Chapter 1

INTRODUCTION

The project **"Non-Invasive Blood Group Detection Using Fingerprint"** presents a novel and user-friendly approach for identifying an individual's blood group without the need for invasive blood sampling. Conventional blood group testing methods rely on drawing blood and conducting laboratory-based analysis, which can be time-consuming, costly, and inconvenient, especially in emergency situations or in areas with limited medical facilities. These limitations highlight the need for an alternative solution that is fast, affordable, and easily accessible.

To address these challenges, this project proposes a non-invasive blood group prediction system based on fingerprint biometrics. Fingerprints contain unique ridge patterns and textures that can be captured easily using scanners or cameras. In this work, fingerprint images are processed using image preprocessing and feature extraction techniques such as ridge density analysis, curvature measurement, and texture-based features. These extracted features are then used to train machine learning classifiers, including Random Forest and Support Vector Machine (SVM), to predict the blood group.

By combining fingerprint image processing with machine learning algorithms, the system enables quick and automated blood group identification without physical discomfort to the user. The proposed approach is simple, cost-effective, and suitable for academic and research purposes. It has potential applications in healthcare assistance systems, biometric-based identification, blood donation management, and digital health records, contributing toward more efficient and accessible healthcare solutions.

Chapter 2

LITERATURE SURVEY

In Paper [1], the authors Halvi Sai Vinnela et al. (2025) discuss a machine learning – based approach for blood group detection using fingerprint and blood images. They used CNN and MobileNetV2 models with preprocessing and a web interface for real- time prediction. Similarly, the proposed system aims to provide a non-invasive and accurate blood group detection platform for quick medical assistance.

In paper [2], the authors T. Nihar et al.(2024) address a non-invasive method to determine blood groups using fingerprint ridge patterns analyzed through CNN models such as LeNet and AlexNet. In alignment with this, the proposed work uses deep learning for accurate fingerprint-based blood group classification.

In paper [3], Tannmay Gupta (2024) explores the use of AI and image processing for predicting blood groups using fingerprint and blood smear images. Consistent with this approach, the proposed system integrates image preprocessing and CNN-based models for reliable blood group detection.

In paper [4], the authors Swathi P et al. (2024) investigate fingerprint-based blood group prediction using CNN and dermatolypic features such as loops, whorls and arches. Similarly the proposed study uses deep learning techniques to analyze these fingerprint traits for improved prediction accuracy.

In paper [5], the authors N. Vijaykumar and D. R. Ingle (2021) present a fingerprint map reading method using image preprocessing and statistical models to predict blood groups. In line with this, the proposed work utilizes advanced feature extraction and classification techniques to enhance non-invasive blood group prediction performance.

In paper [6], Verma and Bhatt (2022) review automated blood group identification approaches using fingerprint analysis and ML algorithms. They highlight advancements in algorithmic accuracy and efficiency. Similarly the proposed study follows ML- based fingerprint processing for automated blood group detection.

In paper [7], Mondal et al. (2019) use 2D discrete wavelet and binary transforms for fingerprint –based blood group identification. Their method extracts detailed ridge information for classification. Similarly, the proposed system adopts advanced feature extraction for accurate non-invasive direction.

In paper [8], Alshehri et al. (2019) introduce an alignment-free cross-sensor fingerprint matching technique using ridge orientation co-occurrence and Gabor-HoG descriptions. Their approach enhances robustness across devices. Consistently, the proposed work benefits from such robust fingerprint feature analysis to improve prediction reliability.

In paper [9], Dr. D. Shiva Sundhara Raj and J. Abinaya (2019) propose a cost-effective method for blood group detection using fingerprint ridge features. Their approach focuses on low-cost preprocessing and pattern analysis for classification. Similarly, the proposed work aims to provide an affordable, non-invasive, and efficient fingerprint-based blood group prediction system.

In paper [10], K. Sharma and R. Mehta (2020) explore fingerprint-based biometric analysis for predicting blood groups using a hybrid CNN-SVM model. Their study shows that combining deep learning with traditional ML improves classification accuracy, Similarly, the proposed work leverages deep feature extraction enhance non-invasive blood group prediction.

Chapter 3

EXISTING SYSTEM & PROPOSED SYSTEM

Existing blood group prediction systems typically use conventional CNNs, machine learning, or hybrid models and often rely on multiple input sources such as fingerprints combined with blood smear or blood images, making them partially invasive. The preprocessing techniques and feature extraction methods used in earlier studies are generally basic, focusing mainly on simple ridge patterns or correlations rather than complete blood group prediction. These systems are usually research-oriented, lack an end-to-end prediction pipeline, and have limited scalability, making real-time deployment and practical user interaction difficult.

In contrast, the proposed blood group prediction system uses fingerprint image processing and machine learning techniques to predict blood groups in a completely non-invasive manner. The system applies effective preprocessing methods to enhance fingerprint ridge patterns, which helps in extracting meaningful features such as ridge density and texture information. These features are then used by trained machine learning classifiers to blood groupprediction. .

Chapter 4

FEASIBILITY STUDY

The non-invasive blood group detection system uses fingerprint images and machine learning techniques, avoiding the need for blood samples. It is simple to use, requiring only fingerprint capture and basic processing for prediction.

4.1 Technical Feasibility

The proposed non-invasive blood group detection system is technically feasible as it is developed using widely available and reliable technologies such as Python, machine learning algorithms, OpenCV, and image processing libraries. The system works with fingerprint images as input, removing the need for invasive medical procedures or specialized laboratory equipment. Preprocessing techniques such as noise removal, skeletonization, and feature extraction enhance fingerprint quality, enabling accurate analysis. The trained machine learning model can be efficiently integrated with a Streamlit-based user interface, making the system practical and scalable.

4.2 Operational Feasibility

The proposed system is operationally feasible as it is simple, user-friendly, following a straightforward workflow where a fingerprint is captured and the system predicts the blood group instantly. It requires minimal training for healthcare workers or operators, as the interface is designed for ease of use. Since the system does not involve blood collection or laboratory procedures, it can be effectively used in clinics, ambulances, emergency situations, and rural or resource-limited areas. Its non-invasive nature, portability, and real-time prediction capability make it highly suitable for day-to-day medical and emergency operations.

Chapter 5

PROJECT MANAGEMENT AND COST ESTIMATION

PROJECT MANAGEMENT

The project is managed using a structured and phased approach to ensure timely delivery and high-quality outcomes. Initially, the planning phase focuses on defining clear objectives, scope, and deliverables for the non-invasive blood group detection system. Requirements are gathered related to dataset collection, fingerprint image preprocessing, and selection of the ML model. A detailed project schedule is prepared, dividing tasks among team members such as data preparation, model development, training, and validation. Risk management is also addressed at this stage by identifying challenges like dataset imbalance, image quality issues, and model overfitting, along with mitigation strategies. During the execution and monitoring phases, the project emphasizes continuous integration and performance evaluation of the machine learning model. Regular progress reviews are conducted to track milestones such as successful preprocessing, model training accuracy, and testing results. Quality management ensures that the system meets accuracy, reliability, and usability standards, especially for healthcare-related applications.Finally, the project concludes with deployment planning, final reporting, and evaluation of system performance, ensuring that the solution is scalable, efficient, and suitable for real-world non-invasive blood group detection.

COCOMO Cost Estimation

Effort and cost estimation is a crucial activity in software project management, as it helps in planning resources, scheduling activities, and estimating the overall project budget. For the Non-invasive blood group detection using fingerprints, the Basic COCOMO (Constructive Cost Model) was used to estimate the development effort, time, team size, and cost.

The estimation considers only the manually written source code, excluding external libraries, frameworks, and auto-generated files. Based on project characteristics such as moderate size, well-understood requirements, and a small experienced team, the Organic mode of the Basic COCOMO model was selected.

Overview of Basic COCOMO Model

The Basic COCOMO (Constructive Cost Model) is used to estimate the effort, development time, team size, and cost of a software project based on its size measured in KLOC (Thousands of Lines of Code).

Our project, Non-Invasive Blood Group Detection Using Fingerprint and AI, is a research-oriented web-based application with moderate algorithmic logic and a flexible development environment. Since the system is developed using standard tools, has manageable complexity, and does not involve strict real-time constraints, it is classified under the Organic project category.

COCOMO Equations Used:

- Effort (E) = $a \times (KLOC)^{b}$ (measured in Person-Months)
- Development Time (T) = $c \times (E)^{d}$ (measured in Months)
- Team Size = Effort / Development Time
- Total Cost = Effort × Cost per Person-Month

Project Size Estimation

The total size of the project was calculated by summing the lines of code developed across different modules.

Module — Technology Used — LOC (Approx.)		LOC (Approx.)
Image Acquisition & Preprocessing	Python, OpenCV, scikit-image	1,800
Feature Extraction & ML Model Training (RF, SVM)	Python, scikit-learn	2,600
Model Evaluation & Prediction Logic	Python	1,200
Frontend / User Interface	Streamlit (Python)	1,400
Dataset Handling & Utilities	Python (Image Dataset Handling)	800
Total LOC		7,800 LOC
Total LOC		7,800 LOC

Module	Technology Used	LOC (Approx.)
Total LOC	Python, 7,800 LOC	7,800 LOC
Total LOC		7,800 LOC

Table 5.1: Project Size Estimation for Non-Invasive Blood Group Detection using Fingerprints

COCOMO Model Constants (Organic Mode)

Based on the COCOMO reference values provided in the model documentation:

Parameter	Value
a	2.4
b	1.05
c	2.5
d	0.38

Table 5.2: Organic Model Constants for Non-Invasive Blood Group Detection Using Fingerprints

Effort Estimation

Effort represents the total amount of work required to develop the software, measured in person-months.

Since the Non-Invasive Blood Group Detection Using Fingerprint Images project is classified as an Organic type project, the Basic COCOMO effort estimation formula is used.

Formula Used:

Effort (E) = a × $(KLOC)^b$\

Calculation:

$E = 2.4 \times (7.8)^{1.05}$

$E \approx 2.4 \times$

$E \approx 20.8$ Person-Months

Result:

Estimated Effort ≈ 21 Person-Months

Development Time Estimation

Development time indicates the total calendar time required to complete the project.

Formula Used:

Development Time (T) = c × $(E)^d$

Calculation:

$T = 2.5 \times (15.8)^{0.38}$

$T \approx 2.5 \times 2.85$

$T \approx 7.1$ months.

Considering parallel task execution, reuse of existing libraries, and efficient division of work, the effective development duration of the Non-Invasive Blood Group Detection system was approximately 5 to 5.5 months, which closely aligns with the actual project timeline.

Team Size Estimation

The estimated number of developers required is calculated
as:

Formula Used:

Team Size = Effort / Development Time

Team Size = 20.8 / 7.1

Team Size ≈ 2.93

Result:

Estimated Team Size ≈ 3 members

The actual team consisted of 4 members, which ensured better workload sharing and timely completion.

Cost Estimation

The total project cost is calculated based on the estimated effort and average cost per person- month.

Assumption:

Since this is an academic / student-level organic
project, the following realistic assumption is made:

- Average cost per person-month = ₹350

Calculation:

Total Cost = 20.8 × 350

Total Cost = ₹7280

Result:

Estimated Project Cost ≈ ₹7280.

Summary of Estimation Results

Parameter	Estimated Value
Project Type	Organic
Project Size	7.8 KLOC
Effort	~21 Person-Months
Development Time	~7.1 Months
Team Size	~4 Members
Estimated Cost	~₹7280

Table 5.3: COCOMO Estimation Summary for Non- Invasive Blood Group Detection Using Fingerprints

Chapter 6

HARDWARE AND SOFTWARE REQUIREMENTS

6.1Software Requirements:

- Computer/Laptop – Minimum Intel i5 processor, 8 GB RAM, 256 GB SSD.
- RAM – 8 GB (minimum)
- Fingerprint Image Source – digital fingerprint image dataset
- Display – Standard monitor for visualization and report generation

6.2 Hardware Requirements:

- Operating System – Windows 10/11, Ubuntu, or macOS
- Programming Language – Python
- Machine Learning Framework – scikit-learn
- Image Processing Libraries – OpenCV, scikit-image
- Data Handling Libraries – NumPy, Pandas
- Web Framework – Streamlit
- IDE / Editor –VS Code

Chapter 7

SYSTEM DESIGN

The system design of the non-invasive blood group detection project is based on fingerprint image analysis using machine learning techniques. Fingerprint images are acquired digitally and passed through a preprocessing stage that includes resizing, noise removal, thresholding, and skeletonization to enhance ridge patterns. From the processed fingerprint, meaningful features such as ridge density, curvature, and texture patterns are extracted. These features are then normalized using a feature scaling technique to maintain consistency. A trained machine learning classifier, such as Random Forest or Support Vector Machine (SVM), analyzes the extracted features. The model predicts the most likely blood group based on learned patterns from the dataset.

7.1Context Diagram

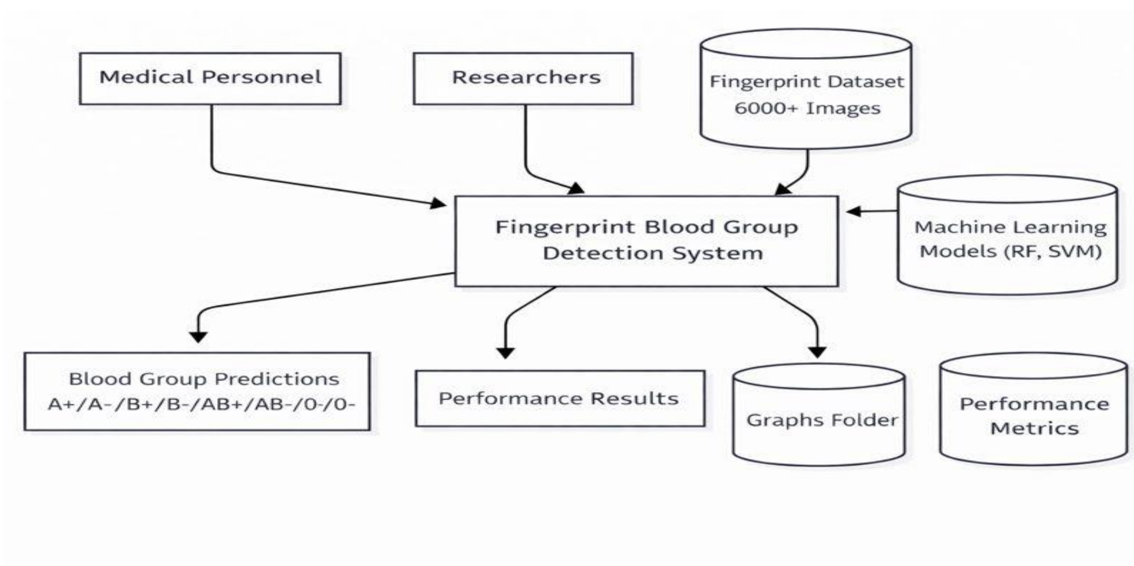
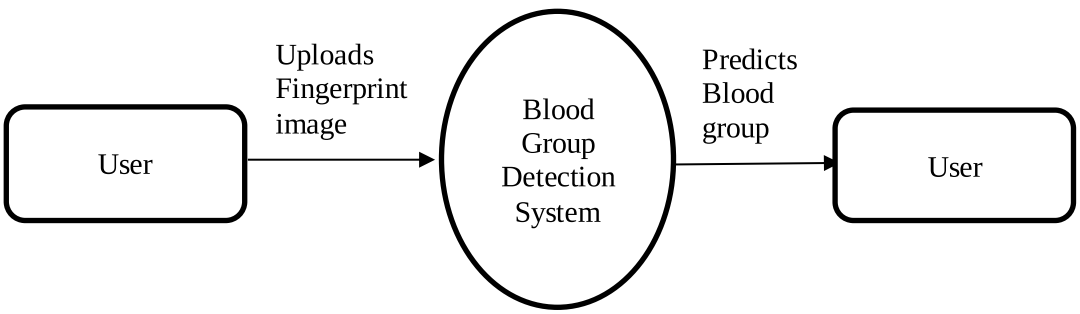


Fig 7.1: Context Diagram for Non-Invasive Blood Group Detection System using fingerprints

The diagram represents the overall architecture of the Non-Invasive Blood Group Detection Using Fingerprint system. Medical personnel and researchers serve as the primary users, interacting with the system by providing fingerprint images and analyzing the generated results. A large fingerprint dataset containing over 4520 images is used during the training phase to build robust machine learning models. Instead of deep learning architectures, the system employs traditional machine learning classifiers such as Random Forest (RF) and Support Vector Machine (SVM) to extract meaningful fingerprint features and perform blood group classification. These trained models are integrated into the central Fingerprint Blood Group Detection System, which processes the input fingerprints and predicts the corresponding blood group. The system outputs blood group predictions along with performance results, evaluation metrics, and graphical analyses, enabling validation of accuracy and overall system effectiveness.

7.2 Data Flow Diagram



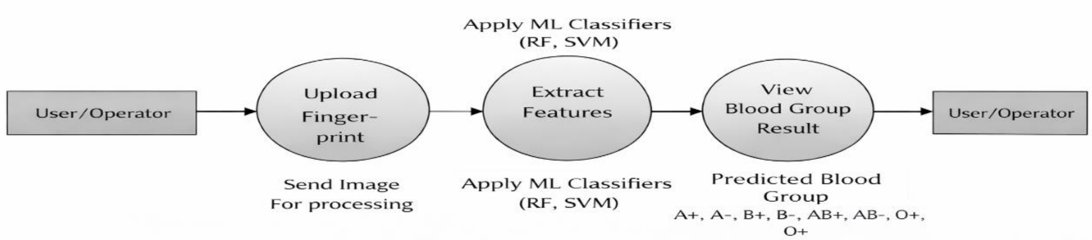


Fig 7.2:Level 0 and Level 1 Data Flow Diagram for Non-Invasive Blood Group Detection System.

The diagram illustrates the complete workflow of the Non-Invasive Blood Group Detection

Using Fingerprint Images system. The process begins when the user/operator uploads a fingerprint image into the system through the user interface. This fingerprint image serves as the primary input for the system.

In Level 0, the system is represented as a single process where the fingerprint image provided by the user is processed by the Blood Group Detection System, and the predicted blood group is generated as the output.

At Level 1, the internal operations of the system are illustrated in detail. After the fingerprint image is uploaded, it undergoes an image preprocessing stage that includes resizing, noise reduction, and enhancement to improve ridge clarity. The preprocessed fingerprint is then forwarded to the feature extraction module, where important features such as ridge density, curvature, and texture patterns are extracted. These extracted features are analyzed using machine learning classifiers such as Random Forest and Support Vector Machine (SVM), which learn the relationship between fingerprint characteristics and blood groups. Based on this analysis, the system predicts the corresponding blood group, such as A+, A−, B+, B−, AB+, AB−, O+, or O−, and displays the result to the user.

7.3 Use Case Diagram

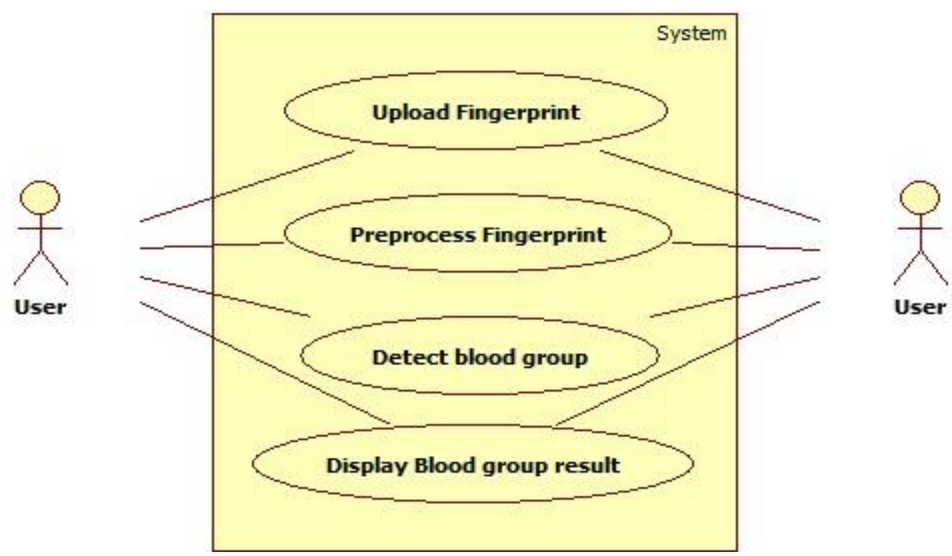


Fig 7.3: Use Case Diagram for Non-Invasive Blood Group Detection System using fingerprints

The above diagram represents the use-case design of the Non-Invasive Blood Group Detection System using fingerprint images. The user interacts directly with the system to determine blood group information without undergoing any invasive medical procedure.

Within the system boundary, the process starts when the user uploads a fingerprint image, which acts as the main input. The uploaded image is first processed through a preprocessing stage where noise is removed, image quality is enhanced, and the fingerprint is normalized for further analysis.

After preprocessing, the system extracts important fingerprint features such as ridge density, curvature, and texture patterns. These features are then analyzed using machine learning classifiers like Random Forest and Support Vector Machine (SVM) to perform blood group classification.

Finally, the predicted blood group result is displayed to the user in a simple and user-friendly format, completing the use-case interaction flow.

.7.4 Sequence Diagram

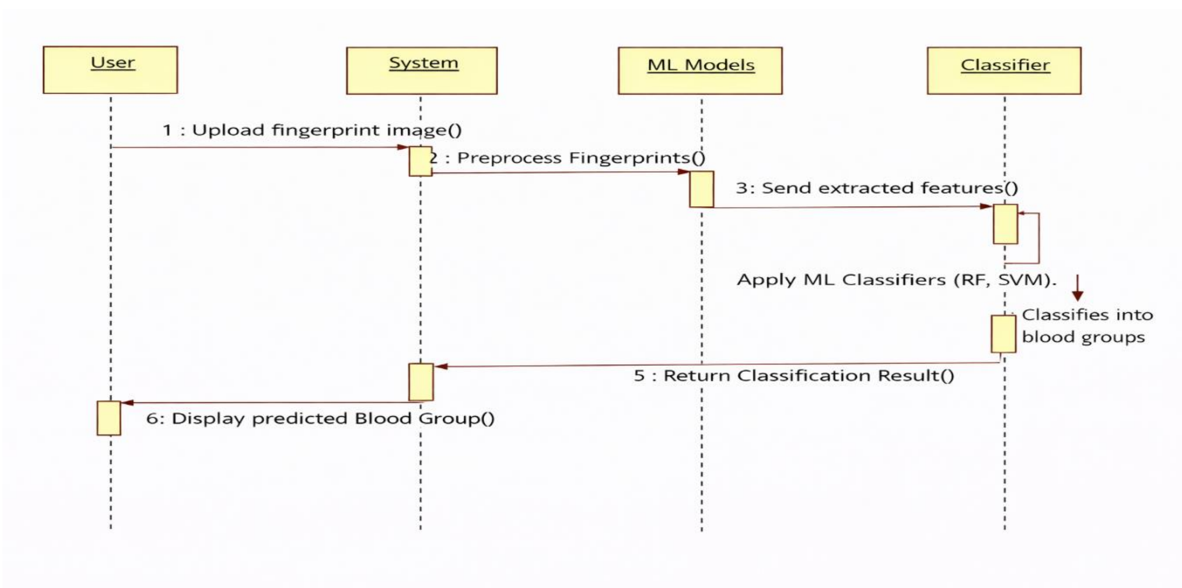


Fig 7.4: Sequence Diagram for Non-Invasive Blood Group Detection System using fingerprints

The sequence diagram represents the interaction flow between the User, System, Feature Extraction Module, and Classifier in the Non-Invasive Blood Group Detection System using fingerprint images. The process starts when the user uploads a fingerprint image to the system. The system first performs preprocessing operations such as grayscale conversion, noise removal, resizing, and ridge enhancement to improve fingerprint quality.

After preprocessing, relevant fingerprint features such as ridge density, curvature, and texture patterns are extracted. These extracted features are then passed to the trained machine learning classifier, where classification is performed based on learned patterns from the training dataset. Once the blood group is predicted, the classification result is sent back to the system. Finally, the system displays the predicted blood group to the user in a clear and understandable format, completing the interaction sequence.

Chapter 8

IMPLEMENTATION

1. Image Acquisition Module

This module captures fingerprint images uploaded by users through the system interface. It ensures that the input images have sufficient ridge clarity and resolution for further processing. The fingerprint images are organized in a structured dataset based on known blood group labels, providing reliable input for feature extraction and model training.

2.Preprocessing Module

The preprocessing module standardizes fingerprint images by resizing them to a fixed dimension and converting them to grayscale. Noise reduction techniques such as Gaussian blurring are applied to remove distortions. Otsu's thresholding and skeletonization are used to enhance ridge structures and extract clear fingerprint patterns. This step ensures consistency and improves the quality of features extracted from the images.

3.Feature Extraction

Instead of deep CNN-based feature learning, this system extracts handcrafted fingerprint features. Key features include ridge density, ridge curvature, and Local Binary Pattern (LBP) texture features. These features capture the structural and texture-based characteristics of fingerprints that are useful for blood group classification.

4. Model Training & Validation Module

The extracted features are divided into training and testing datasets. A Random Forest classifier is trained using the labeled fingerprint feature vectors. Feature normalization is performed using a StandardScaler to ensure uniform data distribution. Model performance is evaluated using accuracy metrics on unseen test data to verify reliability and generalization.

5. Blood Group Prediction Module

In this module, the trained Random Forest model predicts the blood group of a new fingerprint image. When a user uploads a fingerprint, it undergoes preprocessing and feature extraction before being passed to the trained classifier. The model predicts the most probable blood group, enabling fast and non-invasive identification.

6. User Interface Module

The user interface module provides a simple and interactive platform for users. It allows users to log in, enter patient details, upload fingerprint images, and view predicted blood group results. The interface is
designed for ease of use with minimal user effort and clear result display. This module ensures smooth interaction between the user and the system.

7. Result Reporting Module

After prediction, the system generates a structured report containing patient details, predicted blood group, and date of prediction. The report is generated in PDF format and can be downloaded by the user. This module helps in maintaining records and improves usability for healthcare-related applications.

8. System Integration and Deployment Module

All modules are integrated into a single end-to-end application. The trained machine learning model and preprocessing pipeline are deployed using a Streamlit-based web application. The system ensures smooth data flow from image upload to prediction and report generation, making it suitable as an academic and research-oriented prototype for non-invasive blood group detection.

CHAPTER 9

TESTING

9.1 UNIT TESTING

Unit testing involves testing individual modules or components of the Non-Invasive Blood Group Detection Using Fingerprint system to ensure that each unit performs its intended function correctly. Each module was tested independently using predefined test cases with both valid and invalid inputs. This form of testing validates the internal logic, decision-making, and data processing within individual units such as fingerprint image input, image preprocessing, feature extraction, machine learning-based blood group classification, and result display. Unit testing was performed immediately after the development of each module and before system integration. This helped in identifying errors at an early stage and ensured that each component worked as expected in isolation.

Unit testing ensures:

- Correct handling of fingerprint image inputs and outputs
- Proper validation and error handling for invalid or poor-quality images
- Reliability of feature extraction and Random Forest–based classification logic.
- Accurate generation and display of prediction results

9.1.1 UNIT TEST CASES:

Test Case Id	Test Scenario	Input	Expected O/P	Actual O/P	Result
1	Test fingerpint image Upload	Valid fingerprint Image	Image uploaded	Image Uploaded successfully	Passed
2	Test Invalid Image Upload	Non-Fingerprint Image	Error message displayed	Error message displayed	Passed
3	Test empty input	No image Selected	Validation error shown	Validation error shown	Passed
4	Test image processing	Valid fingerprint image	Image preprocessed	Image preprocessed	Passed
5	Test low-quality fingerprint Blurred Fingerprint image.	Blurred Fingerprint Image	Warning	Low confidence not detected	Failed
6	Test invalid file handling	TIFF image file	Error message	Image excepted incorrectly	Failed
7	Test unsupported image format	unsupported image	Error message displayed	Image accepted incorrectly	Failed

9.2 MODULE TESTING

Module testing evaluates the functionality of each major module of the Non-Invasive Blood Group Detection Using Fingerprint system. Each module was tested independently using black-box testing techniques, where inputs were provided and outputs were verified without considering internal implementation details.

The major modules tested include:

- Fingerprint Image Acquisition Module
- Image Preprocessing Module
- Feature Extraction Module
- Machine learning-Based Blood Group Classification Module
- Result Display.

9.3 INTEGRATION TESTING

Integration testing focuses on verifying the interaction between different modules of the system. This testing ensures that data flows correctly between the fingerprint input, preprocessing, machine learning model, and output display modules.

In the Non-Invasive Blood Group Detection system, integration testing validated:

- Data flow from image acquisition to preprocessing
- Proper integration of feature extraction with the machine learning model
- Accurate transfer of predicted blood group results to the user interface

9.4 SYSTEM TESTING

System testing validates the complete Non-Invasive Blood Group Detection Using Fingerprint system as a whole. The system was tested using real-world scenarios such as fingerprint scanning, blood group prediction, and result visualization.

This testing ensured that:

- The system meets all functional and performance requirements
- The blood group prediction process is fast.
- The system operates in a fully non-invasive manner
- The application performs reliably under normal usage conditions

The results of system testing confirm that the proposed system functions accurately and efficiently, achieving the project objective of providing a fast, user-friendly, and non-invasive blood group detection solutions.

CHAPTER 10

RESULT AND DISCUSSION

The proposed Non-Invasive Blood Group Detection System was implemented and tested using fingerprint images and machine learning techniques. The system workflow includes user authentication, patient data entry, fingerprint image upload, preprocessing, feature extraction, blood group prediction, and report generation. Each stage of the system was evaluated to analyze its performance and reliability.

Step1: User Login and Authentication

The system begins with a secure login interface developed using Streamlit. Only registered users are allowed to access the system. Successful login redirects the user to the patient details page, ensuring controlled and authenticated usage of the application.

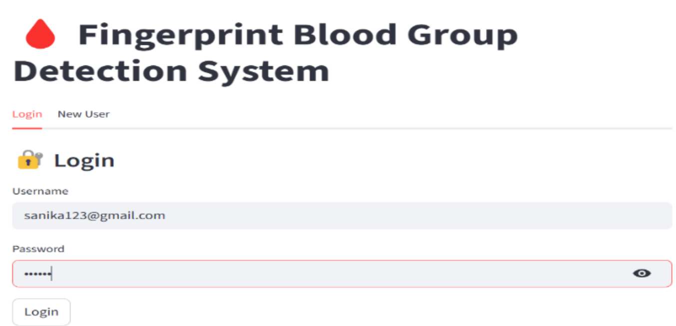


Fig 10.1: User Login Interface of the Blood Group Detection System

Step 2: Patient Details Entry

After login, the user enters patient details such as name, age, gender, and phone number. Input validation is applied to ensure correctness, especially for phone number format and mandatory fields. Once validated, the details are stored temporarily for report generation.

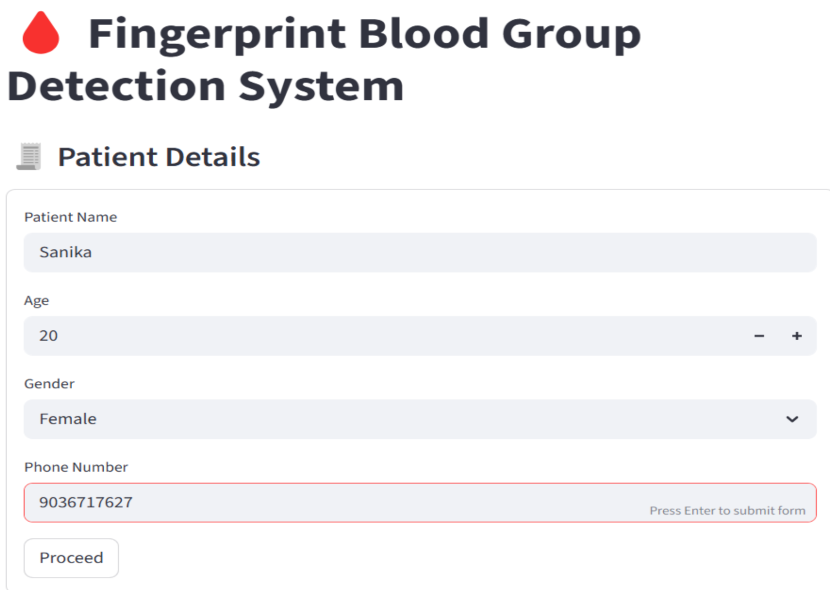


Figure 10.2: Patient Details Entry Page of the Blood Group Detection System

Step 3: Fingerprint Image Upload

The user uploads a fingerprint image in supported formats such as BMP, JPG, JPEG, or PNG. The system restricts invalid file formats and non-fingerprint images. If an incorrect or unclear image is uploaded, an error message is displayed, prompting the user to upload a valid fingerprint image.

Fig 10.3: Fingerprint Image Upload Page of the Blood Group Detection System

Step 4: Image Preprocessing

The uploaded fingerprint image undergoes preprocessing steps including grayscale conversion, resizing, Gaussian blurring, Otsu's thresholding, and skeletonization. These steps enhance ridge clarity and remove noise, improving the quality of features extracted from the fingerprint.

Step 5: Feature Extraction

From the preprocessed fingerprint, important handcrafted features such as ridge density, ridge curvature, and Local Binary Pattern (LBP) texture features are extracted. These features represent the structural and texture properties of the fingerprint and serve as input to the machine learning model.

Step 6: Blood Group Prediction

The extracted features are normalized using a trained StandardScaler and then passed to the trained Random Forest classifier. Based on learned patterns from the training dataset, the model predicts the most probable blood group (A, B, AB, or O with Rh factor). The predicted result is displayed clearly on the user interface.

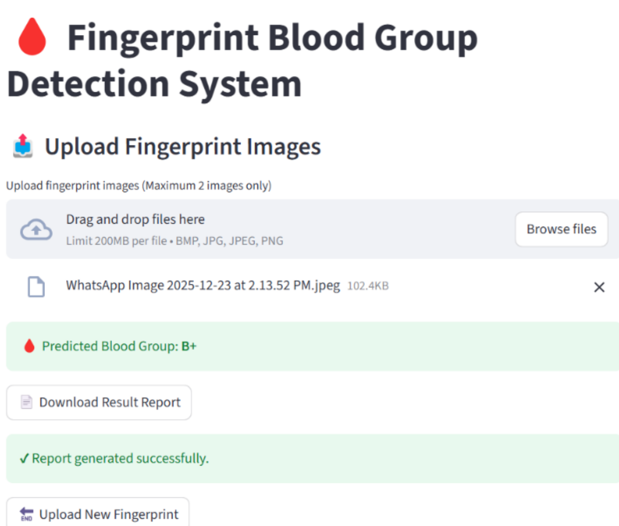


Fig 10.4: Blood Group Prediction Result Page Using Fingerprint Image

Step 7: Result Visualization and Report Generation

After prediction, the system generates a detailed PDF report containing patient information, predicted blood group, date, and a disclaimer stating that the result is generated for academic and research purposes only. The report can be downloaded by the user for reference.

FINGERPRINT BASED BLOOD GROUP DETECTION REPORT

Patient Information

Name : Sanika
Age : 20
Gender : Female
Phone Number : 9036717627

Test Details

Input Type : Fingerprint Image
Method Used : Machine Learning Classification
Date & Time : 03-01-2026 17:36:26

Predicted Blood Group : B+

IMPORTANT NOTE:
This result is generated purely for academic and research purposes. This system is NOT intended for medical diagnosis.

Fig 10.5: Blood Group Prediction Report

CONCLUSION AND FUTURE SCOPE

1. Conclusion

The Non-Invasive Blood Group Detection Using Fingerprints project successfully demonstrates the feasibility of using fingerprint biometrics combined with machine learning techniques for blood group identification. The system provides a fast, reliable, and non-invasive alternative to traditional blood typing methods, which typically require blood samples and laboratory analysis. By extracting meaningful fingerprint features such as ridge density, curvature, and texture patterns and applying classifiers like Random Forest and Support Vector Machine, the system is able to predict blood groups effectively without physical intervention.

2. Future Scope

- The system can be further improved to provide more accurate and reliable blood group prediction by expanding the fingerprint dataset with greater diversity and higher-quality images.
- Advanced machine learning techniques and hybrid models can be explored to enhance classification performance and reduce prediction bias across different blood groups.
- Explainable AI techniques can be integrated to improve transparency by visually indicating which fingerprint features influence the prediction results.
- The system can be extended for use in emergency situations, rural healthcare centers, and mobile medical units, where quick and non-invasive blood group identification is essential.

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Ballari Institute of Technology and Management
Department of Computer Science and Engineering

Project Work Phase-II (22CSP76) – CO PO Mapping

Academic Year 2025-26

U.S.N.	Student Name	Guide Name	Project Title
3BR22CS120	Poorvi H	Dr. C K Srinivas	Non-Invasive Blood Group Detection Using Fingerprints
3BR22CS122	Pragna A		
3BR22CS136	Rajeshwari		
3BR23CS402	B Fouziya		

COURSE OUTCOMES(CO'S)

Course Outcomes COx	Description of Course Outcomes
CO1	Identify an engineering problem based on real-world needs and conduct a comprehensive literature review.
CO2	Formulate project objectives, scope, and methodology with a structured project proposal.
CO3	Develop a preliminary design or solution concept using appropriate engineering tools and techniques.
CO4	Communicate ideas effectively through technical reports and presentations.
CO5	Demonstrate teamwork and ethics.

CO-PO MAPPING

COPO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	2	2	1	1	1	2	1	3	2
CO2	3	3	3	3	2	2	1	2	2	3	2	3	2
CO3	3	3	3	2	3	2	1	1	2	2	2	3	3
CO4	2	2	2	2	2	1	1	2	2	3	2	2	2
CO5	1	1	1	1	1	2	1	3	3	3	2	1	2

Signature of Guide

PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES (POs & PSOs)

PO1: Engineering Knowledge Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2: Problem Analysis Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3: Design/Development of Solutions Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
PO4: Conduct Investigations of Complex Problems Use research-based knowledge and research methods including design of experiments, analysis, and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5: Modern Tool Usage Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6: The Engineer and Society Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO7: Environment and Sustainability Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for, sustainable development.
PO8: Ethics Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
PO9: Individual and Team Work Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10: Communication Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11: Project Management and Finance Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1: Demonstrate the principles, architecture and organization of computers, embedded systems and computer networks.
PSO2: Develop software applications using advanced technologies to cater the growing needs of industry.

Project Guide

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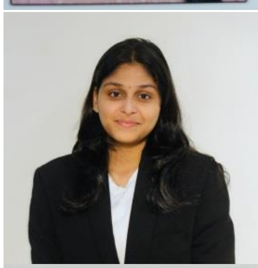

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CHAPTER 13

PUBLICATION STATUS

The project titled "**Non-Invasive Blood Group Detection Using Fingerprint Images**" presents an innovative approach, and a patent application related to this work has been filed. The application is currently under review by the Indian Patent Office (https://en.wikipedia.org/wiki/Indian_Patent_Office).

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