International Journal of Innovative Scientific Research
2025, Vol. 3, Issue 1, pp. 122-127

International Journal of
Innovative Scientific Research

Journal homepage: https://ijisr.net

Research paper

Identification of Human Blood Group Detection using Support Vector Machine and Image Processing

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KEYWORDS

Support vector machine
Image processing
Human blood
Blood group detection
Machine learning
Antigen
Matlab

ABSTRACT

Human survival depends on blood, particularly in situations where transfusions are required. It is vital to know one's blood group under these circumstances. In the past, blood samples were mixed with chemicals, and the agglutination process was observed under a microscope to manually determine blood types. Although this method works well, it can take a lot of time and is prone to human mistakes. In the current digital era, image-processing techniques have made blood group determination more effective thanks to technological improvements. Modern solutions such as image processing now provide fast, accurate, and dependable outcomes. Image processing systems can accurately classify blood types by examining photographs of blood samples. In comparison to conventional methods, this approach allows for the precise identification of blood types in a shorter amount of time by processing datasets of blood samples and numerical data. A major change in medical diagnostics has occurred with the shift from manual to digital approaches, which increase accuracy and decrease mistake rates. Image processing is becoming the tool of choice for determining blood groups in medical settings as it advances. Automated systems are a useful tool in emergencies since they guarantee more accuracy and expedite processes. The support vector machine approach is employed in this study to identify and identify the various blood group kinds. The employed technique demonstrates a very high degree of blood group detection accuracy.

1. Introduction

Blood is a crucial component of the human body. There are many cases in which patients have died because of access to release of the blood from the human body during treatment such as operation, diagnosis, or treatment, etc. This type of issue happens because of not an aware of the blood group of the patient or the concerned person who came for treatment or operation. The identification of blood groups is essential to make sure that the transfusion of blood is safe and not going to harm the patient. The identification of the blood

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DOI 105281/ijisr-1832425

group is more important before the transfusion of the blood because the wrong blood transfusion causes the death of the patient or the person. Even quick blood group identification is very important during blood donation camp when the crowd is huge for donation of blood, there is a situation when a person suffered with road accident and needs immediate operation or treatment, and the doctor requires a blood transfusion for that in that case the detection of blood group plays a vital role in a very short period. The automatic and quick identification of blood groups is today's need for saving the life of the patient. Due to advancements and continuous research in the field of image processing machine learning plays a vital role in the quick identification of blood groups [1]. The image processing domain provides various techniques such as image preprocessing, image enhancement, image segmentation, morphological operation, image feature extraction, color image processing, and various other techniques. All these techniques help to understand the various features and properties of the image for understanding the blood group image. So, in the case of manual blood identification, the blood identification person takes some blood from the patient and adds the antigen to the blood. After adding the anti-gent to the blood is certain reaction took place and a specific pattern occurred. This specific pattern is identified by the blood identification person who determines the type of blood group. This entire process is converted into a form of automatic process with the help of image processing and machine learning-based techniques. Here, the image processing techniques are used to extract various features from the anti-gent mixed blood which occurrence of agglutination in the image, and the support vector machine algorithm is used to identify the type of blood group based on the provided training data set of occurrences of agglutination [2]. The combination of the occurrence of agglutination, or non-occurrence, determines the blood type of the patient [3]. This method is quicker and less time-consuming than the manual blood identification process.

2. Literature review and motivation

The literature highlights the significant advancement and work done by various other people around blood group identification. G. Ravindran et al. developed an image processing-based method for blood type determination, which employs thresholding and morphological operations. Their method automates the traditionally manual slide test, minimizing human errors and reducing processing time, making it highly beneficial in critical scenarios [3]. Rahman et al. extended this concept by proposing a cost-effective approach that leverages digital technologies to improve the accuracy and speed of blood group detection. Their method applies algorithms such as grayscale and edge detection to images of blood samples. By analyzing the agglutination process in real-time datasets, they demonstrate enhanced precision and reliability compared to traditional techniques [4]. Similarly, Talukder et al. focus on improving the speed and accuracy of blood group determination using image processing techniques. Their methodology addresses the limitations of the current plate test process, which involves manual blood sample analysis under a microscope. By automating this process, they aim to achieve faster results with minimal errors, particularly in urgent situations [5]. Ferraz et al. presented a low-cost image processing system designed for blood type detection. Their approach involves capturing blood-serum mixtures with a CCD camera and analyzing them using specialized software. The system is designed to enhance public health efficiency by offering a more accessible and reliable alternative to existing commercial equipment [7]. Finally, Dhande et al. emphasized the growing utility of image processing in biotechnology. They argue that automated systems not only increase the speed of blood group classification but also significantly reduce human-induced errors, making them invaluable in emergency medical applications.

3. Support-Vector-Machine (SVM)

The Support Vector Machine (SVM) method is a popular choice for jobs involving regression and classification. Each data point is plotted in an n-dimensional space, where n is the number of characteristics, to illustrate how it works. Every data point is viewed as a vector, and each one's coordinates stand for distinct observations. Finding the best hyperplane to classify the data points into distinct groups is the main objective of the SVM method. To provide the largest margin between the closest data points of distinct classes, the SVM classifier finds the hyperplane that best divides the classes. The nearest data points are known as support vectors, and they are essential for determining the hyperplane's orientation and location. By maximizing this margin, SVM improves the model's capacity to effectively generalize to new data. Training the SVM model with labeled data, each sample having a unique class assigned to it. It is the first step in the process. Using this training data, the algorithm then gains knowledge and becomes able to predict the class of new, unknown data points by finding patterns and associations. SVM performs effectively when the number of dimensions is more than the number of data points, which is one of its main advantages for processing high-dimensional data. Furthermore, SVM is adaptable and can be tailored to different kinds of data by utilizing multiple kernel functions, which makes it a strong tool for tasks involving regression and classification in a variety of applications.

4. Methodology

To conduct image analysis and identification of blood groups, certain methodologies are applied that facilitate image processing and machine learning techniques. The sample images are the foundation upon which these methodologies operate. In this paper, key techniques such as data acquisition, data preprocessing, feature extraction, and the Support Vector Machine (SVM) algorithm are employed. The detailed explanations for each step are as follows:

4.1 Data acquisition

The below link is used to collect the dataset for the identification of blood groups. The below dataset provided is used for blood testing analysis. It includes various parameters essential for determining blood group types and related classifications. This dataset is a valuable resource for understanding blood group typing trends and advancements in testing techniques. *Courtesy:* http://usindustrynews.com/13534/blood-group-typing-market-size-share-poised-for-growth-by-2024/

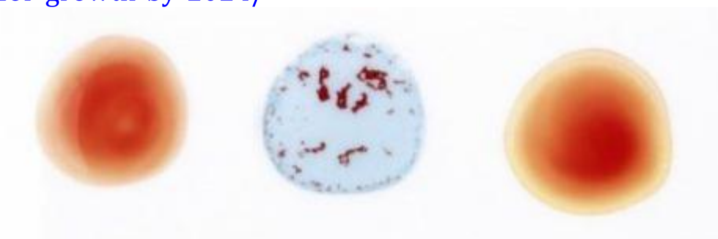

Fig. 1 Sample B+ blood group data

4.2 Data preprocessing and feature extraction

The original image is converted grayscale image. The conversion of the original image into grayscale simplifies images by reducing them to various shades of gray level. It makes the entire process smooth and easier to analyze. The thresholding process now refines the image. The process of thresholding converts grayscale images into binary form which highlights the significant features of the image. After thresholding various statistical features are calculated and based on that training and testing datasets are prepared for training and testing the model for accuracy assessment and evaluation of the model.

Fig. 2 Grayscale Image

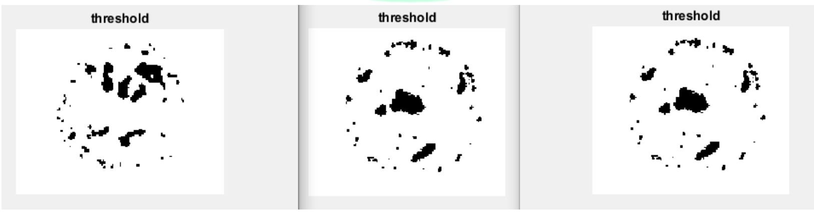

Fig. 3 Threshold Image

4.3 Support Vector Machine (SVM) Model

The SVM algorithm is then used for the classification of datasets. Here, the support vector machine model is implemented using the MATLAB simulation toolbox. The MATLAB simulation toolbox provides a variety of machine-learning algorithms. The toolbox provides the binary SVM classification method; to overcome this issue one versus all technique is used to apply.

4.4 Training and testing

Once the SVM model is created and ready for training then the MATLAB simulation toolbox method is used to train the SVM model with the help of training datasets and after that testing dataset is used to test the performance of the model.

5. Result

Blood groups consist of two key aspects: the ABO type (A, B, AB, O) and the Rh factor (positive or negative), which determine whether the blood is, for example, A+ or A-. The process begins with image processing techniques like Grayscale conversion and Thresholding applied to the patient's blood sample. The main goal is to detect agglutination, indicating whether the blood clumps together or not. The analysis uses a binary system, where 0 represents no agglutination and 1 represents agglutination. For instance, if three samples (A, B, and C) are tested and agglutination occurs in sample A but not in sample B, the blood group is classified as A+. The Rh factor, determined by the third sample, reveals whether the blood is positive or negative. The following tables show the agglutination results and the corresponding binary values for each blood sample. Following is the table which shows the Agglutination part of the blood samples:

Table 1 Agglutination of Blood Samples

Sample A	Sample B	Sample C (Rh Factor)	Result
Agglutination Detected	Agglutination Not Detected	Agglutination Detected	A+
Agglutination Not Detected	Agglutination Detected	Agglutination Detected	B+
Agglutination Detected	Agglutination Detected	Agglutination Detected	AB+
Agglutination Not Detected	Agglutination Not Detected	Agglutination Detected	O+
Agglutination Detected	Agglutination Not Detected	Agglutination Not Detected	A-
Agglutination Not Detected	Agglutination Detected	Agglutination Not Detected	B-
Agglutination Detected	Agglutination Detected	Agglutination Not Detected	AB-
Agglutination Not Detected	Agglutination Not Detected	Agglutination Not Detected	O-

Table 2 Binary Numbers Distribution of Blood Samples

Sample No.	A	B	C	Result
1	1	0	1	A+
2	1	0	0	A-
3	0	1	1	B+
4	0	1	0	B-
5	1	1	1	AB+
6	1	1	0	AB-
7	0	0	1	O+
8	0	0	0	O-

By the agglutination, binary format, and algorithm of the blood samples we get an accurate result. Following is the blood group detected after solving the code and detected as AB+.

```
master =

     1     0     1
     1     0     0
     0     1     1
     0     1     0
     1     1     1
     1     1     0
     0     0     1
     0     0     0

AB+
```

Fig. 4 Text Output

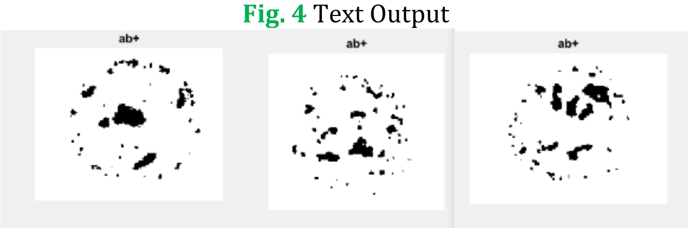

Fig. 5 Image Output

The support vector analysis highlights key data points from the overall analysis. The model achieved 100% accuracy, demonstrating its effectiveness in classification. The training process was completed in 2.1499 seconds, indicating an efficient and swift performance.

6. Conclusion

The techniques used here are image processing and support vector machine algorithm which is a machine learning-based algorithm. These techniques are implemented using MATLAB simulation toolbox which is widely used for various types of simulation tasks related to image processing, machine learning, data analytics, etc. Using these image processing and machine learning techniques which are very efficient and effective can prove that blood tests can be done not only in labs by humans but also on these types of systems by using some software. A system that is not time-consuming and can be used by anyone will be effective and the detection from the test will be fast as compared to a manual test. Just by uploading or downloading or just by giving any input as an image, we can clarify what is the blood group. The work in this paper includes some techniques that will give an accurate result from different image processing algorithms and classifications. In that, the most important part is the detection of an image that is binary and on that, all the functions will be applied. In the future instead of just simply applying grayscale, thresholding, and statistical methods along with a support vector machine other features can also be used such as shape, size, contours, and color. Scientists can prove the blood tests by their manual detection which is adding antigens and waiting for the results whereas the system will give a sure and accurate result from those image processing techniques. In the future, it will not be time-consuming, and the blood transfusion process will be very easy, and the patient will not have to wait for that.

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