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AI-Based Blood Groups Prediction and Classification Through Image Processing Using CNN

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***Abstract*—**The blood groups prediction and categorization may be useful in various medical and emergent studies including blood transfusion, organ transplant, and forensic examinations. Normal blood group forecasting and classification procedures are carried out in a lab, In other words it is by serological method. The techniques are time consuming and inaccurate as it is carried out manually by one person or a team of qualified experts in a laboratory. In this regard, it has been proposed to envision and cluster blood groups through the help of AI technology using microscopic pictures of blood samples as one of the technological innovations of medical and science research. These processes entail the analysis and the extraction of primary images in blood samples to a system of neural networks comprising deep-learning through CNNs to identify patterns in red blood cells to categorize them into four major blood groups which are the A, B, and AB and O blood groups according to massive labeled pictures of blood samples.

Keywords—Al based system, blood group prediction, Convolutional neural network model, Image Processing, blood group classification

INTRODUCTION

Blood grouping is highly essential in the medical diagnostic field especially in the validation of compatibility of transfused blood [1],. Traditional procedure of blood grouping is the use of serological method. It is a method that entails the use of the antibodies that reacts to blood samples [2]. The biggest drawback of the method is that the entire process will be manual. It is also prone to errors [3],[4], [5]. In addition, blood grouping is time consuming. Moreover, the tests are done by selective only. The availability of experts in some remote regions is not assured. Some of the innovations made in the recent past in the field of image processing and artificial intelligence have paved the way to the application of the automation techniques in the medical diagnostic fields. Huge successes in machine learning algorithms in various image classifications have been realized [6], [7]. Among the approaches that have had a colossal success in the healthcare specialties is the Convolutional Neural Networks (CNNs) automated image recognition features in pictures and, thus, it is highly generalizable in blood group recognition of a microscopic blood sample [7], [8]. Nonetheless, the given paper proposes an AI-related implementation of blood group recognition/prediction of a sample by analyzing a picture. This system targets at automating the blood group classification process aimed at increasing speed and accuracy of the process, and the deep learning techniques are deployed[6],[8]. There will be a set of blood sample images that will be trained on the model and will first be preprocessed and input the features of the red blood cells. The intention of the system is to get an efficient, correct and scalable system to assist the medical staffs in determining the blood types, particularly when there is a lot of demand or the resources are scarce. The solution suggested has not only the potential of streamlining the blood group classification process but also it can be a bridge way to other domains of the medical diagnostics and health informatics where automated systems can eradicate human-error and improve the efficiency of the health care delivery process [9], [10].

I. RELATED WORK

A. Automated blood groups detection using image processing using ML.

Journal: International journal of Advanced Research in Computer and communication Engineering (IJARCCE) 2014.

Author: S.B. Patil and B.V. Patil [2].
Purpose: The paper is referring to the use of image processing methods and the machine learning algorithms to predict blood groups using images of blood samples. The authors focus on the image enhancement, image segmentation, and feature extraction as the preprocessing phases that are the follow-ups to the classification using the support vectors machines (SVM). These results support the effectiveness of such a combination technique in the blood group categorization automation with a high level of accuracy.

B. Deep learning-based automated Blood Cell Classification.

Authors: N. Kumar, A. Singh [3].
Description The authors employ deep learning in the article, namely, Convolutional Neural Networks (CNNs) to classify blood cells using microscopic images. The paper presents the capabilities of CNNs to detect the morphology of red blood cells and categorize them in regard to the blood type automatically. This paper confirms the importance of datasets and optimization of deep learning models to provide validated results.

C. Blood group detection with help of image Processing

Journal- International Journal of Computer Scienceand Mobile Computing (IJCSMC).
Authors: S. P. Singh, D. Ghosh [6].
Abstract: This paper entails a study of a new method in blood grouping through the use of microscopic blood smear images. The authors in the literature employed the use of the edge detectors and color based segmenters and a neural network classifier as a form of the feature extraction methods to determine the blood group. As it has been shown in this paper, it is possible to improve the accuracy of blood group types by using both the traditional image processing and machine learning models.

D. AI-Based blood group determination with of microscopic image analysis.

Authors: M. S. Khan et .al [7].

Description: It is a general literature survey of the state of art AI and machine learning methods used to categorize medical images and, more specifically, it features Convolutional Neural Networks.

Decision trees, ensemble and Convolution neural networks (CNNs). It provides the data concerning the difficulties and opportunities of using AI into medical diagnostics and demonstrates the possibilities of using such methods on the way to automatize the work like forecasting blood groups.

E. Deep Learning Nature.

Authors: Y. LeChan et al [9].

Description: This is research that focuses on deep learning application in medical diagnostics, in particular, blood group classification on the basis of a medical image. The authors use deep CNN model to classify blood samples and report high accuracy in the model compared to the traditional methods. It is also discussed in the paper how AI-based systems can be implemented in a real-time clinical setting, and it is also revealed that the implementation can facilitate the diagnosis process.

Image and video analysis based on computer vision and machine learning (CL) has been very popular. The use of OpenCV library offers the convenience of processing real-time images and videos and it is generally implemented in objects detection and face recognition systems [11]. TensorFlow allows the creation of scalable deep learning systems on the computer vision applications [12]. Brownlee also talked about practical applications of image classification, object detection, and face recognition with the help of deep learning in Python [13]. However, the basic image processing methods are tools that are necessary when working with features [14] described by Gonzalez and Woods. Abbas et al. did a comparison of machine learning algorithms, which revealed variations of their performance in classification tasks [15].

F. Existing System

In current clinical practice, the blood group classification is largely done by use of serological techniques. The techniques of this type use the agglutination of a blood sample by combining the sample mixture with antibody solutions. Though this is still true, these tests are highly manual and require experienced technicians as well as they are time consuming. In addition, interpretation of the results might be subjective on the part of some instances especially when the response is weak or ambiguous. This type of traditional testing can introduce a delay and an error in resource constrained environments, or in crises, and therefore some medical systems are starting to engage in the integration of semi-automated devices to help in the blood typing, such as automated analysers. They are also costly, immobile, and need chemical reagents though they are high in throughput and reduce the effort that human beings put in them. In addition, they cannot be used in all the settings particularly in rural areas or emerging nations that have poor infrastructure. The systems are also not flexible and adaptive and therefore, require much calibration and maintenance.

In recent studies, there have been efforts to practice machine learning in medical diagnostics, namely activities like hematology tests, disease classification, and cell classification. Such systems can normally work with well organized or already extracted features, rather than raw images. These methods are, however, not yet popular and commercialized, as far as image processing procedures are involved in the detection and categorization of blood components (red and white blood cells) as opposed to direct blood group categorization. Most of the image-based diagnostic systems are based on the counting or detection of abnormal cell structures rather than the high-level classification (i.e. the blood typing). Moreover, existing models of image classifications used to classify medical images require vast quantities of training samples and they are often prone to lighting, magnification, and sample samples variations.

Generally speaking, the current manual and semi-automated system of blood group classifications suffers the limitations of scale, fastness and versatility. There is a clear lack of connection between the usage of high-level AI and deep learning to perform automated blood group classification of the images of blood samples. This is one of the weaknesses that can be leveraged to come up with an intelligent image based technology that can carry out rapid, accurate and reagentless blood grouping hence the innovation road march to point of care and mobile diagnostics.

II. METHODOLOGY

A. Proposed System

The proposed system introduces a novel AI-driven model of blood groups identification and forecasting on the basis of microscopic blood sample images. This system needs to recognize the blood group automatically without chemical reagents and handling by hands using the potential of the image processing and deep learning, namely, Convolutional Neural Networks (CNNs). The key algorithm in the system is a deep learning model that, given a large number of labeled images of blood samples, may correctly be used to identify samples based on their respective blood groups of A, B, AB and O. The visuals go through a pre-processing phase of normalization and elimination of noise as well as optimization of features to stabilize the image input. The most significant image processing techniques include the image segmentation, edge detector techniques, and morphological techniques that are among the most crucial techniques of image processing, used to generate the features that define the blood cells. These polished pictures are then put through the CNN model which allows it to be trained so that it can learn complex spatial patterns which are associated with specific features of blood groups. Unlike the classic method, the AI-driven system does not require a lot of human effort. Upon training, the model will be capable of detecting new images of blood samples on a high level of accuracy, speed, and consistency in real-time. The system is trainable as well and improves with time and improves its operation with the increment in the data passed to the model. Such flexibility accentuates the ability of it to be deployed at the different environment both inside hospitals and clinics, as well as in the mobile diagnostics unit and remote healthcare environments. Portability and scalability are one of the major strengths of the provided system. The model can find use in the point-of-care diagnostics when deployed on a cloud platform or embedded software (e.g. Smartphone or edge device), especially to underserved regions. It will not need any specific laboratory equipment and reagents and reduces the operating cost significantly and determination of blood groups can be performed to a larger population. In addition to that, the application of AI expands the accuracy not only but also opens the presence of automatic record-keeping, report-generation, and integration with health information systems. The manual blood typing that is limited to the laboratory can also be transformed into an intelligent, fast and universal solution using this innovation. The proposed system is thus a significant move forward in the area of medical diagnostics that incorporates the efforts of the image processing and the artificial intelligence to remove the limitations of the existing methods and meet the demands of the image processing to execute the tasks with high accuracy, speed, and reliability in real-time. It can also learn and his system that is based on AI requires minimum human intervention.

B. Implementation

The proposed AI-based blood group classification system is implemented by using the image processing and deep learning. The samples of blood are then picked and stored in form of microscopic images whose original form is an already labeled set of blood types A, B, AB, and O.During the stage of preprocessing, the images are resized, normalized and filtered to remove noise and maximize contrast. This action leads to a consistency of taken images that are further processed to improve the quality of taken images: segmentation, edge detection, morphological operations. The polished images are then fed into a Convolutional Neural Network (CNN) which is then trained on the processed images to obtain spatial patterns and features that are associated with all blood groups. The final product is made available to the consumer and may be saved in a digital format which can be used at a later stage or may be integrated with the medical information systems.

C. Block Diagram

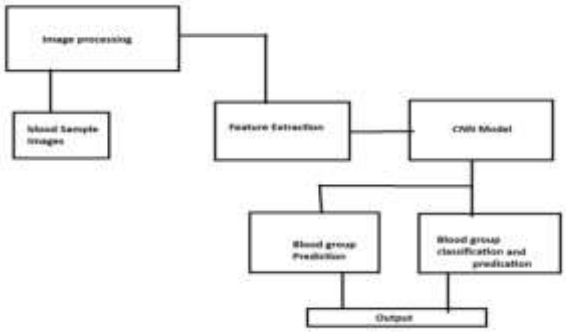

Fig 1: Block Diagram of Blood group Prediction and Classification

Fig.1 the diagram is an illustration of workflow of proposed blood group prediction and classification, including feature extraction, preprocessing, CNN models, with image processing of blood group.

D. System Architecture

The figure 1 shows a deep-learning-based process of classifying blood group diseases with the assistance of medical images. This has begun with the System Acquisition Device that captures the picture of blood samples. Before the conversion of pictures to grayscale and noise removal, this is done in advance in order to

improve the image of the pictures. Key features are extracted and segmentation of the images is carried out to locate individual blood cells. The stages are essential in proper categorization because they screen substantial trends. The data received is then inputted into a deep learning framework that identifies the data so as to display it as a blood group (A, B, AB, or O). The model also creates both predictions as well as results that are presented in a user interface in order to be interpreted by the clinical. The feedback loop that includes the segmentation, prediction and verification of the results aid in maintaining the system perfect in a manner that it becomes more realistic and useful in the medical diagnostics.

III. RESULTS

A. Testing

The system is tested using a different test dataset when it is not being trained hence that performance evaluation is unbiased. The test images are preprocessed and the image processing pipeline are kept the same and the images are classified. The standard measures serving to carry out the performance evaluation are:

1. Accuracy
2. Precision
3. Recall
4. F1-score

Measurement of accuracy: this is done by comparing the predicted blood group with the ground truth label in terms of accuracy. Various test samples of diverse blood groups are evaluated in a strategic move to uphold consistency and dependability are proven through the outcome of the testing to provide hasty, accurate and consistent forecasts with minimal human involvement. This confirms the suitability of the proposed system to real time blood group identification and point of care blood group identification.

B. Outputs

The blood group predictions and classification based on AI and Image processing where the algorithms are used to get new vision of traditional image-based serology. This system is responsible to give high accurate results.

Fig. 2. Python server started

Fig. 3. User Page

Fig. 4. User Register

Fig. 5. Register Successful

Fig. 6. User Login

Fig. 7. Load & Process

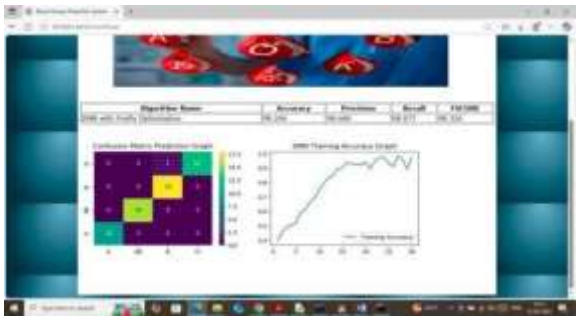

Fig. 8. Results

Fig. 9. Test data

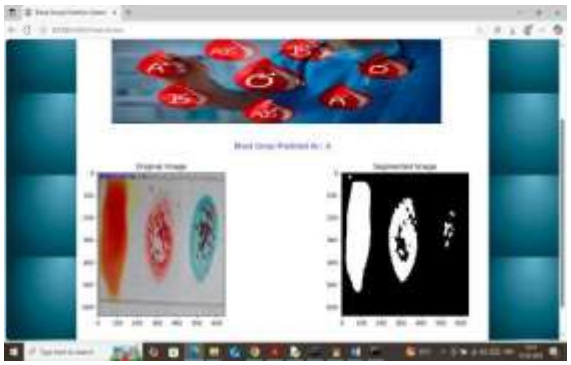

Fig. 10. Prediction

IV. CONCLUSION AND FUTURE ENHANCEMENTS

A. Conclusion

The classifier of the blood groups based on image processing algorithms is a new vision of the traditional image-based serology. The system may lead to high accuracy and efficiency of blood group prediction with the use of blood sample images using sophisticated image processing algorithms and deep learning algorithms. The effect of the new strategy is not only decreasing the use of manual interpretation and chemical reagents but also achieves the most significant issues about time waste, expenses, and the availability of the technology in remote areas and resource limited locations. Through usage of the Convolutional Neural Networks (CNNs) the system in fact trains itself to distinguish between fine patterns and morphological characteristic of various blood groups. Automated solution implies that the results will be quicker with a lesser human mistake that implies that the answer is optimal in crisis responses as well as in regular clinical diagnosis. In addition, the system is scalable and can be easily transportable, and it can be used in mobile clinics and field hospitals, among the other remote care settings, which underscores the disruptive potential of artificial intelligence in medical diagnostics. It gives the rationale to proceed with the addition of other more detailed parameters to blood or open to other medical imaging procedures. Additional training on various datasets and additional development of the model can make it an effective healthcare tool in the global market. Summing up, this project not only proves that it is possible to provide the successful automation of blood groups classification with the assistance of AI but also provides an example of how the further development of the digital health can be.

It imparts the interface between the traditional lab practice and the new AI development and an intelligent, reliable, and convenient diagnostic solution to the future of the healthcare industry.

B. Future enhancements

a. Enhancement and Multiplicity of Data

The additions of a more varied and larger collection of pictures of the blood samples to the dataset are the most useful improvements, which need to be maximized in the future development. The model will be made more overallizable and sustainable through incorporation of the pictures of the various imaging equipment with the help of the lighting conditions, and populations. This will assist the system in dealing with variations that are eminent in real life scenario and eliminate possibilities of misclassification. Reviewing other Blood parameters that would be included.

The additional elaboration of the system might be characterized as examination of other hematological parameters i.e., Rh factor (negative or positive), the white blood cell (WBC) count or platelet count. This would make sure that the system is more of a complete blood diagnostic system as opposed to a mere blood group classifier therefore more medical information can be gotten using one image.

b. Deployment of Mobile and Embedded devices.

By implementing the program to lightweight AI models, like TensorFlow Lite or ONNX, the solution can be highly portable and run on smart phones or tablet solutions or on edge devices. This would be helpful in real time blood group prediction of rural health clinics, ambulance and remote health camps that are not connected to the web and those that lack expensive infrastructure.

c. Medical and The Supervisory Vertebral expert.

In creating the system to be real-world, the system requires clinical testing and validation to be done in conjunction with the medical institutions. One should also work in the future with the purpose to adapt this system to the healthcare norms and standards (e. g. FDA, CE marking) in order to make the system reliable and satisfactory to implement it to the medical field.

d. Video-Stream Based Real-Time Blood Typing.

The second field that can be developed is to offer real-time blood grouping with the use of live video feeds as collected by a microscope camera. This would give the facility to have the ability to analyse the outcomes constantly and also decrease the manual implementation of capturing pictures and also enable a dynamic analysis of the samples in the laboratory.

e. Relationship with HER and Telemedicine Systems

The system will also be later improved so that it can be integrated with the electronic health record (HER) systems and telemedicine systems. It will enable the automatic maintenance of records, remote inspection and better supervision of the patients - to smarter, AI enhanced healthcare ecologies.

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