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Jeevandan-The Blood Portal: An Intelligent Blood Bank and Donor Management System

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Abstract - *The rapid demand for blood in emergency situations often faces challenges due to the lack of timely availability, inefficient management, and limited communication between hospitals, donors, and blood banks. Jeevandan – The Blood Portal is an intelligent, full-stack web application designed to streamline the process of blood donation, request management, and donor search. The system bridges hospitals (doctors), blood banks, and donors through a single digital platform that ensures quick and reliable access to blood when needed. It integrates geolocation services to identify nearby blood banks and donors and uses the Haversine and TOPSIS algorithms to efficiently locate and rank suitable donors based on proximity, health conditions, and donation eligibility. Authentication and data security are handled using JWT and bcrypt.js, while real-time notifications are managed through integrated messaging APIs. The portal also features automated reminders to encourage repeat donations after three months of the last donation, enhancing donor engagement and availability. By automating communication, donor selection, and inventory management, Jeevandan contributes to reducing response time and bridging the critical gap between blood demand and supply in medical emergencies.*

Key Words: Blood Donation, Blood Bank Management System, Jeevandan, Haver sine Algorithm, TOPSIS Algorithm, Geolocation, Donor Search, Emergency Blood Request, JWT Authentication, Bcrypt.js, Twilio API, Automated Notification, Web Application, Healthcare Technology.

1. INTRODUCTION

JEEVANDAN-The Blood Portal is a web application intended for the linkage of blood donors, receivers, and blood banks within one system. The primary purpose of this system is to develop an efficient platform for handling blood donation and availability. This system helps individuals to conveniently register themselves as blood donors, find out about blood availability, and get in touch with nearby donors or blood banks in case of emergency. This portal will not only help individuals to save their precious time but will also make sure that the blood required by them would be available at the right place and at the right time. This system acts as a medium to link up blood donors and seekers. It ensures efficiency and precision of blood donation. JEEVANDAN advocates voluntary blood donation and helps in the development of a self-reliant blood management system. This project becomes very significant and essential in saving lives.

2. PROBLEM STATEMENT

There is no organization in the current system, which delays the search for suitable donors during emergencies. JEEVANDAN- The Blood Portal will develop a web portal to link the donor, recipient, and blood bank in order to facilitate the availability of blood at any time.

3. LITERATURE SURVEY

Efficient Blood Management Systems have been required for many years now, particularly in developing countries where traditional means of blood management such as manual record keeping could lead to wastage of many valuable lives. Several recent studies have come up with some technological advances regarding blood management. However, most of these technologies have failed to scale up and provide features such as real time synchronization, donor verification and intelligent handling of requests.

Earlier, some applications were developed to manage blood banks. Such applications were basically meant to store and manage donor details, blood stock and other information locally. They lacked features such as blood request automation, matching donor to hospital by geolocation and real time information updates. Also, these older blood management systems failed to provide the option for collaboration between hospitals, blood banks and donors.

Web based Blood Donation Management Systems are another development in this field. These applications allowed the user to register himself as a donor and view blood stock available. However, these systems had several shortcomings, including heavy dependency on manual validation, lack of geolocation features and inability to select donors using intelligent algorithm.

The current developments in GIS and AI technologies provide an opportunity to optimize the process of blood management systems through recent techniques. The majority of methods integrate locational services in order to locate the closest donors or blood banks through the use of the Haversine formula, which calculates the shortest distance between two geographical points. Nevertheless, the current techniques consider only the factor of geographical closeness without taking into consideration other crucial parameters for effective blood transfusions such as donor eligibility, date of the latest donation, and health condition of the individual.

A few techniques have already adopted ranking algorithms together with Multi-Criteria Decision Making approach in order to increase the accuracy of donor selection. The most efficient algorithm for evaluation is Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), which uses several weighted parameters such as blood compatibility, hemoglobin content, donor's weight, geographical closeness, and date of the previous donation. Despite the efficiency of this algorithm, there are only a few models that utilize it along with location filtering.

The other innovative solution was the development of automated communication technology that included the use of SMS APIs and cloud-based notification services. Although such solutions have enhanced response times, they generally do not guarantee the continued interaction between the donors and the hospitals after the donation process, leading to reduced retention rates in the long run.

The third research area that has gained traction lately has been related to the investigation into blockchain-based transparency initiatives, use of mobile applications for managing donors, as well as IoT-based technologies for real-time monitoring of the blood bags. Nonetheless, such approaches are relatively complicated and expensive to implement in small- to medium-sized healthcare facilities.

Based on this assessment, one may notice that the previously mentioned systems greatly contributed to the digitalization of the blood donation procedure. Yet, they failed to incorporate smart prioritizing of the donors, geospatial precision, automated reminders, and coordinated activities of the physicians, blood banks, and donors. The identified limitations make a solid ground for developing "Jeevandan – The Blood Portal" system.

4. MOTIVATION

Reasons for designing “JEEVANDAN– The Blood Portal” include the development of an effective and dependable portal through which one can connect with blood donors and receivers. Often, there are many emergencies when people fail to locate blood donors because of the lack of relevant information. With this portal, individuals will be able to connect with blood donors and make requests regarding blood donations easily and effectively. Thus, this portal will help to promote blood donation and ensure that those in need receive timely help from volunteers.

5. SYSTEM ARCHITECTURE

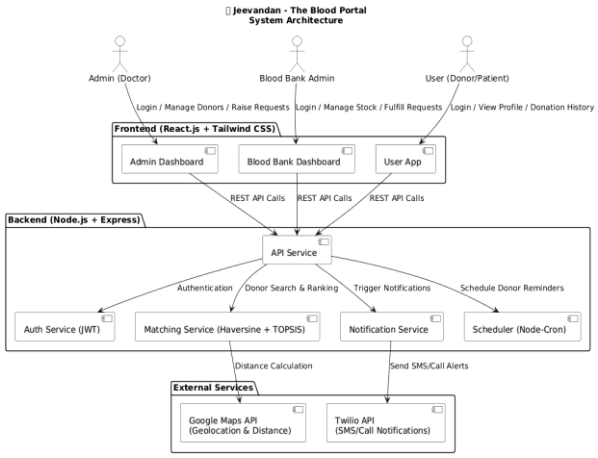

Fig 1. System Architecture

1.User Registration & Authentication: Users (Doctors, Blood Bank Admins, and Donors) securely register and log in using JWT-based authentication.

2. Blood Request Generation: Doctors raise blood requests by providing required blood group and quantity details.

3. Geolocation-Based Search: The system uses Google Maps API and the Haversine Algorithm to find nearby blood banks and eligible donors.

4. Donor Ranking: The TOPSIS Algorithm evaluates and ranks donors based on blood compatibility, distance, health status, and last donation date.

5.Request Prioritization: Blood requests are prioritized according to urgency, patient condition, and blood availability.

6. Notification Service: Twilio API sends SMS and call alerts to selected donors and blood bank administrators.

7. Automated Reminders: Node-Cron automatically sends reminders to donors after 90 days, encouraging regular blood donation.

8. Blood Request Fulfillment: Blood banks approve requests, update inventory, and complete the blood supply process.

9. Result & Monitoring: The system displays request status, donor details, and blood stock information through dashboards for efficient monitoring and management.

6. PROPOSED ALGORITHMS

Algorithm 1– Haversine Distance Algorithm (Blood Bank & Donor Location)

Haversine Distance Algorithm helps in calculating the shortest possible distance between two points on Earth. This algorithm works on the basis of latitudes and longitudes of the geographical locations. This algorithm helps in determining the nearest blood banks or blood donors to the patient.

Explanation of Haversine Distance Algorithm:

1. Input: The current location of the user (latitudes & longitudes) is provided by the user. Location data of various registered blood banks or donors are also stored in the database.

2. Gathering Coordinates: The latitudes and longitudes of the user and different blood banks/donors are extracted from the database.

3. Distance Calculation: The distance between the user's location and that of each blood bank/donor is calculated using the Haversine formula.

4. Comparison of Distances: The system compares the distances of all blood banks and donors that have been calculated.

5. Shortest Distance Selection: It selects the shortest distance between the user and either a blood bank or a donor.

6. Recommendations: It provides recommendations about the closest blood banks and donors arranged from the nearest to the farthest to the user.

Algorithm 2– TOPSIS Algorithm (Donor Ranking System)

TOPSIS stands for Technique for Order Preference by Similarity to Ideal Solution, which is an approach employed in making decisions where several criteria need to be considered in ranking different options. The criteria involved in choosing the best donor in the Blood Bank & Donor Ranking System include distance, availability of blood, donations history, response time, and reliability.

Explanation of TOPSIS Algorithm:

1.Input: Information related to donors like their blood group, distance from the patient, availability status, last donation time, response time, and reliability are taken as input.

2. Creation of Decision Matrix: All the donor information is put into a decision matrix wherein each row denotes one donor, while the columns denote criteria for choosing.

3. Normalizing Data: This step involves normalization of data so that values belonging to each criterion can be compared.

4. Weight Assignment: Assigning weight to each criterion according to its importance level in making decisions. Some examples of more important criteria could be blood availability, and distance.

5. Identifying Ideal Solutions:
- Positive Ideal Solution: Values of best cases for all criteria.
- Negative Ideal Solution: Worst case values for all criteria.

6. Calculation of Rank Scores: For each individual donor, a closeness score is determined. If a donor has a score that is more close to the solution, then it gets a higher score.

7. Final Ranking of Donors: All donors are arranged in the order of their score, which means those having high scores are ranked first.

8. Results: Patients can contact the most appropriate donors easily from the list displayed by the system.

Algorithm 3 – Node Cron Algorithm (Task Scheduling)

Node Cron is a library used to schedule the execution of certain actions at a specific time or periodically. In a Blood Bank System, Node Cron can be used to schedule tasks like sending reminders to donors, updating the blood inventory, and verifying donor eligibility.

Explanation of Node Cron Algorithm:

1. Input: The system creates a schedule (time and date or time period) for the execution of the particular action.

2. Schedule Creation: A schedule is generated using the cron expression.

3. Register Task: Registering the task with Node Cron scheduler.

4. Scheduled Task Execution: Node Cron continuously checks the current time and schedules the action accordingly.

5. Process Task: The required task is performed according to the scheduled time.

6. Output: The scheduled task is automatically executed.

Algorithm 4– Geolocation Filtering Algorithm

Geolocation Filtering Algorithm can be used to filter and show the users, donors, or blood banks by geographically locating them. This algorithm is useful in Blood Bank Management System to locate nearby blood donors and blood banks in a specific radius.

Explanation of Geolocation Filtering Algorithm:
1. Input: The system gets the input data that includes latitude, longitude, and desired radius.

2. Retrieval of Location Information: Locations of all donors/banks of blood registered in the database are retrieved.

3. Measurement of Distance: The system measures the distance between user's location and donor/bank of blood.

4. Applying Filter: Only donors/banks of blood lying within the desired radius are considered.

5. Sorting: The sorted locations of blood donors/banks are arranged from near to far locations.

6. Output: List of available blood donors and blood banks in the vicinity.

Algorithm 5– Request Prioritization

Request Prioritization Algorithm is employed to select the most important requests for treatment first. The Blood Bank Management System uses this algorithm to prioritize cases that need urgent attention depending on several aspects, including the importance, availability of blood, and the status of the patient.

Explanation of Request Prioritization Algorithm:

1. Input: Blood requests received by the system come from hospitals/patients.

2. Priority Assignment: A priority level is given to each request depending upon the urgency of the situation.

3. Sorting Requests: Requests are sorted from high priority to low priority.

4. Processing: Emergency and urgent requests are given preference.

5. Output: The system guarantees that blood requests with higher priorities get attention.

7. METHODOLOGY

Jeevandan – The Blood Portal is a newly devised system for blood management, which makes use of artificial intelligence to ensure that the process of managing blood donations is more efficient. This application makes use of geolocation and ranking algorithms to automate the process of blood management.

I. User Authentication

• The doctors, blood bank administrators, and donors register themselves.
• Authentication and logging into the platform uses JWT authentication with bcrypt password hashing.

II. Blood Request Creation

• Doctors initiate blood requests specifying the amount of blood and its type.
• A database record is created for the same and sent to blood banks nearby.

III. Geographical Information System (GIS)

• The location data is obtained by Google Maps API for donors and blood banks.
• The Haversine Algorithm is used to determine the distance of nearby donors and blood banks.

IV. Donor Priority Using TOPSIS

• The eligibility of donors is determined based on factors like blood compatibility, distance, health status, hemoglobin level, weight, and last donated date.
• Using TOPSIS, donors are ranked based on their priority.

V. Priority of Requests

• Blood requests are prioritized based on their emergency, health of patients, and availability of blood.
• Emergency requests take precedence over normal requests.

VI. Notification System

• SMS and voice messages are sent to donors selected and administrators of blood banks through Twilio API.

VII. Automated Reminder for Donors

• Node-Cron automated reminder system reminds the donor after 90 days of his last donation.
• This helps ensure regular involvement from the donor.

VIII. Blood Request Satisfied

• The request is satisfied either by donor approval or by the blood bank's approval.
• Automated updating of blood stock and donor databases takes place in the database.

IX. Results and Monitoring

• The status of requests, donors, and blood stock levels is displayed via the dashboard.
• The administrator can monitor all the activities in real-time.

8. RESULTS

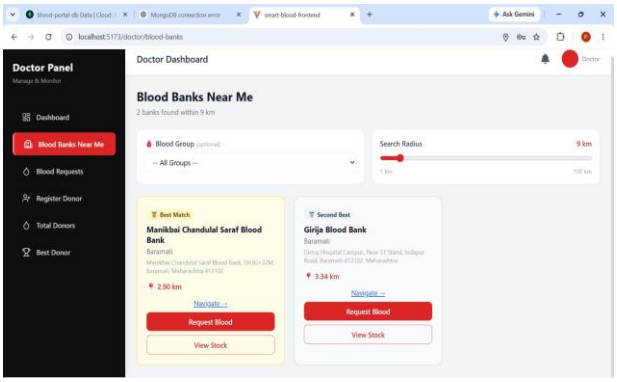

Fig 2.Blood bank near me

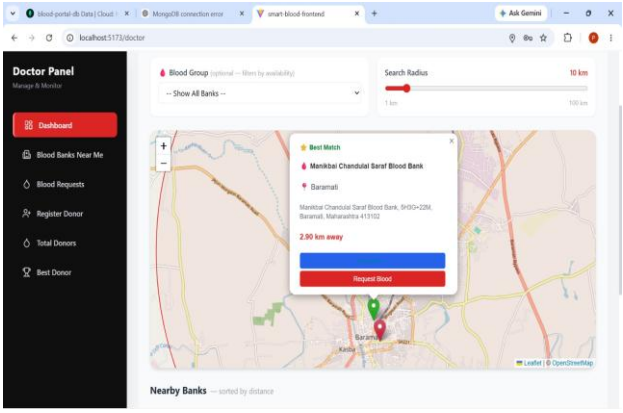

Fig 3. Search nearby banks

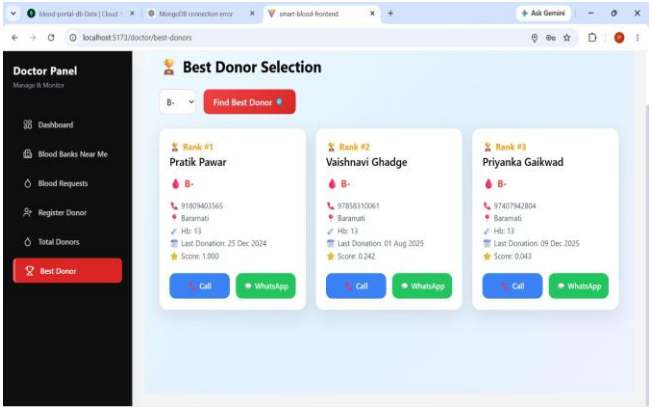

Fig 4. Best Donor Selection

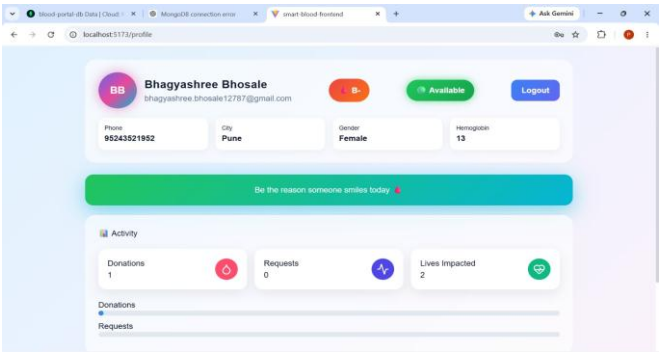

Fig 5. Avilable Donor

9. CONCLUSION

The suggested system, Jeevandan – The Blood Portal, offers an intelligent and effective approach to blood donation and blood banks management. The system brings together the hospital, blood bank, and the donors into one platform that facilitates real-time communication and better emergency response in blood donations. Incorporation of the Haversine Algorithm for finding the closest donor and the TOPSIS Algorithm for ranking the potential donors leads to a faster and more accurate identification of the donor. Notifications through the Twilio API, as well as donor reminder schedules with Node-Cron, contribute to increased donor engagements. In terms of security, the system uses JSON Web Tokens (JWT) and bcrypt.js for protection of sensitive user data.

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