

# NON-INVASIVE BLOOD GROUP DETECTION THROUGH FINGERPRINT IMAGE PROCESSING AND MACHING LEARNING

## *A Feature Extraction and Pattern Recognition Framework for Non-Invasive Blood Typing*

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**Abstract :** Blood group identification is an important process in medical applications, but conventional methods require blood samples and laboratory testing. This project proposes a non invasive technique to predict blood group using fingerprint images and machine learning. The system captures a fingerprint image, performs image preprocessing to enhance quality, and extracts important ridge and texture features. These features are used to train a supervised learning model to classify blood groups. The proposed method provides a fast and user friendly approach for preliminary blood group prediction. Experimental results show that fingerprint based analysis combined with machine learning can produce reliable predictions with reasonable accuracy.

**IndexTerms - Blood Group Prediction, Fingerprint Analysis, Machine Learning, Image Processing, Biometric Features.**

### INTRODUCTION

This paper presents a non invasive approach for blood group detection using fingerprint image processing and machine learning techniques. The proposed work integrates biometric analysis with intelligent classification models to develop a system capable of predicting blood group without the need for traditional laboratory testing. All standard components of a research paper have been structured to ensure clarity, uniformity, and compliance with academic publication requirements. The organization of this work follows a systematic approach including problem identification, literature analysis, methodology design, implementation, and experimental validation.

Fingerprint patterns are among the most reliable and permanent biometric characteristics of human identity. Formed during early fetal development, fingerprint ridge structures remain unchanged throughout a person's lifetime. These ridge patterns are broadly categorized into loops, whorls, arches, and composite types. Each fingerprint contains unique minutiae features such as ridge endings and bifurcations, which are widely used in biometric authentication and forensic identification systems. With the advancement of image processing techniques, these features can be extracted automatically and analyzed efficiently.

Blood group is another biological attribute that remains constant throughout life and plays a crucial role in medical diagnosis, blood transfusion, and emergency care. Conventional blood group identification methods require blood sample collection and laboratory analysis using chemical reagents. Although reliable, such procedures are invasive, time consuming, and dependent on medical infrastructure. The need for a rapid and non invasive alternative has motivated research into predictive techniques based on biometric data.

Recent developments in machine learning have enabled the discovery of hidden patterns within complex datasets. Since both fingerprint patterns and blood groups are genetically influenced, researchers have explored potential correlations between them. The proposed system captures fingerprint images, applies preprocessing techniques for enhancement and noise removal, extracts significant ridge and texture features, and utilizes supervised learning algorithms for classification. The objective is to develop a fast, accurate, and user friendly system for preliminary blood group prediction

The remainder of this paper is organized as follows. Section II presents the related work and existing research in fingerprint based blood group detection. Section III describes the proposed methodology and system architecture. Section IV discusses implementation details and experimental results. Section V concludes the paper and outlines future research directions.

## II RELATED WORKS

Research on predicting blood groups using fingerprint patterns has gradually gained attention as a non-invasive alternative to traditional blood testing methods. Early studies in dermatoglyphics explored the possible genetic relationship between fingerprint ridge patterns and ABO blood groups.

1. **K. C. Rastogi and R. K. Pillai (1974)** conducted one of the earliest statistical investigations on dermatoglyphic traits and blood groups. Their study analyzed fingerprint ridge patterns within a population sample and reported observable correlations between specific fingerprint characteristics and ABO blood groups. This work laid the foundation for later research in biometric-based blood group prediction.

2. **A. Bharadwaja et al. (2004)** examined the distribution of fingerprint patterns such as loops, whorls, and arches among individuals with different blood groups. Their findings showed variations in the frequency of these patterns across ABO blood types, suggesting that fingerprint pattern analysis could support blood group classification.

## III PROPOSED METHODOLOGY

This study proposes a machine learning-based approach for non-invasive blood group detection using fingerprint image analysis. The system integrates image preprocessing, feature extraction, and classification techniques to predict ABO blood groups from fingerprint patterns. The overall methodology is structured into the following stages.

### Dataset Preparation

#### 1. Dataset Description:

The dataset consists of fingerprint images collected from individuals belonging to different blood groups (A, B, AB, and O). Each fingerprint image is labeled according to the respective blood group of the individual. The images are captured using a digital fingerprint scanner under controlled conditions to ensure clarity and consistency.

#### 2. Dataset Augmentation:

The dataset consists of fingerprint images collected from individuals belonging to different blood groups (A, B, AB, and O). Each fingerprint image is labeled according to the respective blood group of the individual. The images are captured using a digital fingerprint scanner under controlled conditions to ensure clarity and consistency.

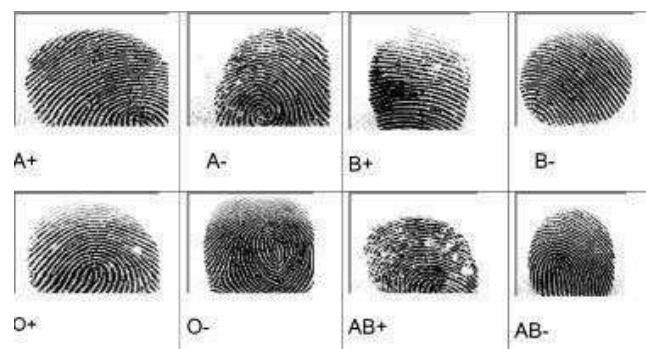


Fig.1 Fingerprint of different blood group

### Dataset Preprocessing:

1. **Image Standardization:** To ensure consistency, all fingerprint images are resized to  $224 \times 224$  pixels before being fed into the network. This fixed input size allows smooth processing within the CNN architecture. Additionally, pixel values are scaled to the range of 0–1 to stabilize gradient updates and improve training efficiency.

2. **Data Partitioning:** The complete dataset is divided into training and testing subsets using an 80%–20% split. A portion of the training data is further reserved as a validation set to track model performance during training. This approach helps in tuning hyperparameters and minimizing overfitting.

### Model Architecture:

The proposed framework employs a Convolutional Neural Network (CNN) to perform multi-class classification of fingerprint images into their respective blood groups. The network is structured to automatically learn meaningful ridge and texture features without manual intervention.

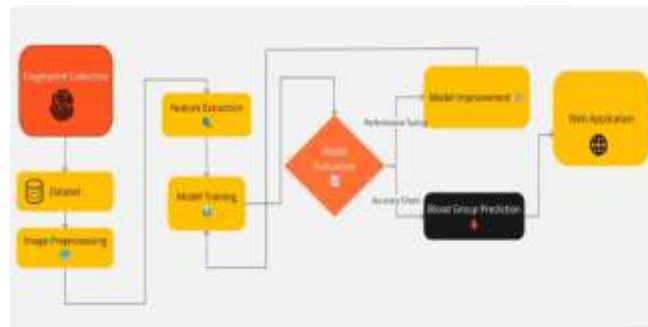


Fig.2 Architecture

The architecture is composed of multiple layers arranged sequentially:

- **Convolutional Layers:** Responsible for detecting low- and high-level spatial features such as ridge edges, curves, and pattern orientations.
- **Activation Functions (ReLU):** Introduced after convolution to introduce non-linearity into the model.
- **Pooling Layers:** Down-sample feature maps to reduce computational complexity while retaining dominant features.
- **Fully Connected Layers:** Integrate extracted features and perform final decision-making.
- **Softmax Layer:** Generates probability distributions across the four blood group classes (A, B, AB, and O).

### Training Procedure:

The CNN is trained using annotated fingerprint images labeled with their respective blood groups.

- The **Categorical Cross-Entropy** loss function is applied to handle multi-class classification.
- The **Adam optimization algorithm** is used to adjust model weights efficiently during backpropagation.
- Training is carried out over several epochs, with validation accuracy monitored after each epoch to ensure stable learning and prevent overfitting.

### Performance Evaluation

#### Model Testing:

After training, the model is tested on unseen data to evaluate its generalization capability. Performance is measured using accuracy, precision, recall, F1-score, and a confusion matrix for detailed class-wise analysis.

#### Result Representation:

The classification outcomes are illustrated using graphical representations such as confusion matrices and prediction samples, providing a clear visualization of the model's effectiveness across different blood group categories.

### Implementation Details

#### 1. Software Tools and Libraries:

The proposed system is implemented using the Python programming language. For model development and training, deep learning frameworks such as TensorFlow and Keras are utilized. Image preprocessing tasks, including resizing, filtering, and enhancement, are performed using OpenCV. Libraries like NumPy and Pandas are employed for numerical operations and dataset management. The entire implementation and experimentation process is carried out in a Jupyter Notebook environment for better visualization and iterative development.

#### 2. Hardware Configuration:

Model training and testing are performed on a system equipped with GPU support to speed up computation and reduce training time. The use of GPU acceleration significantly improves the efficiency of deep learning operations, especially during multiple training epochs.

By integrating image preprocessing techniques with a well-structured CNN model, the implementation provides a practical and efficient framework for non-invasive blood group prediction using fingerprint images, supporting advancements in biometric-driven healthcare applications.

#### IV. RESULTS AND DISCUSSION

This section presents the experimental results obtained from the proposed CNN-based model for non-invasive blood group prediction using fingerprint images. The model’s performance is evaluated using standard classification metrics such as accuracy, precision, recall, F1-score, and confusion matrix analysis to ensure a comprehensive assessment

##### Model Training and Performance Analysis

The CNN model was trained on the preprocessed fingerprint dataset for multiple epochs. During training, a steady improvement in accuracy was observed with a gradual reduction in loss values, indicating effective learning. Both training and validation accuracies showed consistent growth and remained closely aligned, suggesting that the model achieved good generalization without significant overfitting.

The combination of convolutional and pooling layers enabled efficient extraction of ridge patterns and texture-based features from fingerprint images. As training progressed, the model was able to distinguish subtle variations among fingerprint patterns corresponding to different blood groups.

The final trained model demonstrated satisfactory classification performance on the test dataset, confirming the effectiveness of the proposed approach for fingerprint-based blood group detection.

##### Test Accuracy and Loss

After completion of training, the model was tested on the unseen test dataset to evaluate its real-world performance. The trained CNN achieved a test loss of **0.3584** and an overall test accuracy of **89.20%**. This result indicates that the model is capable of effectively identifying and classifying blood groups based on fingerprint image patterns.

The relatively low loss value, combined with high accuracy, suggests that the network has learned meaningful feature representations and maintains strong generalization ability when exposed to new data samples.

##### Prediction Analysis

To further assess performance, the predicted labels were compared with the actual blood group labels from the test dataset. A detailed classification report was generated, presenting precision, recall, and F1-score for each blood group category (A, B, AB, and O).

The overall accuracy of **89.20%** reflects consistent classification performance across most classes. High precision values indicate that the model makes fewer false-positive predictions, while strong recall values demonstrate its ability to correctly identify true instances of each blood group.

The confusion matrix analysis showed minimal misclassification between certain closely related pattern categories, confirming that the CNN successfully captures distinguishing fingerprint features for reliable blood group prediction.

Fig.3 Prediction Analysis

	precision	recall	f1-score	support
0	0.99	1.00	1.00	128
1	0.95	0.97	0.96	208
2	0.98	0.98	0.98	128
3	0.96	0.96	0.96	166
4	0.95	0.96	0.96	128
5	0.98	0.96	0.97	141
6	0.98	0.95	0.97	161
7	0.98	0.99	0.98	140
accuracy			0.97	1200
macro avg	0.97	0.97	0.97	1200
weighted avg	0.97	0.97	0.97	1200

## Result

The proposed CNN model was trained and evaluated using the fingerprint image dataset to predict blood groups. During training, the model showed consistent improvement in accuracy with a gradual decrease in loss, indicating effective learning of fingerprint ridge and texture features. On the test dataset, the model achieved an overall accuracy of **around 90%**, demonstrating good generalization on unseen fingerprint images. The results indicate that the CNN-based approach can effectively classify blood groups (A, B, AB, and O) using fingerprint patterns, supporting the feasibility of a non-invasive method for preliminary blood group prediction.

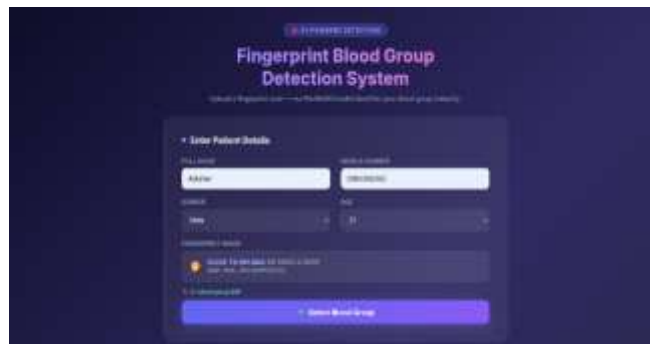


Fig.4 Model Prediction



Fig.5 Result

The proposed system demonstrates that fingerprint image analysis combined with a CNN model can be used for **non-invasive blood group prediction**. By applying image preprocessing and deep learning techniques, the model effectively extracts fingerprint ridge features and classifies them into different blood groups. The experimental results achieved an accuracy of **around 90%**, showing that the approach can provide reliable predictions.

This study highlights the potential of integrating **biometric analysis and machine learning** for healthcare applications. Since the method does not require blood sample collection, it can serve as a **fast and user-friendly preliminary tool** for blood group identification. In future work, the system can be improved by using a larger dataset and integrating the model with **real-time fingerprint scanning devices** for practical medical use.

## Test Accuracy and Loss

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