BLOOD GROUP DETECTION USING EDGE BASED IMAGE PROCESSING WITH APP CONNECTIVITY

PROJECT REPORT

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A Project Report submitted in partial fulfillment of the requirements for the degree of

Bachelor of Technology

In

Electronics and Communication Engineering

By

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19th April 2025

Certificate

This is to certify that the Project entitled "***Blood Group Detection using Edge based Image Processing with App Connectivity***" has been carried out by ***Chetana Pati***(2101209446),***Shivraj Kar (2101209529***),***Sambit Kumar Behera*** (2101209582), under my guidance and supervision and be accepted in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Electronics and Communication Engineering** under **Silicon University**, **Odisha**.

Dr. Lopamudra Das	**Dr. Amiya Bhusana Sahoo**	**Dr. Sudhansu Kumar Pati**
Assistant Professor	**Project Coordinator**	**H.O.D, Dept. of EE**

DECLARATION

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included. We have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/sources in our submission. We understand that any violation of the above will be cause for disciplinary action by the institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Chetana Pati

Shivraj Kar

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Place:*Bhubaneswar*

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Date: 19.04.2025

Department Vision, Mission and PEOs

Vision…

To be recognized as a beacon of quality education and research in the field of Electronics and Communication Engineering

Mission…

1. Continually improve the standard of our graduates by having high caliber motivated faculty members together with quality educational programs and facilities in-line with the rapid technological advancements in the field of Electronics and Communication Engineering (Knowledge, Skill and Quality).

2. Provide a balanced regime of quality education that incorporates theoretical and practical education, innovation and creativity as well as freedom of thought and research with emphasis on professionalism and ethical behavior (Professionalism & Ethics).

3. Promote and support research activities over a broad range of academic interests among students and staff for growth of individual knowledge and prepares for continuous learning (Research and Life-long Learning).

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PEO1. Fundamental Knowledge & Core Competence: To utilize the knowledge of mathematics, science and fundamentals of electronics & communication engineering required to become a successful professional and foster complex problem solving ability.

PEO2. Proficiency for the Real World: To acquire the skills to analyze, design, develop, and optimize novel acceptable electronics and communication systems as per the growing needs of the real world.

PEO3. Leadership & Social Responsibility: To exhibit leadership capability with professional, ethical, interpersonal skills, social & economic commitment with a sense of responsibility towards public policies, community services, humanity and environment.

PEO4. Life-long Learning: To grow professionally through continued education & training of technical and management skills, pursue higher studies, and engage in life-long learning.

Abstract

This project is intended to automate the process of blood grouping using edge based image processing techniques with app connectivity, thereby improving the accuracy and speed by eliminating human error in clinical environments. Traditional methods rely on visual observation of agglutination patterns, which can be subjective and inconsistent. This project proposes a novel technique that uses Canny edge detection and edge density analysis to detect agglutination in blood samples. The test image is segmented into three zones (Anti-A, Anti-B, and Anti-D), and each zone is analysed based on the concentration of edges to determine the presence of antigens. The unique clumping pattern caused by antigen-antibody reactions is detected using edge density thresholds, and the system classifies the sample into one of the eight major blood groups (A, B, AB, O with Rh+ or Rh-). The model has been implemented using Python and is integrated with a Streamlit-based GUI, allowing users to upload test images and receive real-time predictions. This project enhances diagnostic accuracy, reduces processing time, and can be deployed in hospitals, blood banks, and rural clinics where rapid testing is essential.

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

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Chapter 1

Introduction

Introduction

1.1 Background and Need for Automated Blood Group Detection

Blood group detection is a foundational process in clinical diagnostics, crucial for ensuring patient safety in procedures such as blood transfusion, organ transplantation, prenatal care, and emergency treatments. Knowing a person's blood group is vital to avoid potentially fatal immune reactions that can result from incompatible blood transfusions. Traditionally, blood grouping is performed using serological tests, where specific antigens on red blood cells (RBCs) react with corresponding antibodies in reagents like Anti-A, Anti-B, and Anti-D (Rh). These reactions manifest as agglutination or clumping of blood cells, which is then visually inspected by trained professionals.While this manual technique has been widely used for decades, it has several limitations. The process is inherently subjective, as it relies on visual interpretation of agglutination, which can vary based on lighting, user experience, and reagent quality. In addition, manual testing is time-consuming and labor-intensive, making it less suitable in scenarios requiring rapid diagnostics, such as trauma units, blood donation camps, and remote health centers.To address these challenges, automation and digital image processing techniques are being explored to streamline and improve the accuracy of blood group detection. Image processing offers the advantage of objective analysis, reducing the dependency on human observation. It also enables the development of portable, easy-to-use systems that can be deployed in resource-limited settings. By leveraging edge detection algorithms and statistical analysis of image features, it becomes possible to reliably identify agglutination patterns and deduce the corresponding blood group.

1.2 Proposed System and Working Principle Using Edge Density Analysis

In this project, we present an automated system for blood group detection using image processing techniques using Python. The proposed system captures blood test card images, converts them to grayscale, and applies Canny edge detection to highlight edges resulting from agglutinated red blood cells. The image is segmented into three equal parts representing the Anti-A, Anti-B, and Anti-D reagent regions. Each region is analyzed for edge density—a measure of how many edge pixels are present relative to the total number of pixels. This value is used to determine whether agglutination has occurred in that region. Edge density serves as a reliable indicator of clumping. When red blood cells react with antibodies, they form dense clusters that result in more edges. In contrast, non-reactive samples appear smoother and contain fewer edge features. By setting appropriate threshold values for edge density, we can determine the presence or absence of agglutination in each of the three regions and classify the blood group accordingly (A, B, AB, or O, with positive or negative Rh factor).

1.3 User Interface and Advantages of System Integration

This approach minimizes manual interpretation, speeds up the testing process, and ensures a standardized method for evaluating blood samples. The integration of this system into a Streamlit-based web application further enhances usability, allowing users to upload blood test images directly from local storage and receive real-time blood group predictions. The backend algorithm processes each image and displays the results along with intermediate image processing stages, offering transparency and insight into the detection process.

1.4 System Evaluation, Accuracy, and Future Enhancements

The system was tested using various blood group images representing all eight major types: A+, A-, B+, B-, AB+, AB-, O+, and O-. Results demonstrated high accuracy, with some cases of misclassification, which was traced to a low edge density due to faint agglutination. This can be improved by refining preprocessing steps or incorporating additional features such as intensity variance or machine learning-based classification in the future.

Overall, this project demonstrates a promising step towards intelligent, image-based blood group diagnostics. It combines the robustness of digital processing with the practicality of a user-friendly interface, making it suitable for diverse clinical environments.

Chapter 2

Literature Survey

Literature Survey

Numerous studies have proposed automated techniques for blood group detection to overcome the limitations of traditional methods. This section reviews significant contributions in the field and outlines their methodologies and challenges.

2.1 MATLAB-Based Machine Learning Approach for Blood Group Classification

Hansik et al. (2021) [1] proposed an image processing approach using MATLAB, integrating machine learning techniques for blood group classification. The study emphasized the use of supervised models trained on feature sets derived from blood sample images. While it achieved reliable results, its accuracy was heavily dependent on lighting conditions and image quality.

2.2 Digital Microscopy and Image Matching Technique for Blood Group Detection

Nuha Odeh et al. [2] introduced an efficient system that uses digital microscopy and image matching techniques for blood group classification. Their method emphasized the precision of reagent-sample interactions captured through high-resolution imaging. The system proved highly accurate but required advanced microscopy, which limits its use in low-resource settings.

2.3 Deep Learning-Based Blood Group Detection Using CNNs

Dannana and Prasad (2022) [3] developed a deep learning-based classifier using convolutional neural networks (CNNs) for blood group detection. Their method achieved excellent real-time performance but was constrained by the need for large, labeled datasets and GPU-based training environments. The model's adaptability to new test conditions was also a concern.

2.4 Sensor-Based Detection of Agglutination for Blood Typing

Farah Mohammed Alil et al. [4] proposed a sensor-based approach to enhance erythrocyte agglutination detection. Their system relied on monitoring antigen-antibody interactions through physical sensors, allowing for effective detection without image processing. However, this required specialized hardware and was not easily scalable for general-purpose applications.

2.5 Summary

In summary, the literature highlights that while advanced techniques like deep learning and sensor-based analysis show promise, there remains a need for a lightweight, image-based method that balances accuracy, accessibility, and ease of deployment. Taking into account, the limitations of the traditional methods the proposed technique uses edge density and Canny segmentation to addresses this gap by providing a simple yet effective solution using standard imaging tools and algorithms.

Chapter 3

Proposed Technique Name

Proposed Technique

The proposed technique for blood group detection integrates computer vision and digital image processing to classify blood types based on observable agglutination patterns. This method uses Canny edge detection and edge density analysis to determine whether agglutination has occurred in the Anti-A, Anti-B, and Anti-D (Rh) test regions of a blood grouping card image. Below is a detailed explanation of each step involved in this system:

3.1 Image Acquisition

Images of blood group test cards are captured using a camera under consistent lighting conditions. These images are then uploaded to the system for analysis.

Anti-A Anti-B Anti-D

Figure 3.1-Blood Grouping reagents

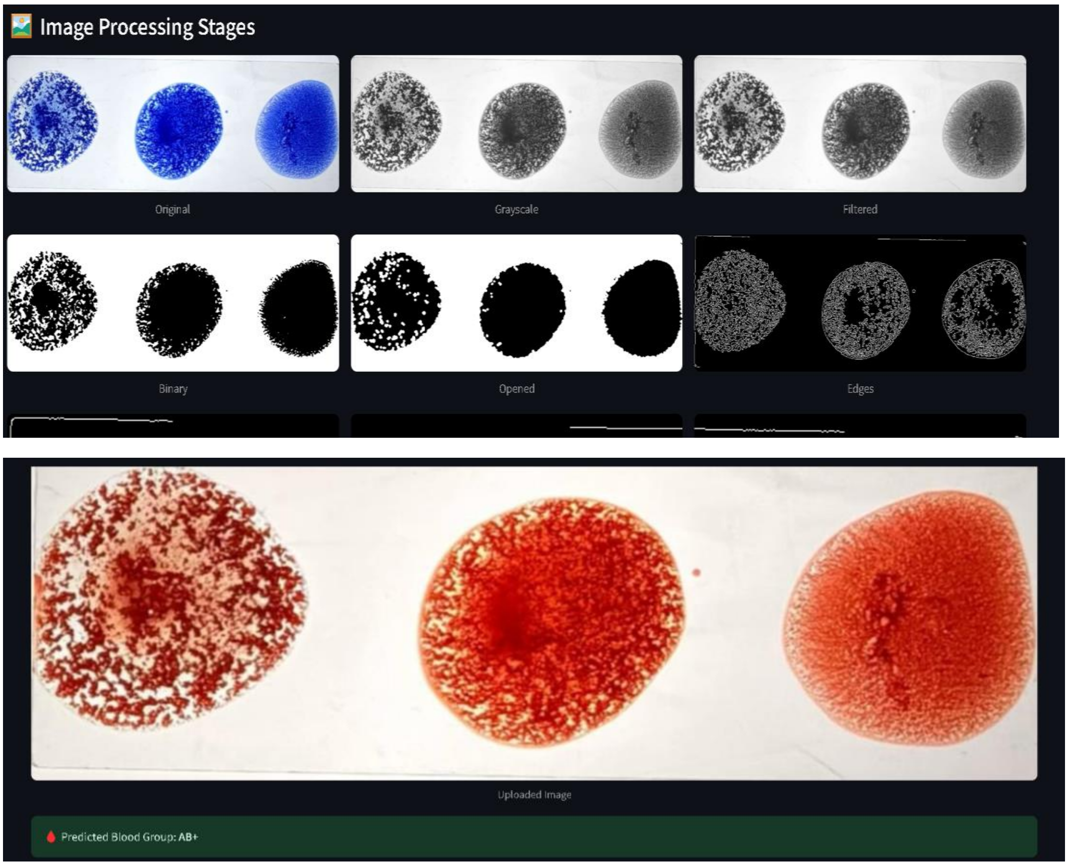

Figure 3.2-Image Processing Stages

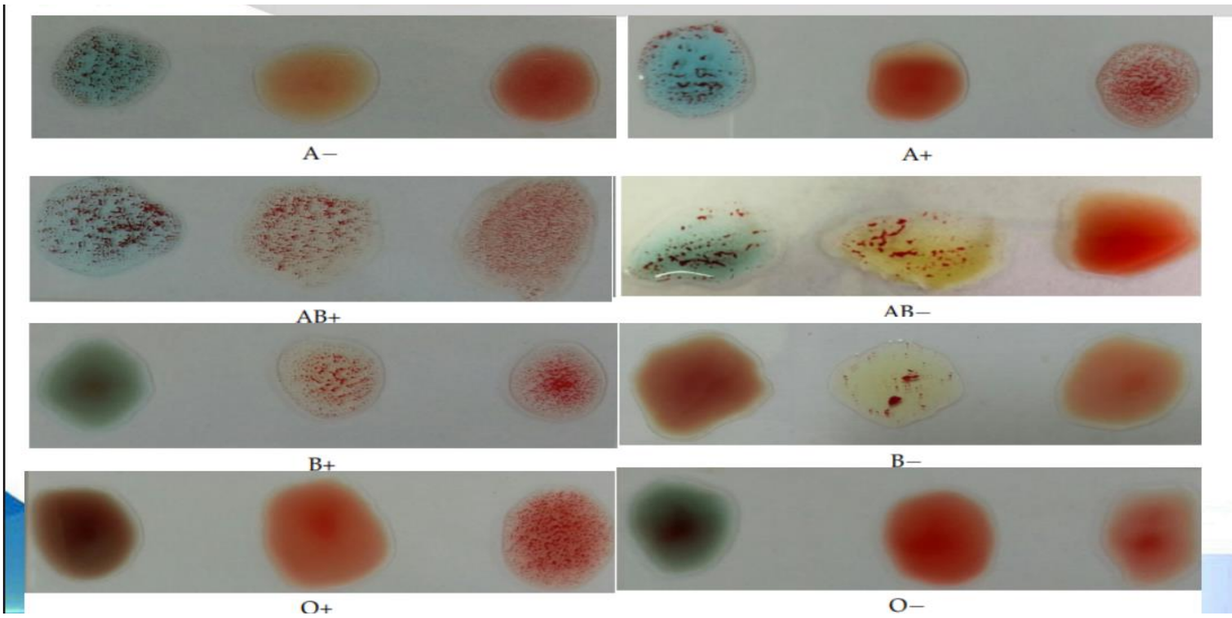

Figure 3.3-Blood Sample images taken from research paper [1]

3.2 Preprocessing

The input image is converted to grayscale to simplify analysis. Preprocessing steps such as median filtering may be applied to reduce noise while preserving edges. This improves the quality of edge detection and reduces false positives caused by noise or lighting artifacts.

3.3 Canny Edge Detection

The grayscale image is subjected to the Canny edge detection algorithm, which identifies edges based on intensity gradients. The Canny algorithm is chosen for its high sensitivity and noise suppression capabilities. It involves:

- Gaussian filtering for noise reduction
- Gradient computation
- Thresholding and edge tracking by hysteresis

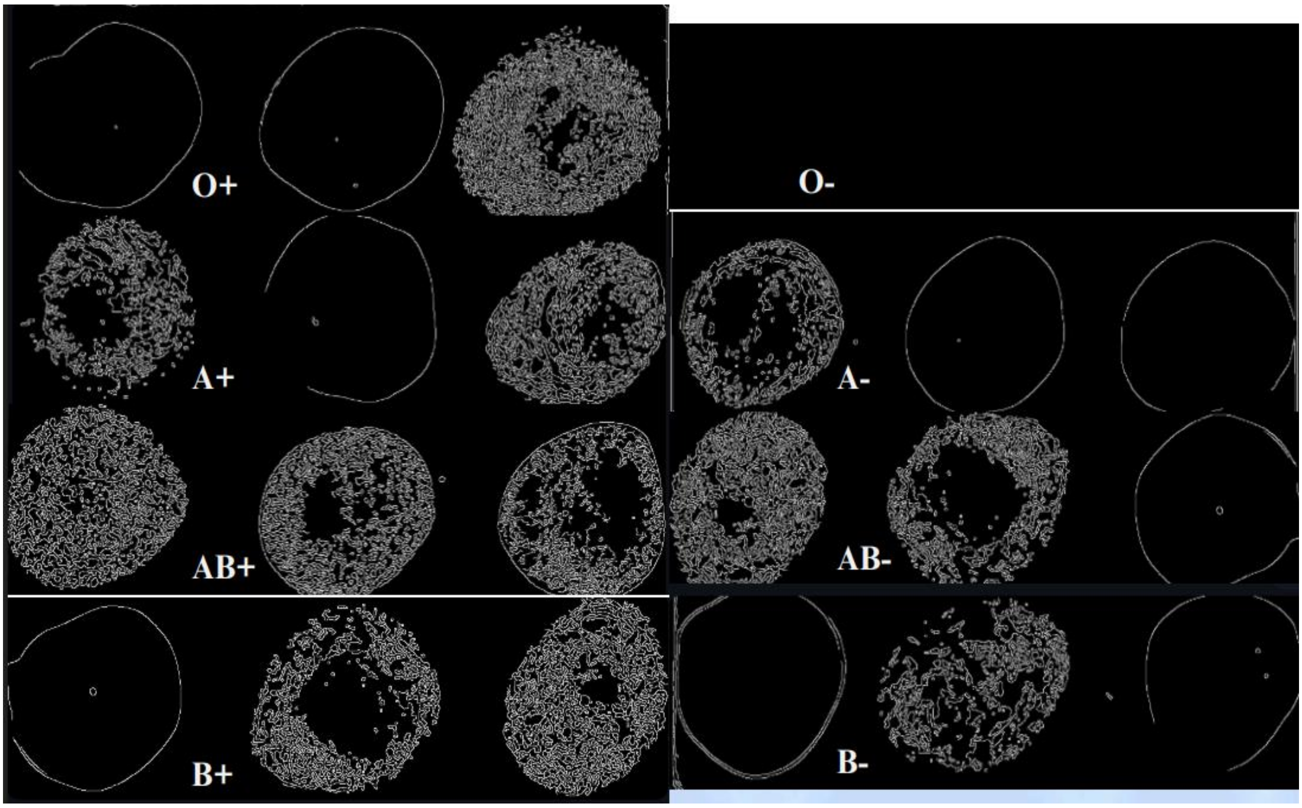

Figure 3.4 :Canny Edge Detection

3.4 Image Segmentation

The edge-detected image is divided into three vertical segments representing the three test zones:

- Left third: Anti-A
- Middle third: Anti-B
- Right third: Anti-D (Rh)

This segmentation assumes that blood group cards are uniformly marked with these reagents. Each region is processed individually to detect agglutination.

3.5 Edge Density Calculation

Edge density is computed by counting the number of edge pixels (non-zero values) and dividing by the total number of pixels in that region. This metric provides a quantitative measure of agglutination, as areas with agglutinated cells contain denser and more irregular edges.

Mathematically: Edge Density = (Number of Edge Pixels) / (Total Number of Pixels)

3.6 Agglutination Detection

A region is considered to exhibit agglutination if its edge density exceeds a predefined threshold:

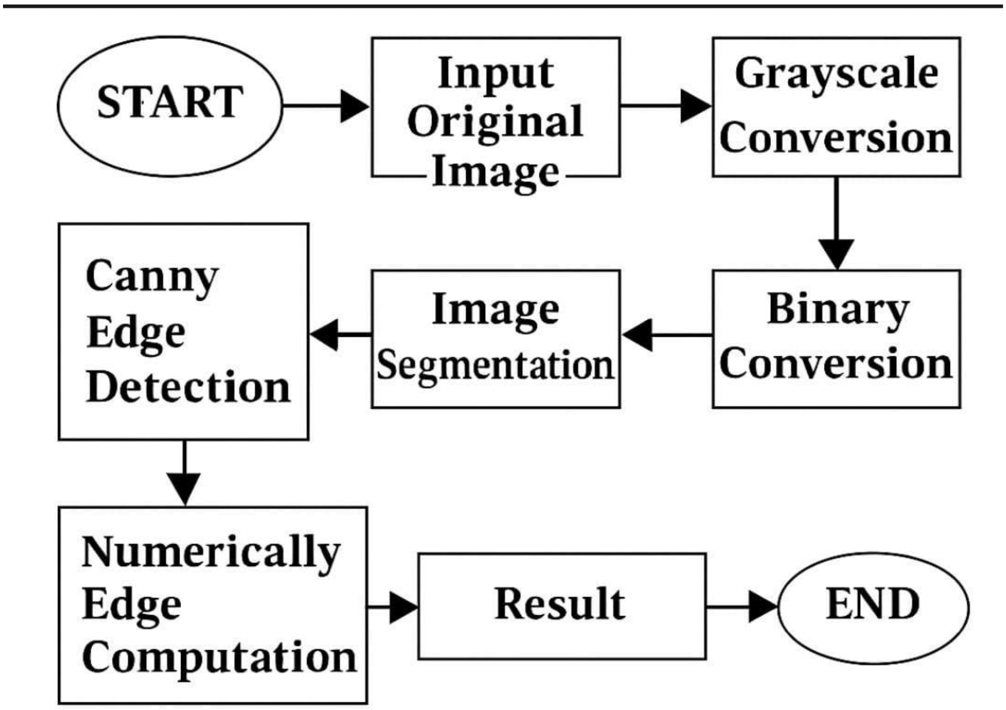

Figure 3.5-Block diagram of proposed method

- Threshold A = 0.06
- Threshold B = 0.04
- Threshold Rh = 0.06

These values were selected based on empirical analysis of sample images. The presence of agglutination is marked as True or False based on whether edge density surpasses the threshold.

3.7 Blood Group Classification Logic:

Based on agglutination presence in each zone, the system determines the blood group which is represented in the below Table 1 :

Group A	Group B	Rh Factor	Blood Group
Not Agglutinated	Not Agglutinated	Not Agglutinated	O−
Not Agglutinated	Not Agglutinated	Agglutinated	O+
Not Agglutinated	Agglutinated	Not Agglutinated	B−
Not Agglutinated	Agglutinated	Agglutinated	B+
Agglutinated	Not Agglutinated	Not Agglutinated	A−
Agglutinated	Not Agglutinated	Agglutinated	A+
Agglutinated	Agglutinated	Not Agglutinated	AB−
Agglutinated	Agglutinated	Agglutinated	AB+

Table 3.1:Blood Classification Agglutination

3.8 Implementation & Interface

This logic is implemented in both MATLAB and Python. The Python version is integrated with a Streamlit-based web application where users can upload images and view real-time detection results. Intermediate image stages such as grayscale, edge-detected, and segmented zones are also displayed to ensure transparency.

Figure 3.6-Outputs of traditional method and our App

3.9 Threshold Tuning and Limitations

The accuracy of this technique is largely influenced by the selection of appropriate edge density threshold values for each test region. These thresholds determine whether agglutination is detected, and hence play a critical role in the final blood group classification. However, in cases where agglutination is very faint or when images are captured under uneven lighting conditions, the calculated edge density may fall below the predefined threshold, resulting in misclassification of the blood group. Such issues highlight the sensitivity of the system to image quality and subtle sample variations. To overcome these limitations, future versions of the system can incorporate **adaptive thresholding methods**, contrast enhancement, or additional features such as **intensity variance and texture analysis** to improve detection reliability across varying conditions.

Sample No	No. of edges in part A	No. of edges in part B	No. of edges in part RH	Predicted Blood Group
1	166	2	14	A-
2	232	248	5	AB-
3	18	397	492	B+
4	2	6	128	O+
5	3	1	1	O-
6	4	144	4	B-
7	155	352	343	AB+
8	250	17	121	A+

Table 3.2:Number of counted edges for A, B, Rh from eight samples of bloods from datasheets

3.10 Advantages:

- Fully automated(without prior biological knowledge) and user-friendly
- Low-cost implementation with minimal hardware
- High transparency through visual feedback
- Accurate and consistent with minimal human bias

In conclusion, the proposed technique leverages simple yet powerful image processing operations to automate a critical diagnostic process. It provides a solid foundation for building portable blood testing kits or integrating with mobile applications for real-time diagnostics in rural or emergency settings.

Chapter 4

Conclusions

4.1 Conclusions

The project, “Blood Group Detection Using Edge Based Image Processing With App Connectivity” presents a practical and efficient approach to blood group classification using image-based techniques. By employing Canny edge detection and analysing edge density in the Anti-A, Anti-B, and Rh zones, the system simulates a human observer's interpretation of agglutination patterns in a consistent and automated manner.

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.

First the sample images were collected from research papers and the algorithm is applied and the blood groups were detected perfectly.The work is also tested through the samples collected from Haldane’s Centre (In-DNA lab) and gave the correct result.Finally,real time blood sample from local Patho Lab also accurately tested for blood group O+ .

Though the system achieved high accuracy during testing, it also revealed challenges in cases of weak agglutination, which may be addressed in the future through adaptive thresholding or the incorporation of additional features like intensity or variance. Nonetheless, the project demonstrates a strong use case for applying image processing in diagnostics, offering a reproducible, interpretable, and scalable solution.

Overall, this project provides a solid foundation for further innovation, including integration with real-time camera inputs or machine learning models. It stands as an example of how interdisciplinary tools can be combined to make healthcare more accurate, efficient, and accessible.

4.2 Limitations of this model:

Canny edge detection is sensitive to noise and variations in lighting, which can lead to inaccurate edge detection in poor-quality images. It also depends heavily on the choice of thresholds, which may not generalize well across different samples. Additionally, it only detects structural edges and does not consider texture or color, which may limit its effectiveness in complex agglutination patterns which we faced for O- blood group.

4.3 Future Aspect of the work:

This system can be improved by incorporating adaptive thresholding and machine learning techniques to handle borderline cases more effectively. Real-time camera integration can enable direct testing without image uploads. The model can also be expanded to handle varied lighting conditions and sample qualities. Additionally, a mobile app version could increase accessibility in rural and emergency settings.

References

[1] P. Hansik Sagarl, M. Jaiesh Reddy, A. Bala Avinash, Dr. V. Jayaprakasan, “Blood Group Detection using Image Processing MATLAB,” International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 9, Issue 5, May 2021.

[2] Nuha Odeh, Anas Toma, Falah Mohammed, Yousef Dama, Farah Oshaibi, Muna Shaar, "An Efficient System for Automatic Blood Type Determination Based on Image Matching Techniques," ECE Department, An-Najah National University, Nablus, Palestine, 2021.

[3] S. Dannana, D. Y. V. Prasad, "Blood Group Detection using ML Classifier," International Research Journal of Engineering and Technology (IRJET), Volume 9, Issue 1, 2022.

[4] Farah Mohammed Alil, Jamal A. Hasan, Eman Ghadhban Khalil, "Enhancement the Agglutination of Erythrocytes in Blood Typing," Nahrain Journal for Engineering Sciences (NJES), Volume 24, Issue 2, 2021.

[5] Hetal J. Vala, A. Baxi, "A Review on Otsu Image Segmentation Algorithm," International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Volume 2, Issue 2, February 2013.

[6] M. Madhuri, G. Bhamare, "Automatic Blood Cell Analysis by using Digital Image Processing: A Preliminary Study," International Journal of Engineering Research and Applications, Volume 2, Issue 9, September 2013.

[7] T. R. Singh, S. Roy, O. Imocha Singh, Tejmani Sinam, Kh. Manglem Singh, "A New Local Adaptive Thresholding Technique in Binarization," International Journal of Computer Science Issues (IJCSI), Volume 8, Issue 6, No. 2, November 2011.

[8] Q. Yang, W. Kang, "General Research on Image Segmentation Algorithms," International Journal of Image, Graphics and Signal Processing (IJIGSP), 2009, pp. 1–8.

[9] J. M. Sharif, M. F. Miswan, M. A. Ngadi, Md. Sah Hj, "Red Blood Cell Counting Using Masking and Watershed Algorithm: A Preliminary Study," International Conference on Biomedical Engineering, Penang, Malaysia, February 2012.