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Emirates International University
Engineering And IT Faculty
Dep. Biomedical Engineering

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الجامعة الإماراتية الدولية
كلية الهندسة وتكنولوجيا المعلومات
قسم هندسة المعدات الطبية

Design A Non-invasive Blood Group Detector Using Near Infrared Technique

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Dedication

To everyone who inspired us, supported us, and helped us along this route, to those who are still with us.

They are the ones to whom we devote this work, along with our deepest thanks. As well as to our doctors and the entire staff of the department of BIOMEDICAL ENGINEERING at the Emirates International University, particularly Dr. Mushtaq Ali Al-azazi, who oversaw our work and was patient with us until the very end, as well as to those who were always diligent in providing us with the knowledge required to do such work and to those who used to be the light of our path.

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First and foremost, all thankfulness to Allah, the beneficent, the merciful, the one on who all depends on, and none is like him. Allah who helps and guide us to overcome the challenges during our study and our life.

Second, always dedicated to our beloved prophet Mohammed, the last prophet and the prophet who had brought us from the darkness to the brightness.

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Mohammed Abdulqawi Alrefai

Watheeq Nasr Al Asbahi

Hussien Abdul-bary Essa

Abstract

The blood Group Detector is an important medical device that must be existing in laboratories and civil status offices.

As it is categorized to be a diagnostic device it plays a critical role in blood transfusion at emergency & blood group detection for several applications including the identification of population blood groups.

In the civil status offices, many faults & mistakes are happened because of crowding, or the materials used are not effective either because of the expiry date of them is over limited, or poor storing.

Noninvasive blood group detection is an efficient solution for people with a phobia of needles. Also, many other properties of our BGD have made the researchers & academic students globally in a competition to produce noninvasive blood group detectors with lower costs.

We design our BGD by going through multiple levels, starting from choosing the appropriate sensor which helps us to acquire accurate data. Moving towards selecting the exact wavelength and translating the work on the Arduino to end up with a complete system with other electronic components then we make it mobile and finally give it a modern structure shape using modern technology.

After getting our marvelous device ready we tested it with different volunteers from different ages and other factors and added a database to our research. We proved its quality with unknown blood group type people as soon we finished. BGD is worth the work, but it needs more work and improvement to enhance its results and get an approximately zero error.

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LIST OF ABBREVIATIONS

ABO	Blood group types
BGD	Blood Group Detector
DAC	Digital to Analog Converter
Ig…	Immuno-globulins
IR	Infra-red
IREDs	Infra-red Emitting Diodes
LED	Light Emitting Diode
NIR	Near Infra-red
OPT	Optical Photo Transistor/Transmittance
RBCs	Red Blood Cells
Rh	Rhesus factor
TFT	Thin Film Transistor
f	Frequency
λ	Wavelength

Chapter 1

Introduction

1.1 Introduction

Blood types (also known as blood groups) are a classification of blood, based on the presence and absence of antibodies and inherited antigenic substances on the surface of red blood cells (RBC's). These antigens may be proteins, carbohydrates, glycoproteins, or glycolipids, depending on the blood group system. Some of these antigens are also present on the surface of other types of cells of various tissues several of these red blood cell surface antigens can stem from one allele (or an alternative version of a gene) and collectively from a blood group system. [1]

When a blood transfusion is needed to save a life, the first thing the physician must do is to test the blood group of the donor, so in such case knowing the blood group is important. Another scope of importance is during the pregnancy to know the blood group of both mother and her baby to avoid any future complications.

1.2 Motivation and Problem Definition

Tests of the blood type are important to check in the case of blood transfusion or knowledge of the blood type of the baby after birth to see if he/she carries the same type as the mother or father, in case the types differ between them, if the baby has a different blood type from his mother, then the mother is having to medicate with a special drug to keep the next baby safe else the way the mother's body is going to produce antibodies against the cells of the baby. As well as knowing the blood type of patient that is undergoing chemotherapy because chemotherapy works to change the factor of Rhesus, so a blood type test is needed every time before the therapy session. But there's a lot of people whose are afraid of surgical intervention as well as errors in analysis of blood test, which potentially occurs in any area by unqualified physician, expired solutions, or any other reasons. Also take in account the infection due to use unsterilized kit. So, we are about to design a device for blood type examination without surgical intervention (non-invasive) and through infrared which avoids test errors, transmission of infections and accuracy in analysis.

1.3 Project Objectives

The main objective of this project is to design a device that do blood type's test and include the features blew: -

1. Non- invasively.
2. Accurately in the results of the examination.
3. Less time.

1.4 Project Organization

This report contains six chapters divided as following: -

- **Chapter one:**

  This chapter contain a general introduction to the project through problem definition, our idea of solution, project objective, and project organization.

- **Chapter two:**

  This chapter presents the medical and engineering backgrounds of the project.

- **Chapter three:**

  This chapter presents the block diagram, system architecture and the flowchart that we have been designed for our project.

- **Chapter four:**

  This chapter presents the designed circuit & implementation Method of work& Power circuit& Overview.

- **Chapter five:**

  This chapter presents to you the practical results of the final shape and the comparison between values of our project and Previous projects and presents to you our conclusion & future work and troubleshooting of device.

Chapter 2

Background

2.1. Introduction

This chapter introduces the mine and major part of our project starting with the medical background which is let us know more about the blood in the human body and its components as well its properties, after that the engineering background is to come to tell us more about earlier tries and studies and how did the previous studies deal with these issues in order to create suitable method to do this test, and finally our work and what it is aim for.

2.2. Medical Background

2.2.1 Hematopoiesis

Hematopoiesis is production of formed elements of the blood normally, it takes place in the bone marrow. Circulating blood normally contains three main types of nature blood cells:

1- Red blood cells (Erythrocytes).
2- White blood cells (Leucocytes).
3- Platelets (Thrombocytes).

These blood cells perform their respective major physiologic functions:

Erythrocytes largely concerned with oxygen transport, leukocytes play various role in body defense against infection and tissue injury while thrombocytes primarily involved in maintaining integrity of blood vessels and in preventing blood loss. The lifespan of these cells in circulating blood is variable neutrophil have a short lifespan of 8-12 hours, followed by platelets with lifespan of 8-12 days, while the RBC's have the longest lifespan of 90-120 days. The rates of production of these blood cells are normally regulated in healthy individuals in such a way to match the rate of which they are lost from circulation [1].

2.2.1.1 Hematopoietic organs

In the human embryo. The yolk sac is the main site of hematopoiesis in the first few weeks of gestation. By about 3rd month, however, the liver and spleen are the main site of blood cell formation and continue to do so until about 2 weeks after birth. Hematopoiesis commences in the bone marrow by 4th and 5th month and becomes fully active by 7th and 8th month, so that at birth practically all the bones contain active marrow.

During normal childhood, and adult life, therefore, the marrow is the only source of new blood cells. However, during childhood there is progressive fatty replacement throughout the long bones, so that by adult life the hematopoietic marrow is confined to the central skeleton (vertebrae, sternum, ribs, skull, sacrum, and pelvises) and the proximal ends of the femur, tibia, and humerus [1].

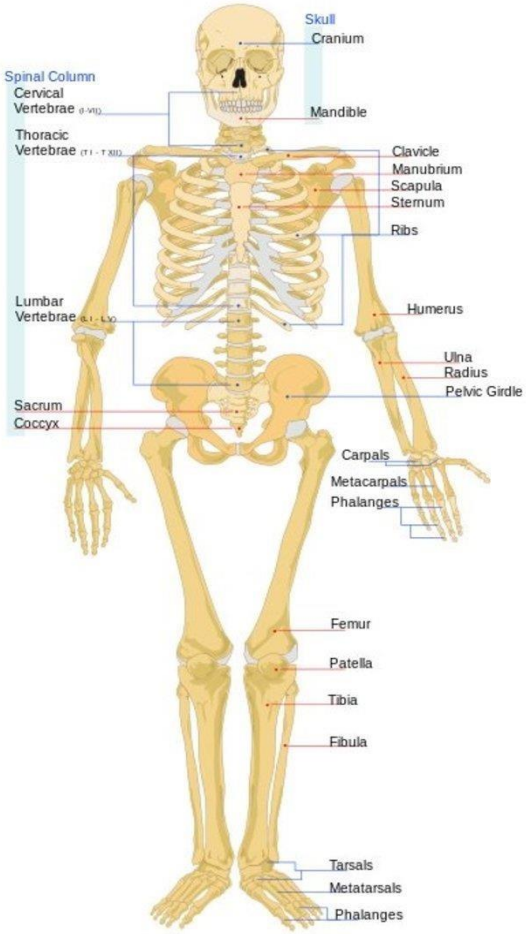

Figure 2.1: Hematopoietic regions of the skeletal system.

2.2.2 RBCs Biology and Preservation

The areas of RBC biology are crucial for normal erythrocyte survival and function:

1- Normal chemical composition and structure of the RBC membrane.
2- Hemoglobin structure and function.
3- RBC metabolism.

Defects in any or all these areas will result in RBCs surviving less than the normal 120 days in circulation.

2.2.2.1 RBC Membrane

A- Basic concepts

The RBC membrane represents a semipermeable lipid bilayer supported by a mesh-like protein cytoskeleton structure [3]

Phospholipids, the main lipid components of the membrane, are arranged in a bilayer structure comprising the framework in which globular protein traverse and more than as Figure 2.2 illustrates.

Proteins that extend from the outer surface and span the entire membrane to the inner cytoplasmic side of the RBC are termed integral membrane proteins [2]

Beneath the lipid bilayer, a second class of membrane proteins, called peripheral proteins is located and limited to the cytoplasmic surface of the membrane forming the RBC cytoskeleton [3]

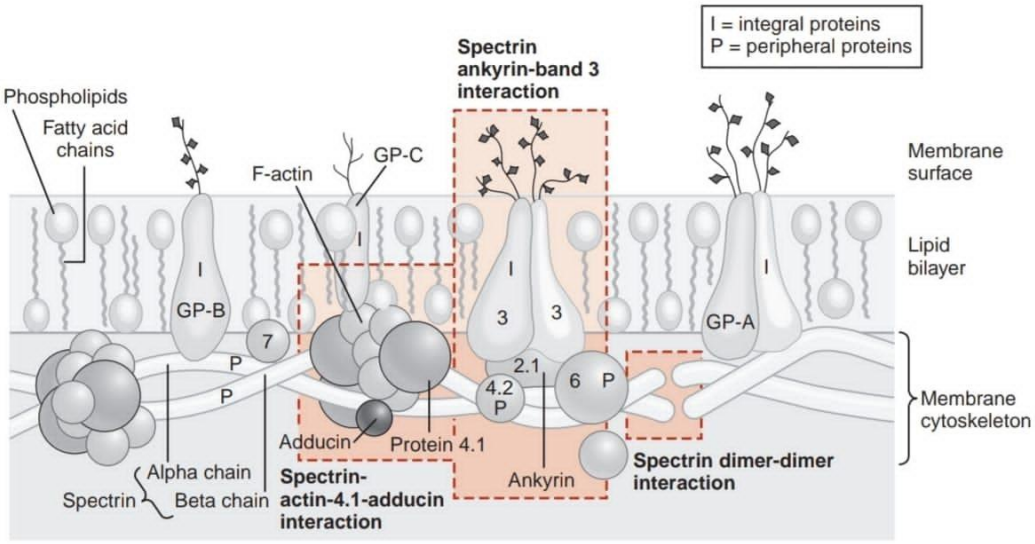

Figure 2.2: RBC membrane.

B- Advanced concepts

Both proteins and lipids are organized a symmetrically within the RBC membrane. Lipids are not equally distributed in the two layers of the membrane [2].

The external layer is rich layer in glycolipids and choline phospholipids [4].

The biochemical composition of the RBC membrane is approximately 52% protein, 40% lipid and 8% carbohydrate [5].

The erythrocyte membrane is crucial to the normal length of RBC survival of 120 days in circulation.

In addition, they maintain a critical role in two important RBC characteristics:

- Deformability.
- Permeability.

2.2.2.2 RBC functions:

Red blood cells are responsible for transporting oxygen from your tissues produce energy with the oxygen release a waste identified as carbon dioxide. Your red blood cells take the carbon dioxide waste to your lungs for you to exhale [6].

2.2.3 ABO Blood Grouping

Several blood group systems have been described in humans. Of these, the ABO blood group system is most significant. But before going farther let us discuss some blood components and properties.

2.2.3.1 Blood Components

- Antigen

An antigen is a substance usually a protein which when introduced into on individual who recognize it as foreign, leads to the production of antibody. This antibody specifically reacts with antigen.

On the red cell surface there is presence of glycoproteins which act as antigens.

They are called blood group antigens. These antigens can be on the surface, below or protrude from the red cell membrane.

If introduced into the body of on individual who lacks the antigens on immune reaction can occur [7].

- Antibodies

These are immunoglobulins present in the serum and can be of 5- types: - IgG, IgM, IgD, IgA and IgE.

If red cells carrying an antigen are introduced into the circulation of an individual who lacks that antigen, antibodies will form and cause destruction of the introduced red cells.

These are immune or acquired antibodies and are IgG in nature they react best at 37℃ [7].

2.2.3.2 Blood Properties:

- Sensitization

It is the combination of antigen and antibody. This is a reversible reaction [7].

- **Agglutination**

It is the clumping of red cells. It occurs when sensitized cells meet each other resulting information of bridges between them and formation of aggregates. It is the most common procedure in blood in blood banking [7].

- **Hemolysis**

As the name suggests is destruction of red cells resulting in the release of hemoglobin from the cells due to the action of complement. This is used in antibody screening tests [7].

- **Neutralization**

Blood group antigens when added to serum containing antibody can neutralize it. This is used in determining secretor status.

If the strength of the antibody reduced, the antigen antibody reaction is assumed to have occurred [7].

- **Genotypes**

This refers to the gens present on the chromosome inherited from each parent irrespective of whether they produced any product which is detected [7].

- **Phenotypes**

This is used to describe the observable effect of the inherited genes or expression of the genes i.e. The blood groups [7].

2.2.4 Blood Group System

2.2.4.1 ABO system

Among the 33- systems. ABO remains the most important in transfusion and transplantation since any person above the age of 6 months possess clinically significant in their serum and vice-versa, while blood group O contains no AIB antigen but both their antibodies in serum [9].

The ABO grouping system is subdivided into 4 types, the antigens and corresponding antibodies in each blood group are shown below.

Table 2.1: ABO grouping system.

Group	Antigen	Antibody
A	A	Anti-B
B	B	Anti-A
AB	A and B	—
O	—	Anti-A, Anti-B

2.2.5 Rhesus system

Rhesus – system is the second most important blood group system after ABO. [10]

Currently, the Rh- system consist of 50 defined blood group antigens out of which only five are important. RBC surface of an individual may or immunogenic D-antigen. Accordingly, the status is indicated as either Rh- positive (D- antigen present) or Rh- negative (D- antigen absent).

In contrast to the ABD system, anti Rh antibodies are, normally, not present in the blood of individuals with D- negative RBC, unless the circulatory system of these individuals has been exposed to D- positive RBCs. These immune antibodies are immunoglobin G (IgG)in nature and hence, can cross the placenta, prophylaxis is given against Rh immunization using anti- D Ig for pregnant Rh- negative mothers who have given birth to Rh- positive child [9].

2.2.6 How to check blood groups.

Material required:

1. Glass slides / white tile.
2. Monoclonal antisera A and antisera B.
3. Glass rod for mixing.
4. Marker pen.

Method:

1. Mark one side of the glass slide as A and other side as B.
2. Put one drop of antisera A on the side marked as A and one drop od antisera B on the side marked as B.
3. Add one drop of test blood sample 20% cell suspension to each antiserum.
4. Mix the blood with the reagent using clean stick, spread the mixture over an area of 15mm diameter.
5. Gently rock the side to and look for agglutination.
6. Record the result.

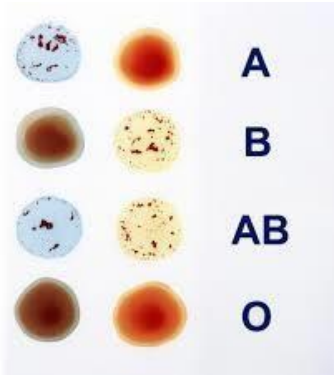

Figure 2.3: Blood clotting.

2.3. Engineering Background:

Since there is no specialized device of blood type analysis, a device our project is based on finding a device that performs this examination without surgical. Intervention through infrared rays.

Blood Group Project a Previous Study:

A - ABO blood group detection based on image processing technology.

A fast, accurate and rebuts method was used to judge blood type based on the image features of the ABO blood group rapid analyzer.

This a method is proposed based on processing of images acquired from laboratory. The image processing techniques such as segmentation, morphological operations and circular through transform are used. Accuracy of the system is high with very low execution time [10].

Manipulation of images using various filters and transformations is known as image processing. Image, as it is represented in computer is nothing but a matrix of intensities values for those three layers namely red, green and blue.

Acquisition of blood images is done using an optical device(camera):

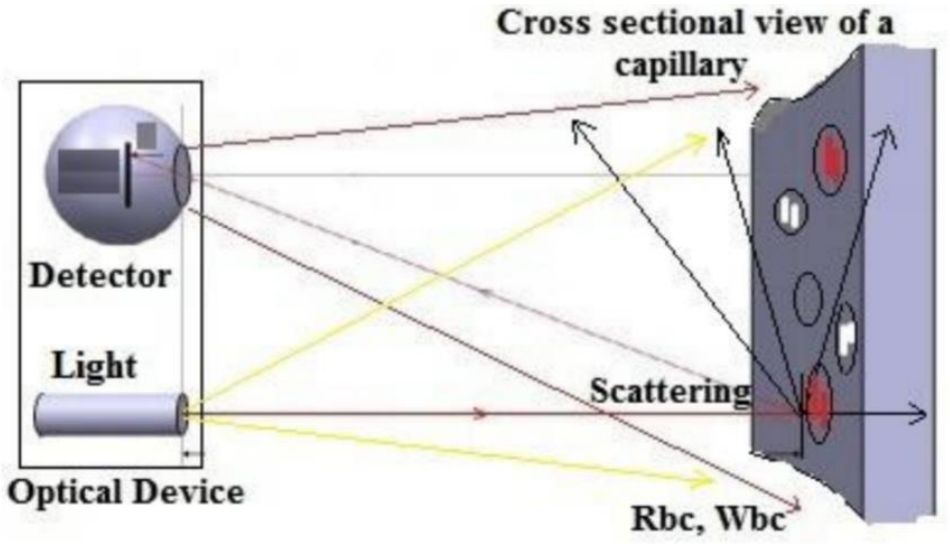

Figure 2.4: Scattering of light triggers the photo detectors to trace both of light reproduced in the images captured by the optical device.

Pattern matching/recognition and interpretation:

This step involves identifying the repetitive pattern in the images by using various pattern matching algorithms.

MATAL programming is used as a software tool for effective pattern matching algorithm implementation and image analysis.

Here the sensitive detectors map the path of light by taking multiple images and plot it onto a graph to represent minute fluctuations of scattered light.

The captured images are consolidated to elucidate the specific pattern for a particular blood group type filter (Low pass/High pass) are applied to these captured images to reduce noise produced by the unwanted deflections from other molecules/components of blood like type.

This data is stored in the database for future pattern matching processor.

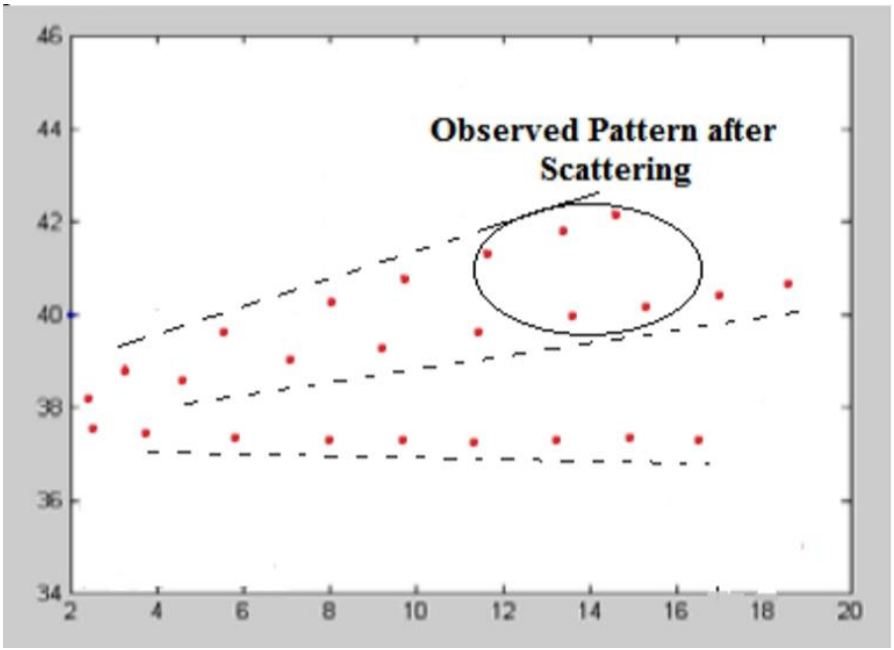

Figure 2.5: The scattering of light over several wavelengths is charted on a graph showing the tiny deviation by antigenic substances in the blood (-A).

Conclusion:

The methodology presented in this work, based on image processing allows determining safely, the blood type of patient, within a short time without the necessity of taking blood samples, therapy eliminating the pain of being stuck with a needle.

The process is useful in emergency situations, blood transfusions, etc. as it greatly reduces the time and hassle of manually testing blood compatibility for the patient.

B - A Project Submitted for The Degree of B.S.C

Non-invasive method was used to determine blood type, light act as a source for optical signals which is allowed to pass through the finger and detector defects the varying voltage. Depending on the output voltage, the blood type is detected.

Chapter 3

Block Diagram, System architecture & Flowchart.

3.1. Introduction

This chapter present to you the block diagram that we have been designed for our project. And system architecture and the flowchart that illustrates the flowchart of the flow whole process of operation.

3.2. Block diagram

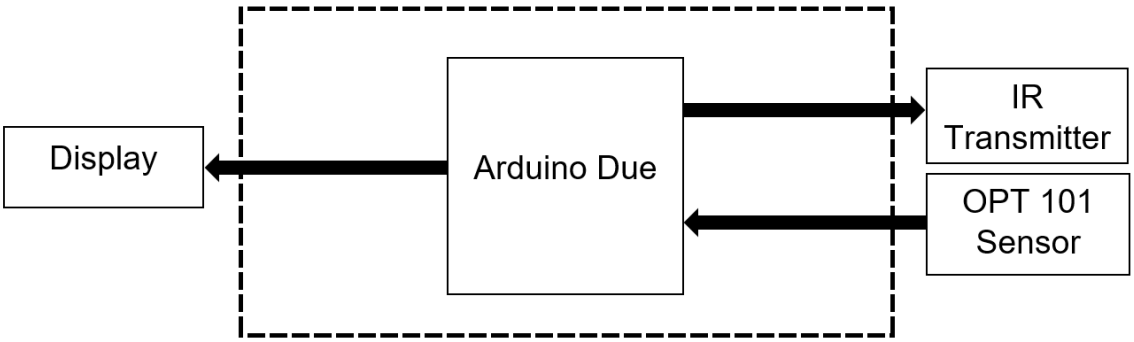

Figure 3.1: Block Diagram of Our Project.

This is the core level of our project which illustrates the assumption that we have built our project based on. It consists of multistage level of gathering a signal, then filter that is the processing stage which determines and identify the blood type, finally we have the displaying stage where the results are shown for visual identification.

IR Transmitter: - To transmit near infrared rays with a wavelength of 940 nm.

OPT 101 Sensor: - Receive the transmitted infrared via the human finger and convert it to an electrical signal.

Arduino Duo: - Which reads the voltages coming from the OPT101 sensor and processes them to determine the type of blood type and sends the result display.

Display: - To display the results.

3.3. System architecture

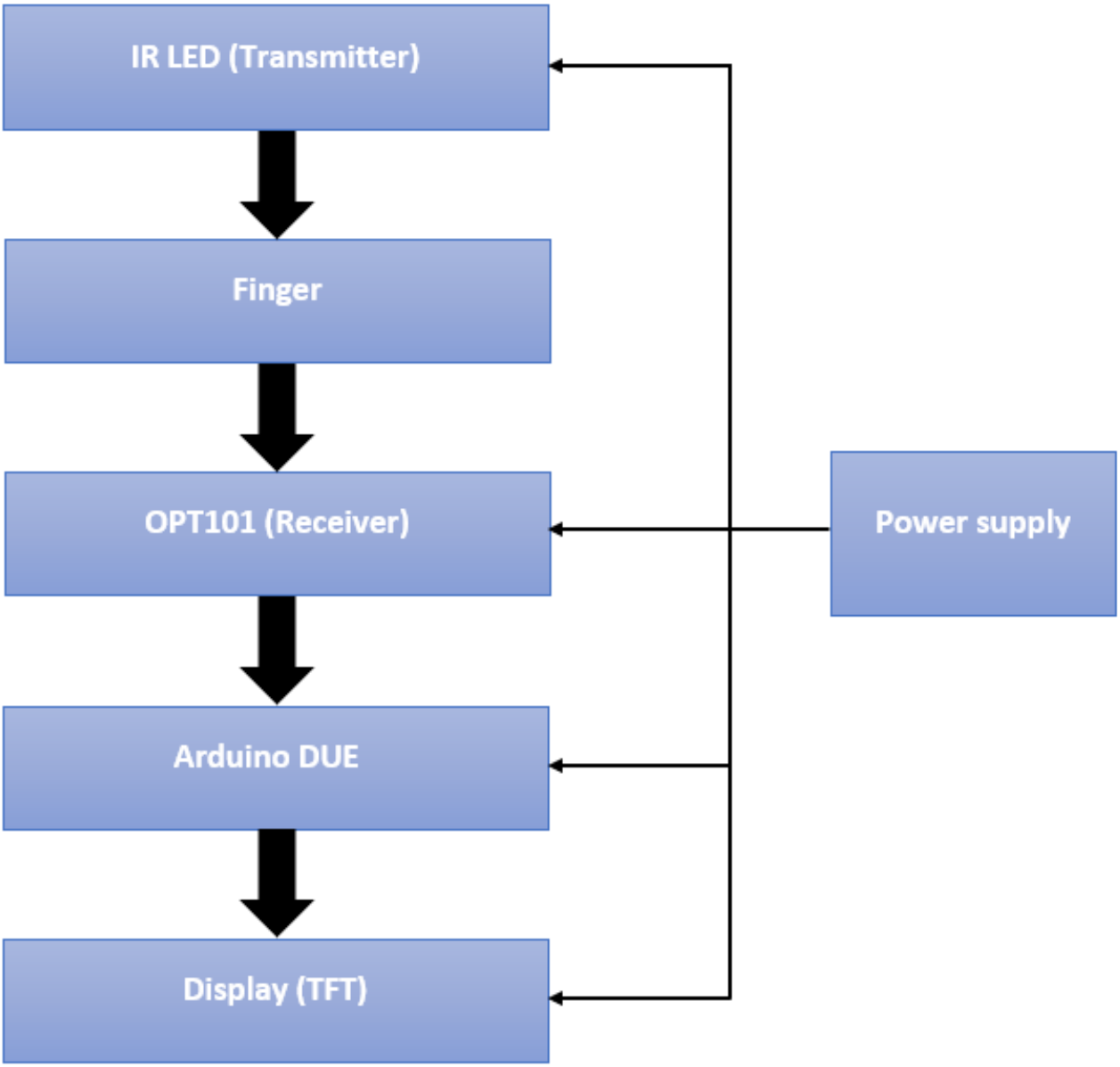

Figure 3.2: System Architecture.

Figure 3.2 shows the structure of the system, where we connect the sensor, LED, Arduino, and the screen to the power source.

The person put his finger on the sensor, and the LED sends an infrared ray that penetrates the finger. The sensor receives the transmitted rays from the finger and converts it to processing it, determining the type of species and displaying the result on the screen.

3.4. Flowchart

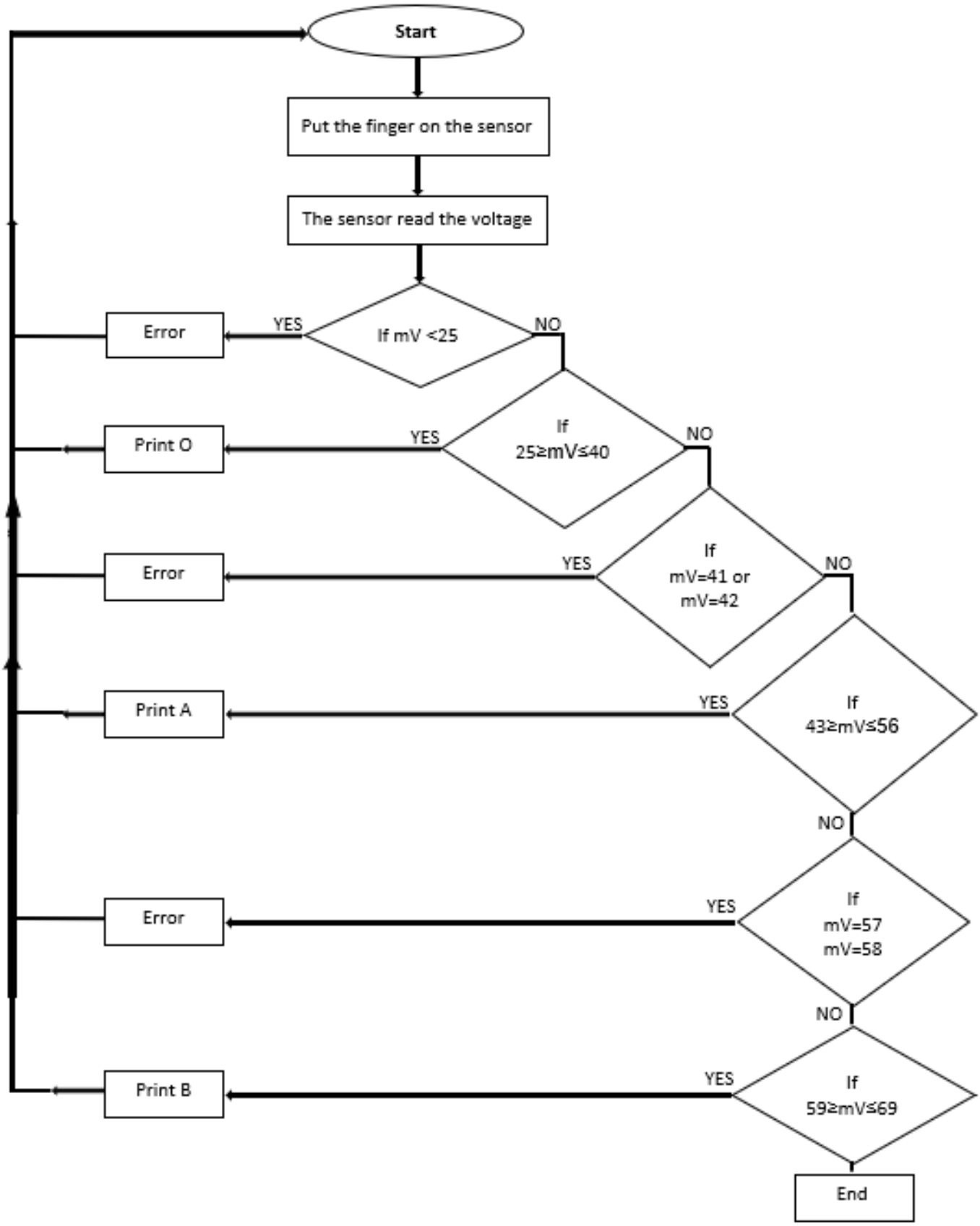

Figure 3.3: Flowchart of the BGD.

Figure 3.3 shows how the device works and how it handles the voltage sent to the processor, where the device starts and the person put his finger on the sensor, if the voltage is less than 25mV, the result is error, but if it between 25-40 millivolts, the result is type (O), and if the voltage is equal to 41 or 42 millivolts the result is error, but if it is between 43-56 millivolts, the result is (A), but if the voltage is equal to 57 or 58 millivolts, the result is error, but if it is between 59-69 the result is (B) then the program ends.

Chapter 4

Designed Circuit & Implementation & Method of work& Power circuit& Overview

4.1. Introduction

This chapter presents the design circuit of the device, which we used to design the fritzing program, and it also explains the components used in the construction of the project and describe the method of work, power circuit, and the overview of project.

4.2. Designed Circuit

In design of the circuit, we used the fritzing program, where the circuit design shows us the connection between pieces and the Arduino board, where we connected the positive pole of the LED on DAC1 terminal, the negative pole of the ground and the OPT101 sensor, where we connected Vcc to 5v and connected the 1MΩ resistor with the out and connected it to the A11 terminal in Arduino, and we connected the -V with the COM and connected it to the ground, we connect the positive pole of the buzzer to the terminal 22 and the negative pole to the ground, and we connected the screen of the type TFT2.8 by connecting:

RD⟶A0, WR⟶A1, RC⟶A3, Cs⟶A3, RST⟶A4 ,5V⟶5V, GND⟶GND, D2⟶2, D3⟶3 D4⟶4, D5⟶5, D6⟶6, D7⟶7, D0⟶8, D9⟶9 as shown in figure 4.1.

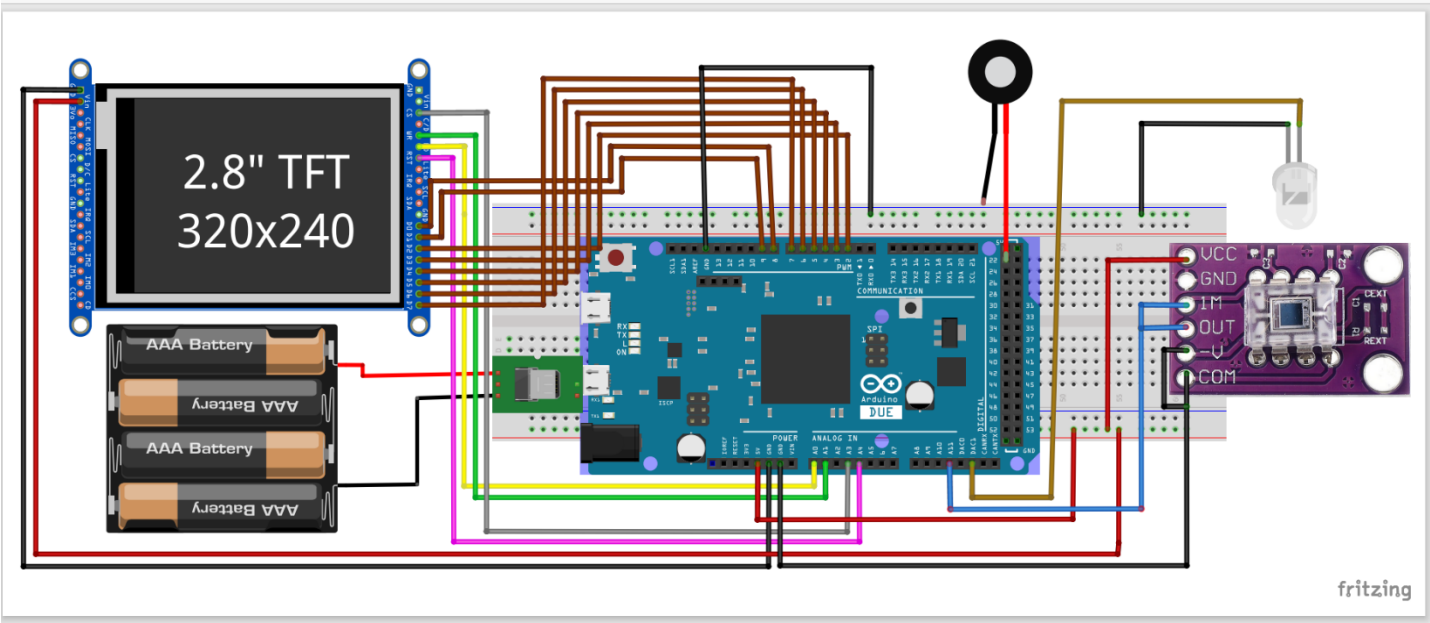

Figure 4.1: Designed Circuit.

4.3. Implementation

4.3.1 OPT101 Sensor: -

OPT101 is a large area photodiode integrated with an optimized operational amplifier that makes the OPT101 a small, easy-to-use, light-to-voltage device.

The photodiode has a very large measurement area that collect a significant amount of light, and thus allows for high-sensitivity measurements.

The photodiode has a wide spectral response with a maximum peak in the infrared spectrum, and useable range from 300nm to 1100nm.as shown in figure: 4.2.

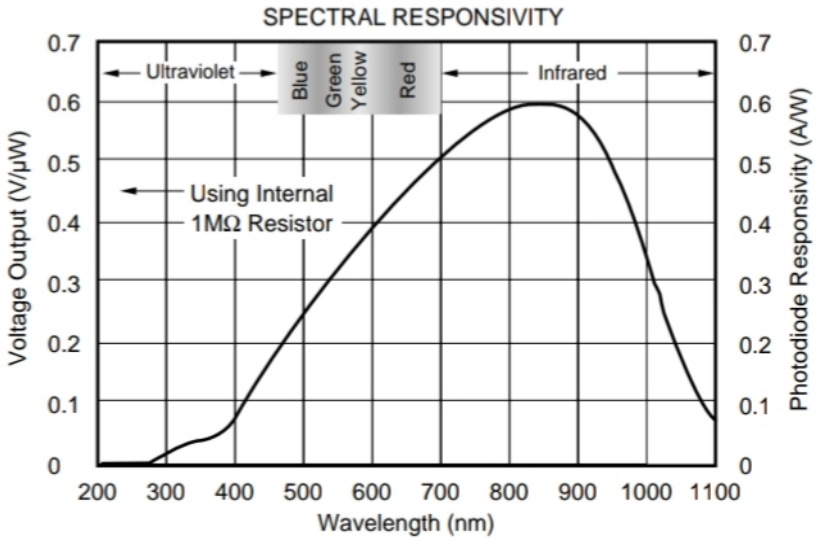

Figure 4.2: Curve spectral response.

The wide power-supply range of 2.7V to 36V makes this device useful in variety of architectures; from all-analog circuits to data conversion base circuits.

The on-chip voltage source keeps the amplifier in a good operating region, even at low light levels.

The OPT101 voltage output is the product of the photodiode current times the feedback resistor, (ID RF) pulse a pedestal voltage, VB of approximately 7.5mV introduced for signal-supply operation.

Output is 7.5mV DC with no light and increases with increasing illumination photodiode current ID is proportional to the radiant power, or flux. Fulling on the photodiode of 650nm (visible red) the photodiode responsivity, R1. Is approximately 0.45 A/W.

The internal feedback resistor is laser trimmed to 1MΩ. Using this resistor, the output voltage responsivity RV approximately 0.45 V/MW at 650nm wavelength as shown in figure: 4.3 [8].

Figure 4.3: OPT101 Sensor.

The OPT101 is used in medical uses and is used with laboratory equipment.

Pin configuration and functions:

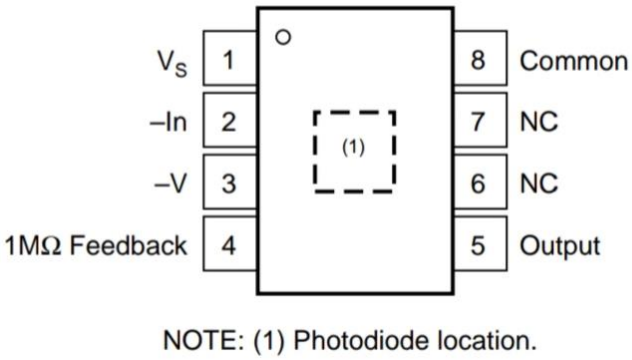

Figure 4.4: OPT101 Sensor pins connection.

Table4.1: Pins Functions.

Pin	Name		
1	Vs	Power	Power supply of device. Apply 2-7v to 36v relative to -v pin.
2	-In	Input	Negative input op amp and the cathode of the photodiode. Either do not connect or apply additional op amp feedback.
3	-V	power	Most negative power supply. Connect to ground or a negative voltage that meet the recommended operation conditional.
4	1MΩ Feedback	Input	Connection to internal feedback network. Typically connect to output, pin 5.
5	Output	Output	Output of device.
6	Nc	**—**	Do not connect.
7	Nc	**—**	Do not connect.
8	Common	input	Anode of the photodiode. Typically, connect to ground.

Table 4.2: Comparison of OPT101, APD and SipMs sensor.

Characteristics	APDS	SipMs	OPT101
Rough diameter (mm)	3	3.50 rb	2
Sensitive wavelength range (nm)	400-1100	200-900	400-1100
Efficiency	Up to 85%	Up to 45%	Up to 90%
Efficiency at 800nm	≈ 80%	5%	86%
Gain	100	107	106
Noise current	100nA	-	2.5pA

Table 4.1: shows the comparison on the negative and positive of OPT101 and other OPT electronic sensors used in NIRs instrumentation. Among all OPT electronic sensor listed, the sensitivity of OPT101 does not stand out; however, it is still high enough to sensitively measure hemodynamic variations in human body noninvasively. Additionally, OPT101 is of high gain and low cost. Pulse, OPT101 has a built-in trans impedance amplifier and does not need any more electronic in clinical NIRs instrumentation, unlike APDs and SipMS. It can be simply embedded with LEDs in a soft electronic circuit pad, making NIRs more portable and even wearable.

The advantages of OPT101, including sensitive-enough responsivity, mini-size structure, advanced electronic properties, and low cost, make it quite suitable for us beside core instrument design in recording light intensity variations at selected wavelengths to measure human body hemodynamic [9].

4.3.2LED (near infrared 940nm)

Infrared radiation (IR), sometimes referred to simple as infrared, is a region of the electromagnetic radiation spectrum where wavelength range from about 700nm to 1mm.

Infrared waves are longer than those of visible light, but shorter than those of radio waves.

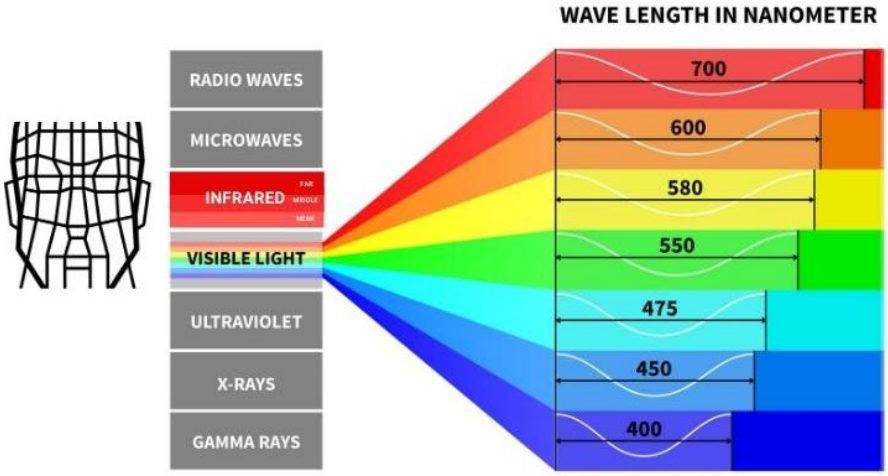

Figure 4.5: Wavelength in visible light.

Correspondingly, the frequencies of IR are higher than those of microwaves, but lower than those of visible light, ranging from about 300GHz to 400THz.

Infrared light is invisible to the human eye, although longer infrared wave can be sensed as heat, it does, however, share some characteristics with visible light-namely, infrared light can be focused, reflected, and polarized [10].

Here is a reference chart that explains the full electromagnetic spectrum, and electromagnetic waves.

Figure 4.6: LED (Near infrared 940nm).

4.3.3 Infrared light safe: -

Infrared light is safe! Infrared and more specifically, near-infrared are safe for the eyes and the body. Both near infrared technology is far infrared technology are said to have health benefits and can be found in saunas and other red-light therapy devices. [11]

The 940nm series of infrared Emitting Diodes (IREDs) consists of two standard chips in three different packages. All devices use high efficiency GoAS liquid phase epitaxial chips mounted p side down for highest output at 940nm [12].

The 940nm wavelength is used in many medical measurements in which the protein bound on red blood cells such as oxygen, sugar, and type is determined.

Note: - The inverse relationship between frequency and wavelength is depending on when the wavelength is higher the frequency is lower, and when the wavelength is lower the frequency is higher.

$$\lambda = \frac{1}{f}$$

$$f = \frac{1}{\lambda}$$

4.3.4 Arduino Due:

The Arduino Due is one of most powerful board of the Arduino series. It was lunched by Arduino. This board is powered by a 32-bit ARM cortex -M3 processor ATMEL SAM3X8E.

Arduino due board features 52 digital input /output pins an,84MHz clock, two micro-USB ports, an SPI header, a JTAO header pins, an ERASE button, and a RESET button [13].

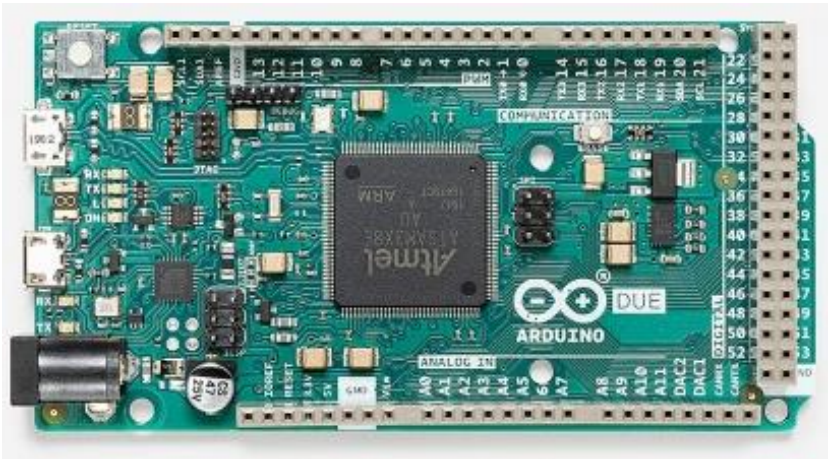

Figure 4.7: Arduino Due.

Introduction to Arduino Due pinout:

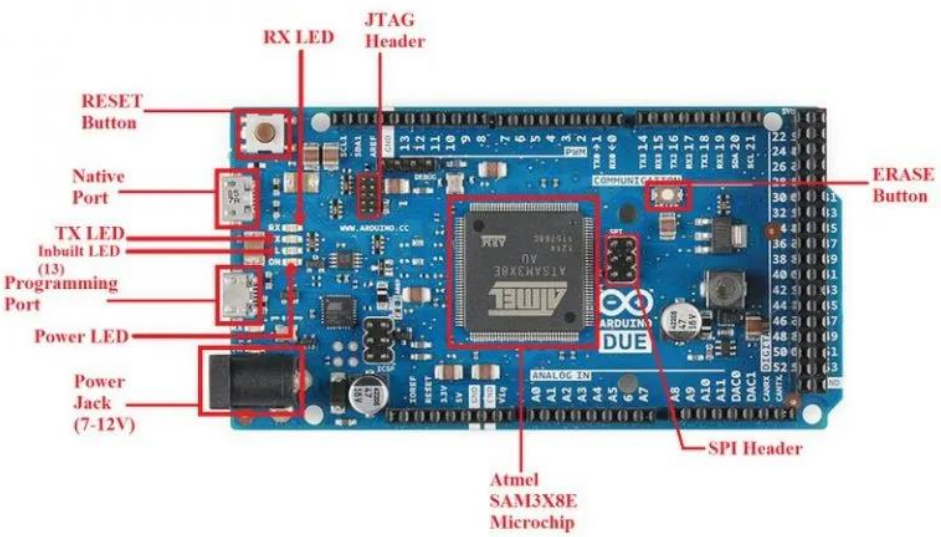

Figure 4.8: Introduction to Arduino Due Ports.

Arduino Due Microcontroller:

The microcontroller on Arduino Due is based on 32-bit ARM core microcontroller i., e ATMEL SAM3x8E, ARM cortex.M3 CPU

- A32-bit core, that allows the transfer of 32-bit wide data per a signal CPU clock.
- CPU clock at 84 MHz
- 96 Kbyte of SRAM.
- 512 Kbyte of flash memory for code.
- A DMA (Direct Memory Access) controller, that helps the processor to communicate with 10 devices without doing memory-intensive tasks.

Arduino Due pinout in detail:

Arduino Due pinout is shown two separate images, pinout image a describes the side pins of the board whereas pinout image B describes the bottom pins of the board.

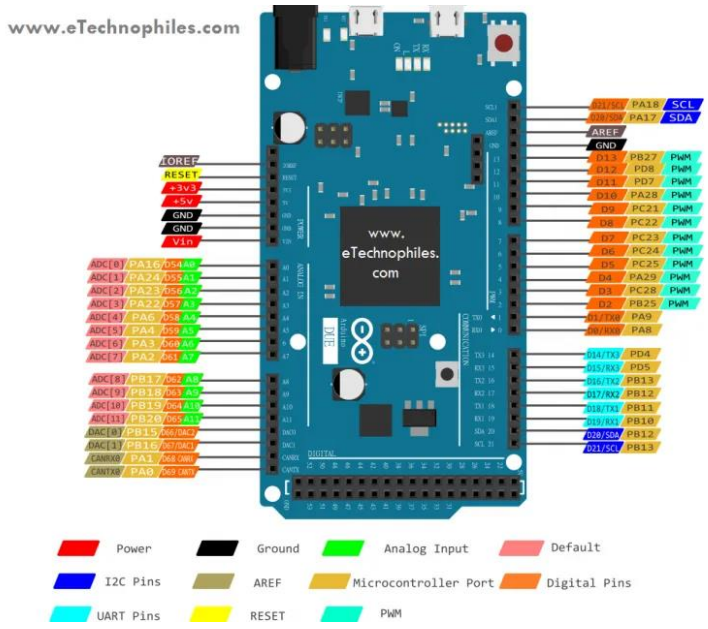

Figure 4.9: Arduino Due Pinout A (side pins).

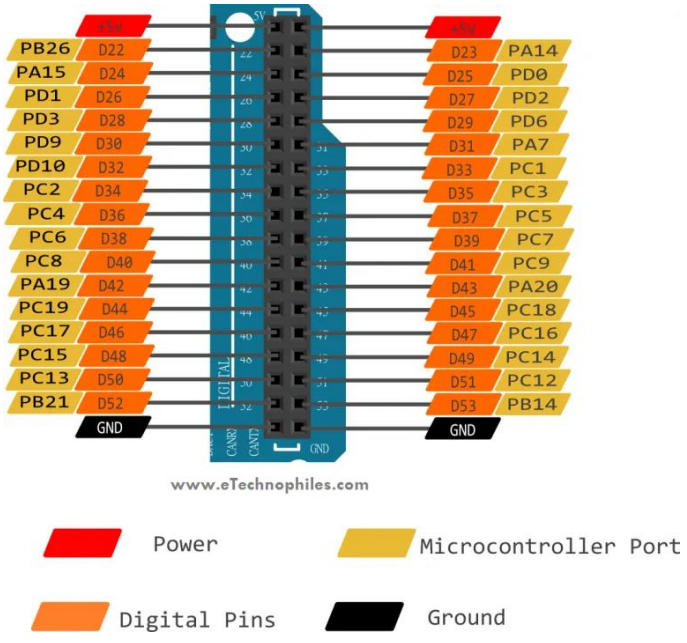

Figure 4.10: Arduino Due Pinout B (bottom pin).

Digital pins on Arduino Due pinout:

The Arduino Due board comes with 52 digital I/O pins that can be used as on input or output. These pins operate at 5 volts.

The Arduino Due board digital pins like every other Arduino board can read one of the two states when the electric signal is present and when it is absent. This type of input is usually known as digital type (or binary) and these states are ferried to as high which is 1 or low which is 0.

Analog Input pins:

These pins that shown in figure: 4.11 are used to read the value that coming from the analog sensor connected to the board.

The Arduino Due consists of 12 analog inputs, labeled as Ax (when X pin no. ranging from 0.11).

All these pins are connected to an inbuilt AD of 12-bit (i.e,4096 different values) resolution.

Figure 4.11: Analog Input pins.

Digital to Analog pins:

Along with the Analog input pins, the board also consists of two channels of true analog outputs with 12-bits resolution (4096 level) that can be controlled with the analog write function. One application of these pin can be to create an audio output using the Audio library [14].

Figure 4.12: Arduino Due DAC pins.

Power pins and ports on Arduino Due board:

- USB port: Arduino Due has two micro-USB ports that can be used to power up as well as program the board.
- 5V: The pin generates regulated 5v output for the externally connected components. The power source of the 5v pin for the Arduino Due board is a USB connector and the Vin.
- GND: Five ground pins are available on the Arduino Due board [14].

4.3.5 TFT 2.8 display:

Supports development board such as Arduino UNO and Mega 2560 for plug-in use without wiring. 320x240 resolution, clear display, support for touch function. Support 16-bit RGB 65K colors display, display rich colors. 8-bit parallel bus, faster than serial SPI refresh on-board 5v/3.3v operating voltage [15].

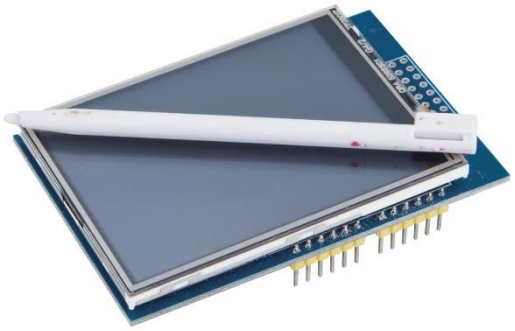

Figure 4.13: TFT2.8 display.

Specification:

1. Touchscreen.
2. 240x320 resolution.
3. Size: 78*52*16mm.
4. Weight:38g.

Pins functions:

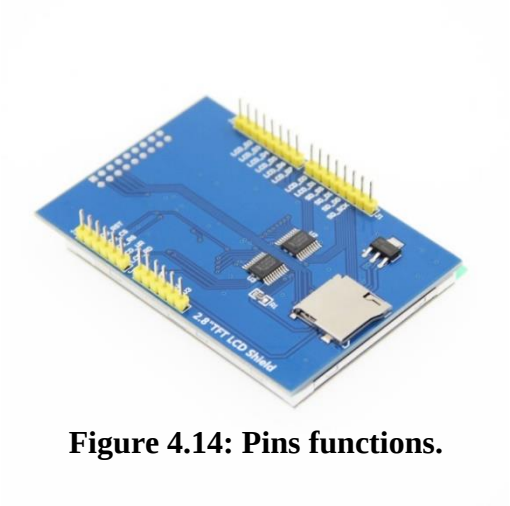

Figure 4.14: Pins functions.

Table 4.3: Pins functions:

Number	Pin Label	Pin Description
1	LCD_RST	LCD bus reset signal, low level reset
2	LCD_CS	LCD bus chip select signal, low level enable
3	LCD_RS	LCD bus command / data selection signal, low level: command, high level: data
4	LCD_WR	LCD bus write signal
5	LCD_RD	LCD bus read signal
6	GND	Power ground
7	5V	5V power input
8	3V3	3.3V power input, this pin can be disconnected
9	LCD_D0	LCD 8-bit data Bit0
10	LCD_D1	LCD 8-bit data Bit1
11	LCD_D2	LCD 8-bit data Bit2
12	LCD_D3	LCD 8-bit data Bit3
13	LCD_D4	LCD 8-bit data Bit4
14	LCD_D5	LCD 8-bit data Bit5
15	LCD_D6	LCD 8-bit data Bit6
16	LCD_D7	LCD 8-bit data Bit7
17	SD_SS	SD card SPI bus chip select signal, low level enable
18	SD_DI	SD card SPI bus MOSI signal
19	SD_DO	SD card SPI bus MISO signal
20	SD_SCK	SD card SPI bus clock signal

TFT Screen is used with Arduino:

Step 1: Download the test program

1. Download the Arduino test program the program download column.
2. For a description of the relevant test procedures please refer to the test program documentation in the package.

Step 2: Connect the Arduino development board:

1. Plug the module directly into the Arduino development board.
2. After the module is plugged in, turn on the Arduino board.

Step 3: Copy the dependent library:

1. Make sure the Arduino IDE is installed on your computer (if it is not installed download the URL of Arduino IDE).
2. After installing the Arduino IDE, you need to copy the development library to the Arduino project directory as follows:
   (a) Decompress the downloaded test package.
   (b) Copy the development libraries folder of the Arduino project directory.

Step 4: Compile and download the program to the development board:

1. Open the sample in the example directory of the package to test compile and download.

Step 5: Observe the running of the program:

1. After the program is downloaded, run it directly and observe the running status.

If it can be displayed normally, the program runs successfully, as shown in the following figure (take the display-graphics program as an example) [16].

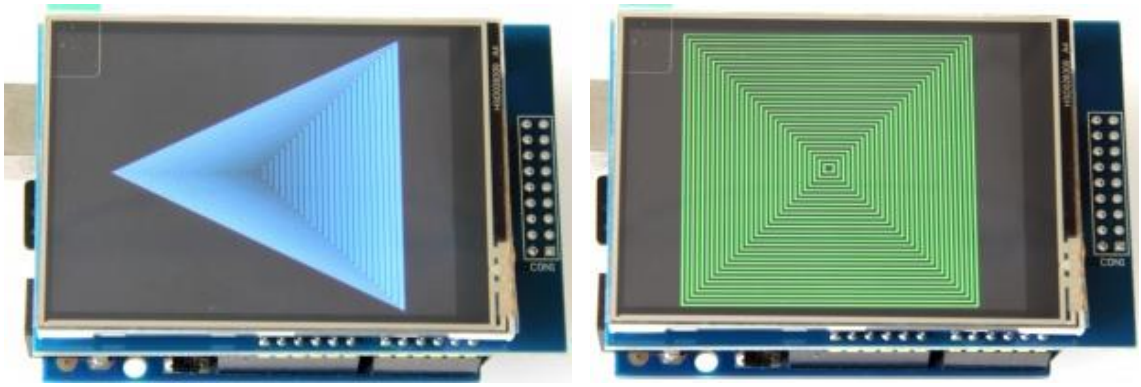

Figure 4.15: (take the display-graphics program as an example).

4.3.6 Pulse oximeter cover

- It is purpose is to protect the sensor
- It is used to fix the finger.

Figure 4.16: Pulse oximeter cover.

4.3.7 Wire lings connect

- It is used to connect the components pieces.

Figure 4.17: Wire lings connect.

4.3.8 Power bank board:

The charger and discharger module are integrated micro-USB interface, and the power bank circuit board can be used to charge other electronic products. This power bank circuit board has integrated overcurrent protection, overvoltage protection and under voltage protection. This power bank board has a high precision.

Battery, they use sophisticated electronic circuitry to manage being charged, and then charging other devices [17].

Figure 4.18: Power bank board.

4.3.9 Battery holder:

Figure 4.19: Battery holder.

4.3.10 Switch:

Figure 4.20: Switch.

4.3.11 Welding board:

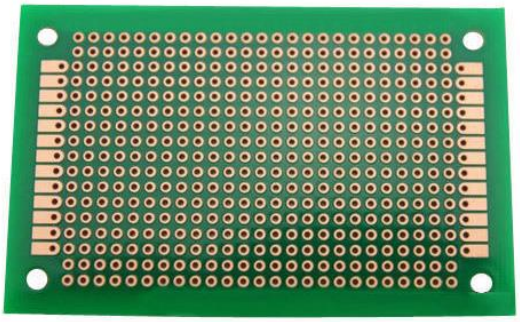

Figure 4.21: Welding board.

4.3.12 Buzzer:

Figure 4.22: Buzzer.

4.4 The method of work

We turn on the device by pressing the power button, and then the person put the middle finger of the sensor, where the LED sends the infrared rays, which the sensor receives after it runs out form the finger and works to analyze it, magnify it and turn it into a filter and then send it to the Arduino, where it works to process it and display it on the screen.

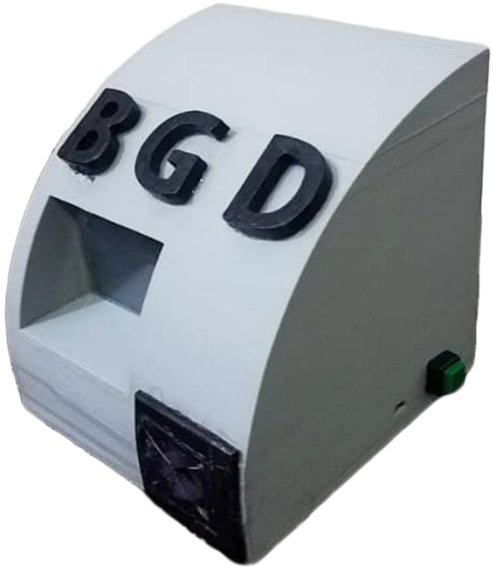

Figure 4.23: Blood Group Detector.

4.5 Power circuit

We used five 3.7V lithium batteries and a power bank circuit. Where it works to charge the batteries and output 5V, which is the required voltage for the work of the device.

Figure 4.24: Power Circuit.

4.6 Blood Group Detector Overview

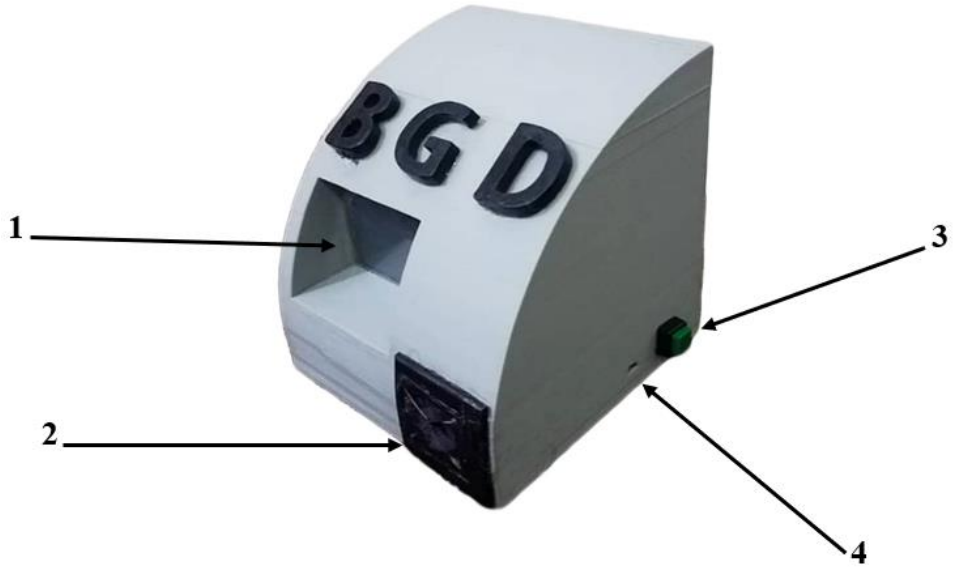

Figure 4.25: Blood Group Detector parts.

1	Display.	3	Switch ON/Off
2	Examinations hole.	4	Charging hole

Chapter 5

Practical Result &Conclusion & Future work &Troubleshooting

5.1. Introduction:

This chapter presents to you the practical results and takes you to a deep discussion about those result and conclusion, and the future work that we will develop it and the troubleshooting for the device.

5.2. Practical results:

The result for device as shown in figure 5.1.

Figure 5.1: Running and testing BGD.

The device examines three blood groups, namely A, B and O. Next, we have made a table for the name, age, gender, skin color, blood diseases, smoking, weight, oxygen percentage in the blood, the size of the finger and the measured fingertips as shown in the table 5.1.

Table 5.1: Experiments tables.

م	الاسم	العمر	الجنس	فصيلة الدم	الفولتية المقاسة	حجم الأصبع	الوزن	لون البشرة	أمراض الدم	التدخين	نسبة الأكسجين
1	مازن العريقي	23	ذكر	O+	40	نحيف	55	أسمر	لا يوجد	لا	94
2	سحر السيد	34	انثى	O+	34	متوسط	75	قمحي	لا يوجد	لا	94
3	عبد الرحمن المسوري	22	ذكر	O+	35	متوسط	52	أسمر	لا يوجد	لا	86
4	عبد السلام الصلاحي	34	ذكر	O+	37	متوسط	60	أسمر	لا يوجد	نعم	93
5	زهراء سليمان	25	انثى	O+	33	نحيف	55	أبيض	لا يوجد	لا	94
6	سعيد حسين	27	ذكر	O+	37	متوسط	63	أسمر	لا يوجد	نعم	91
7	ريناس شهاب	20	انثى	O+	37	نحيف	55	قمحي	لا يوجد	نعم	91
8	طلال سيف	42	ذكر	O+	53	متوسط	70	قمحي	لا يوجد	لا	89
9	ايه السقاف	23	انثى	O+	34	نحيف	46	قمحي	لا يوجد	نعم	94
10	ريان الزاهري	22	ذكر	O+	38	متوسط	63	قمحي	لا يوجد	لا	77
11	عمر حيدر	33	ذكر	O+	29	سميك	74	قمحي	لا يوجد	لا	94
12	عبد الرحمن المخلافي	28	ذكر	O+	38	نحيف	75	أسمر	لا يوجد	نعم	93
13	خلود محسن	18	انثى	O+	38	متوسط	73	حنطي	لا يوجد	لا	92
14	فوزية شريف	50	انثى	O+	35	سميك	63	حنطي	لا يوجد	لا	93
15	مهند علي	26	ذكر	O+	54	سميك	85	أسمر	لا يوجد	لا	94
16	وائل علي	22	ذكر	O+	35	متوسط	75	أبيض	لا يوجد	لا	95
17	اوسان محمد	28	انثى	O+	56	متوسط	60	أبيض	لا يوجد	لا	96
18	ميسون محسن	49	انثى	O+	39	متوسط	71	أبيض	لا يوجد	لا	92
19	علي محسن	55	ذكر	O+	39	سميك	90	أبيض	سكر – كوليسترول	لا	85
20	محمد علي	28	ذكر	O+	34	متوسط	74	أسمر	لا يوجد	لا	90
21	مجاهد مهدي	44	ذكر	O+	37	سميك	81	قمحي	لا يوجد	لا	83
22	حلا النور	24	انثى	O+	53	نحيف	23	أسمر فاتح	لا يوجد	لا	95
23	محمد الرفاعي	24	ذكر	O+	37	متوسط	47	قمحي	لا يوجد	لا	90
24	هنادي العمراني	23	انثى	O+	37	متوسط	50	قمحي	لا يوجد	لا	90
25	أحمد جميل	36	ذكر	O+	36	متوسط	51	أسمر	لا يوجد	لا	91
26	هبه العريقي	36	انثى	O+	35	سميك	65	قمحي	لا يوجد	لا	95
27	مدين فيصل	42	ذكر	O+	37	سميك	60	قمحي	لا يوجد	لا	93

28	محمد الدرسي	22	ذكر	O+	37	سمين	62	أسمر	لا يوجد	لا	85
29	محمد عبدالله	20	ذكر	O+	37	متوسط	59	قمحي	لا يوجد	لا	92
30	اسد محفوظ	22	ذكر	O+	36	متوسط	65	قمحي	لا يوجد	لا	89
31	حسام سمير	18	ذكر	O+	37	متوسط	80	أبيض	لا يوجد	لا	92
32	جهاد الزبيري	21	ذكر	O+	57	نحيف	60	قمحي	لا يوجد	لا	87
33	أمين قائد	22	ذكر	-O	31	متوسط	69	قمحي	لا يوجد	نعم	86
34	بشره الذبحاني	26	انثى	A+	55	نحيف	43	حنطي	لا يوجد	نعم	95
35	أمين الحدي	28	ذكر	A+	54	متوسط	65	حنطي	لا يوجد	نعم	92
36	وثيق الاصبحي	24	ذكر	A+	55	متوسط	53	قمحي	لا يوجد	نعم	96
37	نزار حامد	18	ذكر	A+	54	متوسط	76	أبيض	لا يوجد	نعم	91
38	إبراهيم الاديمي	19	ذكر	A+	53	متوسط	61	أسمر	لا يوجد	نعم	93
39	أحمد شوقي	16	ذكر	A+	53	متوسط	44	أسمر	لا يوجد	لا	93
40	لمياء الفقي	26	انثى	A+	57	نحيف	62	أبيض	لا يوجد	لا	92
41	هديل عبدالله	21	انثى	A+	56	نحيف	47	أبيض	لا يوجد	لا	66
42	رقية عبدالباقي	21	انثى	A+	56	نحيف	50	أبيض	لا يوجد	لا	93
43	ساجده رشاد	20	انثى	A+	52	نحيف	51	أبيض	لا يوجد	لا	96
44	محمد المقطري	29	ذكر	A+	54	متوسط	78	قمحي	لا يوجد	لا	81
45	يوسف الحمودي	25	ذكر	A-	50	نحيف	65	قمحي	لا يوجد	نعم	95
46	مهند العريقي	24	ذكر	-A	55	نحيف	49	حنطي	لا يوجد	نعم	95
47	محمد الأغبري	17	ذكر	B+	59	نحيف	46	قمحي	لا يوجد	لا	90
48	أحمد العفاري	20	ذكر	B+	46	متوسط	50	قمحي	لا يوجد	لا	92
49	نرمين أمين	24	انثى	B+	64	نحيف	55	أبيض	لا يوجد	لا	95
50	فهمي عبده	56	ذكر	B+	44	متوسط	66	أسمر	لا يوجد	نعم	85
51	هيثم عادل	35	ذكر	B+	62	متوسط	75	قمحي	لا يوجد	لا	81
52	عادل سيف	61	ذكر	B+	69	متوسط	82	قمحي	لا يوجد	نعم	89
53	نهى محمد	28	انثى	B+	61	نحيف	50	قمحي	لا يوجد	نعم	92
54	جوهره	20	انثى	B+	58	نحيف	50	أسمر	لا يوجد	لا	96
55	عبدالرحمن لقمان	19	ذكر	B-	59	متوسط	74	قمحي	لا يوجد	لا	92
56	سالي العريقي	25	انثى	B-	57	نحيف	43	أبيض	لا يوجد	لا	87
57	محمد الشرجبي	47	ذكر	B	38	سمين	83	أسمر	لا يوجد	نعم	93

These tables show all the differences that can be affected by the blood measurement, where we used a balance device and a pulse oximeter, and we recorded all the required data in the table.

These experiments showed us the difference in the measured voltage for each species and the other factors that cause confusion on the voltage measurement, which we will fix later.

We calibrated the device using the traditional method for checking blood groups.

5.3 The comparison between values of our project and Previous projects:

Blood group represent a voltage value when return to the electrical form, detecting that value of voltage will achieve a great deal for select which blood type a human has .and the surprising point is when this value could be represented noninvasively. research and published papers of blood groups detection in term of voltages have approved the fact of noninvasive blood group detection by selecting a range of voltages for each blood group for the ABO system according to different methods and principles. You can show in Table [5.2] the voltage ranges of each blood group by using fiber optic for the research.

Table 5.2:(Classification of Blood Groups based on the voltage, using fiber optic).

Blood Groups	Voltage levels, Gain =80
A	2.40-2.48
B	2.20-2.36
O	2.12-2.18
AB	2.02-2.10

Another 3 different studies based on infrared principle are shown different results as shown below in Table [5.3], Table [5.4], and Table [5.5], where there was two of them based on non-invasive IR principle and the last table corresponds to noninvasive IR principle.

Table 5.3:(Classification of Blood Groups based on the voltage, using IR light spectrum).

Blood Groups	Voltage levels
A	0.56-0.58
B	0.59-0.60
O	0.53-0.55
AB	0.61-0.62

Table 5.4:(Classification of Blood Groups based on the voltage, using IR light spectrum).

Blood Groups	Voltage levels
A	0.35-0.36
B	0.59-0.60
O	0.47-0.48
AB	0.65-0.66

Table 5.5:(Classification of Blood Groups based on the voltage, using IR light spectrum invasively).

Blood Groups	Voltage levels
A	0.4-0.8
B	1.7-2.0
O	1.1-1.4
AB	2.2-2.4

As the technology getting higher degree in improving the health care field, making the process of detecting a human blood type should change to become easier, and less effort.

5.4. Conclusion

It is an easy-to-use portable device that measures blood type by infrared, where the device identifies three groups, O, A and B, and the device operates with a 5V power source, which is the only power source that the device needs.

5.5. Future work

- Precise finger placement area to capture better signal for OPT 101 sensors.
- Add AB blood type test.
- Identify the Rh factor.
- Design an application to view the result.

5.5. Troubleshooting:

Table 5.6: Troubleshooting.

<table>
<tr><th>Problem</th><th>Possible reasons</th><th>Solution</th></tr>
<tr><td rowspan="2">The Display Show [ERROR]</td><td>1. The system is still processing your results</td><td>1. Wait for a few minutes</td></tr>
<tr><td>2. Your finger is not fit on the sensor correctly.</td><td rowspan="2">2. Try to fix the position straight forward and press it into the pulse oximeter, hold this position until the ERROR avoided</td></tr>
<tr><td rowspan="3">The Display Show [NON]</td><td>1. The finger plugged inside the pulse oximeter while it is starting.</td><td>1. Wait until the system restart or the voltage value return to the zero drift≈2.35</td></tr>
<tr><td rowspan="2">2. Multiple times you push and pull your finger.</td><td>2. Fix the position until it become stable</td></tr>
<tr><td rowspan="2">3. You must cut them before the Test.</td></tr>
<tr><td>3. You have long nails.</td></tr>
</table>

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