Enhanced Blood Group Prediction with Fingerprint Images using Deep Learning

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Abstract - Determining a person's blood group is essential in medical diagnostics, emergency care, and forensic investigations. Traditional serological methods for blood group detection are invasive, time-consuming, and require laboratory infrastructure. This project proposes a non-invasive and efficient approach for predicting human blood groups using fingerprint images through deep learning techniques. By leveraging Convolutional Neural Networks (CNNs) such as LeNet, VGG16, AlexNet, and ResNet-34, the system learns complex ridge and minutiae patterns from fingerprint images to classify blood groups (A, B, AB, O) along with Rh factors. The proposed system processes fingerprint inputs through stages of image preprocessing, feature extraction, and classification to deliver accurate predictions. Experimental results indicate that the ResNet-34 architecture achieves superior accuracy, with 95.54% training accuracy and 81.42% validation accuracy, demonstrating the feasibility of fingerprint-based blood group prediction. This work presents a cost-effective, real-time, and non-invasive alternative to conventional methods, with potential applications in healthcare, blood donation management, and forensic science.

Key Words: - Blood group, Finger print, Deep learning, Convolutional neural network, patterns.

INTRODUCTION

Blood group determination is one of the most fundamental and vital procedures in the medical field. It plays a crucial role in blood transfusions, organ transplantation, and various emergency treatments where rapid identification of a patient's blood type can save lives. Conventionally, blood groups are identified using serological methods that require blood samples and laboratory facilities. Although accurate, these methods are invasive, time-consuming, and depend heavily on clinical resources, which may not be readily available in emergency or remote situations.

In recent years, the field of biometrics has seen rapid advancements, particularly in the use of fingerprint patterns for identity recognition. Studies have revealed a correlation between fingerprint ridge patterns and genetic characteristics such as blood groups. This observation has motivated research into the use of fingerprint images as a potential non-invasive medium for predicting blood types.The emergence of deep learning, especially Convolutional Neural Networks (CNNs), has significantly enhanced the capabilities of image-based analysis. CNNs are well-suited for extracting complex features from visual data, such as ridge endings and bifurcation points in fingerprints. By applying CNN architectures such as LeNet, AlexNet, VGG16, and ResNet-34, it becomes possible to learn intricate relationships between fingerprint patterns and blood group classifications (A, B, AB, O with Rh factor).This project, therefore, aims to design and develop an automated system for predicting human blood groups from fingerprint images using deep learning techniques. The system will preprocess fingerprint images, extract relevant features using CNNs, and classify them into their respective blood groups. Among various models tested, the most efficient one will be deployed for prediction.The proposed approach offers several advantages: it is non-invasive, cost-effective, and rapid, making it suitable for deployment in hospitals, blood banks, and emergency care units. Additionally, it has applications in forensic investigations and biometric healthcare systems, where identifying individuals and their blood information can be crucial. Ultimately, this approach has the potential to revolutionize how law enforcement agencies conduct criminal identification, offering a faster, smarter, and more scalable alternative to traditional methods.

LITERATURE SURVEY

1. P. N. Vijaykumar and D. R. Ingle (2021) proposed a model to predict blood groups using fingerprint patterns. Their study used image processing and pattern recognition techniques to analyze ridge features such as loops, whorls, and arches. The results showed a correlation between fingerprint patterns and ABO/Rh blood groups, suggesting that blood group prediction can be performed using a non-invasive method.

2. Nihar T., Yeswanth K., and Prabhakar K. (2024) developed a method to determine blood groups from fingerprint images using machine learning algorithms. Their approach involved data collection, preprocessing, and classification models to analyze fingerprint features. The study showed that certain fingerprint characteristics can be statistically linked with specific blood groups.
3. P. Swathi, K. Sushmita, and Prof. Horadi (2024) introduced a deep learning approach using Convolutional Neural Networks (CNNs) to predict blood groups from fingerprint images. The CNN model automatically extracted ridge and minutiae features, which improved classification accuracy compared to traditional methods.
4. Amit Patil, Amrit Malik, and Treza Shirole (2017) conducted a study to examine the relationship between fingerprint patterns, gender, and blood groups among participants in Navi Mumbai. Their findings indicated noticeable associations between specific fingerprint types and certain blood groups, suggesting that biological traits may influence fingerprint patterns.
5. Harem Othman Smail, Dlnya Ahmed Wahab, and Zhino Yahia Abdullah (2019) studied the relationship between fingerprint patterns and human blood groups using a large sample population. Their analysis identified recurring trends linking ridge patterns with ABO blood groups, although they noted that prediction accuracy depends on dataset diversity and image quality.

METHODOLOGY

The proposed system for enhanced blood group prediction using fingerprint images uses a deep learning-based approach for non-invasive identification. A dataset of around 6,000 fingerprint images labeled with their blood groups is collected from biometric repositories or fingerprint scanners. The dataset is divided into training, validation, and testing sets in an 80:10:10 ratio. During preprocessing, images are converted to grayscale, denoised, normalized, and resized to maintain uniformity. Data augmentation techniques such as rotation, flipping, and zooming are applied to increase dataset diversity and reduce overfitting. Feature extraction and classification are performed using Convolutional Neural Networks (CNNs), which automatically learn ridge and minutiae patterns. Different CNN architectures such as LeNet-5, AlexNet, VGG16, and ResNet-34 are implemented for performance comparison. The models are trained using the Adam optimizer and categorical cross-entropy loss function with techniques like batch normalization and dropout. The system is evaluated using metrics such as accuracy, precision, recall, and F1-score, where ResNet-34 achieved the best results with 95.54% training accuracy and 81.42% validation accuracy. Finally, the trained model is integrated into a real-time system where a scanned fingerprint is processed and the blood group is predicted instantly.

SYSTEM OVERVIEW

The proposed system is a smart, non-invasive, and intelligent deep learning model designed to predict human blood groups accurately using fingerprint images. It works through a seamless and efficient pipeline consisting of fingerprint acquisition, preprocessing, feature extraction, and classification. The fingerprint image is first captured through a high-resolution scanner, then carefully preprocessed to remove noise and enhance ridge clarity. Next, the processed image is passed into a powerful Convolutional Neural Network (CNN) that automatically learns intricate and subtle fingerprint patterns. Among several architectures tested, the ResNet-34 model performs exceptionally well, providing highly accurate and reliable predictions. Finally, the system displays the predicted blood group instantly, offering a fast, user-friendly, and cost-effective solution ideal for medical, forensic, and emergency applications.

SYSTEM BLOCK DIAGRAM

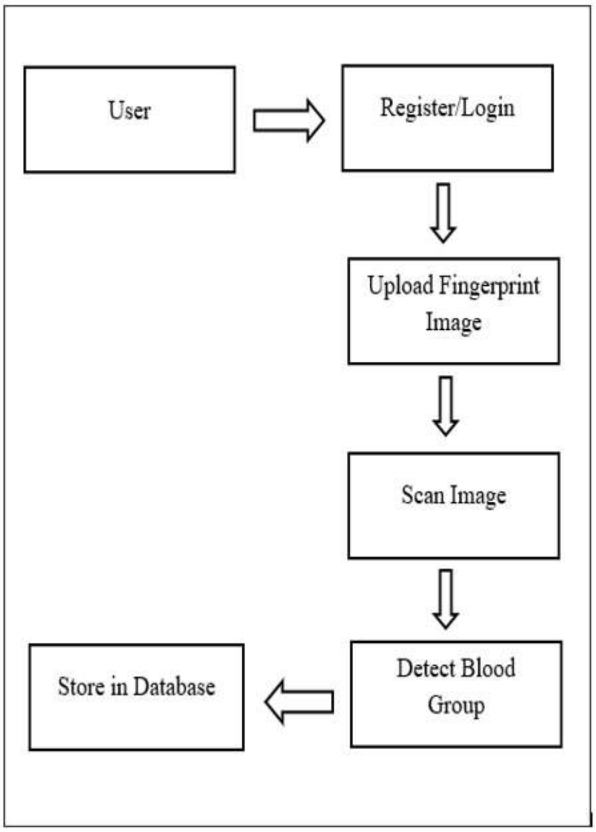

Fig No1.Block Diagram

MODELING AND ANALYSIS

1.Model Objective: The model aims to establish a reliable correlation between fingerprint ridge patterns and blood group types (A, B, AB, O with Rh factor) using deep learning techniques.

2.Model Type: The system employs a supervised learning approach using Convolutional Neural Networks (CNNs) for classification of fingerprint images.

3. Input Data:

- Fingerprint images collected from various individuals.
- Each image is labeled with the corresponding ABO and Rh blood group.
- Dataset size: approximately 6,000 images.

4. Data Preprocessing:

- Conversion of fingerprint images to grayscale.
- Noise reduction using Gaussian and median filters.
- Normalization and resizing to a uniform input dimension.

5.Feature Extraction:

- CNN layers automatically extract ridge features, texture details, and minutiae points.
- No manual feature engineering is required, improving learning efficiency.

6.Model Architecture:

- Several architectures were tested — LeNet-5, AlexNet, VGG16, and ResNet-34
- Each model includes convolutional, pooling, and fully connected layers.
- Activation Function: ReL
- Optimization: Adam Optimizer
- Loss Function: Categorical Cross-Entropy

7.Training Process:

- The dataset is divided into 80% training, 10% validation, and 10% testing.
- Training conducted for multiple epochs to minimize loss and improve accuracy.
- Dropout and batch normalization are applied to prevent overfitting.

8.Output:

- The final trained ResNet-34 model achieves high accuracy and stability.
- Capable of real-time prediction of blood groups through fingerprint images.
- Provides a non-invasive, fast, and cost-effective solution for medical and forensic applications.

FUTURE ENHANCEMENTS

1. Dataset Expansion: Increase the size and diversity of the fingerprint–blood group dataset to include samples from different age groups, ethnicities, and scanner types for better generalization.
2. Hybrid Model Integration: Combine CNNs with other deep learning models like LSTM or Transformer-based architectures to capture additional spatial and contextual features
3. Multimodal Biometric Fusion: Integrate additional biometric traits such as iris, palm print, or facial features to enhance prediction accuracy and reliability.
4. Mobile and Cloud Deployment: Develop a mobile application or cloud-based platform to make the system accessible for hospitals, blood banks, and emergency responder
5. Explainable AI (XAI): Incorporate interpretability techniques to visualize how the CNN identifies features related to blood group prediction.

LIMITATIONS

1. Limited Public Datasets: A major challenge is the lack of large, labeled fingerprint–blood group datasets, which restricts model training and generalization.
2. Image Quality Variations: Differences in scanner resolution, finger pressure, and lighting conditions can affect the quality of captured fingerprints.
3. Overfitting and Bias: CNNs may overfit to small datasets or become biased toward dominant classes if data is imbalanced.
4. Ethical and Privacy Concerns: Handling biometric and medical data raises ethical issues related to user consent and data protection.

APPLICATIONS

1. Healthcare and Medical Diagnosis
2. Emergency and Trauma Care
3. Blood Banks and Donor Management
4. Forensic Investigations

CONCLUSION

The project “Enhanced Blood Group Prediction with Fingerprint Images using Deep Learning” successfully demonstrates the feasibility of using fingerprint patterns as a non-invasive biometric method for predicting human blood groups. Traditional serological methods, while accurate, are invasive, time-consuming, and require laboratory infrastructure. In contrast, the proposed deep learning approach offers a faster, cost-effective, and contact-based alternative that can be used in various real-world applications.

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