ISSN 2278-3091
Volume 14, No.3, May - June 2025
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse051432025.pdf
https://doi.org/10.30534/ijatcse/2025/051432025

Fingerprint Recognition for Personalized Blood Group Identification using CNN: A Review

Prof.Chetan Padole[1], Rashi Bongirwar[2], Asmi Adkane[3], Tejas Nimrad[4], Selina Chambhare[4]
[1]JD College of Engineering and Management, DBATU University.
[2]Computer Science and Engineering (Data Science), JDCOEM Nagpur, Maharashtra, India, bongirwarrashi@gmail.com
[3]Computer Science and Engineering (Data Science), JDCOEM Nagpur, Maharashtra, India, asmiadkane0@gmail.com
[4]Computer Science and Engineering (Data Science), JDCOEM Nagpur, Maharashtra, India, selinachambhare2004@gmail.com
[5]Computer Science and Engineering (Data Science), JDCOEM Nagpur, Maharashtra, India, tejasnimrad09@gmail.com

Received Date: April 21, 2025 Accepted Date: May 23, 2025 Published Date: June 06, 2025

ABSTRACT

Fingerprints are unique and stay the same throughout a person's life, which makes them reliable for identifying individuals. Interestingly, this uniqueness might also help in determining a person's blood group. In our project, we explore a non-invasive method of detecting blood types using fingerprint patterns. Instead of taking blood samples, we analyse fingerprint features like ridge frequency and spatial patterns using tools like Gabor filters and image processing techniques. We'll collect fingerprints from individuals along with their known blood groups, then use deep learning, especially Convolutional Neural Networks your figures. (CNNs), to find patterns that may link fingerprint traits to blood types. This approach could make blood group detection faster, safer, and easier helpful in medical emergencies, forensic investigations, and even everyday healthcare.

Key words: Biometrics, Fingerprint, Blood group, Image-processing, CNN, Classification, Diagnosis, Prediction, Automation, Agglutination.

1. INTRODUCTION

Blood group detection is crucial in current medicine, particularly in cases such as blood transfusion, organ transplantation, and childbirth. Traditional blood group detection employs serological methods, which are accurate but require blood samples, skilled personnel, and laboratory equipment. Such tests tend to be costly, invasive, and time-consuming parameters that limit their use in emergency and resource-poor settings. Scientists these days have been exploring other techniques that are quicker, non-invasive, and simpler to expand. One of the innovative paths is employing fingerprint patterns long established as steady and unique biometric markers as the basis for predicting blood groups. Studies show that specific dermatoglyphic patterns, such as loops, whorls, and arches, may be statistically connected to specific ABO and Rh blood types.

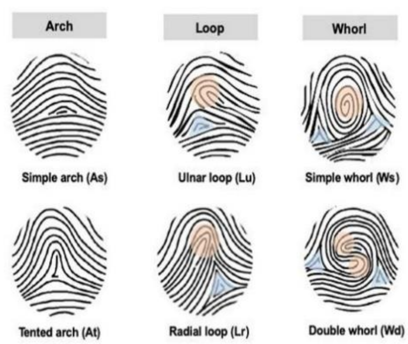

Figure 1: Common Dermatoglyphic Patterns in Fingerprint Classification

In light of this hypothesis, several attempts have been made in recent times to merge image processing with machine learning in order to explore this relationship. Of particular interest is the application of Convolutional Neural Networks (CNNs), which are extremely proficient at perceiving subtle visual features in complex pictures. CNNs are being trained from finger print image data sets with blood type labels to identify patterns unseen by the human eye. AlexNet, VGG16, ResNet, and Inception models have successfully passed preliminary testing which suggests that this method could be employed to identify blood type quickly and without pain.

This review aims to synthesize existing work in fingerprint-based prediction of blood group in terms of approaches, models, datasets, and results used by different studies. We compare simple methods like the K-Nearest

Neighbour (KNN) and Random Forests against current top-class deep learning methods. We touch upon some must-consider parameters such as diversification in datasets, preprocessing methodology, measures used for evaluation, and ethical uses of biometrics for health diagnostic purposes.

2. REFERENCE WORK

This section consists of the reviews of various technical and review articles based on different techniques applied to detect blood group.

- Jashwanth Sai Ganta et al. [1] This article presents a new technique for blood group classification based on image processing combined with deep learning. SIFT and ORB algorithms are utilized by the authors to extract features, while the Convolutional Neural Network (CNN) is used for classification. The system also increases the contrast and suppresses noise of blood images prior to classification. It exhibits high classification accuracy under various image qualities, which suggests its clinical robustness. The combination of CNNs with conventional image preprocessing pipelines presents a hybrid model that is both scalable and accurate for real-time blood typing.

- T. Nihar et al. [2] The current research considers a non-invasive method for detecting blood group based on fingerprint analysis. Gabor filters are utilized to identify ridge frequency and spatial features. Detection of antigens in the sweat secretions within fingerprint ridges is considered for the method. The technique has been recommended as simple and rapid, suitable for use in forensic and emergency scenarios. The research indicates that fingerprint-based blood group prediction can be used to supplement conventional methods and be integrated into biometric systems for immediate identification.

- Vijaykumar Patil & Dayanand Ingle [3] paper introduces an Optimized Convolutional Neural Network (CNN) for mapping fingerprint patterns with ABO and Rh blood groups. The extended AlexNet CNN model is 95.27% accurate. Fingerprint data from 392 people are used in the study and compared to previous CNN models such as LeNet-5 and ZFNet. The stringent testing and architectural creativity emphasize the capability of the model for high-performance prediction of blood groups from biometric inputs.

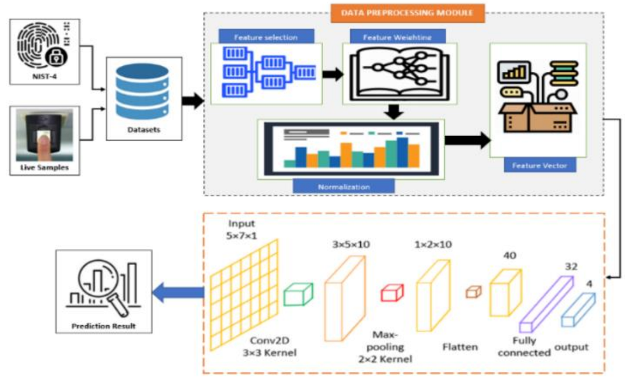

Figure 2: CNN Model Framework Diagram, adapted from [3], licensed under CC BY 4.0

- Vijaykumar Patil & D. R. Ingle [4] This comprehensive review takes into account the association between fingerprint patterns and blood group types, and also with potential associations to lifestyle diseases such as hypertension and diabetes. The paper encourages the use of deep learning to predict both disease status and blood group using the analysis of fingerprint minutiae and demographic factors. The study highlights the concept of using unsupervised learning for pattern recognition and categorization, expanding the fingerprint analysis potential beyond identification into health care predictive analytics.

- Ana Ferraz et al. [5] In this paper, a portable, automated ABO and Rh blood typing prototype using image processing is presented. The plate test is automated, from mixing blood and reagents to centrifugation, image capture, and result interpretation. Image processing techniques such as thresholding, segmentation, and pattern matching are used to detect agglutination. The system is easy to use in emergency and remote situations due to its compact size and automation, which is a significant advancement toward point-of-care diagnostics.

- Jose Fernandes et al. [6] This work details an automated blood typing system using absorption spectrophotometry to detect agglutination reactions. The device enhances diagnostic precision and reduces the time required for blood typing. It emphasizes improvements in measurement instrumentation for medical diagnostics and contributes to the ongoing development of reliable, automated blood analysis tools.

- Dr. D. Siva Sundara Raja & J. Abinaya [7] An economic method of predicting blood groups from fingerprint biometrics is proposed in this study. It explores the correlation between blood group and fingerprint patterns with the aim of reducing dependence on invasive tests. The system takes advantage of fingerprint minutiae along with analysis by slide-based agglutination, providing an affordable solution for rural or resource-poor environments.

- Pavithra & Rajeshwari [8] The paper outlines an image processing system that identifies blood types from test slides on the basis of segmentation, Otsu thresholding, and morphological processing. The procedure highlights standard deviation analysis of segmented regions to detect agglutination. The system's simplicity and accuracy render it suitable for use in mobile or emergency care-facilities.

- Lakshmi Prasad et al. [9] The paper suggests a CNN-based system for blood type prediction based on fingerprint images. It compares architectures such as AlexNet, VGG16, and ResNet using fingerprint images as inputs and assessing performance based on precision, recall, and F1-score. The study presents the possibilities of using biometrics and deep learning for non-invasive diagnosis with accuracy rates over 90%.

- Patil et al. [10] In a forensic analysis of 170 subjects, this paper establishes a statistically meaningful connection between fingerprint patterns and ABO blood groups. The loop pattern was the most common, especially in group O. No significant correlation was found with gender, but the study confirms the use of fingerprints as a potential biometric marker for predicting blood type.

- Ferraz et al. [11] constructed an automatic blood type identification system based on image processing for agglutination reaction analysis of blood samples. The technique produced consistent results within the laboratory, and while the variability of the samples was an issue, it is promising to use within clinics.

- Mounika et al. [12] proposed a new technique to predict blood groups from fingerprints and the KNN algorithm. The study gives a correlation of fingerprint patterns and blood types but is preliminary in nature because there is no proper validation and the datasets are small.

Table 1 below shows the comparison on existing systems for detection of blood groups

Table 1: Comparison table on existing systems for detection of blood groups

Sr. No	Authors	Year	Methodology	Input Modality	Application Type
1	J. S. Ganta et al.	2023	SIFT, ORB, CNN	Blood image	Automated blood group classification
2	T. Nihar et al.	2024	Gabor filter + Antigen analysis	Fingerprint	Biometric blood type identification
3	V. Patil and D. Ingle	2022	Optimized CNN (based on AlexNet)	Fingerprint	ABO & Rh prediction via CNN
4	V. Patil and D. Ingle	2021	Feature correlation + Unsupervised learning	Fingerprint	Blood type and disease risk detection
5	A. Ferraz et al.	2013	Image segmentation + Pattern detection	Slide test image	Portable blood group analyzer
6	J. Fernandes et al.	2014	Absorption spectrophotometry	Optical signals	Fully automated agglutination analysis
7	D. S. S. Raja and J. Abinaya	2019	Fingerprint ridge pattern matching	Fingerprint	Cost-effective group prediction
8	V. Pavithra and J. Rajeshwari	2021	Morphological segmentation, SD analysis	Slide test image	Blood detection using image processing
9	M. L. Prasad et al.	2024	CNN with fingerprint classification	Fingerprint	Non-invasive blood type prediction
10	A. Patil et al.	2017	Dermatoglyphic statistics	Fingerprint	ABO pattern correlation analysis
11	A. Ferraz et al.	2011	Image processing-based classification	Slide test image	Early automated blood type detection
12	G. Mounika et al.	2024	KNN using fingerprint classification	Fingerprint	Blood group detection via machine learning (KNN)

3. SOME COMMON MISTAKES

With the passage of time, with quick leaps in technology, there is also a growing interest in tapping the potential of image processing, machine learning, and spectroscopic analysis to identify blood groups faster and without surgery. The newer systems suggest staying away from the traditional blood testing methods by scrutinizing the patterns drawn from biometric input, either fingerprints or imaging signals. Inspiring as these systems appear to be, there is also the suggestion of the attendant problems that they will present.

3.1 The major problems are:

With the rapid evolution of digital technologies, a trend towards escalating development of non-invasive and automated blood group identification methods is prevalent. Compared to traditional serological techniques involving the extraction of blood samples and laboratory-based antigen-antibody interactions, modern techniques employ biometric data, image processing, machine learning (ML), and spectroscopic analysis to make inferences about blood group information. These projects have a number of advantages: It is likely to be faster than them, It eliminates the agony of needles, and may be cheaper in the long term. It is likely, however, that despite their potential, their application as technical systems has a number of significant challenges that must be addressed before it can be used at large scale.

1. Data Collection Itself and It Being Too Poor

The greatest barrier to biometric adoption is the variable quality and variability of biometric data itself. Fingerprint patterns, for instance, can vary drastically based on scanner resolution, light, finger pressure, dry skin, or even minor wounds. These types of variations can result in noisy or low-quality images and have a direct effect on downstream machine learning model performance and stability. In spectroscopic imaging or in the acquisition of near-infrared (NIR) data, calibration of sensors and external environmental conditions also have great effects on the quality of the data.

2. Complexity in Data Processing and Feature Extraction

Raw biometric data transformation to features that may be used in training models is a sophisticated procedure that requires complex preprocessing pipelines. Operations such as image normalization, segmentation, enhancement of contrast, and detection of minutiae are computationally expensive and typically require special-purpose algorithms. Feature extraction for many studies involves employing deep models such as CNNs that learn automatically spatial hierarchies of fingerprints. This automaton is paid for through requiring high amounts of computation and great, fully-annotated datasets. Besides this, explaining how deep neural networks learn is also challenging, hence model interpretability and transparency will be compromised.

3. Unaccessibility and Accessibility-Aware, Easy-to-Use Interfaces.

While user studies for many of these research prototypes report that they are highly user-accurate in the lab, real-world deployment is often hindered by user friendliness and technical complexity. Systems that require users to enter user commands or perform complex setup processes might limit the accessibility of medical staff who are nautical in nature and nautical-friendly. For day-to-day applications, particularly in clinical or emergency situations, interfaces must be simplified with simple instructions and low learning curves.

4. High Cost and Limited Portability

Another constraint is the cost and infrastructural needs of such systems. High-resolution biometric scanners, GPU-enabled computing hardware for model inference, or specialized NIR devices are not necessarily portable or affordable, particularly in remote or underdeveloped areas. Some of today's models also rely on stable internet access or backend servers for cloud-enabled predictions, rendering them inappropriate for on-the-go diagnosis or field deployment.

4. FUTURE DIRECTION

The novel technologies in blood group identification i.e., image processing based, fingerprint biometrics, and deep learning have great potential. In order to make them more generalizable, accurate, and useful in real-world situations, work must be carried out. One of the most urgent requirements is to build large, heterogeneous datasets. The models are trained on tiny samples and may perform very badly in heterogeneous populations. Expansion of these datasets will increase the models' strength and reduce the prediction results' bias. Optimization of deep learning model efficiency is equally significant. Making models like CNNs lean or inventing sparser versions will help reduce computation time for real-time diagnosis in low-resource environments like smartphones or mobile kits. Moreover, the next generation systems must prioritize complete integration—merging image acquisition, processing, and prediction into a single convenient platform. These types of systems would prove particularly useful in emergency medicine, rural medicine, or disaster relief in which laboratory resources are limited. Ethical and privacy issues must be worked out as well. Because biometric data are the basis for diagnostics, strong data protection policies must be in place to preserve patient confidence and be compliant with the law. Finally, researchers need to explore multi-modal systems, the combination of fingerprints with other biometrics or clinical markers, to improve diagnostic accuracy. These methods can be used to extend the range from basic blood group typing to prediction of rare blood types or susceptibility to disease.

5. CONCLUSION

By utilizing machine learning, fingerprint biometrics can be used to predict blood groups in a non-invasive manner that is highly beneficial. Advanced models such as convolutional neural networks (CNNs) have been shown to be effective in classifying ABO blood types using fingerprint patterns, according to Studie. By using this approach, invasive testing may be eliminated and rapid decision-making may become feasible in critical care settings. The accuracy of fingerprint-based models has been enhanced by innovations in deep learning, such as autoencoders and Siamese networks. Moreover, the use of automated blood typing and agglutination detection systems underscores the growing importance of digital diagnostics. In practice however, there are problems including the scarcity of datasets, issues with standardization and image quality variability. It is imperative that data scientists, engineers and medical professionals collaborate on translating these experimental systems into clinical applications.

REFERENCES

1. J. S. Ganta, M. R. Jaya, S. Pulivarthi, and M. R. Y. Surya .**Blood group detection using image processing and deep learning**, *Int. Res. J. Eng. Technol. (IRJET)*, vol. 11, no. 4, pp. 97–98, Apr. 2023.
2. T. Nihar, K. Yeswanth, and K. Prabhakar. **Blood group determination using fingerprint**, in *Proc. Int. Conf. Mech. Eng. Design (ICMED)*, MATEC Web Conf., vol. 392,pp.01069,2024. doi:10.1051/matecconf/202439201069
3. V. Patil and D. R. Ingle. **A novel approach for ABO blood group prediction using fingerprint through optimized convolutional neural network**, *Int. J. Intell. Syst. Appl. Eng. (IJISAE)*, vol. 10, no. 1, pp. 60–68, Mar. 2022.
4. V. Patil and D. R. Ingle. **An association between fingerprint patterns with blood group and lifestyle-based diseases: a review**, *Artif. Intell. Rev.*, vol. 54,pp.1803–1839,2021. doi:10.1007/s10462-020-09891-w
5. A. Ferraz, F. Soares, and V. Carvalho. **A prototype for blood typing based on image processing**, in *Proc. SENSORDEVICES 2013: Fourth Int. Conf. Sensor Device Technol. Appl.*, pp. 137–142, 2013.
6. J. Fernandes, S. Pimenta, F. O. Soares, and G. Minas. **A complete blood typing device for automatic agglutination detection based on absorption spectrophotometry,** *IEEE Trans. Instrum. Meas.*, vol. 63, no. 2, pp. 319–326, Feb. 2014.
7. D. S. S. Raja and J. Abinaya. **Fingerprint-based blood group prediction: A cost-effective method**, *Int. J. Adv. Study Res. Work*, vol. 2, no. 3, pp. 45–48, Mar. 2019.
8. V. Pavithra and J. Rajeshwari. **Identification of blood group by using image processing techniques,** *Int. J. Eng. Technol. Res. Manag. (IJETRM)*, vol. 3, no. 5, pp. 90–95, 2021.
9. M. L. Prasad, K. Niharika, D. Harshitha, and S. J. Saida. **Blood group prediction using fingerprint**, *Int. Res. J. Adv. Eng. Hub (IRJAEH)*, vol. 2, no. 12, pp. 2835–2839, Dec. 2024. doi: 10.47392/IRJAEH.2024.0392.
10. A. Patil, A. Malik, and T. Shirole. **Fingerprint patterns in relation to gender and blood groups – A study in Navi Mumbai**, *Indian J. Forensic Community Med.*, vol. 4,no.3,pp.204–208,Jul.–Sep.2017. doi:10.18231/2394-6776.2017.0044.
11. A. Ferraz, V. Moreira, D. Silva, V. Carvalho, and F. O. Soares. **Automatic system for blood type classification using image processing techniques,** in *Proc. Int. Conf. Biomed. Electron. Devices (BIODEVICES)*, Rome, Italy, Jan. 2011, pp. 368–373. doi: 10.5220/0003159003680373.
12. G. Mounika, M. Anusha, D. Gopika, and B. S. Kumari. **Blood group detection through fingerprint images using image processing (KNN)**, *Int. Res. J. Eng. Technol. (IRJET)*, vol. 11, no. 3, pp. 1225–1228, Mar. 2024.