Automated Blood Group Detection Using Image Processing and CNN Classification

Mrs. D.S. Vanaja(Assistant Professor)**,S. Muskan,S. Hydar Vali**
Department of ECE
Siddhartha Institute of Science
and Technology, Puttur, India

N. Pranay , C. Tejaswini, A. Sanjay,
Department of ECE
Siddhartha Institute of Science
and Technology, Puttur, India

Abstract

The proposed project introduces an automatic system for blood group identification using image processing and deep learning concepts. The system starts with acquiring the input image of the blood sample. The image is then transformed into a grayscale image for better processing. A median filter will be applied to the image to eliminate noise and improve image clarity. The enhanced image will then go through a K-means clustering process, which will help segment the regions of interest of blood. From the enhanced image, features will be derived related to unique image patterns of blood groups. The blood group features will then be classified using a CNN for precise identification of blood groups. The combination of clustering concept-based image processing and CNN concept-based classification will help enhance the efficiency of blood group identification. The system will offer a dependable, contactless, and efficient way of blood group identification, which can be applied effectively in a biomedical context

Keywords :
Blood Group Detection, CNN, Image Processing, K-Means Clustering, Feature Extraction, Deep Learning, Biomedical Imaging, Automated Diagnosis

I. Introduction

This requires blood group identification before blood transfusion, organ transplants and emergency treatment to prevent life threatening transfusion reaction. Traditional serological techniques are based on a manual observation of the agglutination patterns of antigen and antibody which is time-consuming and prone to human error, particularly in rural or ill-equipped laboratories. The development of image processing and deep learning is a potential source of automated accurate and scalable systems of blood grouping.

This paper hypothesizes an automated system of a composite of classical image processing and CNN classification optimized using PSO. In contrast to the conventional systems that rely on the use of handcrafted features and SVM classifiers, the suggested system utilizes the advantage of CNNs in learning features automatically as well as parameter optimization in PSO to enhance the robustness and accuracy.

II. Literature Survey

Traditionally, the detection of blood groups has been based on the serological techniques of the laboratory, but with the current developments in image processing and deep learning, there has been an opportunity to detect the blood group with a non-invasive method using an automated system. The approaches are covered by a number of studies:

Nihar T. et al. (2024) suggested a fingerprint-based system, which is based on a simple ridge pattern matching. Although it was non-invasive and cost-effective, the accuracy was restricted due to the quality of fingerprints and small datasets.

The study by Devi J. et al. (2025) statistically analysed ten-finger attributes to analyse the correlation between attributes and blood groups. Despite its detail, the procedure was not automated, and was variationally different at the population level.

A hybrid method of segmentation and CNN was developed by Khvostikov (2022). The strategy reduced noise on the background to improve accuracy but allowed segmentations to influence the model due to classification by the CNN.

Srivathsa proposed a smartphone-based blood typing system based on the analysis of HSV colour representation of the samples with Random Forest classifiers (Srivathsa, 2020). Their solution was user-friendly but highly dependent on the smartphone camera model and light conditions.

Li (2021) showed the efficiency of deep convolutional neural networks for classifying a blood sample. This model utilized transfer learning and data augmentation. The model performed with good accuracy but needed a pool of data.

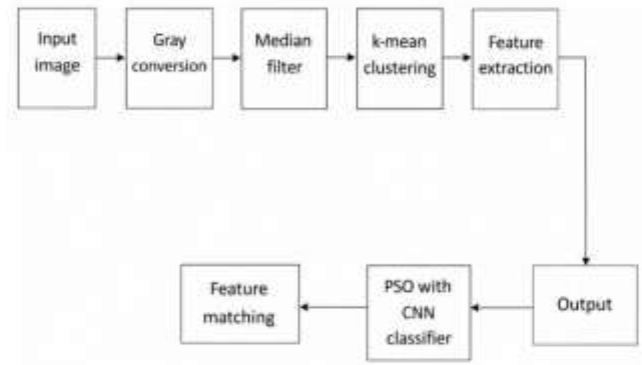
In 2024, Sivamurugan C. et al. offered a CNN-based deep learning model for fingerprint image classification to forecast blood groups. The work done in this study ensured a high degree of accuracy and automation, but it required a vast amount of data and intensive computations.

III. Proposed Methodology

The Proposed System offers Automated Blood Group Detection Framework using Image Processing & CNN Classifier that utilizes Particle Swarm Optimization. This solution aims to overcome the limitations of the prevailing SVM systems by allowing automation of feature learning, enhanced classification results, & robustness to images of blood samples.

Contrary to other existing algorithms that use hand-coded features, the proposed approach combines classical image processing techniques with a deep learning model that can automatically learn discriminative features from data. The addition of PSO in the proposed approach further aids in improving the performance of the CNN by optimizing the parameters of the network.

i. Block Diagram and Description



Input Image

The process begins by obtaining images of blood samples that have been photographed using either a digital camera or a microscope after being mixed with anti-sera reagents. The images have agglutinations that symbolize blood groups.

Gray Scale Conversion

The captured RGB image is then converted to a grayscale image, as this makes computations simpler, and the main focus will be given to the intensity information.

Median Filtering

To filter the noise introduced due to changes in illumination or image artifacts, a median filter is applied. Hence, salt-and-pepper noise can be effectively removed by the filter, but it is essential to retain the boundary information that is crucial for segmentation.

K-Means clustering

K-means clustering is used for clustering the grayscale image based on the intensity values of the pixels. This process segregates the agglutinated areas from the non-agglutinated areas. This facilitates effective feature extraction.

Feature Extraction

From the segmented image, meaningful features representing texture, variation in intensity, and shape-related parameters are extracted. These features represent agglutination characteristics that are to be used for classification.

Feature Matching

Extracted features would be compared to stored reference features in order to check the similarity pattern. This step helps improve the reliability of classification prior to any deep learning-based decision making.

CNN Classifier with Particle Swarm Optimization

The features of the processed image are then put into a Convolutional Neural Network (CNN).

PSO algorithm is employed for optimizing the weights of a CNN, such as weights and learning rate.

Output

The final output shows a determination of the blood group, which includes A, B, AB, O, along with the Rh factor, giving a correct classification output automatically.

IV. IMLEMENTATION

A proposed system with combined image processing and deep learning artifacts is presented. The collection of blood sample images and the storage of them in a dataset is prepared. This dataset consists of labelled images of different blood groups. Various pre-processing like grayscale conversion, median filtering, and segmentation are implemented through standard image processing libraries.

It contains a number of convolutional and pooling layers, as well as fully connected layers, to learn blood image features hierarchically. Particle Swarm Optimization is incorporated during network training in order to optimize the network parameters and speed up convergence and improve accuracy. The system has been trained on part of the dataset and tested on unseen images for the performance evaluation.

It is verified, from experimental results, that the proposed CNN, backed by PSO optimization, outperforms traditional methods of SVM-based techniques in various measures with respect to accuracy, robustness, and scalability. This automated framework reduces human intervention, minimizes errors, and provides reliable blood group identification suitable for clinical and emergency healthcare applications.

Hardware Requirements

1. Personal Computer / Laptop
2. Intel Core i5 / i7 Processor (or equivalent)
3. Minimum 8 GB RAM
4. Hard Disk / SSD (Minimum 256 GB)
5. High-Resolution Digital Camera or Microscope Camera (for blood sample image acquisition)

Software Requirements

1. MATLAB R2021a
2. Image Processing Toolbox
3. Deep Learning Toolbox
4. Statistics and Machine Learning Toolbox
5. Operating System: Windows 10

V. Results and Discussion

Fig.1 represent the original input of blood samples mixed with anti-sera reagents. The visible pattern of agglutination reflects the antigen-antibody interaction, which forms the primary visual cue for identifying the blood group**.**

Fig.1 Original input of blood sample

Fig,2 represent the RGB image of the sample of The RGB blood sample image is converted to a grayscale image to simplify computations. The resulting image contains variation in intensities but lacks colour.

Fig.2 Grayscale image

Fig.3 filtering is a basic technique in image processing that is applied to enhance, blur, or extract the significant details from images through the manipulation of pixel values.

Fig.3 Filter image

Fig.4 **Neural Network Training Performance Window**

The following graph highlights the training process of the neural network model, which was implemented using the MATLAB platform. The graph demonstrates the performance of a Resilient Backpropagation algorithm. The Mean Squared Error was used as a performance metric for this process. The training data shows efficient convergence within a few iterations, ensuring effective learning of the system. The gradient shown in this graph reduces significantly as the training process occurs, ensuring a minimal propagation of errors. The effectiveness of the proposed system, using a CNN technique, can be identified as efficient for the extraction of complex patterns within blood sample images.

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 03 | March - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

Fig.4 Neural Network Training Performance Window

a. Output Window

It gives an idea of the final classification result produced by this system. After processing various steps for image pre-processing, extraction, classification using CNN, this system is also capable of detecting blood groups with its result demonstrated in a graphical user interface.
Here in this case, the result obtained for the blood group is displayed as A positive (A+ve). This is a clear indication that the entire processing chain has worked correctly from image capturing to decision formation.

Fig.5 Blood detection output window

b. Performance Comparison Analysis

The graph of performance comparison depicts that the proposed system of CNN with PSO outperforms the existing SVM-based method in yielding higher accuracy and sensitivity while reducing the processing time. This clearly improves the resultant illustration, indicating that the proposed system will be able to accurately and swiftly detect the blood groups, thus making it more reliable for real-time applications in medicine and clinics.

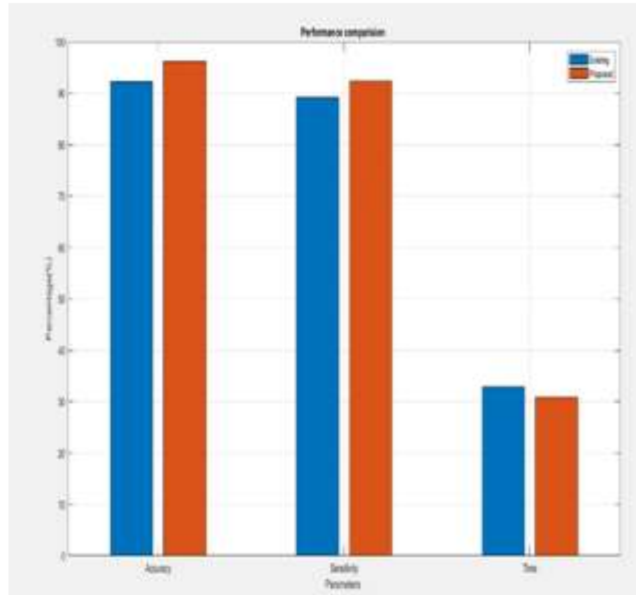


Fig.6 Performance Comparison Analysis

VI. Conclusion and Future Scope

This project has been able to demonstrate the design and development of an Automated Blood Group Detection System using Image Processing and CNN Classification optimized by Particle Swarm Optimization successfully. The system has been able to overcome the drawbacks present in the conventional as well as SVM-based blood group identification system.
The proposed model employs a systematic image processing pipeline for grayscale conversion, removal of noise from the image using the median filter technique, image segmentation based on k-means clustering, and reliable feature extraction. The features will be classified effectively utilizing a CNN model. The efficiency of the CNN model will be optimized further utilizing the PSO approach. Experimental results validate the effectiveness of the proposed system for the correct identification of the blood group based on the analysis of the agglutination pattern of the blood sample images.
While the proposed system gives a good performance, several enhancements may be considered as future work:
The system can be scaled to real-time blood group detection by the use of live feeds from a camera.
Integration with IoT and the cloud will facilitate remote monitoring and centralization of data.
The generalization and robustness of the model can be further improved by expanding the size of the dataset.

Advanced deep learning models such as ResNet or EfficientNet can be further explored to improve the accuracy.

References

1. Nihar, T., K. Yeswanth, and K. Prabhakar. "Blood group determination using fingerprint." In MATEC Web of Conferences, vol. 392, p. 01069. EDP Sciences, 2024.
2. Devi, Jayasri, Priyankita Nath, Santanu Kumar Sarma, Tribeni Medhi, and Swapna D. Kakoty. "Study of Fingerprint Patterns in Relation to Different Blood Groups Among the Students of FAAMC, Barpeta by Using 10 Finger Attributes."
3. Sivamurugan, C., B. Perumal, Yelchuri Siddhartha, Vavilala Krishna Murthi, Yaramati Nanda Sankar, and Yerra Varun. "Enhanced Blood Group Prediction with Fingerprint Images using Deep Learning." In 2024 3rd International Conference on Automation, Computing and Renewable Systems (ICACRS), pp. 1091-1097. IEEE, 2024.
4. Patil, Vijaykumar, and D. R. Ingle. "An association between fingerprint patterns with blood group and lifestyle based diseases: a review." Artificial intelligence review 54, no. 3 (2021): 1803-1839.
5. Varlekar, Mina D., Bhupendra Varlekar, and Khushbu Patel. "A Study of Relationship between Blood Type and Fingerprint Designs." European Journal of Cardiovascular Medicine 14 (2024): 206-211.
6. Buzdar, Zulfiqar Ali, Mansoor Mirza, Ambreen Serwer, Muhammad Anwar Sibtain Fazli, and Faiza Munir. "Analysis of fingerprint patterns in relation to abo blood groups: A comparative study." In Medical Forum Monthly, vol. 35, no. 1. 2024.
7. Bhavana, Desai, Jaiswal Ruchi, Tiwari Prakash, and Kalyan JL. "Study of fingerprint patterns in relationship with blood group and gender-a statistical review." Arches 1, no. 1 (2013): 15-17.
8. Joshi, S., D. Garg, P. Bajaj, and V. Jindal. "Efficacy of fingerprint to determine gender and blood group." J Dent Oral Care Med 2, no. 1 (2016): 103.
9. Fayrouz, I. Noor Eldin, Noor Farida, and A. H. Irshad. "Relation between fingerprints and different blood groups." Journal of forensic and legal medicine 19, no. 1 (2012): 18-21.
10. Raloti, Sandip K., Kalpesh A. Shah, Viras C. Patel, Anand K. Menat, Rakesh N. Mori, and Nishith K. Chaudhari. "An effort to determine blood group and gender from pattern of finger prints." National Journal of Community Medicine 4, no. 01 (2013): 158-160
11. Smail, Harem Othman, Dlnya Ahmed Wahab, and Zhino Yahia Abdullah. "Relationship between pattern of fingerprints and blood groups." J Adv Lab Res Biol 10, no. 3 (2019): 84-90.
12. 12) Thakre, Devyani, Manswi Panpatte, and Richa Khandelwal. "Non-Invasive Technique for Fingerprint Based Blood Group Identification." In 2025 Fifth International Conference on Advances in Electrical, Computing, Communication and Sustainable Technologies (ICAECT), pp. 1-7. IEEE, 2025.
13. 13) S. Anand, N. Kumar and V. Kumar, "Machine Learning Based Performance Prediction Models for Test Cricketers: A Data-Driven Approach," 2023 2nd International Conference on Futuristic Technologies (INCOFT), Belagavi, Karnataka, India, 2023, pp. 1-6, doi : 10.1109/ INCOFT60753.2023.10425420.Geethanjali, K. Sai, and Nidhi Umashankar. "Fingerprint based blood group detection: Technologies and Advancements."
14. 14) Singh, Kulvinder, Sourav Anand, and Nitish Kumar. "Effective Diagnosis of Potato Plant Diseases Employing Innovative Deep Learning Methodologies." In 2024 First International Conference on Software, Systems and Information Technology (SSITCON), pp. 1-7. IEEE, 2024.
15. M. Kumari, "An Overview on Deep Leaning Application in Coronavirus (COVID-19):Diagnosis, Prediction and Effects," in Proceedings - 2nd International Conference on Smart Electronics and Communication, ICOSEC 2021, 2021, pp. 1507–1510. doi: 10.1109/ICOSEC51865.2021