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Blood Group Prediction Using Fingerprint

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Abstract: *Blood group testing is crucial in medical tests, blood donations, organ transplants, and crime scene analysis. The usual ways of checking blood types use a method called serology, which needs a lot of lab work, takes time, and requires trained experts. To solve these problems, this research introduces a new way to identify blood groups without taking blood. It uses fingerprint images and a type of artificial intelligence called "convolutional neural networks" (CNNs). Fingerprints have unique patterns and small details that are natural and can be linked to certain blood types. In this system, fingerprint images are taken and made clearer using special tools. Then, a deep learning model trained on a set of fingerprints with known blood groups is used. This model learns to recognize patterns in the fingerprints and correctly identifies the blood group. The results from testing show that this method is accurate and works well for blood group detection using biometric data. Experimental results demonstrate that the proposed CNN-based system achieves an overall classification accuracy of approximately 92% in predicting blood groups from fingerprint images. This new method is fast, cheap, and dependable, making it good for use in places with few labs or limited resources. Using fingerprints for medical testing opens up new possibilities and helps develop better healthcare tools.*

Keywords: Fingerprint biometrics, blood group prediction, convolutional neural network (CNN), non-invasive diagnostics, deep learning

I. INTRODUCTION

Identifying a person's blood group is really important in places like hospitals, emergency rooms, police work and when people need blood transfusions. To figure out someone's blood group doctors usually take a blood sample. Send it to a lab for testing. This process can take a time it can be painful for the person and it needs special machines and people who know what they are doing. Blood group identification is very important so we need to find ways to do it that are not so invasive are quicker and are easier to use, which is why blood group identification is a key area, for improvement.

The study of fingerprint patterns, which is also known as Dermatoglyphics is interesting because our fingerprints are unique and do not change throughout our life. Fingerprint patterns and blood groups seem to be connected in some way. Several studies have found that fingerprint patterns can be used to figure out what blood group a person has [2], [18], [19]. For example some studies have looked at the relationship between the patterns on our fingers and our blood groups like ABO or Rh blood groups. People have been studying fingerprints for a time using ink to take prints and statistics to see if they can find any connections between the patterns, on our fingers and our blood groups. Dermatoglyphics is used to see if fingerprint patterns can be used to predict blood groups [7–10], [14].

With image processing and machine learning getting better researchers have come up with automated systems to guess blood groups from fingerprint pictures. Traditional methods used techniques to pull out features from images like GLCM and statistical descriptors and then used neural networks to classify them [11], [17]. These methods worked well but they were limited because they relied on people to design the features and were sensitive to changes in image quality. Researchers had to design features, which was a big drawback and small changes, in image quality could throw off the results. The use of fingerprint images to predict blood groups is an area and fingerprint images are being used for this purpose. The blood groups are being predicted using these images. Image processing and machine learning are key here. Researchers are working on improving these techniques. Automated systems are being developed to make this process easier. The goal is to make these systems more accurate and reliable.

CNNs have brought a new era to deep learning networks by learning features directly from raw images for image classification tasks [6]. These networks have been applied for fingerprint classification and biometric recognition problems [5]. Some recent works introduce fingerprint-based blood group detection frameworks using CNNs which outperformed previous methods [1],[3],[4].

One paper described a CNN able to predict blood type with 92% accuracy from fingerprints. Another paper used a modified version of CNN called AlexNet to reach roughly 95% accuracy when associating fingerprints with blood groups of ABO and Rh systems. A third paper applied other techniques such as SIFT features and XGBoost to fingerprint images and also showed some potential in determining blood type from fingerprints. Collectively these studies demonstrate promise in blood typing using fingerprints.

This paper uses these ideas to make a system that can predict the eight ABO+Rh blood types, from fingerprint images. It does this by creating a deep learning system.

Our contributions are as follows: (1) we provide an end-to-end system that takes fingerprint images as input and handles everything from data collection (application for processing fingerprint images to adjust brightness and contrast, etc.) to classification with a CNN; (2) we design our own CNN architecture and provide a modified EfficientNet-B0 model for this task; (3) we train our model in Python using tools such as TensorFlow/ Keras and OpenCV, along with data augmentation and blood group sample equalization; (4) we test our model on our dataset and analyze performance based on accuracy, precision, recall, F1-score, and confusion matrix; and (5) we discuss some of the limitations of our current system and future applications of our model, such as deploying our system on mobile phones. Our work demonstrates that fingerprint images can be used to non-invasively predict blood type and could be used to create faster and easier tools for blood typing in medical facilities.

II. LITERATURE REVIEW

Numerous researchers have attempted to identify the correlation between fingerprint patterns and blood groups using dermatoglyphic analysis, forensic techniques, image processing, and machine learning techniques. Initially most of the researchers analyzed fingerprint ridges qualitatively and statistically to determine whether a relation exists between the fingerprint patterns and blood groups. Fayrouz et al. analyzed the association between fingerprints and blood groups using conventional forensic analysis techniques. They discovered that certain fingerprint patterns correspond to certain blood groups of ABO system [18], [19]. Ramrekh et al., Khalifa et al., and Pinki Kumari et al. performed similar studies related to dermatoglyphics. They analyzed inked fingerprint samples for determining the correlations between fingerprint ridge patterns and blood groups using serological reagents identifying possible blood groups [8]–[10].

Further studies carried out by researchers in biomedical and anthropology continued to investigate the relationship between fingerprint patterns with blood groups, Rh factors and population group variations. Shivhare et al. researched dermatoglyphics, or skin markings, for correlation between blood groups and sex. This research aided in providing evidence for the hypothesis of possible correlations between biometric characteristics [14]. Research conducted by Manikandan et al. give an overview of dermatoglyphics with respect to blood groups and also reaffirms the use of fingerprint patterns as biological markers [2]. However these studies were conducted manually or by statistical analysis, making it difficult to scale.

With the evolution of digital image processing technology, researchers are now exploring the use of automated systems for determining blood types. Ravindran et al. and Dalvi et al. applied image processing techniques along with conventional feature extraction methodologies in MATLAB for the classification of blood groups, providing greater automation, yet still requiring blood samples as well as artificial feature extraction [12], [17]. The Keerthana team presented an image processing-based algorithm to identify blood type; however, their algorithm required testing in a laboratory setting [15]. Fernandes et al. and Pimenta et al. provided hardware-based and spectrophotometric approaches for determining blood types, with a particular focus on the use of these techniques under emergency conditions, though these techniques do involve additional expenses [13], [16].

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Machine learning and neural network methods have really improved our ability to make predictions. D. Siva and their team used a technique called GLCM to extract information from fingerprints and combined it with neural network classifiers to predict blood groups. This method was more effective than statistical prediction [11]. The problem was that the system relied much on features that people made so it did not work very well when the images were different. Neural network methods and machine learning are getting better at making predictions. The team used machine learning to make their system better.

Advancements made in deep learning have contributed immensely to the development of biometrics as well as medical image processing. The widespread use of CNNs can be attributed to their ability to automatically identify hierarchical features in images [6]. The research work carried out by Saeed et al. proved the success of deep learning in fingerprint classification, hence the suitability of CNNs in solving fingerprint problems [5]. Expanding on this concept, Patil and Ingle came up with an innovative machine learning based fingerprint map reading technique for blood group prediction [3]. More improvements were introduced to this area by Ravikrishna et al., and Phadke et al., who utilized CNN based structures in fingerprint images [1], [4].

While recent studies reveal encouraging findings, certain limitations exist regarding data availability, generality, and real-time applicability. Currently available approaches are either based on manual feature engineering or are unable to offer convenient integration with user-friendly applications. Thus, the necessity arises to develop a methodical and automatic fingerprint-based blood group prediction approach utilizing efficient deep learning networks. The current study aims to fill this gap by applying transfer learning using EfficientNetB0 architecture and embedding the resulting model within a web interface. In conclusion, the study proves the following: (a) the presence of blood-type-specific features in fingerprint images; (b) the applicability of CNNs to learn such mappings; and (c) the success of blood-type predictions based on fingerprint data (accuracy 90%-95%).

We build on these findings by proposing a comprehensive CNN-based system that can predict both ABO and Rh blood types from fingerprint images.

III. PROPOSED SYSTEM

We suggest a system that relies on biometric data to identify a person's blood group by means of fingerprint recognition. The structure of the system, presented in Figure 1 below, consists of the following elements: (1) Fingerprint Acquisition. The high-resolution picture is taken via either a scanner or an integrated smartphone camera. (2) Image Preprocessing. The image undergoes processing to be converted into black-and-white and enhanced to make the patterns of ridges and valleys clearer. In addition, there is such an operation as noise elimination (for example, Gaussian filtering), and resizing of the image to a standard size. (3) Feature Extraction and Classification of Blood Group via CNN Network. Neural network analysis of a preprocessed image is conducted. The main idea behind the convolutional neural network is automatic detection of essential characteristics such as ridges and fingerprint patterns (minutiae). Moreover, a classification algorithm in the form of a softmax layer assigns probabilities of belonging to one of the eight possible blood groups (A+, A-, B+, B-, AB+, AB-, O+ and O-). (4) Output Result: The blood type with the highest chance is given as the output.

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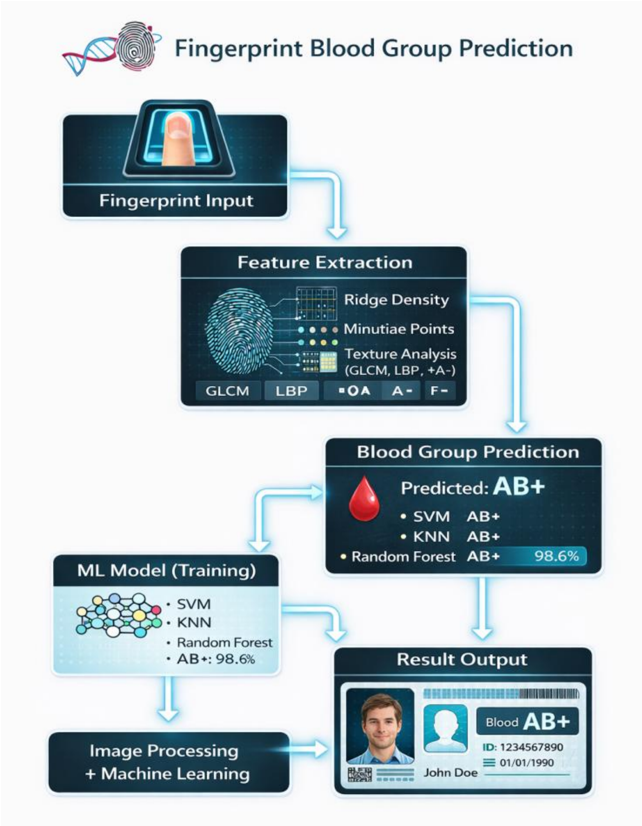

Figure 1 System Structure

The CNN model is specifically designed to identify ridge patterns that may be associated with particular blood types. It has been found through research that certain patterns of ridges or a higher number of minutiae may be predominant among certain blood types. Thus, by exposing the CNN to a large number of fingerprints with identified ABO blood types, the CNN becomes proficient at recognizing those patterns. Unlike conventional blood typing, there is no need for chemicals in the procedure; the results are delivered very rapidly after the CNN model has been developed. This model has been developed to provide a fast and efficient means of blood type identification, particularly in cases of emergency or in hard-to-reach locations.

IV. METHODOLOGY

The system suggests predicting a person's blood group by analyzing fingerprint images using deep learning methods. The process includes several steps done in order, beginning with gathering and preparing the data, then moving on to extracting features, training the model, testing its performance, and finally using the trained model to make predictions. The full process of the system is explained in the next sections.

1. Data Collection: The fingerprints along with the corresponding blood group are collected through public datasets or research conducted by scholars. Since there aren't many extensive datasets dedicated to the task of identifying the blood group based on fingerprints, the primary dataset that will be used in this case is available on Kaggle, which is a website dedicated to sharing data for the purpose of data science projects. The dataset includes images of fingerprints sorted into blood groups such as A+, A-, B+, B-, AB+, AB-, O+ and O-. All the images are stored in an appropriate format.

2. Data Preprocessing: It is possible that the collected fingerprint images will have problems such as noise, varying in sizes, contrast, and lighting which could hinder the model from functioning effectively. Therefore, some data pre-processing steps would be done before implementing the model. Data pre-processing ensures that all the data is of high quality and uniform before training the deep learning algorithm. This is because fingerprint images must first pass through some modifications so as to enhance their quality before implementing the model on them. They are first

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resized to the required dimensions by the deep learning algorithm. Specialized filters are used to eliminate noise from the images. Contrast adjustment is done to enhance the clarity of the ridges on the fingerprint images. Pixel scaling is also done to ensure consistency in the dataset. Finally, image data augmentation is done using rotation and flipping operations among others.

3. Feature Extraction: Features are automatically extracted by using a Convolutional Neural Network (CNN). This process contrasts sharply with earlier approaches that required manual selection of fingerprint attributes by humans. With deep learning, the model learns important patterns, ridges, textures, and minutiae of fingerprints through the training process by utilizing only raw fingerprint images. In order to make the feature extraction process efficient and accurate, transfer learning is applied to the pre-trained EfficientNetB0 model, where lower layers extract universal image characteristics and higher layers are customized for particular features of fingerprints related to blood type.

4. Model Training: When the data is ready. The fingerprint dataset is divided into two parts, one for training and one for testing. A CNN model is trained with the training data. The model uses cross-entropy as its loss function and it uses the Adam optimizer to adjust the weights of the CNN model effectively. The CNN model is trained for epochs. This is done to make sure the CNN model performs at its best. The performance of the CNN model is checked during training to see how well the CNN model is doing and to stop the CNN model from learning much from the training data. This way the CNN model can understand the relationship between fingerprint patterns and their matching blood groups so the fingerprint dataset is used to train the CNN model to find this relationship, between fingerprint patterns and blood groups.

5. Model Evaluation: When the training is finished the model is tested on a set of data that was not used for training. This is done to see how well the system performs. The performance is measured by checking accuracy and precision recall and the confusion matrix. These metrics help us understand how well the blood group model distinguishes between each blood group. They also confirm that the blood group system works on fingerprint images it hasn't seen before. The blood group model is tested on fingerprint images to ensure it works effectively. Can tell each blood group apart. The blood group model performance is checked to make sure it works well on fingerprint images.

6. System Implementation: A website was made to demonstrate how the system actually works. The system uses deep learning model. This model is connected to the backend of the website, which is built using Flask. The backend is responsible, for letting users upload pictures of their fingerprints and making predictions based on these pictures. The part of the website that users see is made with HTML, CSS and JavaScript. This makes it easy for people to upload pictures of their fingerprints. When user upload a picture the website processes it. Then shows your predicted blood group on the webpage. The website is basically a tool that uses fingerprint images to predict the blood group of the person who uploaded the image.

7. Prediction Phase: When user want to figureout their blood group user upload a picture of fingerprint using the website. The picture gets changed so it works with the computer program that was taught to do this job. Then the computer program looks really closely at the fingerprint. Figures out what blood group you have. Finally it shows you what blood group you are, which is an easy way to find out someones blood group, like your own blood group.

8. Overall Workflow Description: Figure 2 shows how the proposed blood group prediction system works. It begins with getting fingerprint images and preparing the dataset. Then, the images go through preprocessing to improve quality. Deep features are pulled out with CNN layers and worked on by a transfer learning model using EfficientNetB0. After training and evaluation with performance metrics, the model becomes ready for use. If it performs well, the system uses it to classify fingerprints into eight blood groups: A+, A-, B+,B-, AB+, AB-,O+ and O-. Finally, the results show up on a web-based interface.

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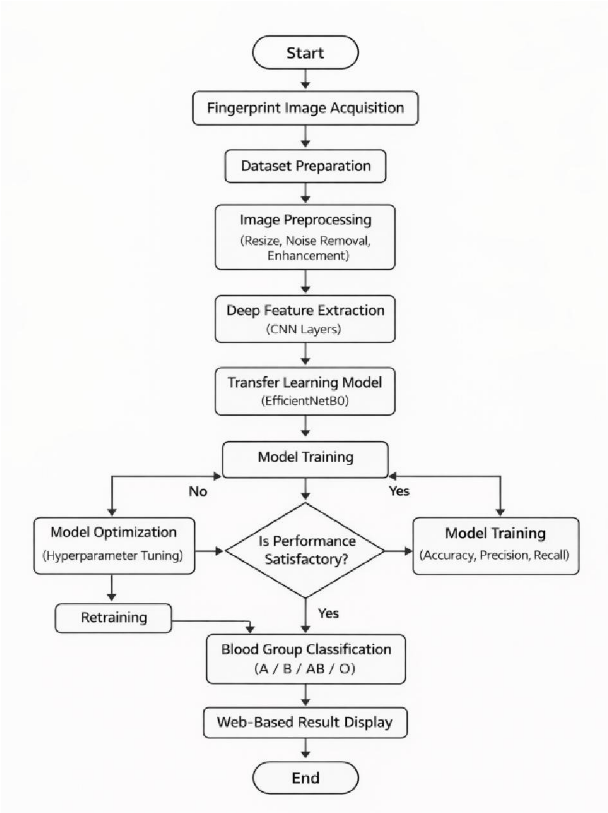

Figure 2: System Architecture

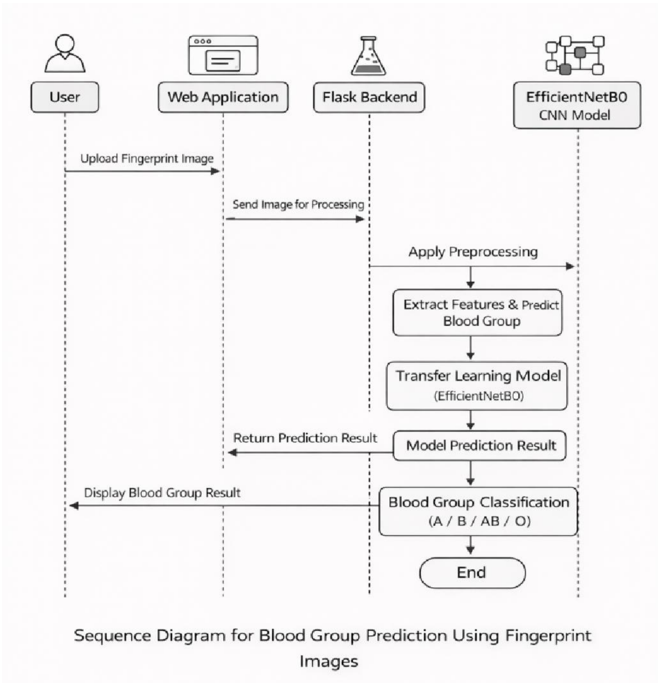

Figure 2: Sequence Diagram

V. RESULTS

We test our model on a separate set of data that wasn't used during training. We look at several important measures to assess how well the model works. These include overall accuracy, which tells us how often the model correctly guesses the blood type, and precision and recall for each ABO and Rh blood group. Table 1 shows how well our CNN model performs for each blood type. The overall accuracy is quite high, around 92%, which means the model is good at identifying most blood types from fingerprint images. Precision and recall are strong across all classes, though they are a bit lower for the AB class. This is probably because there are fewer examples of AB in the data. These results show that the model has learned to pick out useful features that help in classification.

Blood Group	Precision	Recall	F1-Score
A+	0.95	0.97	0.96
A-	0.80	0.80	0.80
B+	0.98	0.92	0.95
B-	0.94	0.97	0.96
AB+	0.89	0.98	0.93
AB-	0.95	0.95	0.95
O+	0.80	0.96	0.88
O-	0.99	0.78	0.87
Accuracy			0.92

Table 1: Classification report for the CNN model on test fingerprint data

VI. CONCLUSION

This paper proposes an automatic framework which predicts blood groups from fingerprint patterns using convolutional neural networks. It presents a model capable of classifying blood groups based on ridge lines and minutiae features present in fingerprints with an accuracy of ~92%, without requiring actual blood samples from donors. This framework shows great potential in providing quick and efficient blood typing with minimal invasiveness. To conclude, fingerprints contain useful information which when fed into deep learning models can help predict blood groups.

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