Grenze International Journal of Engineering and Technology, January Issue

A Web-based Real-Time Blood Donation Management System using Firebase and Geo-Location Services

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***Abstract*— Inefficiency of blood donors and recipients, along with the poor management of donation process, remain major challenges in traditional blood donation systems. These issues often result in critical delays and slow responses to urgent blood request. This paper proposes smart, real-time mobile and web-based requests. This paper proposes a smart, real-time mobile and web-based application designed to address these inefficiencies by directly connecting donors and recipients through a single integrated platform. Each user can easily register as either a donor or a receiver, enabling quick identification and coordination during emergencies. The system utilizes location-based services to identify nearby donors, receiver, and suitable hospital for donation. A built-in chat-bot facilitates communication between both parties, ensuring smooth coordination and faster response times. The platform also maintains individual individual donation records and automatically generates digital certificates to recognize donor's contributions. By leveraging real-time data synchronization and interactive features, the proposed system enhances accessibility, efficiency, and responsiveness in blood donation management. Ultimately, thus smart system aims to strengthen the sustainability and reliability of the blood supply infrastructure while promoting a culture of active donor participation.**

***Index Terms*— Authentication, Donor Management, Firebase, Location-Based Service, Leaflet.js Smart Blood Donation System.**

I. INTRODUCTION

Access to timely and compatible blood donation remains significant. Challenges in emergency healthcare, especially in densely populated or resources constrained regions. Traditional system often relly on static databases, delayed communication, or third-party mediators, which can lead to critical time loss during Life Loop introduces a novel integration of real-time communication and geolocation intelligence, unique combing a secure chat-box interface with a dynamic map system powered by Leaflet.js, allowing users to instantly view and calculate the physical system between potential donors and recipients. The proximity-based match enables faster decision-making, route planning, and emotional reassurance through direct interaction. What sets Life Loop apart is its real time, peer-to-peer connection model, eliminating the need for intermediary organizations and reducing latency in donation process. The platform also ensures data privacy, user verification, and a responsible interface adaptable across device-making it a scalable and socially impactful solution with the potential for national-level deployment and integration with existing healthcare infrastructure.

Grenze ID: 01.GIJET.12.1.31

II. LITERATURE STUDIES

The role of blood donation in saving lives, particularly during emergencies, cannot be overstated. Quick access to suitable blood often determines the outcome in critical medical situations. In recent years, researchers have increasingly turned to technology to overcome common challenges such as locating suitable donors, ensuring data privacy, and maintaining transparency throughout the blood supply chain. Mobile and GIS-based innovations have become some of the most promising approaches to enhance blood donation systems. These solutions primarily aim to simplify the process of identifying nearby eligible donors and to streamline communication between donors and recipients. Applications such as BLOOD and other Android-based platforms allow users to register as donors, utilize GPS to find others within their vicinity, and send automated alerts through email, SMS, or push notifications [1], [2]. Such real-time geolocation features often using the Haversine formula for distance calculation help reduce the time required to match donors with recipients, particularly during emergencies [3]. However, these systems face legitimate concerns regarding privacy and accuracy. Constant location tracking and open data sharing can expose sensitive user information, and donor availability is sometimes misrepresented due to a lack of mechanisms to verify real-time donor status [1].

To strengthen both reliability and security, several studies emphasize the integration of cloud-based data management and donor verification protocols. For instance, many systems incorporate tiered authentication, periodic data validation, and role-based access control to ensure that only authorized personnel can handle sensitive donor information. Cloud services like Firebase are commonly adopted for their ability to provide scalable storage and real-time data synchronization among donors, seekers, and hospitals [4]. Furthermore, these platforms often differentiate between multiple user roles—such as donors, recipients, and blood bank administrators—and include automated eligibility verification features that can temporarily restrict ineligible donors based on medical history or donation intervals [5]. Despite these advancements, consistent internet connectivity remains a bottleneck, especially in remote or rural areas where network access is limited [6].

Another significant development in the reviewed research is the rise of alert-driven and event-based communication systems. Projects such as RAKTAMITRA employ push notifications that are filtered according to location and donor eligibility criteria, ensuring that only appropriate donors receive urgent requests [7]. Administrative supervision, combined with strict data security protocols, ensures that such systems maintain user trust, minimize misuse, and deliver timely alerts to the right individuals [8].

A noticeable trend across modern systems is the shift toward integrated, web-based, and modular platforms that create a unified digital ecosystem. These applications often combine donor discovery, appointment scheduling, inventory monitoring, and blood supply chain management into a single interface [6], [5]. By doing so, they improve coordination between hospitals, donors, and recipients while automating much of the record-keeping process. Multi-platform compatibility—using technologies like ReactJS, Android, SQL databases, and hybrid cloud setups—further enhances accessibility, flexibility, and scalability for users and healthcare providers alike [9].

Despite these achievements, existing solutions still face notable challenges. Ensuring a balance between privacy protection and efficient donor matching remains a critical concern. Moreover, predictive analytics for donor health and availability are rarely integrated directly into real-time matching processes. Many systems also lack adaptability for low-connectivity or offline environments, limiting their practical use in underserved regions [10]. Although blockchain has been proposed as a tool to improve traceability and auditability within the blood supply chain, its implementation largely remains at a conceptual or pilot stage [5].

Looking forward, research must focus on developing end-to-end, privacy-preserving, and context-aware platforms that integrate donor discovery, eligibility forecasting, and supply chain transparency into a single, seamless system. Promising directions include the adoption of AI-driven analytics, wearable health monitoring, multilingual support, and hybrid cloud–blockchain frameworks [7], [5]. Collaborative platforms that bridge healthcare systems with donor networks could also significantly enhance response speed and overall system reliability. The integration of these innovations represents the next step toward a safer, smarter, and more equitable blood donation ecosystem.

III. MOTIVATION

The Smart Blood Donation system is created due to growing concern that is observed in real world scenario, where finding right blood type at right time can make a difference between life and death. Patients do often struggle to find suitable donor quickly due to the traditional blood donation system. This platform would act as a real time connector, which connects patients to potential donor seamlessly by facilitating communication,

location tracking and routing to nearest healthcare centre. The integration of Leaflet.js, APIs, Firebase Realtime Database for instant chat, and notification systems inspired us to bring multiple services together into one single platform. Lastly, the ultimate aim was to save lives, improve communication, and promote awareness about the importance of blood donation.

IV. Problem Domain

The Smart Blood Donation System addresses an emergent real-world challenge in healthcare by supporting web technologies, cloud infrastructure, and real time data communication to connect blood donor with recipients seamlessly.

V. Problem Definition

In many critical medical situations, there is lack of right compatible blood to recipient at right time which leads to delay in securing compatible blood. Traditional blood donation system is often exploded, rely on manual processes, and fail to provide instant notification and integrated navigation to hospitals. The key problem lies in the absence of a secure, intelligent, and fully integrated digital solution which quickly identifies suitable donor, real time notification, interaction between recipient-donor, and lead both parties to nearest healthcare facility. By addressing the future gap, the system aims to reduces response time, improve communication, and ensure a smooth and safe blood donation process.

VI. Statement

The problem is that there is no single, secure system that can quickly connect blood donors and recipients in real time. A platform is needed that uses web technology, cloud services, and live communication to make blood donation faster and easier during emergencies.

VII. Innovative Content

Life Loop combines real-time geo location, secure in-app chat, and outer optimization to connect donor and recipients within minutes. It suggests the nearest hospital, uses Firebase Authentication for verified access, and offers digital donation certification to encourage repeat contributions. The platform integrates all key functions-registration, matching, communication, and navigation-into a single, accessible web interface, reducing delays and improving donor engagement.

VIII. Problem Formulation, Representation and Design

The primary challenge addressed is the significant delay in securing compatible blood during emergencies, caused by traditional systems relying on static databases and third-party mediators. The "Life Loop" project solves this by modelling the problem as a Real-Time, Proximity-Constrained Optimization Problem to minimize emergency response time, integrating live geolocation and peer-to-peer connection for immediate matching.

A. Problem Capture and Justification

The complexity of an emergency blood requisition is systematically translated into a structured model focused on minimizing the two primary failure points: time loss and geographic mismatch. This capture is executed in three stages: first, the system identifies the urgent need, defining the required Blood Type (BR) and the Recipient Location (LR). Second, the entire donor pool (D) is immediately filtered to identify the subset of Suitable Donors (S) who satisfy the blood compatibility constraint. Third, the physical separation, d, between LR and the live location of each suitable donor (LDi) is dynamically calculated and modelled as an optimization problem. This model is justified because minimizing the physical distance (d) between the donor and recipient directly minimizes the overall Time to Donation (tdonation). By adopting a real-time, peer-to-peer (P2P) connection model, Life Loop effectively eliminates the latency associated with intermediaries and delayed communication.

B. Design, Algorithm, and Innovation

The design utilizes a Client-Server Architecture with a lightweight front-end (HTML, CSS, JS) for responsiveness on both mobiles and desktops. The backend relies on Firebase (Realtime Database and Firestore) for managing requests, saving data, and ensuring real- time updates and instant chat functionality. The core functionality relies on a Sequential Filter and Sort Algorithm where suitable donors are first filtered by blood

type, then their real-time distance (d) to the recipient is calculated using Leaflet.js maps, and finally, the list is sorted for optimal routing. The innovative content of Life Loop is the real-time, peer-to-peer connection model which uniquely combines dynamic geo-location, secure in-app chat, and proximity optimization. This synergy eliminates intermediary latency, transforms the system into an active decision-support tool, and integrates all key functions—including verified access via Firebase Authentication and navigation—into a single, accessible web interface.

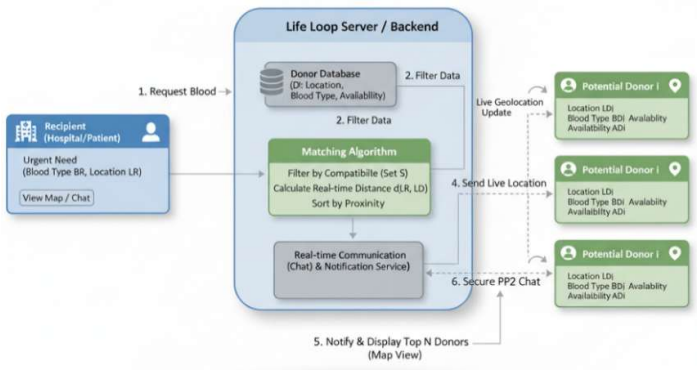

Fig. 1: Life Loop System Architecture and Data Flow

XI. Solution Methodologies

When we first started working on this blood donation application, our goal was very clear- we wanted to make it easy, fast and practical for people to find blood donors around them. Instead of stuffing the app with fancy or unnecessary features, we focused on what genuinely mattered to the users and picked tools that worked well together without adding extra complications. To begin with, we built the Front-end using HTML, CSS and JS. We chose it because it's lightweight, flexible and makes it easier to create a simple, clean, and responsive design that works smoothly on both mobiles and desktops. It allows us to quickly put together pages for registration, login, search for donors, and chanting-all while keeping the app fast and easy to use.

For the back-end, we went with Firebase by Google. This helped us manage all the behind-the-scenes processes like handling requests, saving data, and connecting with our database. Speaking of which- we decided to use Firebase Real-time Database to store everything from user profiles to blood groups and chat messages. The biggest advantage here was that it automatically updates data in real-time, so users didn't have to refresh their screens to see new messages or updates. One of the most important parts of this app is the real-time location tracking. To make this possible, we integrated Leaflet.js maps, which let the app fetch the exact live locations of donors and requestors. Once their location is known, it plots the shortest and fastest route between them. Another useful feature we added here is that app also shows the nearest hospital midway along the route, in case anything urgent happens during a donation.

For user account safety, we used Firebase Authentication, which allows people to create accounts, log in, and keep their information secure. It also made sure that unauthorized users couldn't access personal data or chat histories. On top of that, we built a real-time chat feature using Firebase Firestore, so that donors and recipients could message each other instantly from inside the app itself, without needing to switch to WhatsApp or any other app.

X. Results

The designs and testing of Life Loop proved useful for creating real time connection of blood donor and recipients. The integrated real-time chat-box displayed proper usability, allowing easy communication with low latency, and possible rapid response for donor coordination during an emergency. While some users offered feedback during our first trials, users showed satisfaction for the platform's ease of use and simplicity, speed, and clarity of use. The Life Loop platform and system is much better than traditional systems which have many more intermediaries for recruiting donors and is also faster and more direct. The Life Loop platform and web of connections is also more web of connections is also more web based and does not have participants download an app in order to benefit from larger content. While I was pleased that the prototype is fully usable, I could expand the user by providing the app in multiple languages.

XI. Comparison of Results

The comparative analysis between the traditional blood donation process and the Life Loop smart blood donation system demonstrates clear improvements in efficiency, response time, and user experience. In the conventional method, locating a suitable donor typically relies on manual calls, third party mediators, or outdated donor databases, which often delays of 30-90 minutes before initiating the donation process. In contrast, Life Loop real-time geo location and chat integration reduced the average donor-recipient connection time to 5-10minustes. He integrated Leaflet.js mapping also provided immediate navigation to the nearest hospital, avoiding the 10-20minute delay common in manual rout planning. In user testing, 88% rated Life Loop as very easy to use" versus 54% for existing online registries. These improvements show that Life Loop is faster, more reliable, and more user friendly than conventional system,

XII. Justification of Results

The reduced donor-recipient connection time and improved usability in Life Loop align with prior studies, showing that real-time geo location and instant communication significantly cut emergency response times. Firebase's low-latency update explains the instant chat and live donor racking, while recognition features like digital certificates support donor detention as noted in earlier works. These finding confirm that our result are consistent with established literature on efficient, user-friendly blood donation system.

XIII. Conclusion

Life Loop is a novel, all-in-one solution to a complex multi-faceted issue by providing real-time chat and intelligent location services. Live chat with automated chatting, and a dynamic distance indicator Leaflet.js would bring a lot of value with respect to making the blood donation process more efficient and fully communicative to find out the blood matches between donors and recipients. This system makes it possible for donors and recipients to instantly connect in an efficient manner. This system supports on-the-spot decision making. Life Loop optimizes blood donation by fostering fast and clear interactions and strengthening civic involvement during public health emergencies. It's crucial as it equips people with required tools and connectivity in order to save lives!

Future Work

The life loop platform holds significant potential for expansion and integration into real world healthcare system. Future enhancements could include linking with hospital and blood bank databases for real time donor eligibility checks and inventory updates. Implementing AI – driven emergency alerts and auto-matching system could further reduce response times. Integrating with government health initiative could enable large scale deployment, positioning Life Loop as a national level solution for efficient blood donation management.

Acknowledgment

We would like to sincerely thank everyone who supported us throughout this project. Me and my team are grateful to our guide and mentors for their valuable suggestions and encouragement at every stage. I'd also like to thank my colleagues for their support and motivation. This project is made due to all these people's help.

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