Non-Invasive Blood Group Detection Using Near Infrared (NIR) Sensor

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***Abstract*— Blood group identification is very important in the Healthcare industry for any type of treatment. The presence or lack of specific antigens, which will provoke an immune response if they are alien to the body, is what determines the blood types. The two antigens A and B on the surface of red blood cells define the presence or absence of the four major blood groups (A, B, AB, and O) We currently use a traditional technique (a manual process) to determine blood group. The blood group must be quickly identified in blood banks and hospitals. The traditional method is labor-intensive and involves a laboriously slow process. As a result, new machinery must be developed to solve all issues related to the manual approach. This study suggests a non-invasive method based on the optical characteristics of blood to identify different blood types. When optical signals are permitted to travel through the finger, light serves as the source, and a detector picks up the wavelength. The wavelength value obtained depends on the type of antigen that is present on the RBC because blood's optical properties vary. Blood group analysis is performed using the wavelength value that was acquired. The results are tabulated and examined.**

***Index Terms:* Blood group, antigen, wavelength, near infrared (NIR).**

I.INTRODUCTION

A specific type of bodily fluid is called blood. Plasma, red blood cells, white blood cells, and platelets make up its four primary parts. Blood performs a variety of tasks, such as transferring waste materials to the kidneys and liver and delivering oxygen and nutrients to the lungs and other tissues. It also forms blood clots to stop excessive blood loss. swiftly and effectively! Platelets are created from hematopoietic undeveloped cells and are formed in the bone marrow through the profoundly directed course of haematopoiesis. Hematopoietic immature microorganisms are equipped for changing into red platelets, white platelets, and platelets. Blood is made out of blood cells suspended in blood plasma. Plasma, which is 55% of blood liquid, is generally water (92% by volume), and contains proteins, glucose, mineral particles, chemicals, carbon dioxide (plasma being the primary mode for excretory item transportation), and platelets themselves. The primary protein in plasma is the Albumin, and it functions to control the colloidal osmotic tension of blood.

II. LITERATURE REVIEW

In routine clinical assessment, there are many customary methodology and practices for blood group determination, where virtually every one of them manage blood clustering. There is far and wide scope of blood matching techniques, which contrasts from one another as far as responsiveness, reagents and gear required. There are a few tests with their benefits and weaknesses.

Slide test is least delicate technique among other blood group detection tests. In this technique, the contributor or beneficiary blood is blended in with hostile to A, against B and against D independently on the slide. The blood clumping pattern can be outwardly seen from which ABO and Rh antigen type blood is determined. This test completes within 10-15 min and is reasonable. This test is not reliable enough for completely safe transfusion.

Tube test is more delicate and dependable in contrast with slide test. In this technique both forward and reverse grouping is completed. The forward grouping recommends the existence or non- existence of A and B antigens in RBCs and reverse grouping shows the existence or non- existence of anti-A and anti-B in serum. One drop of each antigen added separately in

the different blood samples. These tubes need to be kept for centrifugation in order to analyse clumping of blood. For the purpose of proper mixing of blood with antigens centrifugation been done.

In column/gell centrifugation controlled incubation and centrifuged blood serum or cells are blended in with Anti-A, hostile to B and Anti-D reagents in microtubes. The gel medium traps the agglutinated and non -agglutinated blood cells that are allowed to pass through the column. This differentiates the different blood group.

Plasma and antigens on RBCs and antibodies in blood is determined using microplate technology. The microplate comprises of enormous number of little cylinders that contain a couple of microliters of reagent, which are treated against the blood tests. The centrifugation and incubation of the clumping can be inspected by a programmed readout device.

Rakibul Hasan Sagor , Md. Farhad Hassan , Sabiha Sharmin , Tasnim Zaman Adry, Md. Arefin Rabbi Emon(2020) have proposed a highly sensitive sensor focuse on two Metal-Insulator-Metal (MIM) waveguides and three quadrilateral depressions sandwiched perpendicularly in between the MIM waveguides. The Finite Element Method (FEM) is utilized to explore the transmission characteristics and awareness of the refractive index sensor for various arrangements mathematically. The straight connection between resonant wavelength and refractive index is utilized to detect the materials.To detect human blood groups using the proposed sensor, a mathematical model is developed[1].

Arun Kumar. B, Soundariya.K, Yuvasree.S (2019) in their work titled “An approach towards non invasive blood group detection” have proposed a method towards non invasive blood group detection. The LED emits light that is designed to pass through the finger, and the photo detector collects the light's conveyed information to produce voltage signals. Based on the voltage ranges that specific antigens contain, these voltage signals are acquired and then programmed to the LCD display to show the blood type. The ability to quickly determine a patient's blood type is tremendously helpful. However, before testing, various aspects including finger size, skin tone, and blood pressure should be taken into account. This will serve very useful for the hospitals to detect the blood groups at times of emergencies[2].

Briliant Adhi Prabowo, Agnes Purwidyantri and Kou-Chen Liu(2018) have reviewed the principles of SPR sensor towards miniaturization and low-cost solid-state light source innovation, like laser diode, light-producing diode (LED), natural light discharging diode(OLED) and smar phone display have been accounted for as verification of concept for the future of minimal expense SPR sensor [3].

Mohammad Reza Rakhshani, Mohammad Ali Mansouri-Birjandi(2017) have proposed high responsiveness plasmonic sensor with silver nanorods in square resonator. The resonance frequencies having a direct relationship with the refractive index of the materials under recognition. The refractive index sensitivity values can be obtained as high as 2320 nm/RIU. Its relevance is displayed for the identification of various human blood groups (A, B, and O) [4].

Sandip D. Sahane, Uttam M. Chaskar(2017) have proposed an Easy and Fast Means of Identification of Blood Group Using IR Sensors. The distinction in the sum absorption by each blood group is taken advantage of in order to classify the blood groups. The light from the pulsating IR LED is gone through the blood sample and the transmitted light is then distinguished, conditioned and is changed over into voltage signal[5]

W.H. Mohd Saad, N.A. Abd Salam , F. Salehuddin, M.H. Azmi Ali and S.A. Abd. Karim(2017) have concentrated on various scope of NIR sensor estimation for various concentration of glucose solution. Three distinct frequencies of NIR sensor are utilized for the testing, 800 nm, 940 nm and 950 nm. A few trials were directed to track down the connection between the result voltages and glucose concentration. The consequences of the examinations demonstrated that the direct connection between output voltages and glucose concentration is critical for all NIR sensors utilized and the NIR sensor with a frequency of 940 nm shows the best fit[6].

T.Jayaprabha , A.Suresh(2016) have proposed a technique to detect Blood Flow, Vein and Nerves using an NIR Sensor with RLS Estimation for Embedded Signal Processing. This technique includes to sense, signal conditioning and ADC to sample electrical signal into digital values for further processing[7].

Hui Li, Lei Lin, Shusen Xie(2015) made a study that provide the dispersive relations of refractive index of

human whole blood with different types in the visible and near-infrared ranges and other conditions[8].

T.M Selvakumari, (2011) has suggested that modern electronic correspondence frameworks and fiber optics-based devices assume a prevailing part. The optical property variations made the way for the identification of ABO blood groups of humans utilizing optics. Blood grouping in most cases is done by manual process, which is also time consuming when considering large amount of blood samples. So, in order to overcome this drawbacks, a new instrumentation method, using light pulses from Light emitting diode are allowed to permeate through blood samples by using optical fiber cables at one end. The opposite finish of the optical cable is associated with a photodetector. The optical variations got from the sensors are utilized to adjust the blood group. The voltage variations in the result of the photograph identifier because of optical varieties of ABO blood groups. In light of this technique, the blood gatherings can be effectively distinguished. In medical clinics, the developed instrument has been tried for different blood tests. The voltage levels of the different people are distinguished and noted[9].

Anuj K. Sharma, Rajan Jha, Himansu S. Pattanaik, Gerhard J. Mohr(2009) have proposed a method of detection of human blood group using SPR sensor. The performance of sensor is closely analysed in terms of shift in SPR curve & SPR wavelength. Optimization of SPR units have been carried out for a reliable and accurate blood-group identifier[10].

III. METHODOLOGY

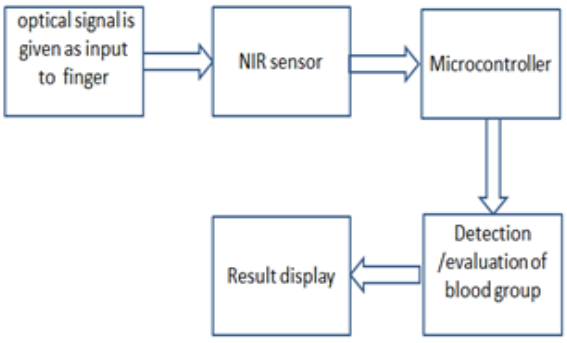

Figure 1: Proposed System

Light acts as a source for optical signals which is permitted to go through the finger and the detector detects the wavelength. As the optical property of blood varies for different antigen present on the RBC, the wavelength value obtained also varies. Depending upon the obtained wavelength value, blood group analysis is done.

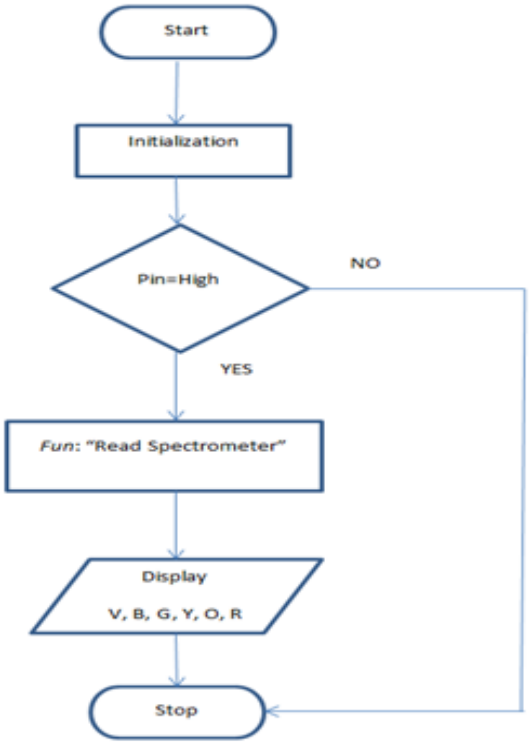

Figure 2: System Flow Process.

Input voltage of 5V is supplied to the microcontroller for initializing. Once the Led turns on index finger is placed and the sensor takes the respective wavelength readings. The obtained wavelengths are displayed in OLED and analyzed.

IV. RESULT

An overall 25 subject data was collected and tabulated. The sensor gives 6-channel output whose wavelength are 610, 680, 730, 760,810, and 860 represented as V, B, G, Y, O, R respectively. A total of 10 subjects including both male and female is subjected for the test procedure, which involves placing index finger in such a way that light passes through it and the variations of blood in the finger is sensed by the sensor. A graph of A+ blood group subject versus their respective wavelength is plotted. The graphical representation of A+ data is shown below in fig.3.

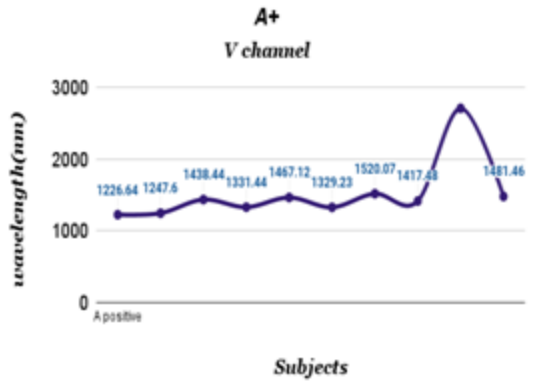

Figure 3: Graphical representation of A+ blood group wavelength

A total of 7 subjects including both male and female is subjected for the test procedure. A graph of B+ blood group subject versus their respective wavelength is plotted. The graphical representation of B+ data is shown below in fig.4. Similarly 4 subjects for O+, and AB+ blood group data is collected and the plotted graph is shown in fig.5 and fig.6 respectively.

Figure 4: Graphical representation of B+ blood group wavelength.

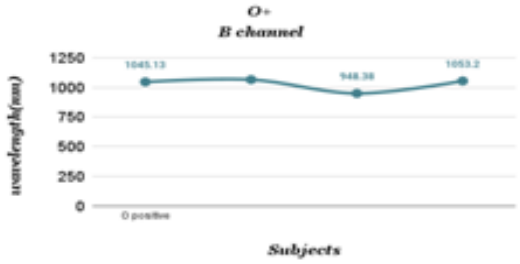

Figure 5: Graphical representation of O+ blood group wavelength.

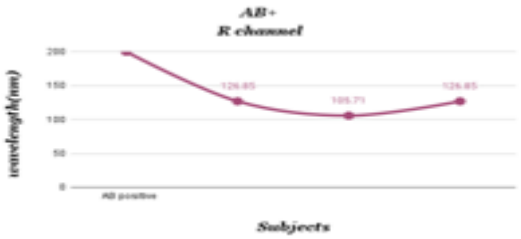

Figure 6: Graphical representation of AB+ blood group wavelength.

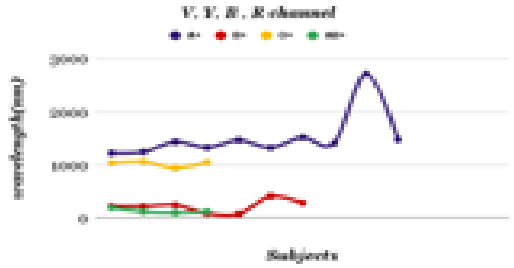

Figure 7: Graphical representation of all 4 blood group wavelength.

The 6 channels of the sensor having wavelength 610, 680, 730, 760, 810, 860nm is used for the above analysis. It is found that the values obtained from 6 channels are in descending order that is the wavelength value decreases as it moves from 610nm to towards 860nm. For each subject the values obtained almost remain same for all 10 fingers. The wavelength values are obtained in V, Y, B, R, channel at 610, 760, 680,860nm for A+, B+, O+, AB+ respectively. In order to confirm the relationship there is a necessity to collect more data and analyze it.

V. CONCLUSION

Determination of blood group is very important and it is a basic test among all the test which are performed. It is a necessary parameter which has to be known for any medical emergencies and it plays a major role during blood transfusion and also during pregnancy. In Present invasive technique which involves drawing of blood from the patient, such as slide test, tube test, column/gell centrifugation etc, is followed which is painful, laborious and time-consuming. This project proposes a method to determine different blood group non -invasively based on optical properties of blood using NIR sensor. Light act as a source for optical signals which is allowed to pass through the finger and detector detects the wavelength. As the optical property of blood varies for different antigen present on the RBC, the wavelength value obtained also varies. Depending upon the obtained wavelength value, blood group analysis is done. The obtained values are tabulated and analyzed. The problem of human errors, time consumption, inconvenience faced by people can be solved by this proposed idea.

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