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Non-Invasive Blood Group Detection using Nir Sensor

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Abstract
The need for an economical Blood Group measuring solution is widespread, and it is especially critical in developing nations. The most widely used approach in both resource-rich and resource-limited environments is image processing, which would be an appropriate choice for this solution. In Invasive method to determine the blood type the patient blood sample is collected by pricking the fingertip of the patient, it may cause infection and pain to the patient. The aim of the proposed system is to provide a non-invasive Blood Group measurement processes using image processing and machine learning algorithm. In order to compute blood groups, it is also examined how different data collecting locations, bio signal processing methods, theoretical underpinnings, the photoplethysmogram (PPG) signal and feature extraction procedure, image processing algorithms, and detection models differ. The results of this study were then utilized to suggest practical methods for developing a non-invasive point-of-care tool for Blood Group measurement based on Image Processing. Blood group identification is required prior to blood transfusions in emergency conditions. It is done before a blood transfusion in an emergency or when checking a person's blood group for donation. Currently, lab personnel perform tests manually in the laboratory. This takes time and may result in human mistake when determining blood type. The goal of the study survey is to use image processing to reduce the amount of physical labor required to identify blood groups. The presence or absence of agglutination reaction of blood with antigen will be used to determine the blood group.

1. Introduction

Non-invasive blood group detection is the use of methods to identify a person's blood type without extracting blood from them. This is a significant development in the field of transfusion medicine since it enables the quick and painless determination of a patient's blood type. Using saliva or buccal swabs to collect genetic material and examine certain DNA sequences linked to blood types is one approach of non-invasive blood group testing. This process, known as DNA-based blood typing, has shown to be incredibly accurate. Using specialised cameras to look for specific antigens on the surface of red blood cells is another non-invasive technique. Photometric blood typing is a method that is particularly helpful in urgent cases where speed is of the essence. Since no blood must be drawn and there is less danger of infection and other consequences from intrusive procedures, non-invasive blood group identification offers the potential to increase the safety and effectiveness of blood transfusions. Based on preserved DNA, it may be used for forensic investigation, paternity testing, and even to determine the blood type of extinct animals. The method may also be employed in rural or resource-constrained areas where access to blood typing labs is restricted. Non-invasive blood group detection has the potential to revolutionise how we approach blood type and transfusion therapy, making it more accessible, effective, and safe as research in this area continues to improve. The area of non-invasive blood group detection is still in its infancy, and further study is required to improve its precision and dependability. To guarantee that the genetic material acquired is adequate and of good quality, meticulous sample collection and processing are especially necessary for the application of DNA-based blood type.Additionally, there could be variations in the precision of the different non-invasive procedures

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depending on the age, health, and nutrition of the patient. Therefore, to increase the precision and dependability of non-invasive blood group detection and to broaden its applications in medicine and other fields, ongoing research and development in this field are required. It is crucial to remember that while non-invasive blood group detection might be useful for learning about a person's blood type, it cannot give a full picture of how their blood is doing overall. For instance, non-invasive methods could miss the existence of uncommon blood types or other elements that might affect transfusion compatibility. Therefore, in some circumstances, such as in complex transfusion instances or when treating patients with various medical illnesses, traditional blood typing and cross-matching techniques may still be required. Therefore, non-invasive blood group identification should be considered an additional tool rather than a substitute for conventional blood typing techniques.

2. Existing System

Currently, blood must be drawn in order to determine blood type, which is then done in a lab using traditional serological methods. The most well-known and therapeutically relevant blood group systems are the ABO and Rh systems. Blood group systems can take many different shapes. The ABO blood type system is based on the surface antigens of red blood cells. People with type A blood have an antigen, those with type B blood have a B antigen, those with type AB blood have both A and B antigens, and those with type O blood have neither an A nor a B antigen. The ABO blood group system is essential in transfusion therapy since receiving blood from a person with an incompatible blood type might result in potentially fatal reactions.

1) Minimally Invasive Styles

Small incisions and specialized equipment are used in minimally invasive blood group detection methods to collect blood samples for analysis. A fingerstick gadget is one least invasive techniques for blood group identification. With the use of this instrument, a little amount of blood is drawn from the finger and analyzed to ascertain the blood type of the user. Utilizing a tiny needle to draw blood from a vein, such as one in the arm or hand, is another minimally invasive technique[13]. Compared to conventional venipuncture, which entails using a bigger needle to take blood from a vein, this technique is less intrusive. Researchers are also investigating the use of minimally invasive processes, such as microfluidics and biosensors, to identify blood group antigens in tiny amounts of blood, which may allow quick and reliable blood type diagnosis without the requirement for invasive treatments[11]. The use of less invasive techniques for blood group identification has several benefits over standard blood sample techniques. First of all, they result in less discomfort and stress for patients because they call for smaller incisions or needle punctures. Second, compared to conventional blood drawing, these techniques often result in smaller scars and less recuperation time.

2) Photometric blood typing

Specialized cameras are used in this method to look for specific antigens on the surface of red blood cells. The blood type may be determined by the cameras using light absorption and reflection, and the findings can be acquired in a matter of minutes. When quick blood type is required to inform transfusion decisions, photometric blood typing is very helpful[21]. Due to its speed, simplicity, and accuracy, photometric blood typing is a non-invasive blood typing procedure that is often employed in clinical settings. Specialized cameras are used in this method to look for specific antigens on the surface of red blood cells. The blood type may be determined by the cameras using light absorption and reflection, and the findings can be acquired in a matter of minutes. In an emergency, where quick blood typing is required to inform transfusion decisions, photometric blood typing is very helpful. Additionally, it is helpful in cases when conventional serological blood typing techniques may be challenging or impossible to apply, such as in patients with agglutinating antibodies or those with uncommon blood types. All things considered, photometric blood typing presents a prospective substitute for invasive blood typing techniques and has the potential to completely change how blood typing is carried out in clinical settings.

3) Microfluidic-based blood typing

The microfluidic chips used in this method are created to imitate the physical and chemical characteristics of blood arteries. The chips may be utilized to mimic blood typing processes and find out whether a certain antigen is present on the surface of red blood cells. Although it is still in the experimental stage, microfluidic-based blood typing has shown promise in preliminary experiments. The use of microfluidic chips to imitate blood typing responses and

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find the presence of certain antigens on the surface of red blood cells is a unique and promising method for blood typing[19]. The chips have microchannels that may be used to alter and analyze blood samples and are made to replicate the physical and chemical characteristics of blood arteries. In comparison to conventional serological blood typing techniques, microfluidic-based blood typing has several benefits, such as the capacity to carry out numerous blood typing responses at once, a need for smaller sample volumes, and quicker processing times. The methodology is currently in the experimental stage, thus further study is required to improve the method's accuracy and reliability and to confirm its efficacy in various clinical settings. Microfluidic-based blood typing has the potential to revolutionize blood typing by offering a quicker, more precise, and less intrusive approach.

3. Literature Survey

Photometric Evaluation In a paper published in 2018, Gupta et al. suggested a photometric technique for non-invasive blood type identification that makes use of the light reflection from the fingers. This technique was discovered to be highly accurate in detecting ABO blood types. NIRS (Near-Infrared Spectroscopy). The application of near-infrared spectroscopy (NIRS) for non-invasive blood group identification was examined in different research by Kobayashi et al. (2019). The researchers discovered that this technique has a high sensitivity and specificity for determining blood group type. Microfluidics Huang et al.'s third research (2020) investigated the application of microfluidic technology for non-invasive blood type identification. Using a Smartphone for Analysis Using a smartphone, Chaudhary et al. (2021) suggested a non-invasive approach for blood group detection. This technique entailed photographing the patient's hand and using a smartphone app to analyze it. The researchers discovered that this technique had a high degree of accuracy in detecting the ABO blood group type.

Disadvantages:

• Lack of clinical validation

• Limited detection range

By using biological markers found in tear fluid, the device continually and non-invasively checks a patient's health state, doing away with the necessity for blood sampling. Biosensors, an optional display, and electronic interconnects are all part of the system. This innovative method represents a significant advance toward continuous and non-invasive physiological Blood Glucose monitoring, which can significantly enhance the management of diabetes.

Disadvantages:

• This method only provides rough Blood Grouping concentrations.

• Need for PDMS layer, which costs high

The sensor, which is flexible and optically transparent and has gold electrodes sandwiched between two PDMS layers, is described in the publication. Without any manual alignment, a revolutionary self-registration approach was used to create the sensor. The sensor was created utilizing "Soft-MEMS" techniques without sticky agents and was able to track tear Blood Grouping levels.

Disadvantages

• Lack of clinical validation

• Limited detection range

In the year 2020, Jasbir N. Patel, Bonnie L. Grey, and Bozena Kaminska suggested a non-invasive blood group identification algorithm to classify blood (ABO Blood). The following approach was used to implement this system: image acquisition, image pre-processing and segmentation, blood group type detection, image pre-processing, which includes the submodule technique HSV conversion. Using inexpensive mobile phones to capture photographs of the fabric strip after testing, the suggested system then uses noise reduction to analyse the images and determine the blood type automatically.

Disadvantages

• Tested using a limited sample size of blood samples.

• Lack of larger and more diverse samples.

4. Proposed System

Designing a portable, non-invasive Blood Grouping monitoring device is the goal of the suggested system. It can ascertain the blood grouping type and display it on the LCD screen. The NIR sensor and Proteus virtual tool are used to collect the online and offline data at first.

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Utilizing techniques for data cleansing, data transformation, and data reduction, the obtained data are pre-processed. Techniques for feature extraction, including Principle Component Analysis (PCA) and Independent Component Analysis (ICA), are used for the pre-processed data. Techniques for feature selection, such as the Fisher score and correlation coefficient, are used to process the extracted data. The patient's blood type is identified utilizing the Local Binary Pattern (LBP) of CNN and image processing methods from ORB. To effectively predict blood groups, the design incorporates suggested data-gathering techniques, signal processing, point computing procedures, and machine learning algorithms. In impoverished nations, it is especially important to have access to inexpensive blood grouping tests, and a smartphone is an access device that may make this feasible. The hemoglobin location is determined by the suggested approach using information from spectroscopic measurements, image detector data, and a photoplethysmography (PPG) detector. The optimum data collecting locations are the lower eye conjunctiva and the fingertip region. A near-infrared LED light is utilized as the implicit light source to record blood grouping responses from live tissue. PPG signals recorded under vivid light sources can offer important physiological data. Following a binary-wavelength theoretical framework, the characteristics of PPG signals acquired under NIR LED are thought of as stylish signal combinations, and inheritable algorithms are utilized to choose the best features. To predict blood grouping scenarios from the chosen characteristics, CNN-based models are finally created.

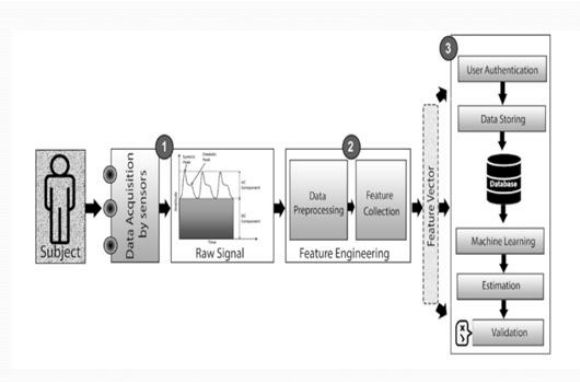

Figure 1. Non-invasive blood group detection Structure

The technique uses immersion and reflectance spectroscopy at 940 nm and 1300 nm, two distinct wavelengths. The voltage values corresponding to the intensity of the incoming light are recorded when the fingertip is positioned between the emitter and the sensor. The shift in light intensity determines how much attention is paid to the blood grouping patch. To verify the correctness of the non-invasive blood grouping data, they are contrasted with those from an intrusive tool called the SD check glucometer.

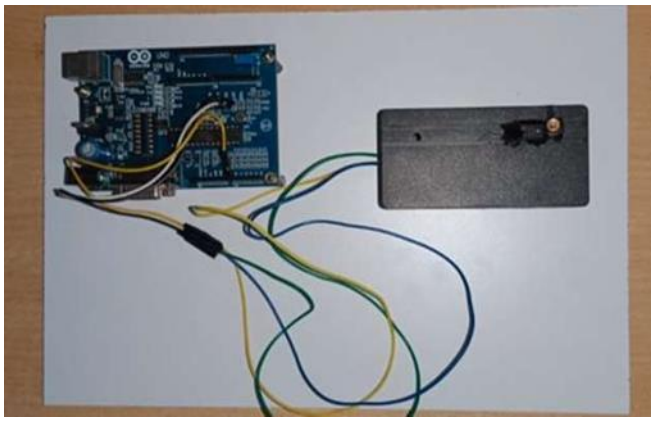

Figure 2. Proposed setup

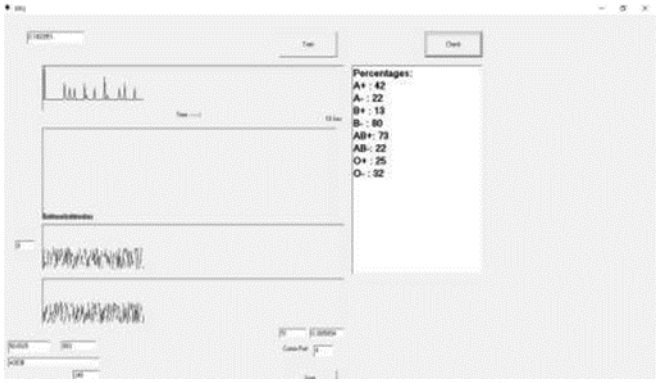

Figure 4. Blood Grouping of an individual type

Three sensors voltage readings are concurrently gathered, and a high-precision 4-channel analog to the digital motor is used to transform the values precisely into decimal form. After logging the data, coherent averaging is performed on the absorbance or scattering values, which are obtained as 128 samples per second. Averaging 1024 samples that were logged from advertisements in 8 seconds is required for the data validation. This technique offers a precise and non-invasive approach to identifying blood grouping molecules, which might be helpful in poor nations where blood grouping tests must be accessible and inexpensive. The sensor's output from three channels serves as the models' input data. The anticipated values are then verified using the calibrated models. Blood Grouping attention levels are predicted using the calibrated models for confirmation. For

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successful prediction, the acquired data from the samples must be transformed into predicted Blood Grouping attention values using an optimized kernel. There are 97 samples total in the dataset utilized for device estimate, including pre-diabetic, diabetic, and healthy people. CNN models are deep learning algorithms that can recognize patterns and characteristics in data by filtering it through several different layers. Several image and signal processing applications, including medical diagnosis and prediction, have effectively utilized these models. In this instance, to forecast the Blood Grouping attention levels, CNN models are trained using input data from the sensors.

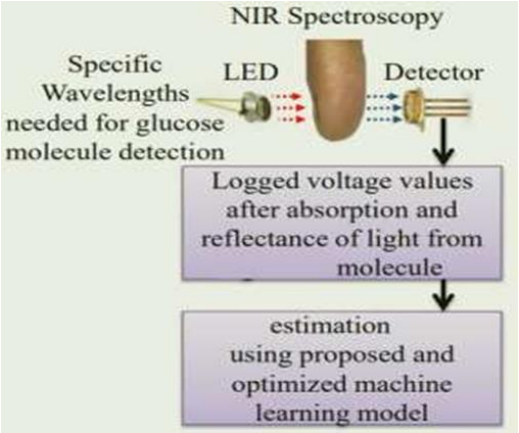

Figure 3. NIRS based Blood grouping estimation

5. Results and Discussion

By contrasting the outcomes of the non-invasive blood typing method with those of conventional invasive blood typing methods, the accuracy of the methodology would be assessed. The accuracy of the technique's identification of the ABO and Rh blood types in a particular population would be used to gauge how well it performed. The debate will concentrate on the benefits and drawbacks of the non-invasive blood typing technique as well as suggestions for future advancements.

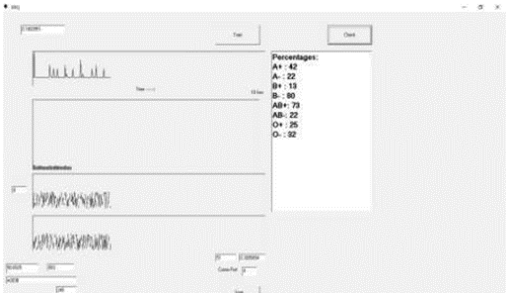

Figure 4. Blood Grouping of an individual type

The findings and subsequent discussion will also point out the potential advantages of non-invasive blood typing techniques in clinical settings, including less patient pain and quicker turnaround times. Overall, the findings and discussion of a study on non-invasive blood type identification would offer insightful information about the viability and potential of non-invasive blood typing techniques and their uses in clinical practise. In circumstances where standard serological blood typing techniques may be challenging or impossible to use, such as in patients with agglutinating antibodies or in people with unusual blood types, the suggested system may potentially investigate the possibilities of non-invasive blood typing techniques. The findings and discussion would offer insightful information on the possible advantages and restrictions of non-invasive blood type techniques and their applicability in various clinical settings, ultimately paving the way for the creation of more reliable and efficient blood typing techniques.

6. Conclusion

The use of image processing for non-invasive blood group detection is a ground-breaking innovation that might revolutionise the way blood typing is done in medical settings. This module provides a more convenient, affordable, and effective alternative to invasive blood tests that can greatly enhance patient care, especially in low-resource settings. A potent tool that can precisely identify a person's blood type and Rh factor from a straightforward digital image of a blood sample has been developed thanks to the integration of image processing and machine learning algorithms. This technique has the potential to revolutionise blood typing and dramatically enhance healthcare services throughout the world with additional research and improvement. The technology described in this paper, which is based on image processing, enables the safe and quick determination of a patient's blood type without the need to draw blood samples, which eliminates the discomfort of being stabbed with a needle. The method is helpful for blood transfusions, emergencies, and other situations since it significantly cuts down on the time and effort required to manually evaluate a patient's blood compatibility. A low-cost, portable system for the automated determination of blood groups is proposed to be developed for future work. Employees take direct photographs of blood slides and identify blood types using portable devices. The project has also been expanded to include an Android app. In the Android

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application, users may photograph a blood slide on their phones to determine their blood type.

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