Evolution in Electrical and Electronic Engineering Vol. 4 No. 1 (2023) 139-145

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

Development of Optical Fiber Sensor for Blood Types Classification

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DOI: https://doi.org/10.30880/eeee.2023.04.01.016
Received 15 January 2023; Accepted 03 April 2023; Available online 30 April 2023

Abstract: Prior to giving a blood transfusion in an emergency situation, blood type determination is crucial. Currently, technicians must do these checks manually, which is prone to human error. It is crucial to accurately and quickly determine the blood types without human mistake. In order to identify abnormal blood grouping on the human body, a technique based on classification blood grouping has been created. A LED is activated by the analogue input, and the LED then transmits light through fiber optic Using optical fiber connections, the LED's light pulses are made to fall on blood samples. There will be matching voltage differences in the light detector's output due to the optical variances of the various blood groups. As a result, we can quickly determine the blood by each of their group which is A, B, AB and O.

Keywords: Blood, Plastic Optical Fiber, Grouping

1. Introduction

Blood typing is a method to tell what type of the blood that we have [1]. Blood type grouping is performed just before blood donation or blood transfusion in order to ensure the blood correctly supplied to specific patient [2]. Besides, the blood type classification is performed to see if some of the substance called Rh factor on the surface of the red blood cells. Our blood type is based on whether or not certain proteins are on the red blood cells [3]. These proteins are called antigens and our blood type (or blood group) depends on what types of the generation passed to next generations. Blood is often grouped according to the ABO blood typing system. There are 4 major blood types which is type A, type B, type AB and type O. In this project, fiber optic is playing as a prominent role as the blood type classifier. The flexibility of the fiber makes it suitable to be used for transmitting and receiving light for sensing purpose. The light is passed through the blood sample and variation in the reflection light is measured to determine the blood types. Usually, doctor takes approximately 10 minutes to determine blood types. This procedure is done using special antigen and perform manually on the special card [4]. In such an emergency case, even there are delay in time in transfusion blood may lead to the death of the patient.

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So due to delay of manual method, the plastic optical sensor (POF) was used in this blood grouping to speed up the process. The way it works I will transmit the light from the transmitter to the receiver by through the blood. As the blood clumped on plastic optical fiber (POF), it changes the light intensity and this change by the value that detected by receiver [5]-[7].

2. Materials and Methods

The method of blood classification detection was divided into 2 parts which is involved manual method and plastic optical fiber (POF) method. The reason this method is conduct is to know the differentiate of time to blood grouping to detect and also differentiate between amount of blood that were used. On manual method, the blood that are mix with the antigen need to be waited for the blood triggered with the antigen to see the result of the blood types while plastic optical fiber (POF) method, when the blood is mixing with the antigen the ambient light that passthrough from transmitter to the receiver will detect and the data will be recorded.

2.1 Materials

The main component that will used for development the sensors that were used in this project is ESP32, TEMT6000, Laser Pointer Beam, PMMA plastic optical fiber, and ABO blood antigen.

a. PMMA plastic optical Fiber

PMMA plastic optic fiber or POF is optical fiber is made from plastic material. POF is widely used in many applications especially in the development of sensor because its less expensive and easy to handle. It's also had properties such as flexibility and lighter in weight. The size diameter that used in this project is a 1mm.

b. Powerful Green Laser Pointer

The laser pointer is used as a light source to illuminate the POF for blood grouping sensor. The power of laser pointer is around 5mW that can illuminate high light luminance that can pass through the blood that are mixed with antigen and can be detected by the sensor.

c. NodeMCU ESP32

The NodeMCU ESP32 module has built in ESP32 module Wi-Fi where it can send data from analogue sensor or digital sensor. Basically, the NodeMCU ESP32 module is used to monitor and saved the data IoT platform. The response of the POF will be shown in LCD 16x2 to monitoring the blood type during the antigen is mixed mix will blood sample.

2.2 Flowchart

Figure 1 shows the flowchart of this study. The output data were produced by light intensity of receiver circuit. The plastic optic sensor (POF) detects the blood if the blood in clumped with the antigen or not. As the blood is clumped on plastic optic sensor (POF), it changes the light intensity and this change the value detected by receiver circuit. The receiver transferred the data signal to the LCD by using NodeMCU ESP32.

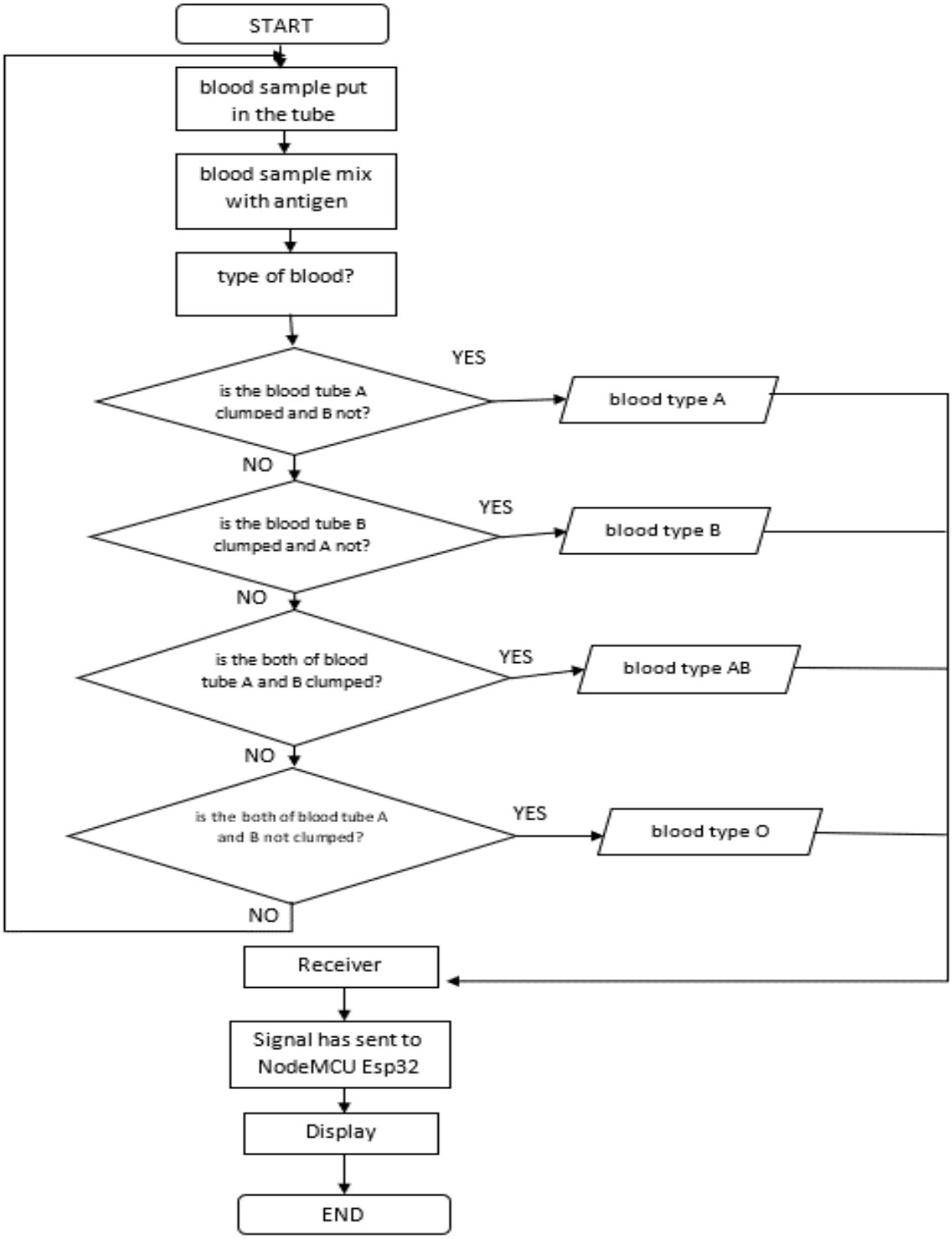

Figure 1: Flowchart of the study

3. Results and Discussion

Figure 2 shows the circuit design on board. Based on the blood sample that have been tested on blood grouping, based on the result that the O blood mixed with the antigen does not clump and the condition of the blood such as water and light can pass through the blood. While for type B blood it is clotted and the condition of the blood forms like a solid and in a concentrated state and light cannot

pass through the blood. It also same on for type A blood it clumped when mix with antigen A while for type AB blood clumped when mix with both antigen which is antigen A and B. Based on the response of the ambient light sensor temt6000, it shows the current voltage of the signal when it detects the light from plastic optical fiber by using the multimeter, we get the result testing on the sensor 1 and sensor 2.

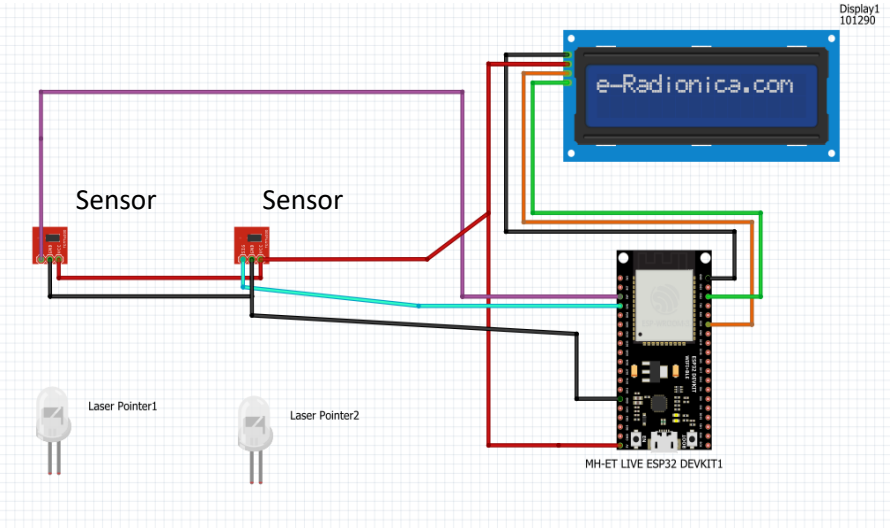

Figure 2: Circuit design on board

The light from optical cable is then passed through the blood sample which is placed in a specially designed black box that made by 3D print. In the two compartment, two receivers are placed just like in Figure 3. The blood sample is placed in the right compartment and light from optical fiber is passed through the blood sample and the transmitted light is then detected by the photodiode in that compartment. These receivers convert their respective input light into voltages by using multimeter. The voltage levels that were shown for the various blood person are noted that are shown in Figure 4 (a)-(d).

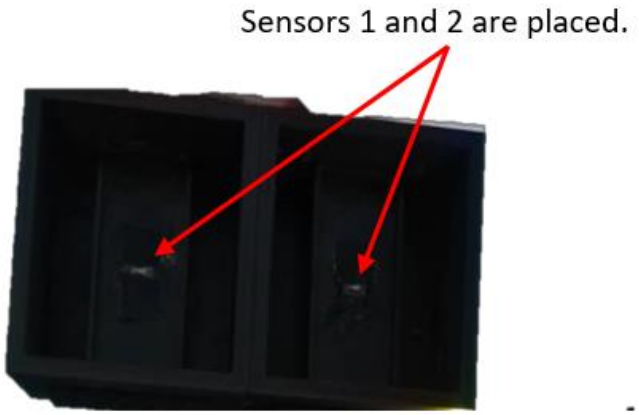

Figure 3: Position of sensor 1 and sensor 2

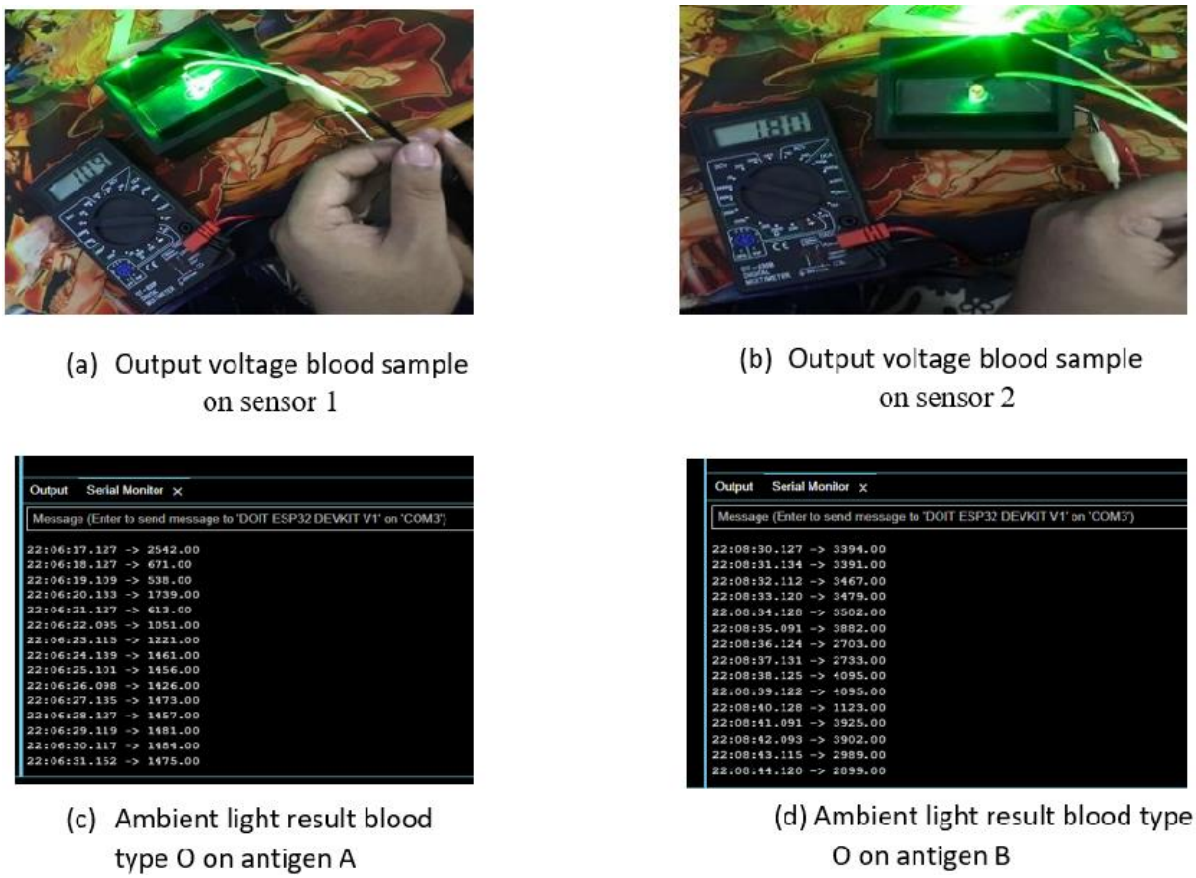

Figure 4: (a) Output voltage blood sample on sensor 1, (b) Output voltage blood sample on sensor 2, (c) Output ambient light blood sample O on Antigen A, (d) Output ambient light blood sample O on Antigen B

After some testing that been made, the result range value for every blood type have been recorded as in Table 1.

Table 1: Example of presenting data using a table

BLOOD TYPE SAMPLE	FORSURE ABO ANTIGEN BLOOD	RANGE VALUE OF THE AMBIENT LIGHT PASSTHROUGH BLOOD (LUX)
BLOOD TYPE A	ANTIGEN A	100 - 1200
	ANTIGEN B	1200 - 3500
BLOOD TYPE B	ANTIGEN A	1200 - 3500
	ANTIGEN B	100 - 1200
BLOOD TYPE O	ANTIGEN A	1000 - 3000
	ANTIGEN B	1000 - 3000
BLOOD TYPE AB	ANTIGEN A	100 - 1200
	ANTIGEN B	100 - 1200

Every blood type has different range current voltage value due to the output that receiver got from the transmit light that passthrough the blood. These receivers convert their respective input light into voltages by using multimeter. The voltage levels that were shown are for the various blood person are noted. The blood group detected by the multimeter was compared with that of the conventional method. Therefore, the voltage levels that are fixed for various blood group are as in Table 2:

Table 2: Example of presenting data using a figure

Blood type	Range voltage
A	2.20 - 2.29
B	2.04 – 3.08
O	1.45 – 1.84
AB	2.61 – 3.14

After the experiment that been made, the range ambient light of each blood type is different. When the blood is clumped the ambient light that transmit through the blood are low due to the blood that clumped will blockage the transmit light from the transmitter to the receiver. While the blood that not clumped that are different because it not blocked the transmit light from the transmitter that will make it easier to the light passthrough the blood to the receiver. Due to that the optical fiber that transmit light need to be adjust to get the suitable value and also the optical fiber need to put correctly on the tube the get the reading.

4. Conclusion

The main objective of this part of the project is to design and detect the blood grouping with the plastic optical fiber (POF) and because of that also the comparison with the manual method also can be made. The development instrumented were tested by several individual for the various blood sample. From the result there are multiple ambient light range value for the blood type and also due to that range, the comparison between the blood type can be made. In terms of future recommendations many areas of the blood test and receiver may be enhanced. The prototype blood test may be need to redesigned to make it more user friendly and make it can be easily to blood sample to clump with the antigen. Next, for troubleshooting process, the receiver may need to enhanced that it only needs to detect the ambient light from the Plastic optical fiber (POF) and the coding to need to improve to get the accurate output. Furthermore, compact wiring eliminates the possibility of a short circuit with the chemical.

Acknowledgement

The authors would like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its support.

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