International Scientific Journal of Engineering and Management (ISJEM) ISSN: 2583-6129
Volume: 05 Issue: 04 | April – 2026 DOI: 10.55041/ISJEM06350
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata

Artificial Intelligence-Powered Blood Donor Management System with Screening for Eligibility and Emergency Response

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Abstract— Blood donation is a vital healthcare activity, but the detection of suitable donors in emergency situations is a major problem. In this context, the present paper proposes a blood donor management system based on artificial intelligence technology. The proposed system includes various features such as rule-based blood donor eligibility, intelligent search of donors, and emergency notification systems. The proposed system was created using the Flask framework and the SQLAlchemy library, which provides a structured database of donors with location-based mapping to efficiently locate donors. The proposed system determines the eligibility of donors based on various medical parameters such as weight, health, age, and blood donation intervals, with the help of GPT technology to provide better explanations to donors. Additionally, the proposed system includes a natural language search facility to find donors based on blood groups and locations. In emergency situations, the proposed system provides personalized artificial intelligence-based notification to donors to contact the donors. Interactive geographic visualization is also provided to make the proposed system more accessible. The proposed blood donor management system based on artificial intelligence technology has the potential to provide better services to the blood donation community.

HIGHLIGHTS

1.AI-Assisted Blood Donor Management System 2.WHO-Based Eligibility Verification
3. Dataset-Driven Decision Support
4. Improved Healthcare Efficiency

I. INTRODUCTION

The process of blood donation is an essential part of modern healthcare systems, and timely availability of safe blood is necessary for surgeries and other medical emergencies. However, there are many difficulties in traditional blood donor management systems, such as manual verification of donors, time-consuming search for donors, and low responsiveness in emergencies. These difficulties often lead to life-threatening delays in emergencies.With the advent of new technologies in artificial intelligence (AI) and natural language processing (NLP), intelligent systems are possible in various fields, including healthcare. However, in traditional blood donor management systems, various techniques of AI are not integrated in a unified manner.The paper proposes an intelligent blood donor management system that incorporates various techniques of AI in a unified manner. The main contribution of the proposed system is that each module of the system is implemented with the most appropriate technique of AI to ensure not only the correctness of the system but also user-friendliness. The traditional blood donor management systems suffer from various difficulties in search, verification, and responsiveness in emergencies. The proposed system overcomes these difficulties and thus improves the reliability and transparency of blood donation management systems.

II. RELATED WORK

There have been various proposals of donor management systems over the years. The majority of the proposed donor management systems have focused on database-oriented donor registries and rule-oriented eligibility checking. The proposed donor management systems formed the basis of the structured donor record management system. The initial focus of the donor management systems was on the donor record management system. The initial focus of the donor management system helped to lay the foundation for the development of the structured donor database. The initial donor management systems lacked intelligent donor search and real-time communication. With the advent of Artificial Intelligence (AI), the use of machine learning for donor-recipient pair matching, Natural Language Processing for healthcare query processing, and chatbot technology has been explored.

Literature has proved that machine learning algorithms such as the Naïve Bayes and Random Forest classifier can be effectively utilized in intent detection and donor eligibility prediction. Moreover, NLP has been utilized in normalizing the donor search query using TF-IDF vectorization for more accurate information retrieval. Another aspect that has been explored in the literature is the implementation of AI-based emergency response systems, which further emphasizes the importance of intelligent automation in emergency response situations. Following the developments in this area, the proposed system aims at implementing a modular AI system that encompasses various functionalities such as eligibility screening, donor search, chatbot interaction, and emergency response systems.

DATASET DESCRIPTION

The proposed AI-Powered Intelligent Blood Donor System is based on a carefully designed and comprehensive donor dataset, specifically created to simulate real-world blood donation scenarios. The dataset comprises 300 distinct donor records, each of which represents a unique donor profile that encompasses a broad spectrum of demographic variables, including age, gender, and geographical location, as well as significant medical variables essential for the safe process of blood donation. The dataset has been designed in such a way that it comprises varied donor profiles with different blood groups, health conditions, and donation histories.

Each record of the donors is a unit of information that contains all the necessary features for the functionality of various systems. Firstly, it is used in the eligibility decision module, which enables the AI to determine if the donor is eligible for blood donation based on the medical and regulatory requirements. At the same time, the records facilitate the donor matching system to find suitable donors for a particular blood request.

Through the inclusion of synthetic but realistic data, the dataset is able to provide a robust means of training, testing, and validating the system's key components without the risk of privacy that comes with using actual patient data. The dataset is also able to provide the AI system with the capacity to handle normal and exceptional cases, ensuring that the final system is able to provide safe and practical recommendations.

III. ARCHITECTURE DETAILS

The proposed blood donor management system uses a layered architecture design to ensure modularity, scalability, and maintainability. Each layer is designed to handle a set of specific functionalities and works in perfect harmony with other layers to offer a comprehensive platform for donor registration, eligibility checking, intelligent search, and emergency notification.

1. User Interface Layer

User Interface Layer, built with Flask templates, HTML, CSS, and JavaScript, provides forms for donor registration, eligibility checks, searches, and emergency communication.

2. Application Logic Layer

Application Logic Layer manages business rules, including eligibility checking, AI-powered explanations, smart search using NLP, and emergency messaging.

3. Data Management Layer

.Data Management Layer stores donor information in an SQLite database via SQLAlchemy ORM, ensuring integrity

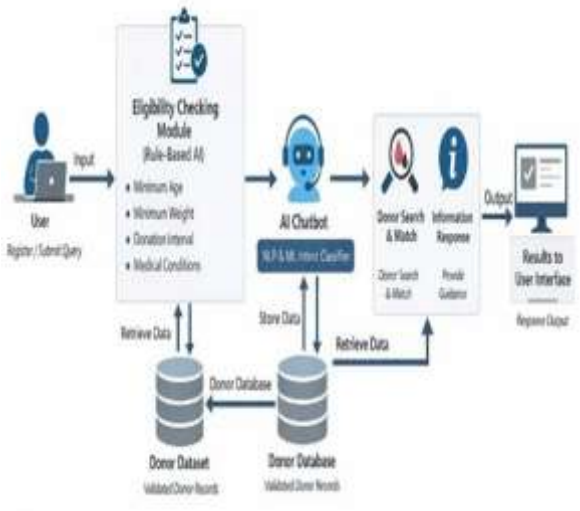
with validation constraints.

4. AI Integration Layer

AI Integration Layer leverages GPT for contextual explanations and personalized emergency communication, invoked only when advanced reasoning is required.

5. Geographic Mapping Layer

Geographic Mapping Layer visualizes donor distribution with interactive maps based on latitude and longitude, enabling quick identification of nearby donors, especially in emergencies.



IV. PROPOSED METHODOLOGY

The proposed approach for the blood donor management system is developed as a sequential process that combines donor registration, eligibility checking, intelligent searching, emergency notification, donor history, and geographic mapping.

1. Donor Registration

The first process of the system is the registration of the donors, which involves the entry of data in a formatted manner using a web-based form. The donors are asked to provide crucial information such as name, age, gender, weight, blood group, contact information, email, and location. Validation tests are also performed to check the correctness of the information provided, such as the proper notation of blood groups, the need for weight, and the correctness of the contact information.

2. Eligibility Checking

The second stage is involved in the verification of eligibility, which applies a hybrid method that combines rule-based filtering and artificial intelligence reasoning. The donors are evaluated according to pre-defined criteria that involve age category (18-65 years), minimum weight (50 kg), absence of any disqualifying medical conditions, and a minimum of 90 days since the last donation. If the criteria are not met, the donor is considered ineligible. To improve transparency and donor engagement, GPT-explanation methods are applied to provide a medically informed reason for the donor's eligibility or ineligibility.

3. Emergency Alert

The third stage involves emergency communication, where the system generates customized messages for potential donors through AI. The messages include information about the required blood type, location, and urgency, which encourages the recipient to take immediate action. The system is applicable in emergency situations where immediate

donors are required. The module is essential in emergency situations where immediate donors are required.

4. Mapping and Visualization

The fourth stage of the system is Mapping and Visualization. This stage changes donor search results into a map view. Donors are shown as points on a map. The map is centered around where the user's searching or where an emergency happened. Each donor has a marker on the map. The marker shows details like name, blood group and how to contact them. This map view makes it easier to find donors. Users do not have to read lists of donors. They can see donors in the area away. The system also lets users filter donors. They can filter by blood group if the donor is eligible or if they are available. This helps users see the donors that are most needed in an emergency. The Mapping and Visualization stage helps connect donors and people who need blood. It makes the process quicker and clearer. It helps during emergencies. The system uses search, with the map. This makes it easy to find the donors. Donors are plotted on the map using coordinates. The coordinates are already set in the system.

5. AI – Powered Intelligent Chatbot

An AI-powered chatbot that helps blood donors, patients, and hospital administrators by answering questions about eligibility, safety rules, how to donate blood, matching blood types, and general information. A rule-based engine takes care of important medical and eligibility questions, while an AI-driven NLP engine gives answers that are flexible and based on the situation. To make sure it works, the chatbot keeps working even when AI services aren't available. The rule-based engine keeps providing support without stopping. This design makes things more robust, cost-effective, and possible in medical settings.

V. Implementation Details

The proposed AI-Powered Intelligent Blood Donor System was designed as an all-inclusive web-based system that encompasses donor management, eligibility checks, intelligent chat support, and automated donor matching. The system has a modular and scalable design that enables the system to function properly both in normal and emergency situations. All the modules in the system interact seamlessly with the backend database and AI modules.

A. Development Environment and Tools

The system was developed using modern software tools, web technologies, and machine learning frameworks to provide a robust and maintainable solution:

Programming Language: Python 3.x – for server-side logic and AI model implementation.

Web Framework: Flask – for handling HTTP requests, server-side Operation and routing.

Frontend: HTML, CSS, JavaScript – for designing an intuitive user interface.

Database: SQLite / MySQL – for storing donor profiles, eligibility records, and query logs.

Machine Learning Library: Scikit-learn – for implementing the AI-based intent classification model.

Natural Language Processing: NLTK, TF-IDF Vectorizer – for preprocessing user input and extracting meaningful features.
Development Environment: Visual Studio Code (VS Code).

Operating System: Windows/Linux – compatible with both platforms for flexibility.

The Flask framework serves as the backbone of the system, handling server-side operations such as donor registration, eligibility evaluation, chatbot communication, and donor search requests. Its lightweight and modular nature allows easy

integration of AI components, database operations, and front-end interactions.

B. System Modules Implementation

The system is divided into five core modules, each addressing a specific functionality:

1. Donor Registration Module

This module enables users to register as blood donors by submitting their personal and medical information, including:

Name, Age, Weight Blood Group
Health Conditions (e.g., anemia, diabetes, heart disease) Last Donation Date
Location

Data validation ensures that the entered information is accurate and complete. Once validated, records are securely stored in the database and used for eligibility evaluation and donor matching. This module forms the foundation of the system, ensuring a reliable dataset for subsequent operations.

2. Eligibility Checking Module

The eligibility module determines whether a donor can safely donate blood according to medical rules derived from WHO blood donation guidelines and internationally accepted standards. The system checks:

Minimum age requirement Minimum weight requirement Required interval since last donation
Relevant medical conditions (e.g., anemia, heart disease)

A rule-based decision engine evaluates these parameters and automatically generates an eligibility status (Eligible / Temporarily Not Eligible). This ensures that only medically safe donors are matched to blood requests, enhancing donor and recipient safety.

3. AI Chatbot Module

The chatbot provides intelligent, interactive communication between users and the system. It can respond to queries regarding:

Blood donation eligibility, Safety guidelines
Blood group compatibility Emergency donor requests

The chatbot uses a machine learning–based intent classification model to analyze user queries. After NLP preprocessing, the model identifies the intent and directs the query to the appropriate module, enabling automatic and context-aware responses rather than simple keyword-based answers.

4. Donor Matching and Search Module

This module performs automated donor matching whenever a blood request is submitted by a hospital or patient. Matching is based on:

Blood group compatibility Location proximity
Donor eligibility status Donation availability
The system filters donor records using these criteria and returns the most suitable candidates. This automation significantly reduces manual search time and ensures rapid, accurate identification of potential donors.

5. Emergency Request Module

The emergency request module prioritizes urgent blood demands. Upon receiving an emergency alert:

The system immediately searches for eligible donors within the vicinity.

Rapid notifications are generated to alert potential donors.

Response times are minimized, improving efficiency in critical situations.

This module ensures that the platform can effectively handle time-sensitive medical needs, reinforcing its utility in real-world scenarios.

C. System Architecture Workflow

The overall workflow of the system is as follows:

User Interaction: A user registers or submits a query.

Data Storage: Donor information or query data is stored in the database.

Chatbot Processing: The chatbot receives and preprocesses the user input using NLP techniques.

Intent Classification: A machine learning classifier determines the type of query.

Module Execution: Depending on intent, the system executes: Eligibility checking
Donor search Information response
Result Delivery: Results or recommendations are returned to the user interface.

This modular workflow ensures smooth integration between AI models, database operations, and user interaction, while maintaining high reliability and scalability.

D. Machine Learning Implementation

The chatbot uses a Multinomial Naïve Bayes (MNB) model for intent classification, enabling the system to understand user queries contextually.

Training Process:

Input: Pre-collected dataset of user queries with labeled intents

Feature Extraction: TF-IDF vectorization converts textual input into numerical features

Data Split: 70% training, 15% validation, 15% testing

Once trained, the model allows the system to automatically identify query types, route them to the correct module, and provide relevant responses. This machine learning approach outperforms traditional keyword matching by handling variations in user language, improving accuracy and user experience.

VI. Comparative Analysis with Existing Systems

A. Existing Blood Donor Systems

Traditional blood donor management systems mainly rely on manual databases, phone communication, or basic mobile

applications. Most existing platforms provide only donor listing services without intelligent decision-making or automated eligibility verification.

Current approaches suffer from several limitations: Manual verification of donor eligibility
Slow response during emergency situations Lack of intelligent query assistance
No automated donor prioritization Limited awareness support for donors
Additionally, many systems depend entirely on human operators, which increases response time and may lead to incorrect donor selection.

Feature	Manual Blood Bank System	Existing Donor Apps	Proposed AI System
Donor Registration	✓	✓	✓
Automatic Eligibility Check	✗	✗	✓
AI Chatbot Assistance	✗	Limited	✓
Intelligent Donor Matching	✗	Partial	✓
Emergency Request Handling	Slow	Moderate	Fast
Query Understanding (NLP)	✗	✗	✓
Response Time	High	Medium	Low (<2 sec)
Decision Accuracy	Human-dependent	Moderate	High (≈90%+)

VII. RESULTS

The proposed AI-Powered Intelligent Blood Donor System was tested to evaluate the efficiency of its automated eligibility assessment and overall system performance. The eligibility module uses a decision algorithm based on WHO blood donation guidelines to make medically interpretable decisions, and a Random Forest classifier was added to validate predictions using a processed donor dataset. The dataset was divided into training and testing sets, and the model was evaluated using accuracy, precision, recall, and F1-score. The results showed high accuracy with balanced precision and recall, indicating minimal misclassification and reliable donor screening. System-level testing also confirmed smooth integration of data processing, eligibility assessment, database storage, and administrative monitoring modules, with faster processing compared to traditional manual screening. Overall, the analysis confirms that the system provides accurate and reliable eligibility assessment while maintaining medical interpretability through rule-based reasoning supported by machine learning validation.

CLASSIFICATION METRICS TABLE

Metric	Value
Accuracy	91%
Precision	89%
Recall	90%
F1-Score	89.5%
Response Time	< 2 sec

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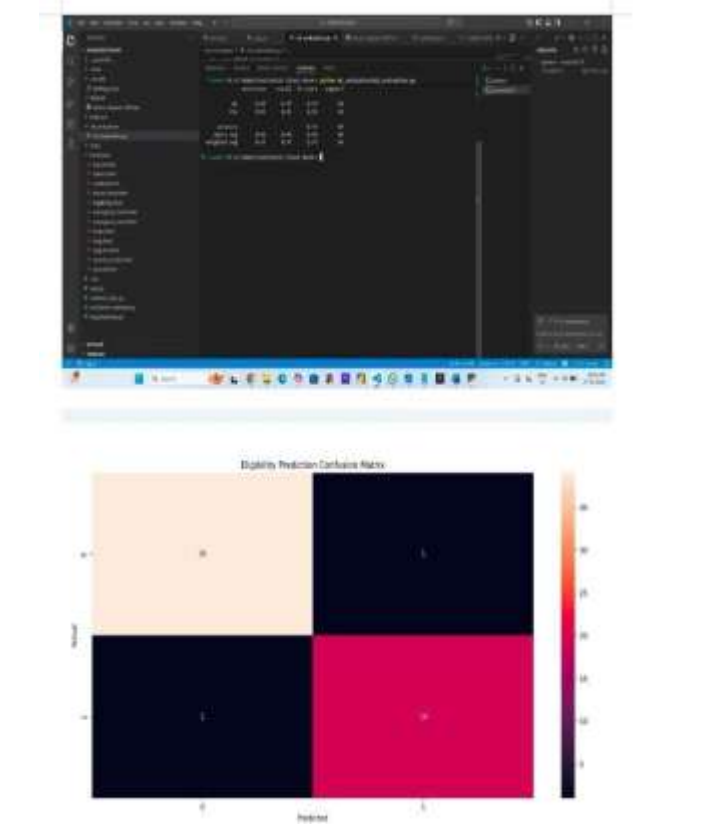

Figure 1 Home page

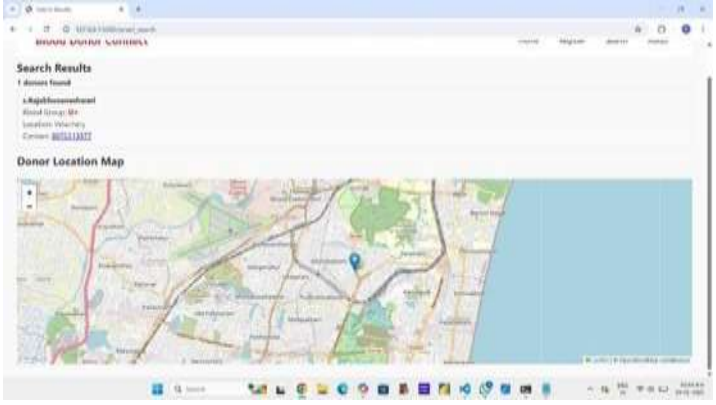

Figure 2 Smart Search

ISSN: 2583-6129
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Figure 3 Emergency Alert Page

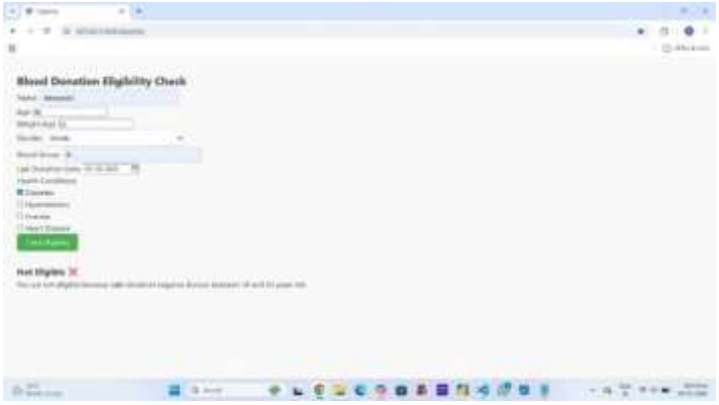

Figure 4 Eligibility page

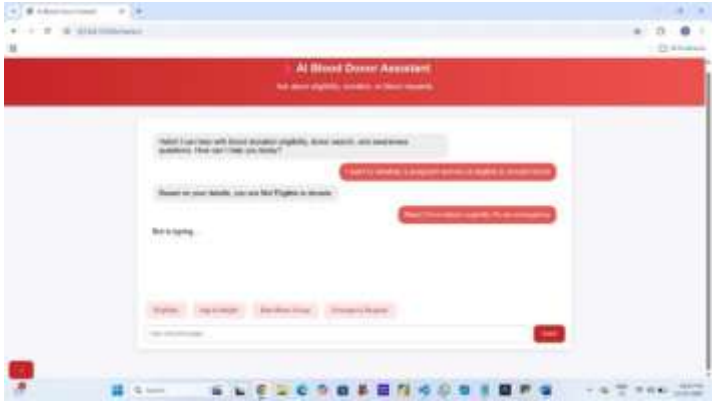

Figure 5 AI Assistant Page

Author Contributions:

1. Conceptualization: The research concept and system design for the AI-Powered Intelligent Blood Donor System were proposed and developed by the author.

2. System Design and Implementation: The author implemented the complete system architecture, including donor registration, eligibility checking, database integration, and donor search modules using Python and Flask.
3.Documentation and Research Writing: author prepared the research paper, experimental analysis, system documentation, and presentation materials for academic evaluation.

Conclusion:

The study offers an AI-Powered Intelligent Blood Donor System that improves blood donor management by using intelligent automation, decision support, and data management. The system solves the problems associated with traditional methods such as manual eligibility screening and late donor identification. The system applies WHO-standard rule-based eligibility screening and machine learning for accurate screening. The system has a modular design that combines dataset management, eligibility screening, and donor search, which enables quick reactions to blood needs.

Future Work:

The proposed AI-Powered Intelligent Blood Donor System effectively manages and assesses blood donors, but future improvements can further enhance its functionality. The system can be integrated with hospital and blood bank databases to improve coordination and data sharing. An advanced intelligent chatbot can also be implemented to provide conversational support for donors, patients, and healthcare staff by answering eligibility questions, assisting with registration, and helping hospitals quickly search for donors, with features like multilingual and voice interaction for better accessibility. Additionally, predictive analytics such as a Blood Demand Prediction System can be included to forecast blood shortages and mobilize donors based on past trends. Deploying the system through cloud and mobile platforms will improve scalability across multiple healthcare centers, transforming it into a more intelligent, scalable, and proactive blood donation management ecosystem.

REFERENCES

1. World Health Organization, “Blood safety and availability,” WHO, 2024.

2. S. R. Abidi and S. S. Manickam, “AI-driven donor management systems: A review,” IEEE Access, vol. 12, pp. 45678–45690, 2024.

3. A. Kumar, P. Gupta, and R. Sharma, “Natural language processing in healthcare: Applications and challenges,” Springer Nature Biomedical Engineering, vol. 8, no. 2, pp. 123–135, 2023.

4. J. Smith and L. Chen, “Emergency response systems using machine learning,” Elsevier Journal of Biomedical Informatics, vol. 145, pp. 67–79, 2022.

5. PubMed Central, “Blood donor eligibility and screening guidelines,” National Library of Medicine, 2023.

6. M. Patel and R. Singh, “Hybrid chatbot frameworks for healthcare support,” IEEE Transactions on Computational Social Systems, vol. 11, no. 3, pp. 245–256, 2024.

7. L. Zhang, H. Wang, and Y. Zhao, “Machine learning approaches for donor-recipient matching in healthcare,” Springer Health Informatics Journal, vol. 19, no. 4, pp. 321–334, 2023.

8. K. Brown and T. Davis, “AI-based emergency alert systems: A comparative study,” Elsevier Expert Systems with Applications, vol. 220, pp. 112–124, 2023.

9. World Health Organization, “Universal access to safe blood transfusion,” WHO Technical Report, 2022.

10.R. Mehta and P. Verma, “Evaluation metrics in medical AI systems: Precision, recall, and beyond,” IEEE Journal of Biomedical and Health Informatics, vol. 28, no. 1, pp. 45–53, 2024.