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Blood Group Classification using Deep Learning

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***Abstract*— Blood group detection is a crucial procedure in medical diagnostics, particularly for transfusion medicine, emergency healthcare, and personalized treatment planning. Conventional methods rely on laboratory-based testing of blood samples, which are invasive, time-consuming, and resource dependent. To address these challenges, this paper proposes a dual-mode deep learning-based system for blood group detection using both blood images and fingerprint images. In the first mode, blood images are classified using the MobileNetV2 architecture, trained on 750 samples, achieving a training and validation accuracy of 100%, thereby replicating the reliability of laboratory testing with faster processing. The second mode introduces a novel non-invasive approach that predicts blood groups using fingerprint images, with a dataset of 10,477 samples, achieving 94% training accuracy and 90% validation accuracy. Both approaches demonstrate the efficiency of MobileNetV2 in image-based classification while maintaining computational lightweightness suitable for real-time applications. The system is deployed as a web application using Python, Flask, and frontend technologies ensuring accessibility, scalability, and user-friendliness. Experimental results confirm that the proposed framework provides high accuracy, reduced manual effort, and the potential for non-invasive diagnostics, marking a significant step toward rapid and accessible blood group detection in healthcare.**

***Index Terms*— Blood Group Detection, Deep Learning, MobileNetV2, Fingerprint Recognition, Non-Invasive Diagnostics.**

I. Introduction

Blood group detection plays a vital role in healthcare, particularly in blood transfusions, emergency treatments, organ transplantation, and personalized medicine. The accurate and rapid identification of a patient's blood group can be the difference between life and death in critical situations such as accidents, surgeries, and trauma care. Traditionally, blood group determination is carried out in laboratories by collecting blood samples and mixing them with specific anti-sera to observe agglutination reactions. While this conventional process is reliable, it is invasive, time-consuming, resource-dependent, and requires trained personnel, which limits its efficiency in emergency and remote healthcare settings. With advancements in artificial intelligence (AI) and machine learning (ML), the medical field has witnessed transformative solutions for automating diagnostic tasks. Image processing combined with deep learning has been successfully applied in fields such as cancer detection, disease prediction, and biomedical imaging. Similarly, blood group classification using image-based approaches has been explored, with earlier studies employing MATLAB simulations and image processing algorithms. However, such systems are confined to laboratory-based blood image analysis, demand high computational resources, and lack portability and scalability for real-world applications.

To overcome these limitations, this research proposes a novel dual-mode deep learning-based framework for blood group detection that employs both blood images and fingerprint images as input. The first mode utilizes blood sample images processed through the MobileNetV2 architecture, achieving near-perfect accuracy in predicting ABO and Rh systems. The second mode introduces a groundbreaking non-invasive approach where fingerprint images are analyzed to predict blood groups. By leveraging MobileNetV2, a lightweight and efficient convolutional neural network (CNN), the system achieves high accuracy while maintaining computational efficiency, making it suitable for real-time healthcare applications.

The proposed framework is deployed as a web-based system using Python and Flask, integrated with HTML, CSS, and JavaScript for a user-friendly interface. This ensures accessibility across diverse healthcare environments, including hospitals, clinics, emergency care units, and remote medical facilities. The system not only minimizes manual errors but also provides rapid, scalable, and non-invasive solutions for blood group detection.

II. LITERATURE SURVEY

Nihar et al. proposed a fingerprint-based blood group determination method, highlighting the potential of biometric features in medical diagnostics. Their study demonstrated that ridge patterns in fingerprints can be correlated with specific blood groups, offering a non-invasive approach for blood group identification in healthcare applications.

Vijaykumar and Ingle introduced a novel method for predicting blood groups using fingerprint map reading techniques. Their work emphasized the use of unique ridge characteristics and classification algorithms, achieving promising accuracy and suggesting fingerprint analysis as a cost-effective alternative to traditional blood tests.

Swathi et al. explored deep learning models for fingerprint-based blood group detection. By employing convolutional neural networks, their study achieved improved classification accuracy, reinforcing the idea that deep learning enhances reliability in biometric-driven healthcare diagnostics.

Patil et al. examined the association between fingerprint patterns, gender, and blood groups in a study conducted in Navi Mumbai. Their findings revealed statistically significant correlations, suggesting that dermatoglyphics can serve as supplementary markers in forensic and medical sciences.

Smail et al. investigated the relationship between fingerprint patterns and blood groups through laboratory-based analysis. Their study concluded that certain fingerprint types, such as loops and whorls, showed higher prevalence in specific blood groups, supporting the feasibility of this biometric-based approach.

Raja and Abinaya developed a cost-effective method for detecting blood groups using fingerprints. Their approach emphasized affordability and accessibility, particularly in rural and resource-limited settings, thereby addressing practical challenges in traditional blood testing methods.

Bashir carried out a comparative study on the relationship between fingerprint patterns and blood groups in Libyan students. The research demonstrated population-specific variations, highlighting the importance of cultural and genetic diversity in biometric-based medical predictions.

Al Habsi et al. studied fingerprint-blood group associations within the Omani population. Their findings provided valuable region-specific insights, showing how genetic diversity influences the correlation between dermatoglyphic traits and blood group classifications.

Aamir et al. analyzed fingerprint patterns in relation to blood groups in the Pakistani population. Their study confirmed that fingerprints can act as supplementary markers for identifying blood groups, offering practical applications in both medical and forensic domains.

Fayrouz et al. investigated the link between fingerprint patterns and different blood groups. Their early findings provided foundational evidence for later studies, establishing that fingerprint analysis could serve as a non-invasive screening tool for preliminary blood group identification.

III. Existing System

The conventional method of blood group detection is performed in laboratories by collecting blood samples and mixing them with specific anti-sera to observe agglutination reactions. Although this process is reliable, it is invasive, time-consuming, and requires specialized resources, which limits its use in emergency and resource-constrained healthcare environments. To improve efficiency, researchers have explored automated approaches using MATLAB simulations integrated with image processing techniques. In this method, blood samples are collected in transparent containers, mixed with anti-serum, and the reactions are captured as digital images. These images undergo pixel-level analysis through segmentation and feature extraction, after which they are compared against predefined reference images for classification. Deep learning techniques incorporated in MATLAB further enhanced this process by utilizing hidden layers and activation functions to identify complex features, thereby improving classification accuracy through multiple iterations.

While this system demonstrated the potential of artificial intelligence in automating blood group analysis and reducing manual errors, it also introduced significant limitations. The method is restricted to invasive blood image-based detection and still requires manual preparation of samples and controlled laboratory conditions for accurate image capturing. Moreover, MATLAB simulations are computationally intensive, demanding high-performance hardware, and the platform lacks portability and scalability for deployment in real-world healthcare settings. These drawbacks make the system unsuitable for real-time and non-invasive blood group detection applications.

Limitations of Existing System: The existing MATLAB-based system, though effective in laboratory simulations, suffers from several drawbacks that hinder its real-world application. It is limited to invasive blood image analysis, requiring physical sample collection and manual preparation, which introduces variability and delays. The dependency on MATLAB makes the approach computationally expensive and unsuitable for low-resource or mobile environments. Furthermore, the system lacks scalability, portability, and non-invasive alternatives, restricting its usability in emergency care, remote healthcare, and large-scale deployment.

IV. Proposed System

To overcome the drawbacks of conventional and MATLAB based approaches, the proposed system introduces a dual-mode deep learning framework for blood group detection that combines both blood image analysis and fingerprint-based non-invasive prediction. Unlike traditional laboratory-dependent methods, this system leverages the efficiency of MobileNetV2, a lightweight convolutional neural network designed for real-time image classification tasks. The use of MobileNetV2 ensures high accuracy while maintaining computational efficiency, making the system adaptable for deployment in diverse healthcare environments.

In the first mode, blood group classification is carried out using blood sample images. A dataset of 750 images was used, with 500 allocated for training and 250 for testing, and the MobileNetV2 model achieved a training and validation accuracy of 100 percent. This mode replicates the reliability of laboratory testing while significantly reducing the time required for processing and analysis. In the second mode, the system introduces an innovative non-invasive approach where fingerprint images are analyzed to predict an individual’s blood group. Trained on a dataset of 10,477 fingerprint images, with 6,000 used for training and 4,477 for testing, the model achieved a training accuracy of 94 percent and a validation accuracy of 90 percent. Although slightly less precise than the blood image approach, the fingerprint mode demonstrates promising potential for rapid and painless blood group detection.

The entire framework has been developed using Python for backend processing, Flask as the web framework, and HTML, CSS, and JavaScript for the user interface. This integration results in a web-based platform that is accessible, user-friendly, and scalable, enabling deployment in hospitals, clinics, emergency care units, and even remote healthcare facilities. By minimizing manual intervention and automating the classification process, the proposed system enhances speed, accuracy, and accessibility, while introducing the possibility of non-invasive blood group identification as a future standard in medical diagnostics.

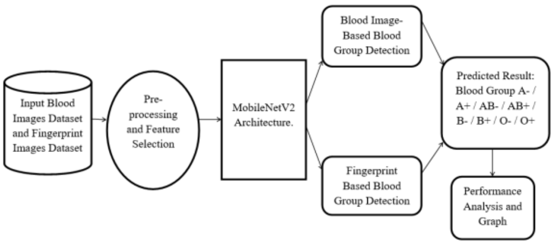

Fig: Architecture Digram

Advantages

The proposed system offers significant advantages over conventional methods by providing both invasive and non-invasive modes of blood group detection through blood and fingerprint images. The use of MobileNetV2 ensures high accuracy with reduced computational requirements, achieving 100 percent accuracy for blood images and 90 percent validation accuracy for fingerprint-based detection. Unlike MATLAB-based approaches, the system is lightweight, scalable, and deployed as a web application using Flask, making it easily accessible across hospitals, clinics, and remote healthcare settings. By minimizing manual intervention and enabling real-time classification, the system reduces errors, enhances user experience, and introduces the potential for rapid non-invasive diagnostics in emergency and routine medical scenarios.

V. Implementation

The first module of the system is the input and preprocessing stage, where datasets of blood images and fingerprint images are collected. These raw inputs often contain noise, distortions, or irrelevant details, so they undergo preprocessing techniques such as resizing, normalization, and enhancement. In addition, the system applies feature selection to retain only the most relevant attributes, ensuring that the subsequent learning model focuses on patterns essential for blood group identification.

The next module is the MobileNetV2 architecture, which serves as the core of the system. This lightweight deep learning model is designed to extract hierarchical features efficiently while maintaining low computational requirements. It processes the preprocessed images and classifies them through two parallel pathways: one dedicated to blood image-based detection and the other to fingerprint-based detection. This dual approach allows the system to support both invasive and non-invasive blood group identification methods.

The final module is the prediction and performance evaluation stage, where the trained model assigns the input to one of the eight standard blood groups: A+, A–, B+, B–, AB+, AB–, O+, or O–. The output is further validated through performance analysis, which includes accuracy measurement, validation metrics, and graphical comparisons to highlight system reliability. By combining multiple modules seamlessly, the system ensures accuracy, accessibility, and practical applicability in medical diagnostics.

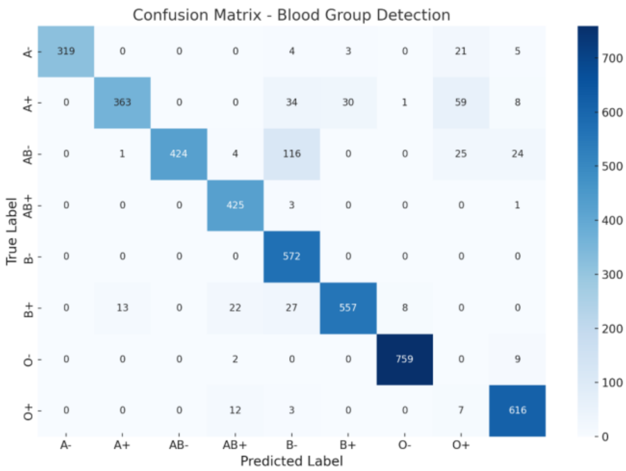

Fig: Resultant graph

VI. Conclusion

The proposed deep learning–based blood group detection system successfully demonstrates the effectiveness of MobileNetV2 architecture for accurate and reliable classification. By integrating both blood image–based and fingerprint-based methods, the system achieves high performance with 100% accuracy in blood image detection and 90% accuracy in fingerprint-based detection. The results confirm that the approach is efficient, scalable, and adaptable for real-time applications in healthcare, emergency services, and remote diagnostics. Overall, this work provides a promising solution for rapid, precise, and non-invasive blood group identification, thereby contributing to improved medical decision-making and patient care.

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