

# Biometric Blood Group Identification Using Fingerprint Images with EfficientNet and Confidence-Aware Deep Learning

Mrs. A. Adaikkammai, B.E., M.E. Assistant Professor, Kumaran A, Monish MD

Department of Computer Science and Business Systems  
R.M.D. Engineering College

**Abstract-** Blood group identification is a fundamental requirement in medical diagnostics, transfusion procedures, and emergency healthcare. Conventional blood grouping techniques rely on invasive serological testing, which requires laboratory infrastructure, trained personnel, and time. This paper presents a non-invasive fingerprint-based blood group identification system using deep learning. The proposed approach employs an EfficientNet-based convolutional neural network for automatic feature extraction and classification from fingerprint images. To enhance system reliability, a confidence-aware decision mechanism is incorporated to avoid uncertain predictions. Additionally, explainable artificial intelligence techniques are used to visualize fingerprint regions influencing the prediction. Experimental evaluation using fingerprint image datasets demonstrates that the proposed method serves as an efficient, transparent, and deployable decision-support system for academic and prototype-level healthcare applications.

**Keywords:** Fingerprint biometrics, Blood group identification, EfficientNet, Deep learning, Confidence-aware prediction, Explainable AI.

## I. INTRODUCTION

Blood group identification plays a critical role in medical emergencies, blood transfusion management, organ transplantation, and prenatal care. Accurate and timely identification of blood groups is essential to prevent adverse medical outcomes. Traditional blood group detection methods are based on serological analysis, which requires invasive blood sample collection and laboratory-based testing. These constraints limit accessibility in emergency scenarios and resource-constrained environments.

Recent advancements in biometric systems and artificial intelligence have enabled the exploration of non-invasive approaches for medical decision support. Fingerprints are unique, permanent, and genetically influenced biometric traits that have been extensively used for authentication and identification. Emerging research suggests that fingerprint ridge patterns may exhibit correlations

with certain physiological and genetic traits, including blood groups.

Deep learning models, particularly convolutional neural networks (CNNs), have demonstrated remarkable success in image-based pattern recognition tasks. EfficientNet, a modern CNN architecture, provides high accuracy with reduced computational complexity through balanced model scaling. Motivated by these advancements, this work proposes a fingerprint-based blood group identification system using EfficientNet combined with confidence-aware and explainable prediction mechanisms.

## II. Literature Review

Early studies on fingerprint-based blood group identification focused on statistical correlations between fingerprint patterns such as loops, whorls, and arches and ABO blood groups. These approaches relied on basic statistical tools and

produced inconsistent prediction accuracy due to limited feature representation.

With the emergence of machine learning, classifiers such as Support Vector Machines, K-Nearest Neighbors, and Decision Trees were applied to fingerprint images using handcrafted features such as ridge count, orientation, and minutiae points. While these methods improved performance compared to purely statistical approaches, they were sensitive to noise, image quality variations, and feature selection.

Recent research has demonstrated the effectiveness of deep learning models, particularly CNNs, in biometric image analysis. CNN-based approaches automatically learn hierarchical features from raw fingerprint images, reducing dependency on manual feature extraction. Some works further introduced hybrid architectures combining CNNs with Graph Neural Networks (GNNs) to capture both local texture information and global ridge connectivity. Although these hybrid models achieved improved accuracy, they introduced increased computational complexity and deployment challenges.

The literature highlights the need for a lightweight, reliable, and interpretable deep learning approach that balances accuracy, efficiency, and practical deployment for fingerprint-based blood group identification.

### III. Existing System

Existing fingerprint-based blood group prediction systems primarily rely on traditional image processing techniques or complex hybrid deep learning architectures. Many systems use handcrafted features followed by classical machine learning classifiers, resulting in limited generalization and sensitivity to image quality.

More recent systems employ deep learning models such as CNNs or CNN-GNN hybrids to improve classification accuracy. However, these approaches often involve high computational overhead, complex model design, and dependency on specialized hardware for fingerprint acquisition. Additionally,

most existing systems always produce a prediction without evaluating confidence, which may lead to unreliable outcomes in healthcare-related applications.

## IV. Proposed System

The proposed system addresses the limitations of existing approaches by introducing an efficient, confidence-aware, and explainable fingerprint-based blood group identification framework. The system is implemented as a web-based application where users upload fingerprint images obtained from standard datasets or controlled acquisition.

Fingerprint images undergo preprocessing operations such as resizing, normalization, and quality enhancement to standardize input data. An EfficientNet-based deep learning model is employed for automatic feature extraction and blood group classification. A confidence-aware decision mechanism is applied to the model output to reject uncertain predictions, thereby improving reliability. Explainable AI techniques are integrated to provide visual interpretation of model decisions.

## V. System Architecture and Modules

The system architecture consists of multiple modular components designed to ensure scalability and clarity. The primary modules include fingerprint image upload, preprocessing, deep learning classification, confidence evaluation, explainability, and result display.

The fingerprint upload module allows users to submit fingerprint images through a web interface. The preprocessing module standardizes image dimensions and enhances ridge patterns. The classification module employs EfficientNet to predict blood groups. The confidence evaluation module validates predictions based on probability thresholds, and the explainability module visualizes influential fingerprint regions. The result display module presents the final output to the user.

## VI. Experimental Results and Discussion

Experimental evaluation was conducted using fingerprint image datasets with experimentally assigned blood group labels for academic validation. The EfficientNet-based model demonstrated stable classification performance across multiple test samples. The confidence-aware mechanism successfully filtered low-confidence predictions, improving system reliability.

Compared to complex hybrid architectures, the proposed approach achieved comparable performance with reduced computational complexity. The explainability component enhanced transparency by highlighting fingerprint regions influencing predictions, which is essential for trust in healthcare-related decision-support systems.

## **VII. Conclusion and Future Work**

This paper presented a non-invasive fingerprint-based blood group identification system using EfficientNet and confidence-aware deep learning. The proposed approach improves efficiency, reliability, and interpretability compared to existing methods while maintaining practical deployability.

Future work includes expanding the dataset, incorporating multi-biometric fusion, and conducting clinical validation to further enhance system accuracy and applicability.

## **REFERENCES**

1. Y. LeCun, Y. Bengio, and G. Hinton, "Deep learning," *Nature*, vol. 521, no. 7553, pp. 436–444, 2015.
2. D. Maltoni et al., *Handbook of Fingerprint Recognition*, Springer, 2009.
3. M. Tan and Q. Le, "EfficientNet: Rethinking Model Scaling for Convolutional Neural Networks," *International Conference on Machine Learning*, 2019.