IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Automated Blood Group Classification From Fingerprint Images Using Vision Transformer

Author Names: SELAKA.T , MRS.G.MAHALAKSHMI,MS.PAJASRI.P

Final Year Post Graduate Student, Department of Computer Applications, Dr. M.G.R. Educational And Research Institute, University in Chennai, Tamil Nadu, India.

Assistant Professor, Department of Computer Applications, Dr. M.G.R. Educational And Research Institute, University in Chennai, Tamil Nadu, India.

Assistant Professor, Department of Computer Applications, Dr. M.G.R. Educational And Research Institute, University in Chennai, Tamil Nadu, India.

ABSTRACT

Blood group prediction plays a crucial role in medical applications such as blood transfusions, organ transplants, and forensic investigations. Traditionally, blood grouping has been performed manually through serological testing, which is time-consuming, costly, and susceptible to human error. These limitations pose challenges, especially in emergency situations where rapid and accurate blood group determination is essential. Moreover, the need for automated systems to enhance efficiency and reduce dependency on traditional methods has become increasingly important. To overcome these drawbacks, our proposed project introduces a Fingerprint-Based Blood Group Prediction System using Vision Transformer (ViT), a state-of-the-art deep learning model designed for image-based classification tasks. Unlike conventional methods that rely on static feature extraction, Vision Transformers leverage self-attention mechanisms to analyze both local and global relationships within fingerprint images. This enables the model to capture nuanced patterns and dependencies, thereby improving the accuracy of blood group prediction. In this system, fingerprint images are processed through the Vision Transformer model, where individual patches are extracted and fed into attention layers for feature extraction. The resulting features are then used to classify the fingerprint into one of the blood groups: A, B, AB, or O. This approach eliminates the need for manual feature engineering and reduces processing time, making it more efficient and scalable.

I. INTRODUCTION

Blood Group Testing determines a person's blood type based on the presence or absence of specific antigens and antibodies in the blood. The blood test involves mixing a sample of blood with antibodies against type A and B blood. Common blood types are A, B, AB, or O, along with Rh-positive or Rh-negative. A blood sample is collected, and antibodies react with A, B, and Rh antigens to identify the blood group. Results help ensure safe blood transfusions, and organ transplants, and manage pregnancy risks. Blood group testing, also known as blood typing, is a diagnostic procedure that determines an individual's blood group based on the presence or absence of specific antigens and antibodies in the blood. The two main systems used for blood typing are the ABO system and the Rh factor. In the ABO system, blood is categorized into four types: A, B, AB, and O, and the Rh factor further defines blood types into positive (+) or negative (-). Blood testing is important for medical procedures as it ensures compatibility for blood transfusions, identify potential risks of adverse reactions, and for organ transplantation.

Blood Grouping Principals

Blood is a fluid connective tissue that circulates throughout the body and is responsible for transporting oxygen, nutrients, hormones, and waste products. It is also important for maintaining homeostasis, immune response, and clotting. Blood is composed of 55% plasma and 45% formed elements including red blood cells, white blood cells, and platelets.

1. Red Blood Cells (RBCs): RBC transport
2. s oxygen throughout the body.
2. White Blood Cells (WBCs): WBC are an important part of the immune system and defends against infections.
3. Platelets: Platelets aid in blood clotting and prevents excessive bleeding.
4. Plasma: It forms liquid component of blood and carry nutrients, hormones, and waste products.

Blood grouping also known as a ABO Blood Group system is based on the presence or absence of specific antigens and antibodies in the blood.

- ABO System
    - Blood is classified into four main groups: A, B, AB, and O, based on the presence or absence of antigens (A or B) on red blood cells.
    - Individuals inherit one ABO gene from each parent, resulting in specific blood types.
    - Blood type O has neither A nor B antigens, A and B types have their respective antigens, and AB type has both.

- Rh System
  - Rh factor (Rhesus factor) determines whether blood is Rh-positive or Rh-negative.
  - If the Rh factor is present, the blood type is positive (e.g., A+, B+), and if absent, it is negative (e.g., A-, B-).
  - Rh factor inheritance is independent of ABO blood group inheritance.
- Antibodies and Agglutination
  - Anti-A and anti-B antibodies in the plasma react with foreign antigens.
  - Agglutination (clumping) occurs when antibodies react with incompatible antigens.
  - Testing involves introducing blood to anti-A, anti-B, and anti-Rh antibodies to observe reactions.
- Compatibility
  - Blood transfusions and organ transplants require compatibility between donor and recipient blood types to prevent adverse reactions.

II. LITERATURE REVIEW

2.1. A Novel Plasmonic MIM Sensor Using Integrated 1 × 2 Demultiplexer for Individual Lab-on-Chip Detection of Human Blood Group and Diabetes Level in the Visible to Near-Infrared Region

Authors: Rummanur Rahad, Mohammad Ashraful Haque, Md. Omar Faruque (2024)
DOI: 10.1109/JSEN.2024.3372692

Methodology: This study employs the Finite Element Method (FEM) for numerical simulation of a Metal–Insulator–Metal (MIM) structure, featuring a diamond-shaped silicon nanodot array. It integrates a 1×2 demultiplexer to prevent cross-contamination and operates within the 700–920 nm range.

Merits:

- Achieves high sensitivity (865.9 nm/RIU) and a high Figure of Merit (FOM) of 58.4.
- Provides an extraordinary transmission coefficient (~−18 dB), enhancing detection accuracy.
- Portable and suitable for on-site applications, making it ideal for rapid diagnostics.
- Enables fast and precise detection of blood groups and diabetes levels.

Demerits:

- The limited operational range (700–920 nm) may not cover all biological applications.
- The design's nanostructured complexity may pose fabrication challenges

2.2. A Numerical Study of Different Metal and Prism Choices in the Surface Plasmon Resonance Biosensor Chip for Human Blood Group Identification

Authors: Sanjeev Kumar Raghuwanshi, Purnendu Shekhar Pandey (2023)
DOI: 10.1109/TNB.2022.3185806

Methodology: This research explores an optimized SPR-based biosensor design using various metal-prism combinations. It utilizes theoretical modeling with refractive index data from blood samples to enhance sensitivity and detection accuracy. The study finds that a Silicon prism with Aluminum (Al) as the SPR metal provides optimal performance.

Merits:

- Ensures better accuracy and stability by incorporating a buffer layer.
- Demonstrates a high blood group discrimination factor (δθSPR).
- Effectively reduces oxidation and contamination issues that typically affect biosensors.

Demerits:

- Lacks experimental validation, as results are based on theoretical modeling.
- The sensor's sensitivity is limited to the near-infrared wavelength range.

2.3. ABO/Rh Blood Typing Method for Samples in Microscope Slides by Using Image Processing

Authors: Felipe Porge Xavier, Lucas Gabriel de Araujo Silva (2018)
DOI: 10.1109/TLA.2018.8358669

Methodology: This study proposes an image-processing-based blood typing method, analyzing high and low-resolution images from 48 blood samples collected from 30 patients. The system evaluates agglutination patterns using digital image processing techniques.

Merits:

- Achieves high accuracy (97.92% for Anti-A, 89.58% for Anti-B, and 88.89% for Anti-D).
- Offers a low-cost and straightforward approach without requiring complex biosensors.
- Utilizes a non-invasive and easily accessible method for blood typing.

Demerits:

- Dependent on image quality, with lower accuracy for low-resolution images.
- Lighting variations and sample inconsistencies may cause errors in detection.

III. PROPOSED SYSTEM

The proposed system aims to develop an advanced Blood Group Detector System that accurately identifies blood groups using fingerprint images and deep learning techniques. The system utilizes Vision Transformer (ViT) and a self-attention mechanism to enhance accuracy, efficiency, and reliability. Unlike traditional methods, which require blood samples, this system provides a non-invasive, AI-driven approach to blood group identification.

- **BloodNet Model Training**

The BloodNet model, built using Vision Transformer (ViT), is trained on the preprocessed dataset. The training process involves multi-class classification, mapping extracted fingerprint features to the respective blood groups.

- **Blood Group Prediction**

Users input their fingerprint images into the system, and the trained BloodNet model predicts the blood group with high accuracy. The model evaluates confidence scores to ensure reliability.

- **Result Visualization and Test Report Generation**

The system provides an intuitive interface where users can view predicted results, confidence scores, and download test reports. The results are stored securely for future reference.

3.2.1. ADVANTAGES

- Non-Invasive – No blood sample needed, painless process.
- Fast Results – Real-time blood group prediction.
- High Accuracy – Deep learning improves reliability.
- Cost-Effective – Reduces lab and personnel requirements.
- Easy Integration – Usable in hospitals and blood banks.

IV. SYSTEM DESIGN AND DIAGRAMS System

Architecture Diagram:

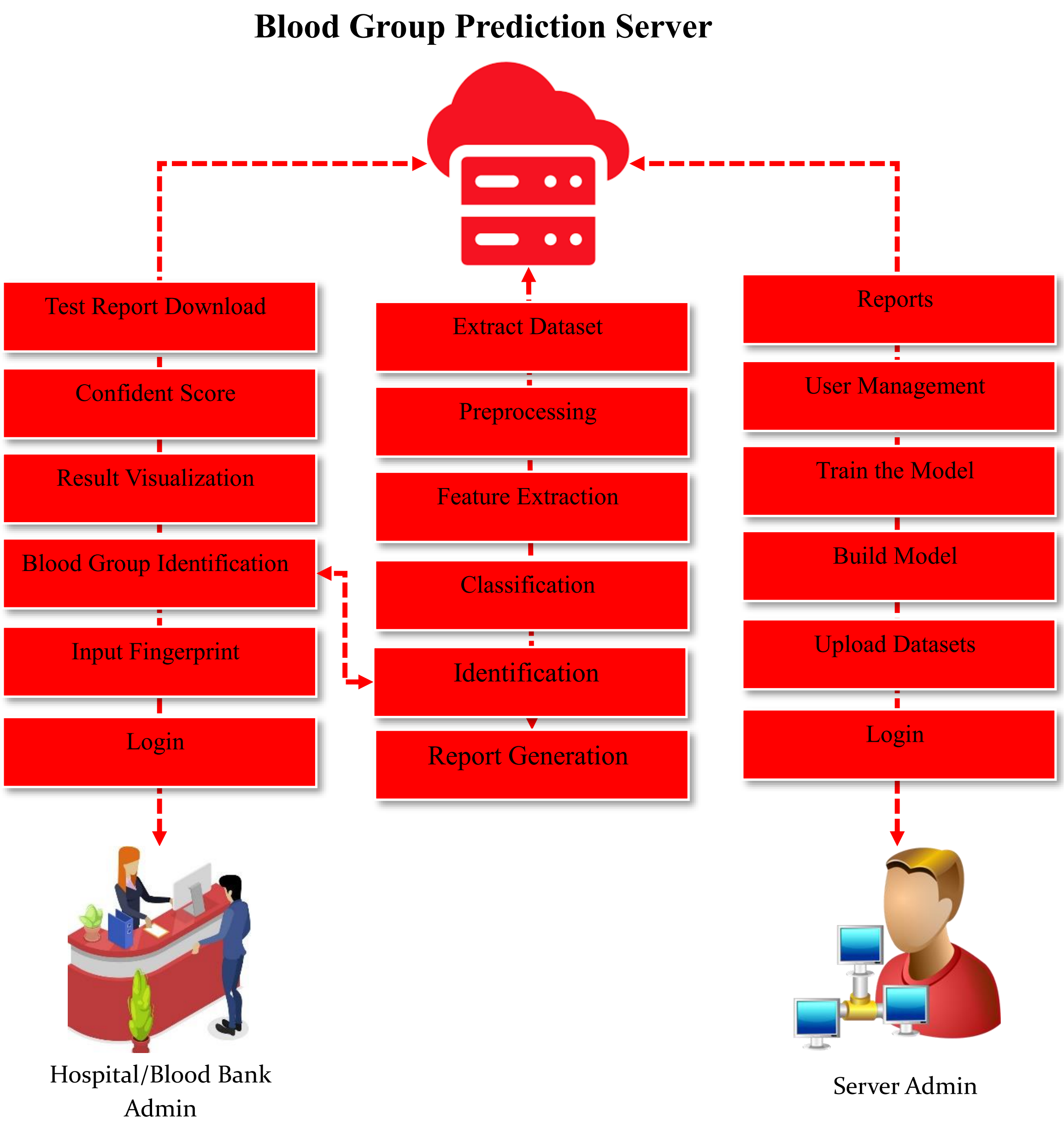


Figure 1. Architecture Diagram.

Use Case Diagram:

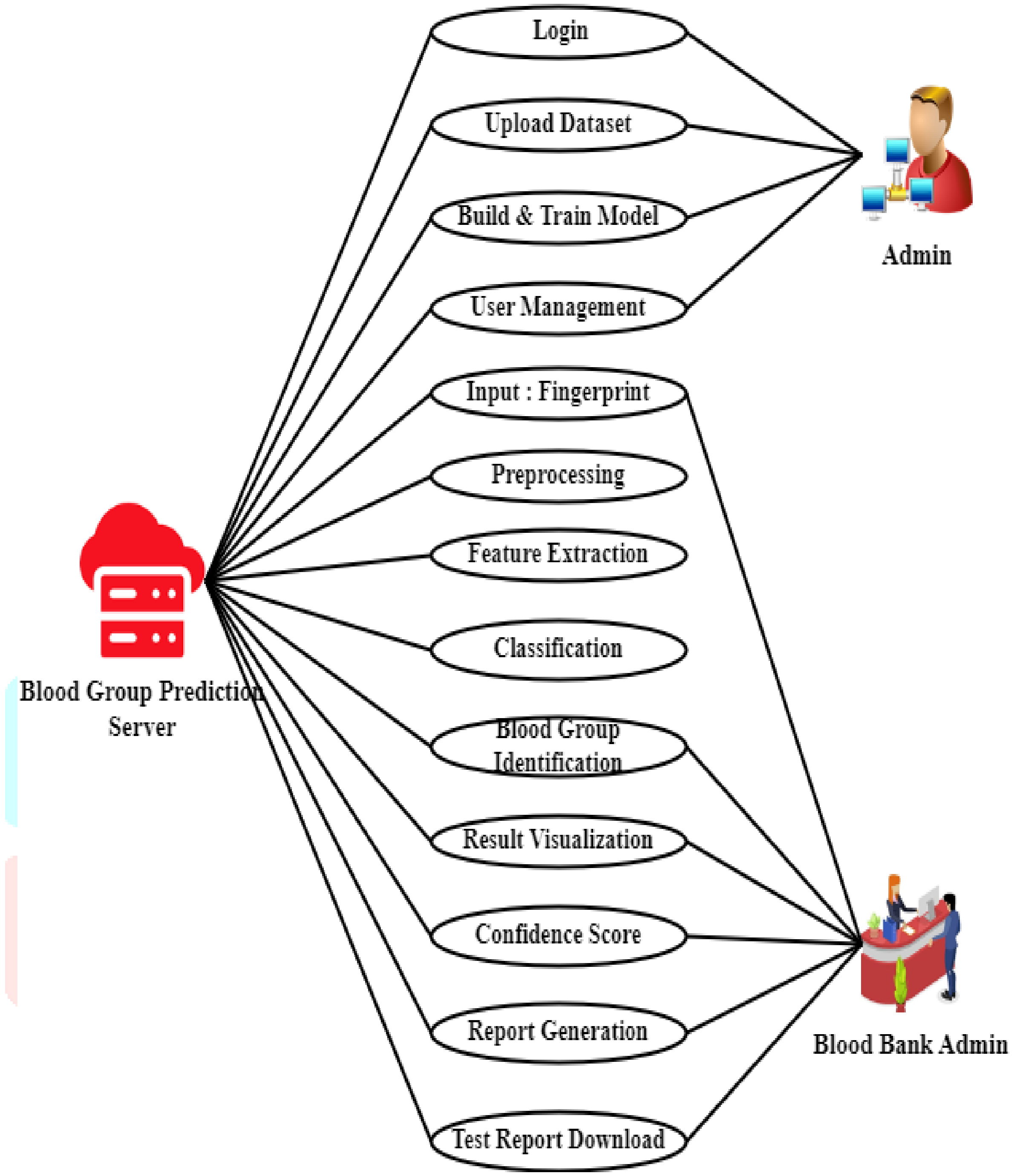


Figure 2. Use case Diagram.

Sequence Diagram:

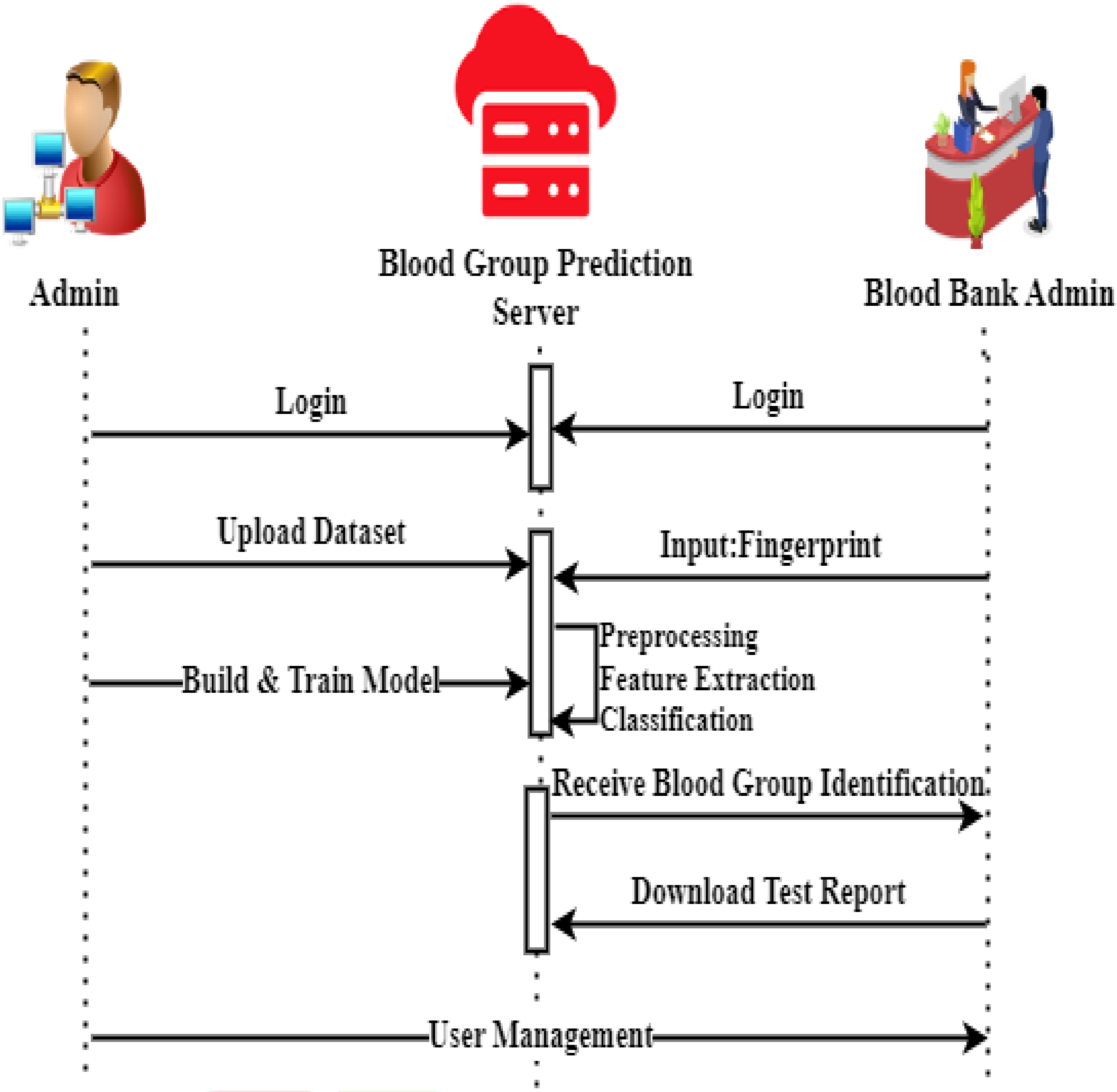


Figure 3. Sequence diagram

Data Flow Diagram (DFD):

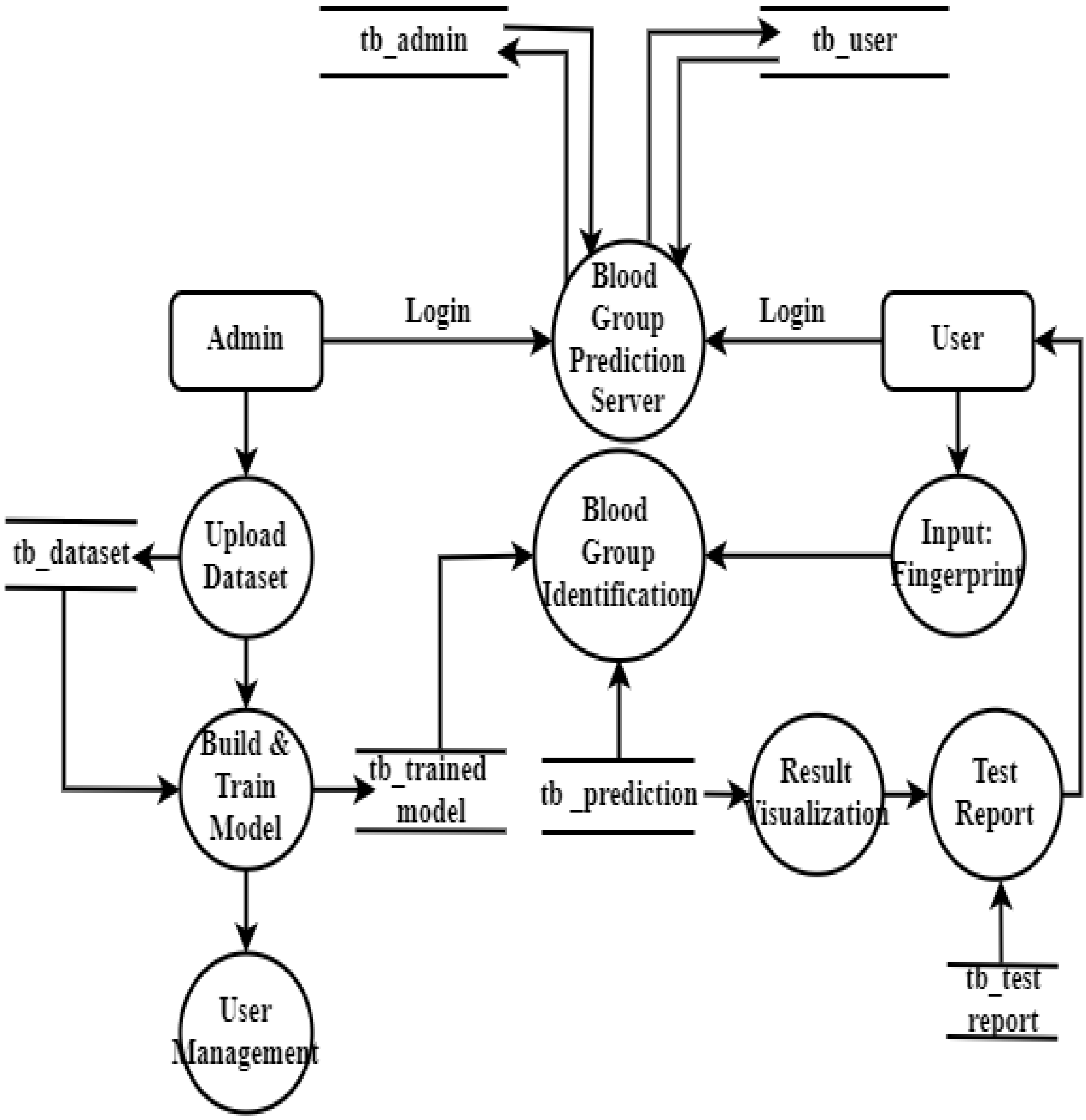


Figure 4. Data Flow Diagram

V. SYSTEM REQUIREMENTS

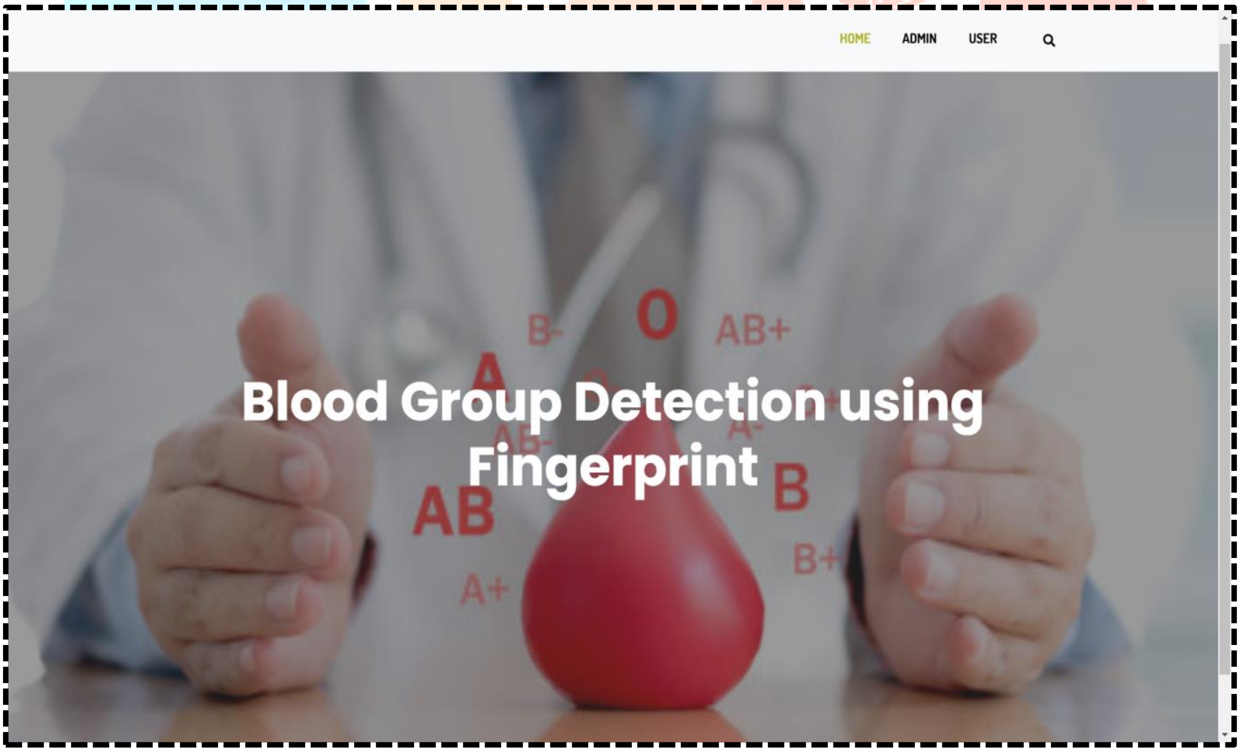
5.1. HARDWARE REQUIREMENTS

- **Processor** : Intel Core i5 or higher
- **RAM** : 8GB or more
- **Storage** : Minimum 256GB SSD
- **Graphics Card** : Optional (for model training acceleration)
- **Display** : 1080p resolution or higher

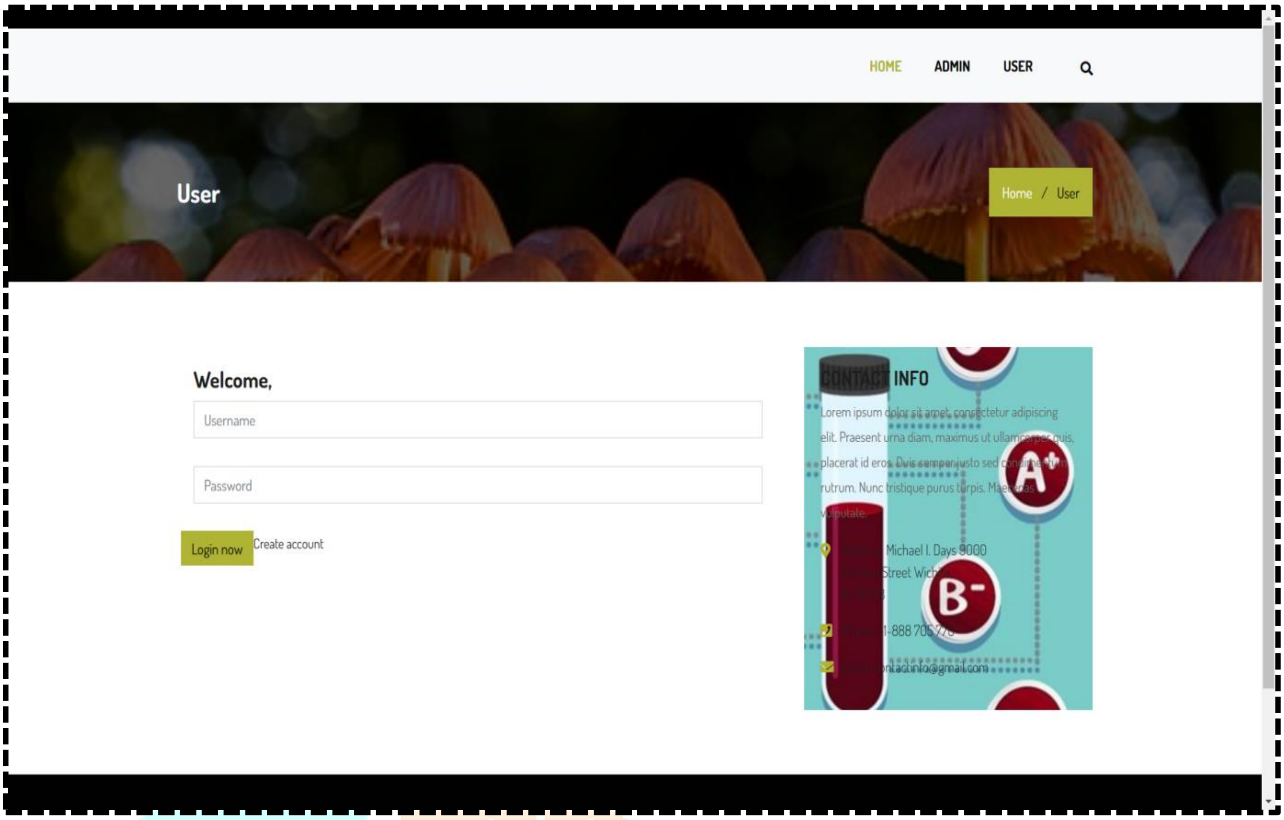
5.2. SOFTWARE REQUIREMENTS

- **Operating System** : Windows 10/11
- **Programming** : Python 3.8
- **Frameworks & Libraries** : Flask, TensorFlow, OpenCV, NumPy, Pandas, Scikit-learn, Matplotlib
- **Database** : MySQL
- **Server** : WampServer
- **Web Technologies** : HTML, CSS, Bootstrap

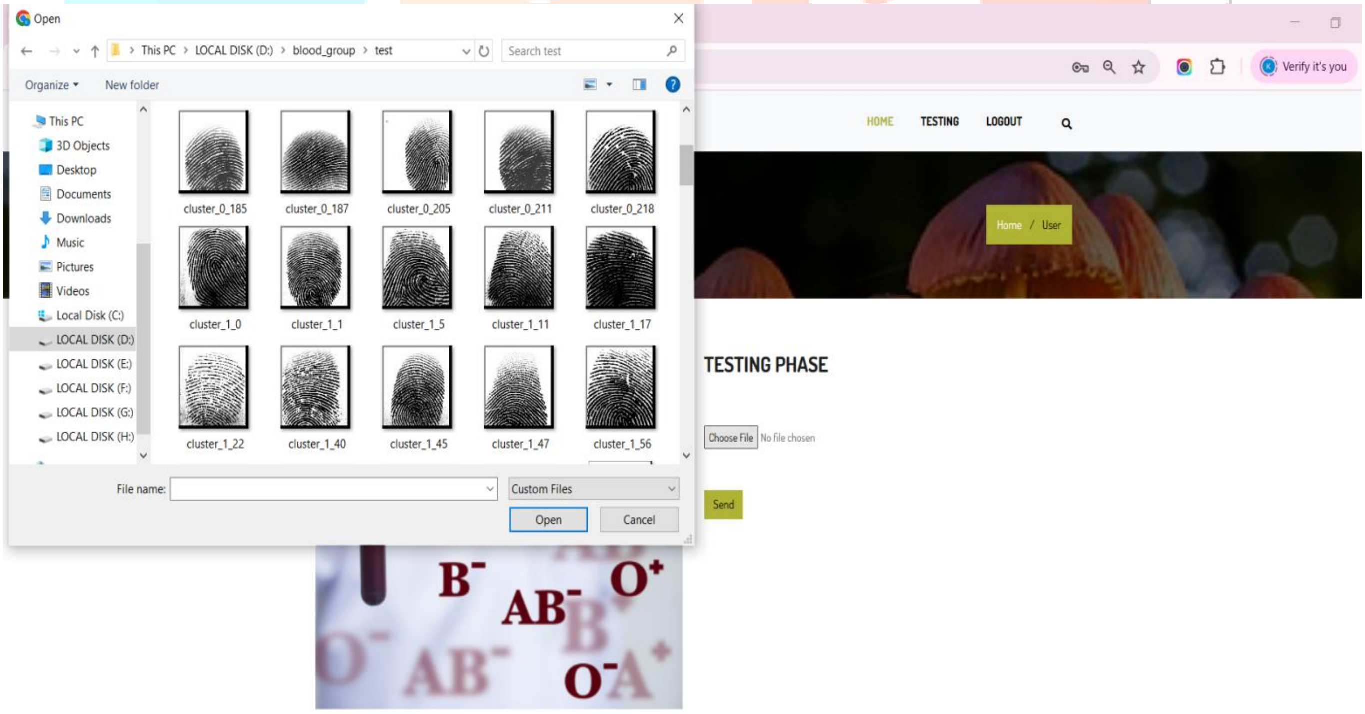
VI. SCREENSHOTS



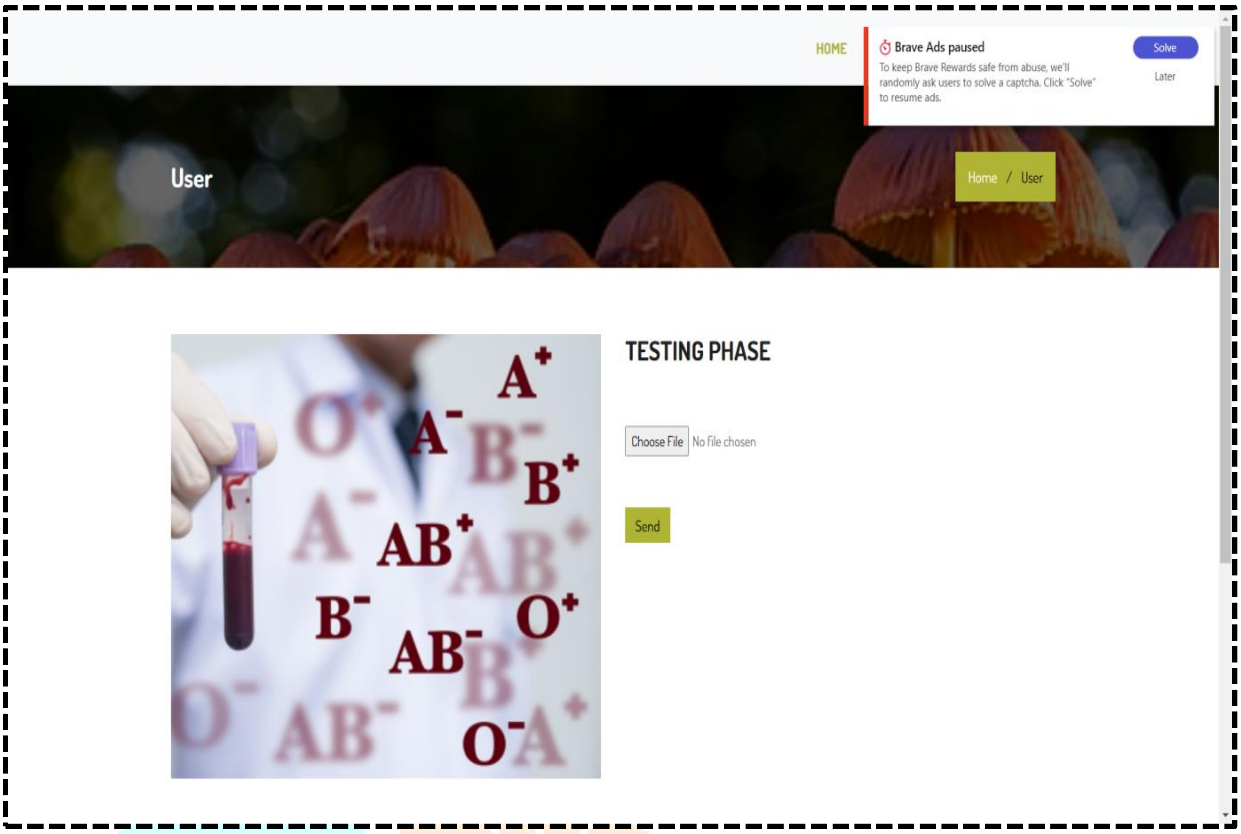
HOME PAGE

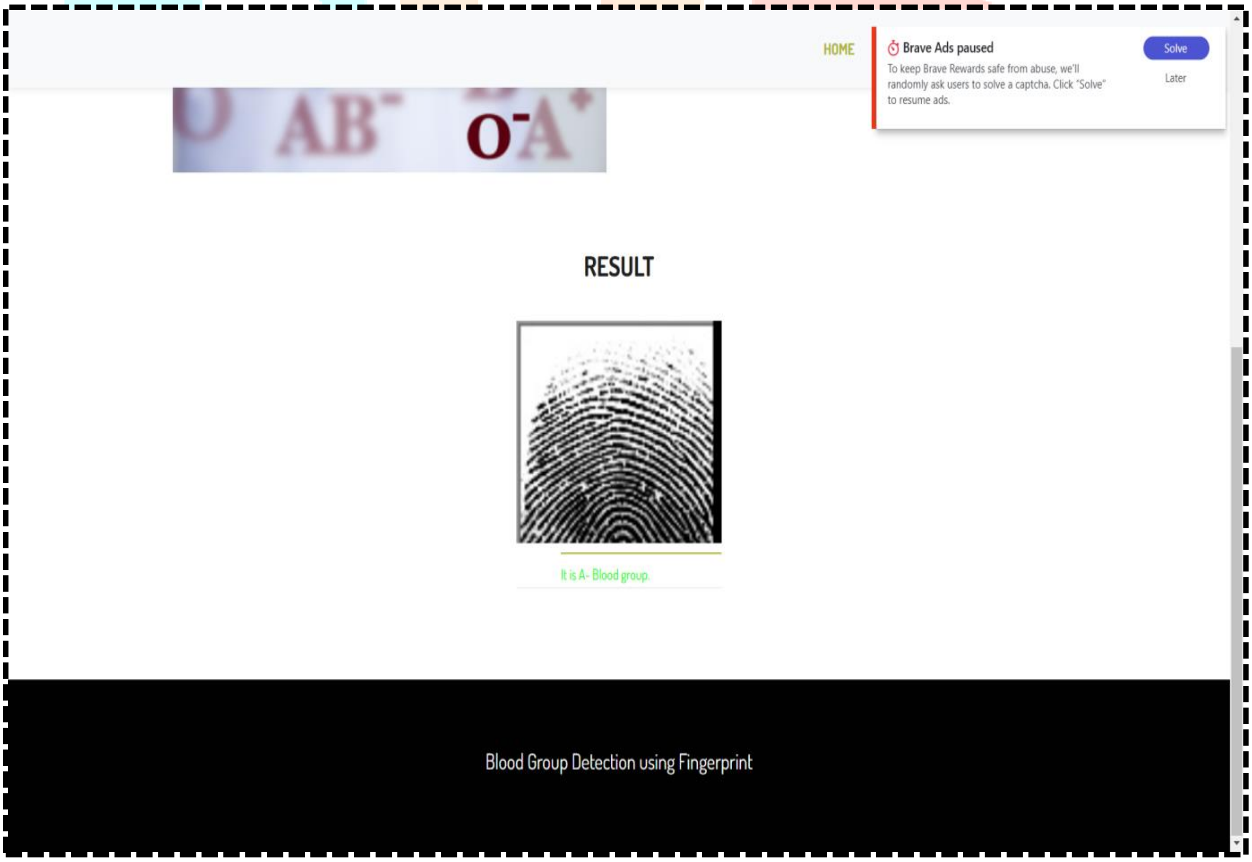


USER PAGE



TESTING PHASE





BLOOD GROUP RESULT

VII. CONCLUSIONS

In conclusion, the project presents an innovative and automated approach to predicting blood groups using fingerprint analysis. By leveraging advanced machine learning techniques, particularly the Vision Transformer (ViT) model, the system enhances the accuracy and efficiency of blood group identification. Unlike traditional methods that require blood sample collection and laboratory analysis, this system offers a non-invasive, rapid, and reliable alternative, making blood group detection more accessible and convenient. The integration of a web-based application allows users to interact with the system seamlessly, ensuring a user-friendly experience for both administrators and end-users. The admin module facilitates dataset management, model training, and overall system supervision, while the user module enables individuals to register, input fingerprint images, and receive instant results. The system's real-time result visualization, confidence score assessment, and test report generation provide transparency, allowing users to understand the accuracy of predictions and maintain official documentation. Furthermore, this system has the potential to be widely adopted in hospitals, blood banks, emergency medical services, and remote healthcare facilities, where quick identification of blood groups is critical. By reducing the time and resources needed for blood group testing, it improves the efficiency of medical workflows and enhances patient care. Thus the project represents a significant technological advancement in healthcare, combining biometric fingerprint analysis with AI-powered classification to provide a novel, efficient, and scalable solution for blood group identification.

VIII. REFERENCES

"Deep Learning with Python" by Francois Chollet: This book provides an in-depth introduction to deep learning with Python and covers topics such as neural networks, convolutional neural networks, and natural language processing.

1. "TensorFlow for Deep Learning: From Linear Regression to Reinforcement Learning" by Bharath Ramsundar and Reza Bosagh Zadeh: This book provides a comprehensive introduction to TensorFlow, one of the most widely used deep learning frameworks, and covers topics such as neural networks, convolutional neural networks, and recurrent neural networks.

2. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurelien Geron: This book provides a practical and hands-on approach to machine learning and covers topics such as data preprocessing, classification, regression, and clustering.

3. "Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili: This book provides an introduction to machine learning with Python and covers topics such as supervised learning, unsupervised learning, and deep learning.

4. "MySQL for Python" by Albert Lukaszewski: This book provides an introduction to MySQL and covers topics such as database design, data modeling, and SQL queries.