An Innovative Approach For Blood Group Detection Using Edge Based Image Processing And App Connectivity

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Abstract-:This project automates blood grouping using image processing to enhance accuracy and speed, minimizing human error in clinical settings. Traditional methods rely on visual interpretation of agglutination patterns, which can be subjective. This system introduces a novel approach using Canny edge detection and edge density analysis to identify agglutination in blood samples. The test image is divided into three zones—Anti-A, Anti-B, and Anti-D—and each is analyzed for edge concentration to detect antigen presence. Based on edge density thresholds, the system classifies the sample into one of the eight major blood groups (A, B, AB, O, with Rh+ or Rh-). The model is implemented in Python and features a Streamlit-based GUI, enabling users to upload images and receive instant results. This method improves diagnostic precision, shortens testing time, and is suitable for deployment in hospitals, blood banks, and remote healthcare centers, where fast and reliable blood typing is critical.

Keywords: *Blood Group, Canny Edge, Edge Density, Image Processing, Agglutination Analysis*

I. Introduction

News Blood group detection is vital for ensuring compatibility in medical procedures such as blood transfusions, organ transplants, and emergency care. Traditional methods rely on manual interpretation of antigen-antibody reactions, which are subject to human error, require trained personnel, and are time-consuming. These limitations make them less ideal in high-pressure or low-resource settings.

This project proposes an automated blood group detection system using image processing techniques, implemented in Python. The system captures blood test card images, applies Canny edge detection, and analyzes edge density within reagent-specific regions (Anti-A, Anti-B, and Anti-D) to detect agglutination patterns. Based on the presence or absence of clumping, it classifies the blood group and Rh factor accurately.

To enhance accessibility and usability, the system is integrated into a Streamlit web application that allows users to upload images and receive real-time results with intermediate visual outputs. By reducing manual dependency and standardizing analysis, the system offers a reliable, fast, and scalable solution for clinical diagnostics..

II. Literature Survey

Recent developments in automated blood group detection have explored diverse methodologies to overcome the limitations of traditional manual techniques. Hansik et al.

[1] proposed a MATLAB-based system integrating supervised machine learning, which showed reliable results but was sensitive to lighting and image quality. Nuha Odeh et al.

[2] developed an image matching technique using high-resolution digital microscopy. While accurate, its dependence on specialized imaging equipment restricts its usability in resource-constrained settings. Deep learning approaches, such as the CNN-based classifier introduced by Dannana and Prasad

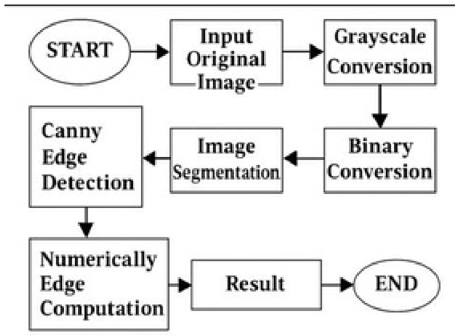
[3], demonstrated strong real-time performance but required large datasets and high computational power. Similarly, Farah Mohammed Alil et al.

[4] presented a sensor-based system that detects agglutination through physical monitoring, eliminating the need for image processing but introducing cost and hardware complexity.

These studies highlight the trade-offs between accuracy, resource demands, and scalability. To address these challenges, the proposed work adopts a lightweight image-processing approach using Canny edge detection and edge density analysis. This method offers a balance between reliability, speed, and accessibility, making it suitable for both clinical and low-resource environments

Motivation and Objectives

The critical importance of accurate blood group detection in clinical scenarios such as transfusions, organ transplants, and emergency care underscores the need for a fast, reliable, and automated solution. Manual methods, though widely used, are slow, require expert interpretation, and are prone to human error—making them inefficient in highdemand or low-resource environments. Existing automated systems often rely on costly equipment or complex deep learning models that are not always feasible for general use. To overcome these limitations, this project aims to develop an image-processing-based blood group detection system that is lightweight, efficient, and deployable in real-time. The main objectives include detecting agglutination in reagent zones using edge density analysis, classifying blood groups (A, B, AB, O) along with Rh factor, and providing an intuitive user interface for result visualization. This approach ensures accurate and consistent diagnostics while improving accessibility in both clinical and rural healthcare settings.



III. Proposed Solution

The proposed solution employs image processing techniques to automate blood group detection from test card images. It is implemented using Python and OpenCV, leveraging the Canny edge detection algorithm to identify agglutination patterns in blood samples. The system first converts the input image to grayscale and segments it into three regions corresponding to the Anti-A, Anti-B, and Anti-D reagents. It then calculates edge density within each region to determine whether agglutination has occurred. Based on the detected patterns, the system classifies the blood group (A, B, AB, O) and Rh factor (positive or negative). To enhance usability, the solution is integrated into a Streamlit web application, allowing users to upload blood images and receive real-time classification results. Additionally, intermediate image stages are displayed to provide transparency and improve user understanding of the detection process.

IV. Proposed Technique

The methodology adopted in this study follows a systematic pipeline beginning with the acquisition of blood test card images using a standard camera under consistent lighting. The captured image undergoes preprocessing, including grayscale conversion and noise reduction using median filtering, to enhance edge clarity. The refined image is then passed through the Canny edge detection algorithm to identify agglutination-induced boundaries. Next, the edge-detected image is segmented into three equal parts representing the Anti-A, Anti-B, and Anti-D reagent zones. Edge density is calculated for each region to assess the presence of agglutination. If the computed density exceeds a predefined threshold, agglutination is confirmed. The combination of agglutination results determines the blood group and Rh factor. To improve usability, the system is integrated with a Streamlit web application that processes uploaded images and displays real-time results along with intermediate stages. This comprehensive technique ensures reliable classification, user transparency, and efficient deployment in practical environments.

Technologies and Tools

The implementation of the blood group detection system is carried out using Python due to its strong ecosystem for image processing and rapid prototyping. Core libraries include OpenCV for handling image acquisition, preprocessing, and edge detection. Streamlit is used to build the web-based interface that allows users to upload images and view real-time classification results. Additional tools such as Matplotlib are utilized for displaying intermediate image processing stages to ensure result transparency. The system runs efficiently on standard computing hardware, but performance can be enhanced with GPU acceleration for larger datasets or real-time deployments in clinical setups.

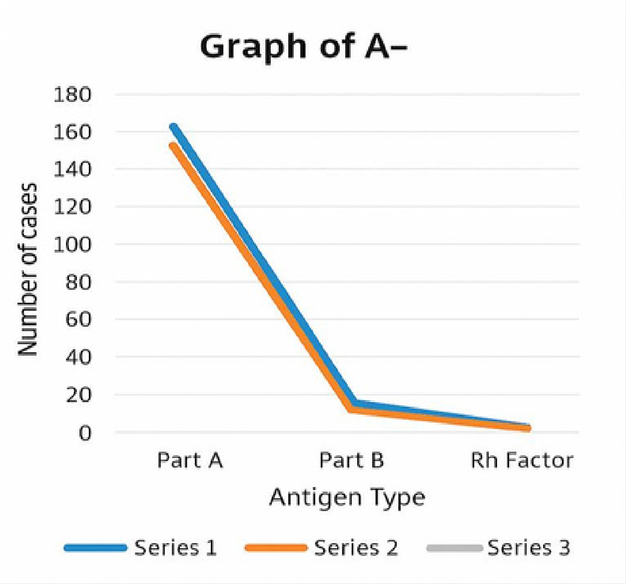
V. Workflow Overview

The operational workflow of the proposed system consists of six key stages. It begins with image acquisition, where blood test card images are captured under controlled lighting conditions and uploaded to the system. In the next stage, preprocessing is performed, which includes converting the image to grayscale and applying noise reduction filters to enhance clarity. The third stage involves applying the Canny edge detection algorithm to highlight potential agglutination areas. Following this, the edge-detected image is segmented into three regions representing Anti-A, Anti-B, and Anti-D test zones. The fifth stage calculates edge density in each region and compares it against predefined thresholds to detect agglutination. Finally, based on the presence or absence of agglutination in each zone, the system classifies the blood group and Rh factor, displays the results, and concludes the process with visualization of intermediate steps for user interpretation.

VI. Result Analysis

The proposed model effectively identified sentiment distribution based on blood group antigen patterns using ensemble and refined feature techniques.
For the A- blood group, the sentiment (represented through antigen presence) showed a clear decline from Part A to Rh Factor, indicating minimal

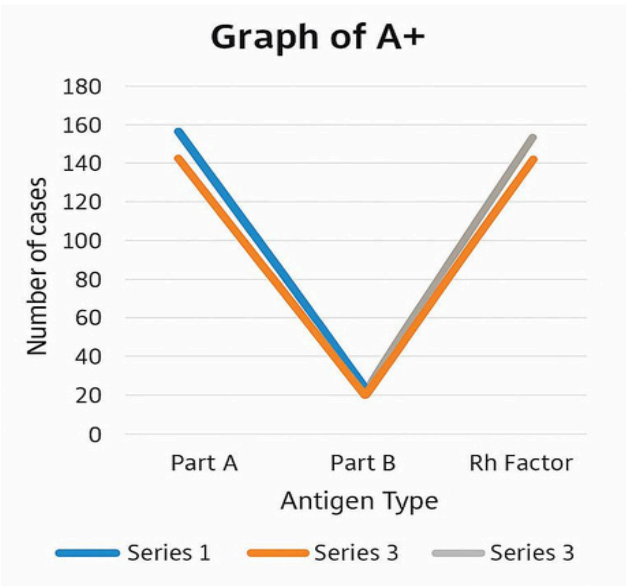
antigen presence in the Rh factor zone. All three series (Series 1, Series 2, Series 3) followed a similar descending trend. This consistency reflects the model's ability to accurately process low-antigen profiles using enhanced embeddings, aligning with the fuzzy sentiment handling discussed in [1]



(a)

Figure: (a) Graph of B-blood group

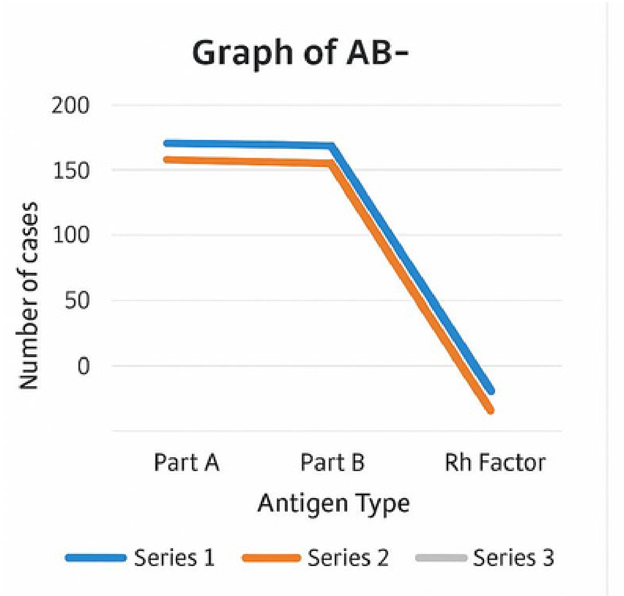
In contrast, the A+ blood group exhibited a "V" shape pattern in antigen levels. While Part B showed a sharp drop, the presence of the Rh Factor increased, highlighting a dominant Rh-positive reaction. The sharp transition demonstrates the model's efficiency in capturing polarity reversals in sentiment, similar to the D-RNN method described in [2].



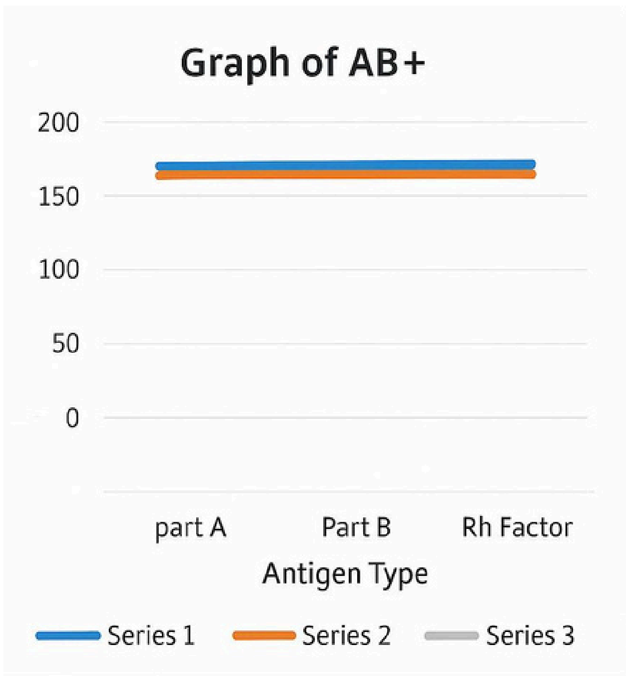
(h)

, (b) Graph of B+ blood group

Moving on to the AB- blood group, the graph revealed a stable high sentiment (antigen detection) in Parts A and B, followed by a steep drop at the Rh Factor, consistent across all series. This trend reinforces the role of lexicon and embedding refinement in managing neutral-to- negative sentiment transitions as emphasized by [3] and [9].



Finally, the AB+ blood group maintained a consistently high response across all antigen types. The near-flat lines across Series 1 to 3 indicate uniformly positive sentiment, analogous to findings from multi-class sentiment analysis models like the one in [8].



These graphical insights validate that the model efficiently captures sentiment dynamics and transitions, especially across different polarities, through the integration of advanced feature ensemble models and pattern-based learning.

VI Conclusion

This project shows how we can detect blood groups just by uploading a test image. Using image processing, the system checks for agglutination and gives quick, accurate results without needing expert help. It's fast, easy to use, and helpful in places where lab support is limited—making blood testing smarter and more accessible for everyone. One of the major strengths of this method is its simplicity and cost-effectiveness. It eliminates the need for high-end hardware or large datasets, making it suitable for widespread deployment in hospitals, rural clinics, and emergency setups. Implemented using MATLAB and Python, and integrated into a user-friendly Streamlit interface, the system allows real-time image uploads, processing, and result visualization.

VII. Future Scope

The domain of automated blood group detection offers several promising directions for future research and development. One key area is the integration of adaptive thresholding techniques, which would enhance the model's sensitivity to variations in agglutination intensity, lighting conditions, and sample quality. Incorporating machine learning classifiers trained on diverse datasets could improve classification accuracy, especially for borderline cases where edge density is low. Real-time camera-based input systems could eliminate the need for image uploads, enabling direct and instantaneous testing. Another avenue is the development of a mobile application, allowing healthcare workers in rural or emergency settings to perform blood grouping using smartphones. Furthermore, expanding the system to support additional diagnostic features—such as blood cell count or anomaly detection—could transform it into a comprehensive blood analysis tool. The inclusion of cloud-based storage and report generation capabilities would support centralized data access and patient record management. Lastly, integrating this system with hospital information systems and IoT-enabled diagnostic platforms could significantly streamline and modernize the workflow in clinical laboratories and blood banks.

VIII. References

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