delays and reduced unnecessary contact attempts. Overall, the system improved coordination efficiency, response reliability, and operational transparency in emergency donor management.

VI. Case Study

To evaluate the practical effectiveness of the proposed LifeLink system, a simulated emergency case study was conducted. The objective was to analyze the system's ability to identify and notify suitable donors under time-critical conditions while ensuring medical eligibility and geographic feasibility.

A. Emergency Scenario Description

A hospital reported an urgent requirement for O-negative blood following a severe road accident case. The request included high urgency classification and specified the hospital's geographic location. The system database contained multiple registered donors with different blood groups, donation histories, and varying distances from the hospital.

B. System Execution Process

Upon receiving the emergency request, the system initiated compatibility filtering and shortlisted donors with O-negative blood group. Next, the eligibility verification module checked each donor's last blood donation date to ensure compliance with the mandatory 90-day recovery period. Donors who had recently donated were automatically excluded from further consideration.

The location-based filtering module then calculated the geographic distance between eligible donors and the hospital. Donors outside the predefined service radius were marked as unavailable. The remaining candidates were ranked based on proximity and historical response reliability.

C. Notification and Response Handling

Top-ranked donors received real-time mobile notifications containing request details and urgency level. One donor accepted the request within minutes, and the system immediately updated the hospital dashboard with confirmation status. Other shortlisted donors were automatically notified that the request had been fulfilled, preventing redundant communication.

D. Outcome and Observations

The system successfully identified a medically eligible and geographically nearby donor within a significantly reduced time frame compared to traditional manual coordination. The structured filtering process eliminated ineligible candidates, while priority ranking ensured rapid response. The case study demonstrates the system's capability to enhance emergency preparedness, improve coordination efficiency, and safeguard donor health through automated rule enforcement.

E. Case Study Flow Diagram

The workflow of the emergency case study is illustrated in the below figure.

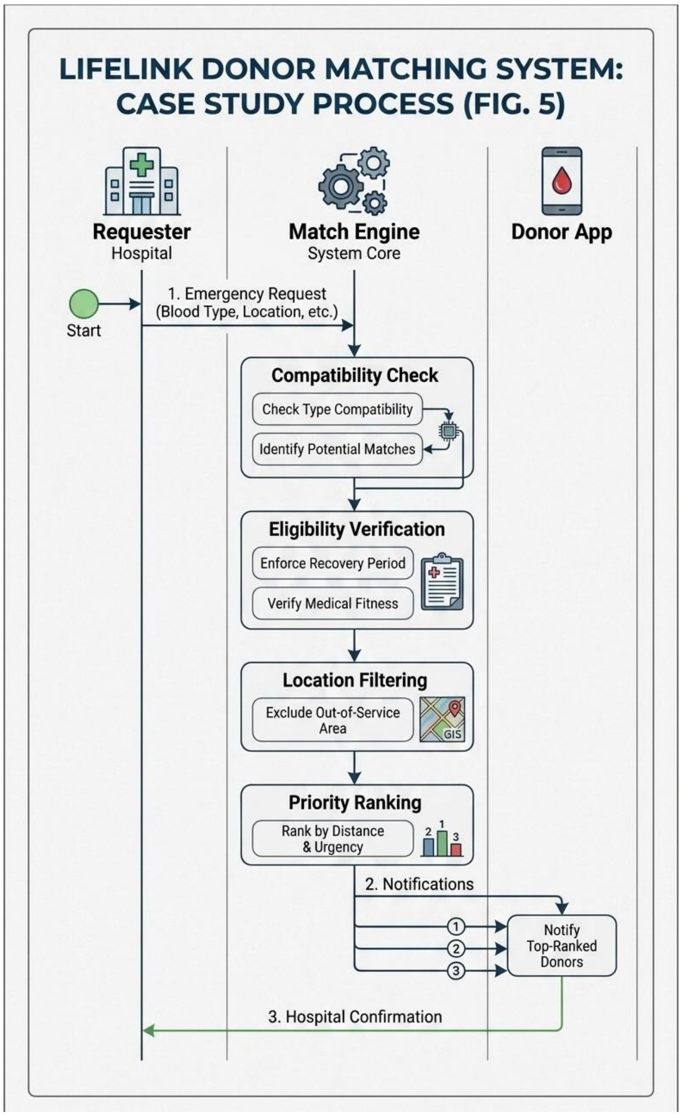

Fig. 5. case study flow diagram

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