ABSTRACT

by Neeli Praveen

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FingerPrint Based Blood Group Classification Using DeepLearning

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Abstract

Healthcare, particularly blood donations, organ transplants, and critical care, requires blood type detection. An effective, non-invasive and rapid method for detecting an individual's blood type is proposed by this project based on a deep learning-based approach based on fingerprint images. The dataset contains a total of 4800 training images of size 256x256x and an additional 1200 images of size256x256x for Validation . And remaining 1200 images of similar size of Validation for testing, complete data cleaning, preprocessing techniques including grayscale transformation, resizing images, and edge detection, as well as data augmentation for resolving class imbalance, are all part of the strategy.The images are in BMP format and have a resolution of 256x256. Each experiment has 30 epochs to ensure a thorough evaluation. The results demonstrate the effectiveness of the technique in Blood Group identification, promising enhanced Blood Group identification with an impressive best accuracy of 82.33 percentage. With the best-performing model implemented into an easy-to-use Flask-based web application. User can upload fingerprint images, and the system will predict and display the blood group. Detecting blood groups easier is a major step forward in healthcare based on the results of this study.

Keywords: [Fingerprint, grayscale, BMP, Flask-based]

1 Introduction

1

The investigation conducted by Dr. Harold Cummins in 1926 demonstrated the vitality for fingerprint-based research and its continued circulating for a number of centuries. Human detection via patterns of fingerprints are the most prevalent biometric technique. In the majority of businesses across the country of India, fingerprint-based fingerprint verification is employed, whereas age and sex recognition are also significant forms of usage. In opposition to symbols or login credentials, the concept of 'you are your own private key' is the key aspect of biometric [3]. Since the sixteenth century, fingerprint-based methods of matching have been widely utilized, including Henry Fauld pioneering substantially about 1880. His research revealed the distinctiveness and creativity of fingerprints. The integration into modern fingerprint-based methods for identification.

The British scientist Sir Francis Galton [9] conducted comprehensive biometric analyses during the the 18th century searching for fingerprints that followed straightforward representations like loops, whorls, and arcs. The work of Cummins [10] whose stated skin viewpoint illustrations at the fingers "Dermatoglyphics (skin 1/4 the epidermis glyphic 1/4 a turn) of weapons and merely verified that point courses in growth are settled now not entirely with the use of heredity or natural effects which develop volume, however with the aid of utilizing.

Midway through the twentieth century, "law approval associations" officially accepted fingerprinting as a "compassionate individual" Identification process, and it later became a regular practice in the legal science. Furthermore, prints are essentially carvings of the epidermis, which form throughout the early stages of life, continue during the fetal life span from the tenth to the 16 week, and persist throughout one's lifetime [7]. Yet another biological hallmark that remains constant throughout an individual's entire life is the blood cluster. It's also used in the evaluation cycle to eradicate almost all infections. Blood samples are obtained by pressing a needle on the finger or by injection; the collected blood samples are then combined to determine the type of illness.Antigen may need to be purchased, which could cost money. The main problem with developing a blood group method for forecasting is that there aren't enough instances of distinct mark types. Exams reveal very little about blood group prediction or the many illnesses that come with growing older, particularly when using biometrics as a fingerprint technique. Fingerprints can have four different types of patterns: loops, whorls, arches, and blended or composites patterns. According to the informative index, circles are most commonly viewed, with roughly 65 percent of the data discovered. A particular kind of structure known as the circle is formed when one or more edges emerge from a single side of the structure's frame and escape from the opposite side of the structure from where they originally entered.A line joining characteristics in several fingerprint areas of the image could be one of the key distinguishing aspects. A combined time period is employed in feature pairings that don't neatly fit into any of the previously provided depictions [17].

2 LITERATURE REVIEW

Depending on the blood association prominence of any person or female, dark red blood cells of that person or female are connected with choose neutralizer strategies. If the procedure, for instance, includes threat of B autoantibodies and the person or female or teenager has antigens from B on cells, it will pack. If the blood does not respond to any of the anti-A or anti-B antibodies, it is considered blood charge O. For understanding blood acquiring, tests using restrictive types of autoantibodies are probably being developed. If a male or female or young woman holds blood grasping the male or female or younger female's blood is likely to have attempted speak to an establishment. ABO and RhD antibodies are found within nearby companion cells. If there's no reply, the closest duplicate blood having a comparable ABO and RhD type is likely done. It demonstrates that the blood is reacting with dazzling immunizer and is hence no longer outstanding with blood carrying any such slaughtering skilled overseer. If the blood fails to agglutinate, it implies that the blood lacks antibodies, depriving the required homogeneous reaction with within the substance being used. The blood energy is truly resolved in the cutting-edge structure. Plans for development aids, for illustration, reversal to a, menace to b, antagonism to d to certain blood workouts occurred at a later period. The process of a can also occur after a certain amount of time. Depending on the level of agglutination, the blood from the gathering may be compelled to use the guy or lady genuinely. The downsides of this shape include increased potential of mistakes made by humans. Only professionals are able to reveal the blood request using the guide that depends into the agglutination system. A plate check and chamber check are widely used to determine blood percentage [10].

While completing any transfusions, blood must be collected safely and precisely match with the patient's condition, in order to ensure the blood type of the receiving donors match that of the providing donors [11]. There are various infections in blood that cause serious illnesses that can be propagated through a blood transfusion, such as AIDS and HIV, anemia, HBV HCV, and so on [15]. But there are various emergency situations occurring across the world around every hour where the life of an individual is in danger and a blood transfusion is required urgently. Before every blood transfer, the specific blood type must be determined. Obtaining a sample of blood at that time and determining the type of blood that the patient has cannot be done because they are in an inaccessible place. It is hard for medical professionals or paramedics to transport blood in vehicles in such a serious circumstance. It is critical to handle the right kind of blood and transfer it to the patient's body at the appropriate moment. The present approach necessitates blood testing in institutions [16]. A blood type incompatibility may trigger Agglutination and the repercussions of bloodstream can result in the demise of the individual. Although this danger, it can be mitigated by injecting a pair of universal donor's 0 negative blood only during emergency to individuals of any group of blood. Because even minor human error can be lethal in the case of an intravenous transfusion. As a result, it is critical that we automated these blood group determination techniques and provide reliable findings in a crisis.[7]

.Creating an integrated form that uses an Image organising figure to do the blood respect selections condition to blood making approaches. As required, the form enables us to select the blood type of a person or female performing large binds condition to the average of the complete partner, lowering preserving reaction threats and shattering variables of unequivocal last piece without personal mix-ups. This paper interacts in reducing human intervention and playing out an extensive of inquiry unimpeded from finish of antigenic substances to minimize the age of the unavoidable effects and provides the consequences in fine obligated appropriate c programming language for period of time with precision and exactness close to the limit of the entire last content for enacted on referrals. Recognizing an enjoyable framework in advance of what a lot can also recall practical errors and ensures that the perfect look is fragile at the satisfactory approach, the fine results were provided, and the satisfactory blood stage obligated the good prompted personality on the lowest time. The proposed gadget deals with the cost of the game affiliation and the use of a sharp extra important inconspicuous framework that gives the charming experience that we require for evaluation at an obscured cost and without the requirement for actually coordinating managers.

3 Methodology

3.1 Data Preprocessing

Preparing a collection of fingerprinting images for six different blood group classes, each of which contains over 800 photographs, necessitates thorough curation and preparation. The first step in ensuring excellent data quality is to filter out corrupted or useless photos. This procedure seeks to preserve the dataset's quality by deleting any photos that are damaged, distorted, or contain flaws that might interfere with a precise evaluation. The dataset becomes more dependable and suited for further analysis and training of models after this quality check.

Following the refinement of the dataset, the following stage incorporates data preprocessing procedures. Converting images to grayscale is an important step since it reduces data from images through the elimination of color information. This not only decreases the dataset's dimensionality but also improves it. key qualities for fingerprint identification. Resizing the photos to a standard size, generally 256x256pixels, provides uniformity throughout the dataset and makes deep learning models compatible. Furthermore, using filters such as the Gaussian filter assists in decreasing noise in the photos, which leads to clearer and more distinct fingerprint patterns As we can see in Figure 1 illustrates the 256x256x3 Dimensions.Finally, using edge detection methods such as Canny edge detection improves the dataset by accentuating the subtle patterns inside fingerprints, making them easier to analyze and classify.

To summarize, the process of creating this fingerprint dataset begins with careful image choosing to guarantee the confidentiality of the information, and then proceeds to a number of preliminary processing operations with the goal of simplifying the data, improving features, and making the fingerprint patterns more apparent and appropriate for successful analysis and model training.

3.2 Data Augmentation And Data Splitting

A complex data augmentation approach was implemented to improve the model's resilience and extension capabilities. Random rotations, intensity changes, and horizontal flips were used to enhance the training dataset, filling it with various cases that contributed to the model's flexibility. Which augmentation strategies work best will be determined by the specific challenge at hand as well as the characteristics of the data. It is vital to achieve a balance between increasing variation and keeping the semantic meaning of the data during augmentation. When data is either uneven or inadequate,

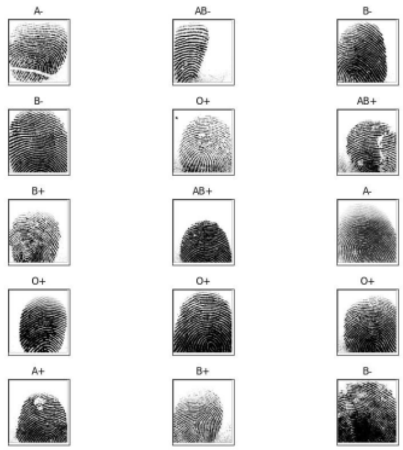

Fig. 1
After Preprocessing Images Of Size 256x256x3

carefully selecting and designing augmentation procedures can considerably improve the effectiveness of predictive designs.

The dataset was meticulously partitioned and deliberately separated into three unique sections. The following subsets were carefully assigned: 70percent for training, 15percent for validation, and 15percent for testing. The segmentation was precisely coordinated using the train,test,split function integrated within the well-known sklearn framework. This function was critical to the stratification process, ensuring that each subset had a proportional and faithful representation of the dataset's natural richness and diversity.

3.3 ResNet50 Model Architecture

ResNet50 is a deep neural network architecture that is well-known for overcoming the problem of disappearing gradient in deep networks. It includes residual interactions, allowing a network to learn residual mappings rather than fitting the intended fundamental mapping directly. Residual blocks, ResNet50's core units, contain convolutional layers and connections with shortcuts that skip one or more levels, allowing the network to avoid certain modifications. This skip connection aids gradient propagation during training, facilitating the improvement procedure for larger networks. The design consists of 48 layers of convolution, as well as shortcut connections and pooling layers, leading to a global average pooling layer and fully linked classification layers. ResNet50 efficiently addresses the degradation problem and enables the training of deeper networks by utilizing these remaining connections.

Increased feature extraction and greater precision in applications including image categorization and identifying objects.

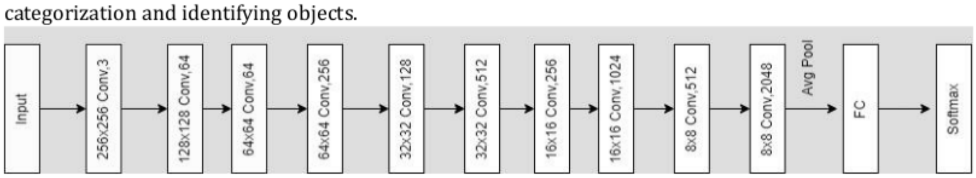

Fig. 2
ResNet-50 Model Architecture

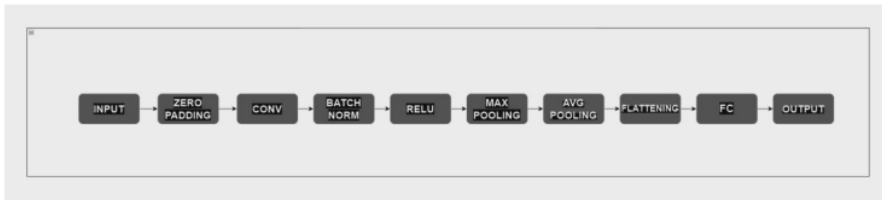

Fig. 3 Enter Caption

As the underlying model for transfer learning, the ResNet50 architecture was chosen. The majority of the layers in the pre-trained ResNet50 model were frozen, with the exception of the last layers, which were smoothly updated to coincide with the particular blood group categorization objective. The addition of a new dense layer with eight output nodes aided in the mapping of fingerprint patterns to blood types.

ResNet-50, an important architecture in the ResNet family, represents a deeplearning breakthrough by overcoming the problems associated with developing ultradeep neural networks using traditional methods. Kaiming He and others developed it, and it was published in their foundational article "Deep Residual Training for Image Identification" at CVPR 2016. This design gets its name from the depth of it, which consists of 50 layers and uses residual connections. These connections enable the network to acquire residual operations, which greatly aids in countering the issue of vanishing gradients seen in deeper networks. ResNet-50 is a mid-sized version among ResNet models such as ResNet-101 and ResNet-152, exhibiting outstanding accuracy. In different tasks related to computer vision such as picture recognition and classification yet maintaining an appropriate equilibrium between complexity of models and computing efficiency. Its influence has prompted innovations in training.deep neural networks are altering the surroundings of current deep learning systems.

Algorithm 1 ResNet50 Model Architecture

Input: Image with shape (256, 256, 3)
Output: Probability distribution over 8 classes
Convolution Block 1:
ZeroPadding2D (262, 262, 3)
Conv2D (128, 128, 64)
BatchNormalization
ReLU Activation
ZeroPadding2D (130, 130, 64)
MaxPooling2D (64, 64, 64)
Residual Blocks 2-5:
for *i* in range(2, 6) **do**
    Block i:
    Identity Block
    Identity Block
    Identity Block
    Convolutional Block
end for
Final Layers:
GlobalAveragePooling2D
Dense (128, activation='relu')
Dense (128, activation='relu')
Dense (8, activation='softmax')

3.4 Design of proposed Model Architecture and Model Algorithm

4 About Dataset

[H] Blood Groups: Red blood cells are classified into groups according to certain antigens, and surface markers, that are present on their surface. The most widely used approach, the ABO blood group classification, divides blood into A,B,AB and O kinds based on whether specific antigens are present or absent. Blood type is further tailored by the Rh factor (+/-), a further vital component. In medical procedures which include organ transplants and transfusions, understanding the different types of blood is necessary for providing compatibility and reducing the possibility of unpleasant responses. Just imagine being able to determine a person's blood group based on their fingerprints. The study of fingerprints for distinctive patterns that might be related to particular blood groups is a developing area. My goal is to use advanced deep learning techniques by arranging a dataset that is categorized into distinct blood groups and capturing fingerprints from each group. The objective is to teach a computer model to identify fingerprint patterns related to different blood groups. This revolutionary method, that employs a quick and non-invasive fingerprint scan to predict blood group, has the potential to completely transform medical diagnostics. The combination of biometrics and healthcare has the potential to revolutionize blood group identification techniques as well as enhance accuracy and efficiency in medical settings. The research project analyzes a large dataset of 11gerprint images categorized on blood group, that includes numerous folders labeled A+, A-, B+, B-, AB+, AB-, O+, and O-. The Fingerprints in each folder have been assigned to the corresponding blood group, amounting to a total of approximately 6000 images across all categories.As a result of the detailed organization of the dataset, it is possible to clearly understand how fingerprint images are split across different blood groups. A graphical representation of the distribution delivers information about the size of fingerprint images in each blood group.The distinct blood group categorization of this dataset provides an exciting avenue for further inspection, possibly investigating associations or trends between fingerprint attributes and blood group differentiations, thereby adding a wide range of potential makes use of in biometric identification or medical research

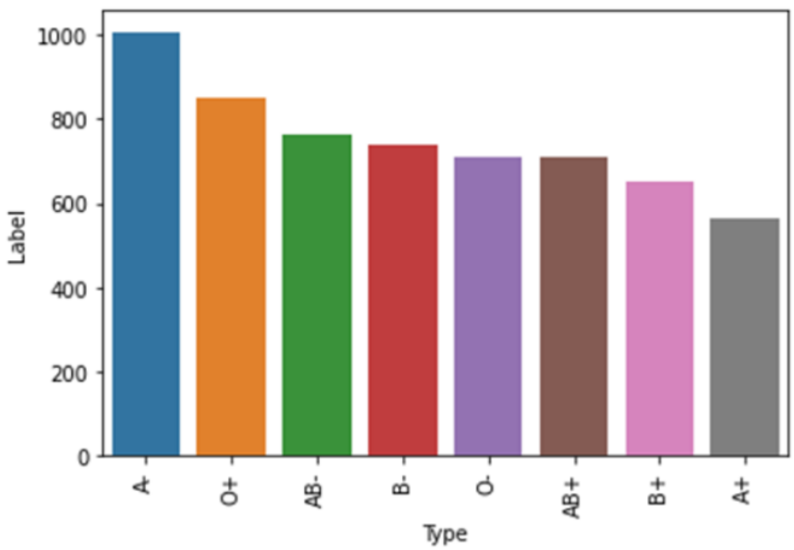

Fig. 4

Description of Dataset

Well-balanced datasets are crucial for solid construction of models and generalization. First of all, by decreasing bias toward a specific class, they assist in developing models that perform well with new, undiscovered data as well. Classes that are balanced avoid the model from being biased in favour of the majority class, which promotes a more balanced capacity for prediction. In addition, the prejudice issues which arise with imbalanced datasets can be prevented with balanced data. Models usually do worse on minority classes when there is under-representation in one class because they put more importance on the majority class. This bias can be eliminated by balancing the data, which improves the general fairness of the model. The effect of balance on learning is also important: balanced datasets provide an equal representation of each class, thereby making it feasible for models to successfully pick up on the unique characteristics and patterns associated to various classes. As a result, the model performs well since it gains information from an extensive set of examples. Training stability is practically provided by balanced data. Disproportionate datasets can lead to training instability, which can result in less-than-ideal answers or issues with model convergence. Stability is made possible by balancing data, which increases convergence when the model is being trained.

5 Activation Function and Loss Function

ReLu: Neural networks employ the activation function Rectified Linear Unit, or ReLU. By setting the number of negatives in the input to zero while keeping positive values, this produces non-linearity. It is a common choice in a variety of neural network architectures because of its ease of implementation and effectiveness in reducing the problem of vanishing gradients. Compared to certain other activation functions, ReLU allows for easier gradient computation, that improves overall training and helps models learn faster.

$$F(x) = \max(0, x)$$

- x represents the input to the function.
- $f(x)$ is the output of the ReLU function.

The final classification layer's primary activation function in ResNet50 is known as Softmax. It enables multi-class classification positions by transforming the network's raw output into probabilities in this architecture. Softmax enhances prediction analysis by leveling the output scores to a probability distribution across classes. In addition, Softmax together with categorical cross-entropy loss aids in the model's process of learning by analyzing the discrepancy between actual labels and predicted class probabilities. In complicated image classification scenarios, Softmax in ResNet50 enables reliable and accurate predictions across an extensive variety of classes.

$$Softmax\ (z_i) = \frac{e^{z_i}}{\sum_{j=1}^{n} e^{z_i}}$$

- e denotes the base of the natural logarithm (Euler's number).
- z_i represents the score/logit for a particular class i.
- The denominator is the sum of the exponential scores for all classes.

Fig. 5

Activation Function

$$Categorical\ Cross\ Entropy = -\sum_{i=1}^{c} y_i . \log(p_i)$$

- *yi* represents the actual probability distribution of the classes. It is a one-hot encoded vector where only one element is 1 (the true class) and the rest are 0.
- *pi* represents the predicted probability distribution (usually obtained through the Softmax function) for each class.

Fig. 6

Loss Function

6 Evalution and Metrics

The explained test loss in one specific output example is 0.62211, which demonstrates the degree to which the model aligns test set predictions with true labels. Generally all, lower test loss values are seen as positive. In addition, the test accuracy has been reported as 75.27 percentage, showing that approximately 75.27 percent of the test dataset's cases were identified correctly using the model. When considered as an entire, these indicators provide information about how well the model expands to new and unproven information. The test loss functions as a continuous indicator of prediction quality, whereas accuracy offers an overview of accurate predictions. For an in-depth examination, it's essential to take into account both measures, considering in mind that their interpretation may change depending upon the particulars of the problem and dataset in issue.

Precision is a classification indication that measures how well a model predicts favorable outcomes. More specifically, it calculates the ratio of correctly predicted positive cases to all positively predicted cases (true positives plus false positives). The accuracy or precision of the model's positive predictions is what precision matters regarding.

$$Precision = \frac{True\ Positives}{True\ Postivies\ + False\ Positives}$$

The F1 Score is a balanced measure of a model's performance in binary classification, determined as the harmonic mean of precision and recall. It combines the recall's potential to capture true positive instances with the precision's accuracy of positive predictions. When precision and recall are balanced, a high F1 score is achieved; which renders it suitable for situations where a fair evaluation of precision and recall is essential, like in imbalanced datasets.

$$F1\ Score = 2\ X\ \frac{Precision\ X\ Recall}{Precision +\ Recall}$$

A model's recall, also known as sensitivity, measures how well it captures every single instance of a particular class. It reacts, "How many actual positives did the model correctly predict?" High recall reduces false negatives, which is crucial in applications such as medical diagnosis in order to lower the possibility of missing important instances.

$$Recall = \frac{True\ Positives}{True\ Postivies\ + False\ Negitives}$$

7

By dividing the number of accurately predicted cases by the total number of instances, accuracy measures how accurate a model is overall. It works well with datasets that are balanced, indicating that each class is given an equal amount of weight.

7 Results

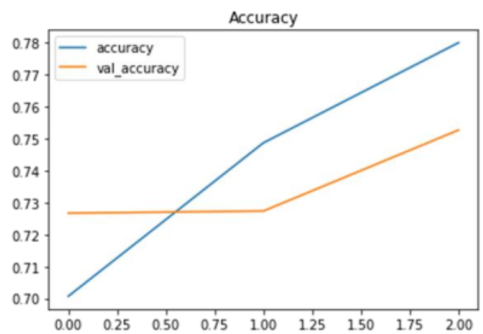

Fig. 7

4

Graph evaluating the trained model on a test dataset and printing the test accuracy

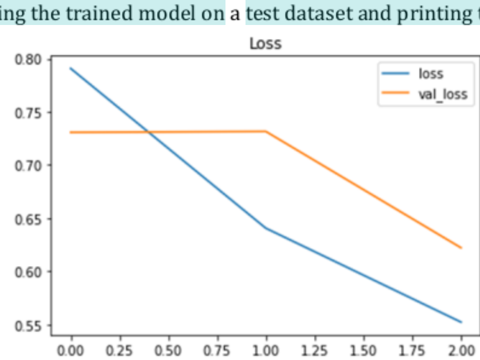

Fig. 8

Graph evaluating the trained model on a test dataset and printing the test loss

	precision	recall	f1-score	support
A+	0.63	0.86	0.73	138
A-	0.76	0.69	0.73	224
AB+	0.77	0.81	0.79	181
AB-	0.85	0.67	0.75	218
B+	0.78	0.74	0.76	163
B-	0.86	0.88	0.87	185
O+	0.68	0.72	0.70	210
O-	0.71	0.71	0.71	181
accuracy			0.75	1500
macro avg	0.76	0.76	0.75	1500
weighted avg	0.76	0.75	0.75	1500

Fig. 9

Precision , Recall, f1-score, of each blood group generated

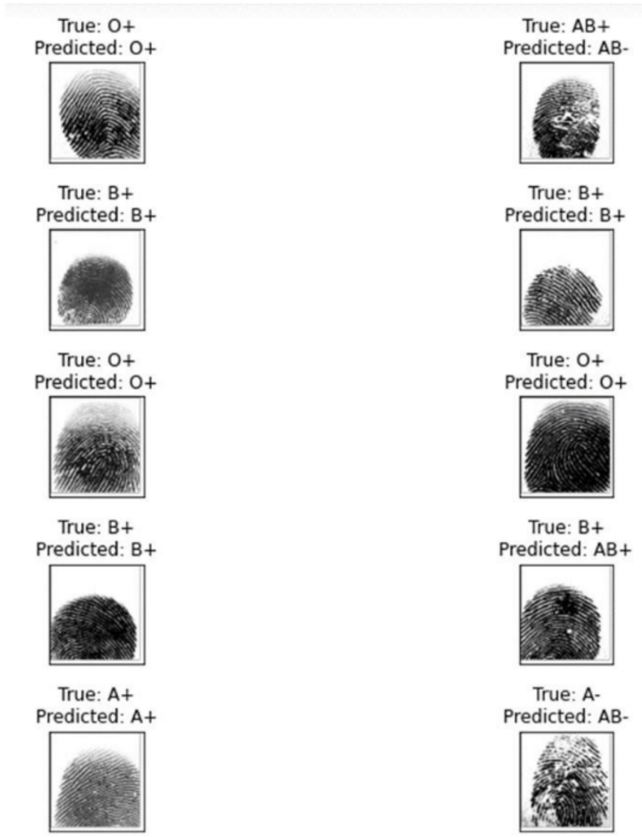

Fig. 10

Displaying sample images with their real and predicted labels

8 Conclusion

In conclusion, the development of a fingerprint-based blood group Classification system using deep learning method has resulted in a comprehensive and efficient solution for accurately determining a patient's blood group. The procedure entailed training a ResNet50 model using painstaking data cleaning, preprocessing, and augmentation techniques to boost the model's performance.

This project not only highlights the potential of deep learning in fingerprint applications, but also its practical application in the healthcare sector. Accurate and rapid blood group classification via fingerprint analysis can considerably accelerate medical processes, resulting in better patient care and faster emergency response.

The success of this initiative demonstrates the value of interdisciplinary teamwork, which combines knowledge in deep learning, data preprocessing, and healthcare. Moving ahead, the framework can be tweaked and developed to include other capabilities, helping to advance medical technology. In general, the fingerprint-based blood group Classification system exemplifies how novel technologies may be used to solve real-world problems and improve healthcare services.

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