Republic of Yemen
Ministry of higher Education and Scientific research
University of Emirates international
Faculty Engineering

Smart Monitoring Unit For Vital Signs

وحدة المراقبة الذكية

Student Name: Hajar Abd-ulwahab Ahmed Al-Thulaya

Supervised by

Assoc. Prof./ Farouk Al-Fahaidy

Title
Smart monitoring unit

2022_2023

Summary

- Introduction:

SMU: is a smart monitoring unit to observe the vital signs of humans as:

ECG (electrocardiogram), body temperature, pulse oximeter & heart rate, and non-invasive blood sugar measurement. With using smart screen and IoT technology so that the specialist or the doctor informed with any change happens.

- Problem definition

  • One of the most important problems that the project faced was how to measure and check blood sugar without pricking and using kit Research and studies related to this aspect.

  • Displaying the data in a way that makes it easier for everyone to read the vital signs and understand the current health status.

- Main objectives of the graduation project

  The first step to avoid exacerbating the patient's health problems is to monitor his condition by monitoring vital signs, so that possible risks can be predicted, controlled and managed, and to increase the health security of the individual. The focus of the study lies in measuring vital signs and sending them via IoT to the doctor or specialist.

- Tools

  • Arduino environment, python

  •TensorFlow, keras .

  •Solid Work.

  •Excel.

- Results

  I showed results a test reliability that there a an agreement good To measure glucose between both ways(Accu-check And NIR Sensor), which It was completed prove it from difference rate low error(3% -17%)to an acceptable mean error**9.35%**when Both Done comparison measurements glucose For several people of different races and ages, it was noticed that it gives a good and promising response and results for dark skin, like normal skin. We can say that the factor material for individuals may be impact on measurements according all who are they being the individual for him thickness leather different Than impact on breakthrough Signal rays under red and he has being there Factor last because of Spread Signal rays under red in Regions surrounding and he will receive led the couple photosynthesis Less rays.

- Conclusions and recommendations

  In this study of a non-puncture glycemic monitoring system, two measurement ideas were used, namely continuous monitoring and multiwavelength average measurement. The experimental result after testing proves that this system has an improved advantage in predicting blood sugar, and the multiple wavelength model of middle Glucose obtained from the average of two transmitter values in permeability mode has contributed greatly to improved performance and accuracy. Monitoring blood sugar without tingling is not only beneficial for patients diabete , But also for normal people to maintain glucose level in the normal range to maintain a healthy lifestyle. As a recommendation for future improvements We recommend using a sensor with a higher light sensitivity and faster response time to further improve performance and obtain better accuracy results than our recommended sensors**FDGA05**And**FGA21**

Authorization

We authorize university of Emarites International faculty of Engineering to supply copies of our graduation project report to libraries, organizations or individuals on request.

Student Name	**Signature**	**Date**
Hajar Abd-ulwahab Althulaya		

Dedication

Praise be to God until praise reaches its end, and prayers and peace be upon the Messenger of God. I dedicate this work to my family, because they are the source of my strength and success. If it were not for God, then if it were not for them, I would not have reached this stage .. You have all my thanks for every word or letter that we learned at your hands. We ask the Almighty to help us. To respond to their favor with obedience and good manners.

Acknowledgment

Before and above all, we would like to record our endless thanks to **Allah** for everything he gives us.

We wish to express our deepest gratitude and appreciation to **Dr. Farouk Al-Fahaidy** for excellent guidance, kind encouragement, scientific advice, helpful supervision and good wishes instilled the strength in us to make this work possible.

Last but not least, we owe a great deal of gratitude, thanks and appreciation to all members of our families, for their kind support, help and encouragement.

Examiner Committee

Project Title:……………………………………………………………………..

Supervisor

No	Name	Position	Signature
1			

Examiner Committee

No	Name	Position	Signature
1			
2			
3			

Department Head

…………………

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List of Abbreviations

Acronym	Definition
SPO2	Peripheral Oxygen saturation.
HR	Heart Rate
ECG	Electrocardiogram
IoT	Internet of Things
SMU	Smart Monitoring Unit
NIR	Near infrared

Chapter 1

Introduction

Chapter 1: Introduction

1.1 Overview

At a time when knowledge is increasing in all fields and transcends, and scientific research adds every day more real realistic understanding of the phenomena of nature, we present this project that contributes to the development processes witnessed by our university for the advancement of the scientific community and an attempt to find new things that rise to the level of science and its scientific applications. We present our project this Entitled (SMU) for researchers and interested scientific.

Open-source Syringe Pump (no date) Open-source syringe pump - Appropedia, the sustainability wiki. Available at: https://www.appropedia.org/Open-source_syringe_pump (Accessed: March 12, 2023).

The theoretical section presents a detailed theoretical study of the device and includes the following three chapters:

The first chapter presents a theoretical study of the vital signs monitoring unit in the intensive care unit or the home, the design, equipment, and classifications approved for the unit, while the second chapter explains the most important vital signs that we are interested in monitoring and the program deals with (blood sugar level - temperature - heartbeat - oxygen saturation in the blood- ECG).

0800-3111-111: Digi-key electronics (no date) Digi. Available at: https://www.digikey.com/en/products/detail/advanced-photonix/0800-3111-111/10294611 (Accessed: March 12, 2023) which is shown the sensor of sugar blood.

The third chapter presents the components and circuits used to implement the project.

Practical and programmatic section: It consists of three chapters:

The first chapter defines the programming language that we relied on in building the project, and why it was chosen.

The second chapter explains the mechanism and principle of operation of the device and how it was worked on in detailed steps.

Chapter 3 explains how to program the display that was used and the capabilities it offers.The third section of the project is the section that explains the design of the device that was implemented and how it was simulated with similar devices to ensure the device's ability as a monitoring device.

In conclusion, I hope that I have laid an important building block in the scientific edifice, and I hope that the productive and service sectors in our beloved country will benefit from this scientific achievement.

1.2 Problem Statement

• One of the most important problems that the project faced was how to measure and check blood sugar without pricking and using a kit

Research and studies related to this aspect.

• Displaying the data in a way that makes it easier for everyone to read the vital signs and understand the current health status.

1.3 Project Objectives

• High health care costs in medical facilities

• Many, especially the elderly, refused to go to hospitals.

• Lack of medical awareness among the community and individuals.

• The fact that the device does not require long or medical experience to understand and read vital signs.

• Easy to check the sugar level without pricking.

• Easy access to patient information through the application and the extent improvement in health deterioration.

• Monitoring by home or hospital specialists.

Early detection of the deterioration of the patient's condition.

• Small size and low costs.

1.4 Project Scope and Limitations

- Choosing a small size for the device to make it easy to carry, move around and store.
- Choosing the most important vital signs in the human body that indicate the health of the patient's body.
- Checking the sugar level without taking a blood sample.
- Measurement of all vital signs without pricking.

1.5 Project Methodology

Chapter1				Chapter2	
Month 1	Month 1	Month 2		Month 3	Month 4
Was to search about idea for the project, search about The devices and easy to get.	Search for the selected idea and identify project implementation requirement.	Determine the first design of the project and importing electronic pieces.		Start connecting the components, configuring and preparing them to work .	System design , build programs and applications .

Chapter 2

Background and Literature Review

Chapter 2: Background and Literature Review

2.1 Background

To avoid aggravation of the patient's health problems, his condition must be monitored by monitoring the vital signs to manage the potential risks. The aim is to reach a medical device that measures some of the patient's vital signs in addition to measuring sugar without pricking in the human body and sending it through the application to the specialist. In this study, the Focusing on measuring the glucose level in an optical way that contains a sensor to measure the level of glucose in the blood without pricking using near-infrared spectroscopy .as well as the percentage of oxygen in the blood and heartbeat | body temperature | heart stitching |

In addition to using artificial intelligence to detect some diseases.

Glucose results without pricking: It has been observed that as glucose concentration increases, the sensor output voltage increases in permeability mode. In the data collected, there was a good correlation between voltage and concentrations and their relationship was almost linear. Therefore, it is possible to use non-puncture methods to predict glucose concentration. In vivo human tissue experiments with 23 human samples were carried out in the implementation phase, and ten subjects were used to test the model.

The average glucose concentrations were obtained in the permeability mode, the mean error percentage was 9.35, and the mean root square error was 18.204 mg/dL.

CONCLUSIONS: From this research, it can be inferred that visual methods without pricking applied can be used anytime and anywhere in the future as an alternative to traditional blood glucose measurement methods.

2.2 Literature Review

Continuous scientific development in the units of medical monitoring devices, and competition in creating new methods that contribute to increasing the reliability and accuracy of reading medical information, and reducing costs as well, to reduce the difficulties resulting from some measurement methods, for example, measuring devices that rely on acupuncture to measure the level of sugar in the blood, Which is one of the indispensable devices in homes and health facilities and because of unhealthy eating habits, in society and hereditary diseases, diabetes has become a common and widespread disease, and scientists have been interested in developing new methods that work to measure sugar in non-traditional ways and to adopt a new approach to measurement without pricking accredited This includes optical measurement methods, such as near-infrared spectroscopy or visible red laser light, and satisfactory results in their research and studies that may serve the purpose as a substitute for lancets with high accuracy and safety.

In 2013, Musab Ahmed prepared a study [1]:

Its aim is to implement and use a monitoring device to measure blood glucose and enable diabetic patients to give appropriate doses of insulin at home. Near infrared spectroscopy was used to determine blood glucose levels, based on the permeability of the spectroscopy on the earlobe. The researcher reached the result of the standard Clarkson error network diagram, which is A standard used to determine the accuracy of glucose meters and the results obtained were satisfactory. This is because the Psoc-51p provides capabilities to convert an analog signal into a digital signal with high accuracy and low noise.

In 2017, researcher Haider Ali and others conducted a study [2]:

The aim is to apply a simple, small-sized, non-invasive device, and to use a new approach to blood glucose measurement that uses visible red laser light with a wavelength of 650nm, which is distinguished from near-infrared rays by having a higher transmittance to human tissues, and the refractive index of laser light is more sensitive to changes in glucose concentration and response speed.

During their implementation, they used a 650nm laser optical sensor, an Arduino Uno board, and a display

Experimental results were obtained that more than 90% of the glucose levels measured using the laser are within an acceptable range, while deviating by 8-10% from the reference values for blood glucose, and obtaining higher accuracy for sugar readings above 130mg/dl, and sensitivity to the glucose level for diabetics in general with accuracy. From 90% to 92% by adopting the phenomenon of transmittance and refraction.

<u>Chandrakant Dattrao Bobade and others conducted research in 2016: [3]</u>

Their study aims to reduce the cost of health care and the difficulties that result in traditional measurement methods. The main goal is to analyze NIR through a blood glucose sam ple for humans to measure the level of glucose in the blood. A near infrared transmitter and receiver, a microcontroller, and Bluetooth were used to send data. The test was performed on the device. For two categories before food and after food and compare the results with a commercially reliable device and the results obtained are good and with acceptable reliability.

<u>In 2014, the researcher Mitra Muhammad Uday prepared a study [4]:</u>

Its aim was to detect different glucose concentrations, determine the required insulin dose and use it for diabetics, as well as the possibility of using it for non-diabetics. The main hardware components of the system include a 1550nm transmitter sensor, an FGA10 photodiode, an OP491 operational amplifier, an Arduino Uno microcontroller, and a screen keyboard.

The results of the reliability test showed that there is a good agreement for measuring glucose between the Accue Check device as a reference value and the NIR device that was designed in the study, and they were compared, and the error rate for the NIR reading compared to the reference value. 12.5%

Bahareh Javid and others conducted a 2018 study [5]:

It aims to provide a healthcare system for monitoring blood glucose and mobile bilirubin that includes a non-invasive sensor to measure blood glucose and bilirubin using near-infrared spectroscopy and optical methods respectively by communicating with a smartphone.

Through the results, they noticed that when the concentration of glucose increased, the output voltage increased in the transmittance mode and decreased in the reflection mode, and the data collected there was a correlation between the voltage and concentration, and their relationship was almost linear. Therefore, it is possible to use non-invasive methods to predict glucose, and an error percentage of 8.27% was obtained.

2.3 System available

Currently, there are a few systems available for non-invasive blood glucose monitoring. Here are some examples:

1. Glucose Monitoring Watches: These are wearable devices that use sensors to measure glucose levels through the skin. They typically utilize optical sensors that analyze interstitial fluid to estimate blood glucose levels.

2. Glucose Monitoring Patches: These patches are applied to the skin and use a combination of microneedles and sensors to extract interstitial fluid and measure glucose levels. They are designed to be minimally invasive and provide continuous monitoring.

3. Glucose Monitoring Contact Lenses: These smart contact lenses incorporate tiny sensors that detect glucose levels in tears. They can continuously monitor glucose levels and transmit the data wirelessly to a device for analysis.

4. Glucose Monitoring Breathalyzers: Breath-based glucose monitoring devices analyze the levels of acetone in the breath, which can correlate with blood glucose levels. Users blow into the device, and the measurement is taken non-invasively.

It's important to note that while these non-invasive glucose monitoring systems exist, they may have limitations in terms of accuracy, reliability, and availability. They may also require calibration against traditional blood glucose meters for accurate readings. Additionally, some of these systems are still in the development or early commercialization stages and may not be widely accessible. It's recommended to consult with healthcare professionals or refer to up-to-date research and product information for the most accurate and current details on available non-invasive glucose monitoring system.

Schedule :Comparison between this study and studies previous			
Research	**Glucose**	**Percentage error (%)**	**RMSE**
Our proposed system	Yes	9.35%	18.2 mg/dl
Masab Ahmed [12]	Yes	Not reported	Not reported
Mitra Mohd Addi [4]	Yes	12.5%	Not reported
Chandrakant Datrao Bobade [3]	Yes	Not reported	Not reported
HAIDER ALI [2]	Yes	8-10%	Not reported
Bahareh Javid [5]	Yes	8.27%	18.52 mg/dl

Chapter 3

Requirement and Material

Chapter 3: Requirement and Material

3.1 Overview of Patient Monitoring Systems

Monitoring can be defined strictly and precisely as "repeated or continuous observations or measurements of a patient and to monitor, inter alia, his physiological function and the function of life-support equipment for the purpose of guiding management decisions including when to perform therapeutic interventions, and the evaluation of those interventions. The patient monitor may not alert or Providers of care to potentially life-threatening events, many patient monitors also provide physiological input data that is used to control directly connected life support devices.

3.2 Block Diagram

3.2.1 non-invasive blood sugar measurement.

3.2.1.1 Explain block Diagram for non-invasive blood sugar measurement.

To measure blood sugar without pricking, with near-infrared radiation, such as the 1050 sensor FAG10 sensor, Arduino Uno and OLED (0.96).

Blood Sugar:

It is a glucose sugar level in the blood, where glucose sugar is the main source of energy in the human body, and it is regulated by a group of hormones in the human body. Blood contains many types of monosaccharides, which are the simplest types of carbohydrates such as: fructose, galactose, and pentose , the most important of which is glucose, which is considered one of the most important sources that provide the body with energy, and the level of sugar in the blood can be measured by examining a sample of blood in the laboratory, or by using instant glucose testing devices that measure blood sugar through a drop of blood drawn from one Fingers, and the result of the examination appears within a few seconds (this method is commonly used daily in diabetic patients)

Figure (1) shows the sender (LS-1050nm) &Figure (2) shows the receiver FAG10 (SD0800)

Figure (1): (LS-1050nm)

Figure (2): FAG10 (SD0800)

InGaAs sensors FAG10:

It converts the light received from the transmitter into an electric curre

Future features:

- Low noise.
- Low dark current and amplitude.
- High sensitivity.
- The runway and the elevator are isolated.
- Includes short and far infrared.
- Reagents are sealed.
- Range from 940 to 1700 nm

Its applications:

- Industrial sensor.
- Security areas.
- Medical fields.

Features of transmitters:

- The wavelength transmission range is 1050 nm.
- High reliability.
- Long life.
- RoHS compliant.

Its applications:

- smart phones.
- Automation.
- Infrared data transmission.
- Sensing areas.
- Consumer electronics.
- Industrial and medical equipment.
- Command and control circuits.

Figure (3) shows the screen

Figure (4) shows the Amplifier

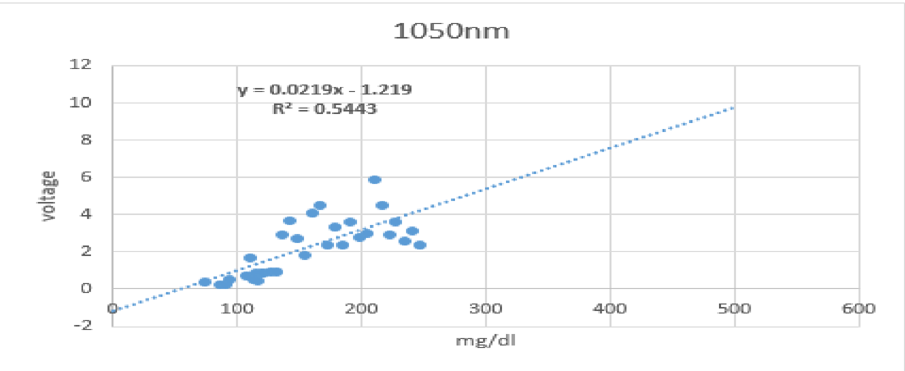
Mechanism of Action:

When you press (pushbutton), an order is given to the controller to activate both sensors, as the transmitter sensor sends infrared rays with a specific wavelength, as the blood sugar level has a specific wavelength in

As the percentage of sugar increases, the wavelength increases and the transmittance to the receiver sensor increases, so the output is an electrical signal, as it was found that the relationship between them is linear. After that, both sensors experience amplification and noise removal, as an amplifier MCP603 with RC For the receiver with 5 volts and for the transmitter a transistor and a resistor with 3 volts.

After that, the values are connected to the microcontroller, which is the Arduino Uno

An equation was added to the code to convert current to voltage, as well as a linear regression equation to obtain the glucose percentage after the values were entered in Excel, and the equation was obtained as shown in Figure (5).



Figure(5): a linear regression equation to obtain the glucose percentage

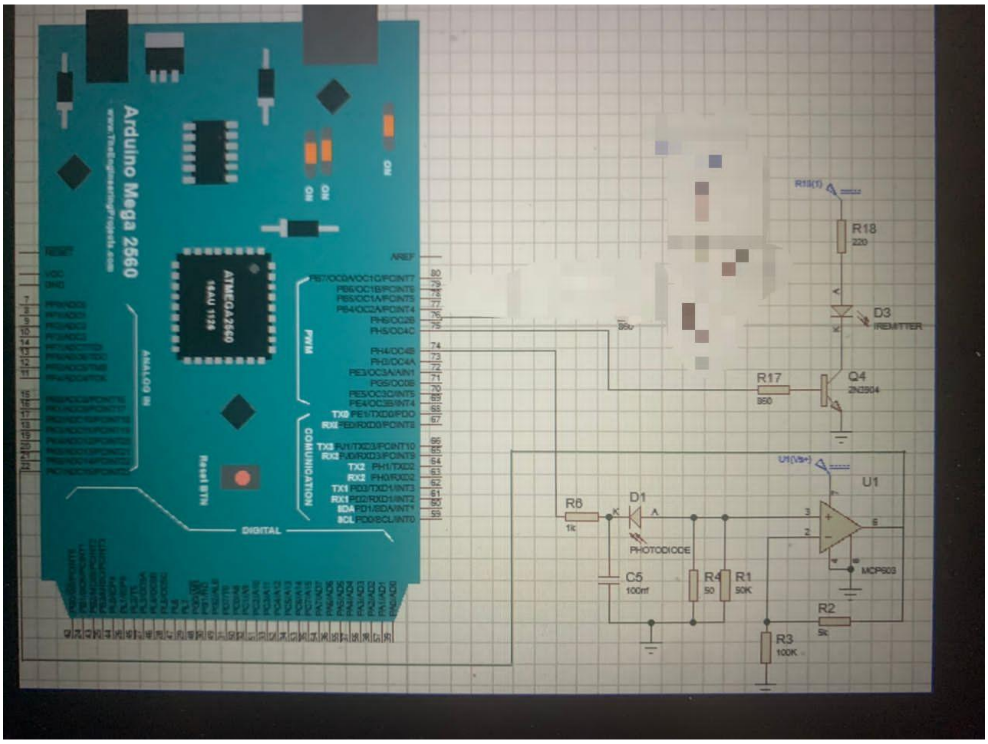
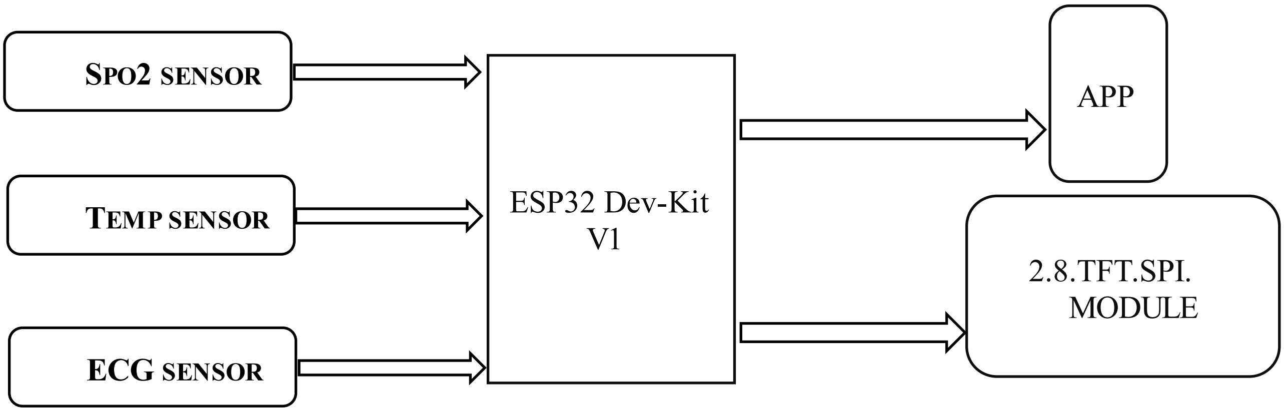


Figure (6): show the connection of a planelectronic tomea suring circte sugar

3.2.2 Vital signs Measurement.



3.2.2.1 Explain block Diagram for Vital signs Measurement.

Sensors (Max30102 & Mlx90614 & Ad8232) were used:

sensor (Mlx90614)

Non-contact temperature sensor via infrared. as shown in Figure (7).

Mlx90614 Sensor Features:

- Small size, low cost and ease of use.
- High accuracy and response.
- Temperature measurement from -70 degrees Celsius to 380 degrees.
- Safe use in the medical field.

Figure(7) (Mlx90614)

Basic circuit components: microcontroller, display temperature sensor, laser diode, timer switch After pressing the start switch, the laser works to direct the measurement location, while the sensor senses the temperature and produces an output signal that is sent to the microcontroller and then displayed on the screen. Figure (8) shows the connection of the sensor with the microcontroller

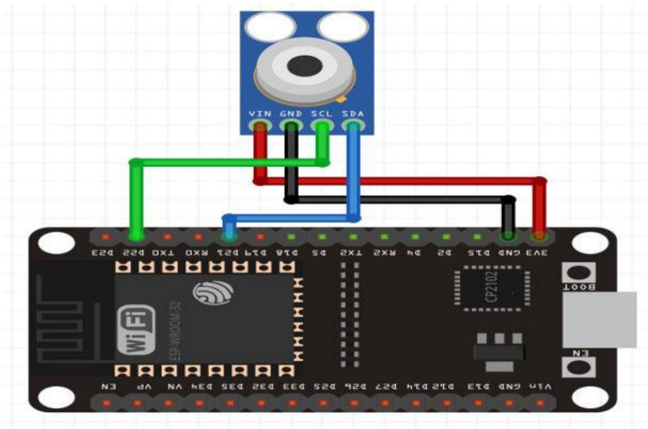


Figure (8) shows the connection of the sensor with the microcontroller

Sensor(MLX30102)

Integrated circuit incorporating internal LEDs, photodetectors, optical elements and low-noise electronics with a high common rejection ratio.as shown in Figure (9).

<u>Max30102 Sensor Features:</u>

- Low power operation.
- Fast data output and high precision sampling rate.
- High subscriber rejection rate.

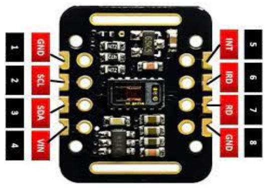


Figure (9) (MLX30102)

Main circuit components: microcontroller, Max30102 sensor When placing a finger, infrared rays are sent and reflected Then the amount of oxygen in the blood is determined by measuring the capacitance The wave heart rate is calculated by analyzing the response of the radiation time series and then sending the data to the microcontroller.Figure (10) shows the connection of the sensor with the microcontroller.

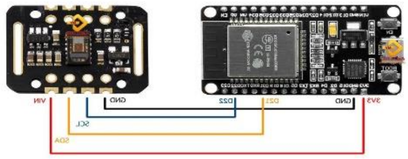


Figure (10)) shows the connection of the sensor with the microcontroller.

sensor(AD8232)

A circuit designed to extract, amplify and filter signals Small Vital with a superior analog-to-digital converter. as shown in Figure (11).

Ad8232 Sensor Features:

• Low current, high co-rejection rate.

• High-pass filters.

• Digital and analogue outputs.

Its applications:

• Heart rate monitors for fitness and activity.

• Medical devices and remote monitoring.

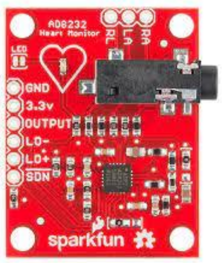


Figure (11): (AD8232)

Basic circuit components: microcontroller, Ad8232 layout sensor

After placing the electrodes on the patient, the electrical signals of the heart are polarized and the diagram is sent to the microcontroller to be displayed on the screen. Figure (12) shows linking the screen with the microcontroller

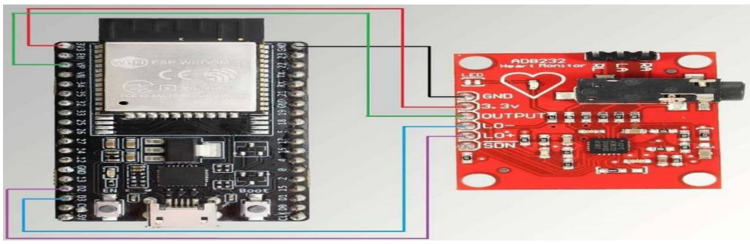


Figure (12) shows linking the screen with the microcontroller

screen (2.8 TFT SPI Module)

A resistive screen with a graphical interface that can be created as required and used in many applications.as shown in Figure (13).

Figure (13) (2.8 TFT SPI Module)

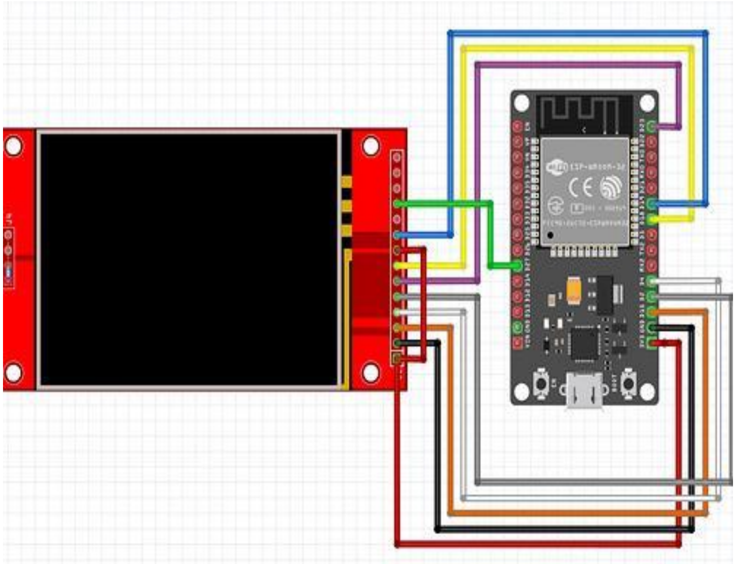


Figure (14) shows linking the screen with the microcontroller

Controller(ESP32 Dev-Kit)

Daul core is a series of low-cost, low-power system-on-chip microcontrollers with built-in Wi-Fi and dual-mode Bluetooth that comes with 48-pins with multiple functions. Not all pins are exposed on all ESP32 development boards, and some pins cannot be used.

It contains both SPI and I2C protocols. Figure (15) shows the controller

Figure (15)controller

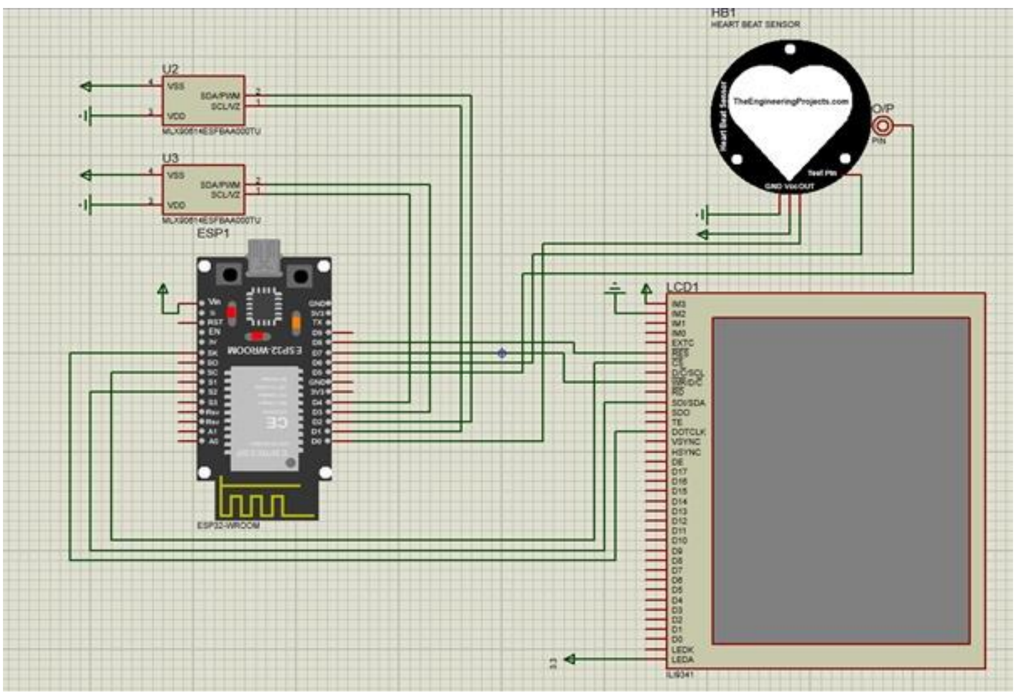


Figure (16) shows the connection of electronic chart of the device circuit.

Mechanism of Action:

Where an order was given to the controller when placing a finger on two sensors, the (max30102 &mlx90614) executes the code to obtain a measurement of both sensors as well as the ECG signal, and each of the results is linked to a screen that has been programmed and the screen interface is shown in Figure (17)

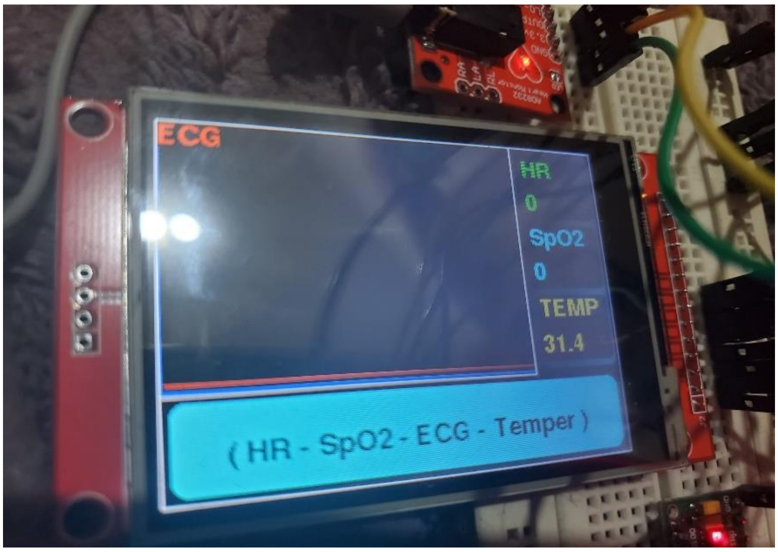
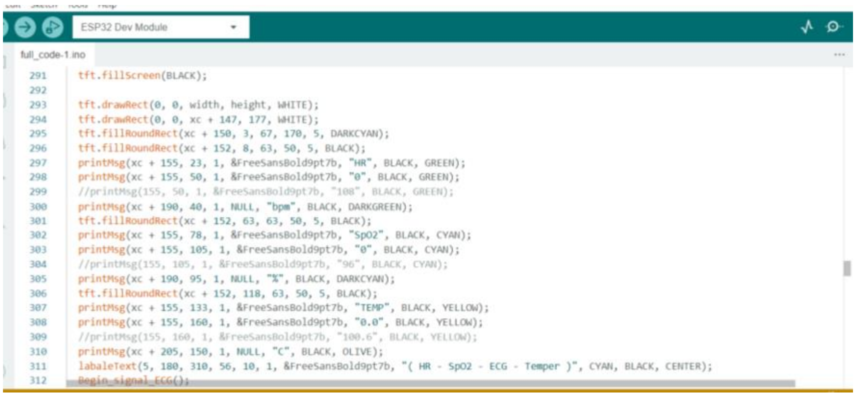


Figure (17) linked to a screen that has been programmed and the screen interface



```
tft.fillScreen(BLACK);

tft.drawRect(0, 0, width, height, WHITE);
tft.drawRect(0, 0, xc + 147, 177, WHITE);
tft.fillRoundRect(xc + 150, 3, 67, 170, 5, DARKCYAN);
tft.fillRoundRect(xc + 152, 8, 63, 50, 5, BLACK);
printMsg(xc + 155, 23, 1, &FreeSansBold9pt7b, "HR", BLACK, GREEN);
printMsg(xc + 155, 50, 1, &FreeSansBold9pt7b, "0", BLACK, GREEN);
//printMsg(155, 50, 1, &FreeSansBold9pt7b, "108", BLACK, GREEN);
printMsg(xc + 190, 40, 1, NULL, "bpm", BLACK, DARKGREEN);
tft.fillRoundRect(xc + 152, 63, 63, 50, 5, BLACK);
printMsg(xc + 155, 78, 1, &FreeSansBold9pt7b, "SpO2", BLACK, CYAN);
printMsg(xc + 155, 105, 1, &FreeSansBold9pt7b, "0", BLACK, CYAN);
//printMsg(155, 105, 1, &FreeSansBold9pt7b, "96", BLACK, CYAN);
printMsg(xc + 190, 95, 1, NULL, "%", BLACK, DARKCYAN);
tft.fillRoundRect(xc + 152, 118, 63, 50, 5, BLACK);
printMsg(xc + 155, 133, 1, &FreeSansBold9pt7b, "TEMP", BLACK, YELLOW);
printMsg(xc + 155, 160, 1, &FreeSansBold9pt7b, "0.0", BLACK, YELLOW);
//printMsg(155, 160, 1, &FreeSansBold9pt7b, "100.6", BLACK, YELLOW);
printMsg(xc + 205, 150, 1, NULL, "C", BLACK, OLIVE);
labaleText(5, 180, 310, 56, 10, 1, &FreeSansBold9pt7b, "( HR - SpO2 - ECG - Temper )", CYAN, BLACK, CENTER);
Begin_signal_ECG();
```

Figure (18) shows the code to program the screen

As well as linking the code to an application through the Internet of Things technology

It requires connecting the controller to the Internet

Figure (19) represents the code to link the controller to the application

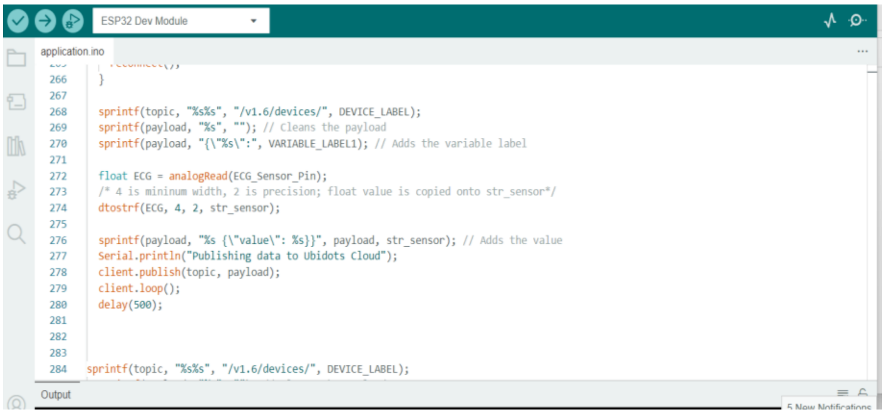


Figure (19)

Chapter 4

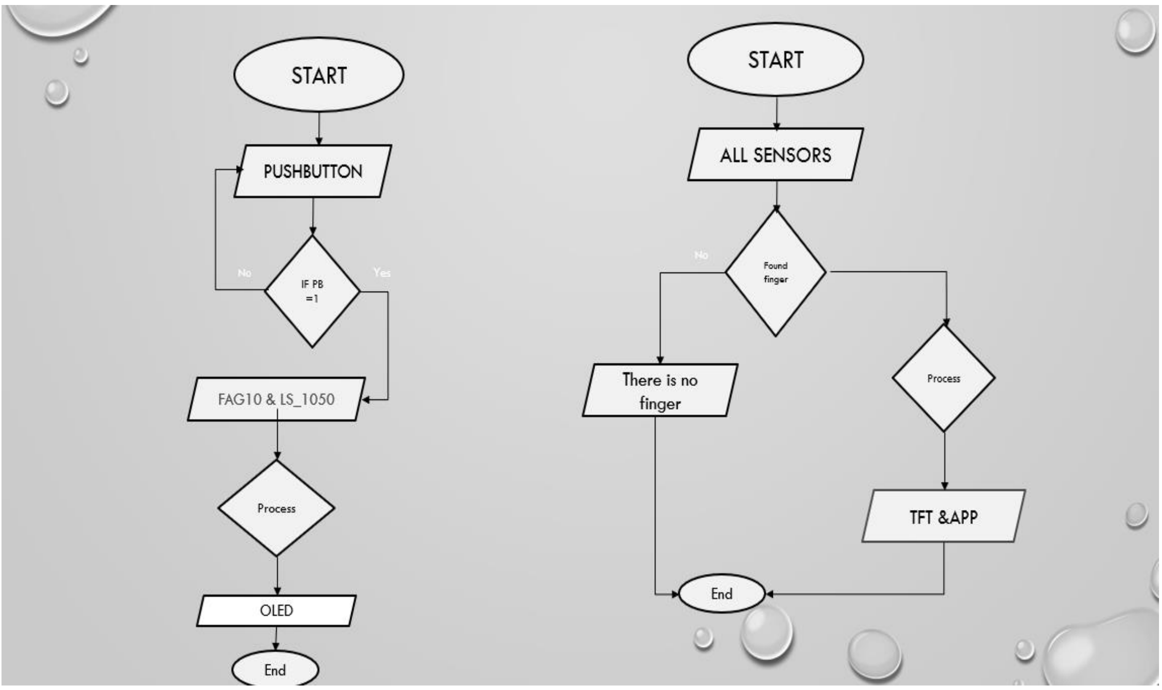
Results and Discussions

Chapter 4: Results and Discussions

4.1 Introduction

from tags vitality that Complete monitor it and measure it in lonliness treatment and surveillance measurement level Sugar with blood Without tingling via analysis spectral for rays under red nearby after study Experimental I ran Aims to implement road measurement New to level Sugar in the blood to be substitute security Same reliability and accuracy High slime problem measurement for those with skin dark being rate absorption for rays They have less from five to ten times Than impact also on permeability X-rays and hack it for tissues dark poignant negatively on practical accuracy measurement level Sugar They have and give results not minute.

4.2 flow chart



Besed to non-invasive blood sugar: when you press in the pushbutton

You will make the sensor ready, so now if pb =, no action then wait to had press Else if pb = 1, sensors will send NIR.

When it send the controller will do the process that we had and show them in the Oled screen

Then end the process until had new change.

Other vital signs: when there is no finger theres no action, so it will appear in the screen (there is no finger)

until there is change as found had the controller recevice the order then do the process to show the result in screen and application, after that end the process until had new change.

4.3 Definition of the language used in the project:

In general, programming languages are similar to the middle ground in understanding between humans and other beings, so if a person wants to talk to a cat, she will certainly not understand the words that come out of his mouth, and also he will not understand the language of the cat when she speaks, and therefore it is necessary to find a language of understanding between them that is Different from the language of each gender, this is how the programming language is, as it is the middle solution between the user and the devices, where the Arduino environment, i.e. the Arduino language, was used with the ESP32 desks

The Arduino language is a language of communication and communication for understanding between the user and the various electronic devices so that these devices can carry out the required commands. Perform the required tasks on the board.

Arduino language:

It is just a collection of C/C++ functions i.e. mainly derived From C and C++ and the Wiring and Processing frame works It is open source. Arduino is used to program

Figure(11): Arduino interface

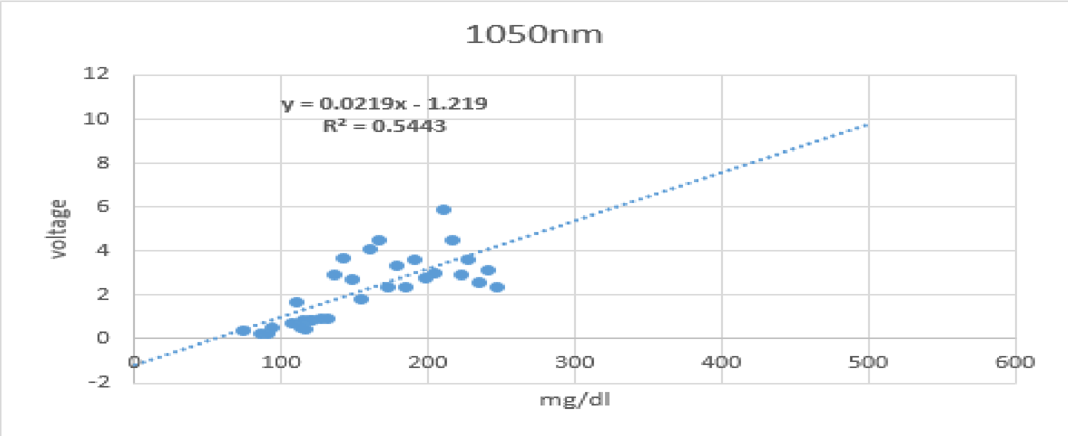
boards Arduino of all kinds unifies the way to program boards Their types and the

controls on which they are based differ, and facilitate the process Programming is for those without a prior programming background. The Arduino language is distinguished from the C language - from which it is derived - in that it is an object-oriented language, as it contains many classes and objects such as the String and Stream classes. In addition, Arduino is rich in many libraries that provide more functions, such as working with any additional piece or electronic component, modifying data, etc. The Arduino language is not only required to be used with the Arduino IDE, but can also be used with other environments

Measurement of blood sugar:

It was completed Procedure the study on two types from sugars sugar the blood natural(glucose the blood)in tissue Human body to contain23a sample mankind Include males And the females from all Colors multiple categories age And done get on concentrations different in border0-1000mg/deciliter about road thaw powder monohydrate glucose in water distilled pure to get on Sugar Industrial near for glucose the blood and monitor rate permeability And he was affected went out the couple photosynthesis when difference concentrations glucose and find relationship Effort The resulting with difference concentrations. Figure (21): show Testing a glucose solution in LMRS permeability modeto1050nm

Figure (21) Testing a glucose solution in LMRS permeability modeto1050nm



figure(22):Show Relationship between glucose solution concentration and output voltage in transmittance mode of a 1050 nm transmitter.

Figure displays (21) Test glucose in synthetic solutions in permeability mode for the same sender wavelength of 1050 nm to obtain the relationship between voltage and solution concentrations, then a scatter plot was drawn and the relationship was obtained through linear regression. Figures show (22) Graphs.

It is inferred that when near-infrared radiation is transmitted in a transmitter with a wavelength of 1050 nm, the output voltage increases with an increase in the concentration of the synthetic glucose solution and decreasesBy increasing the concentration of glucose solutions LSynthetic in a transmitter with a wavelength of 1550 nanometers. figure(23): Show test and measure the location of the finger in LMRS transmittance modeto1050nm.

figure(23): Show test and measure the location of the finger in LMRS transmittance modeto1050nm.

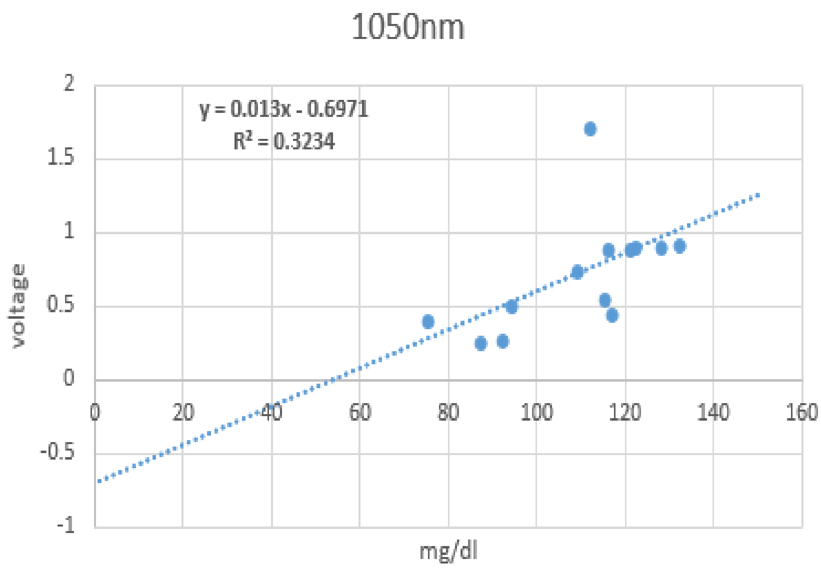


figure (24): show Relationship between blood glucose concentration and output voltage on the body in permeable mode for a 1050 nm transmitter.

After that , Tig was done Lord previous on the body in figure (23).

Firstly,20 samples were used as training data to obtain the relationship between the sensor output voltage and blood glucose concentration. Everyone whose blood glucose is measured with a glucose meter (glucometer).

l have been used Accu-Chek blood glucose meters The glucose meter, which is an acupuncture method to compare Measuring device without twitching. Data was collected and conducted anonymously with the consent of volunteers.

Measurement of blood glucose without pricking of the surface of the skin in different locations such as the palm, forearm, earlobe, cheek, and arms where blood passes in these areas in a way that may not reduce errors because any slight delay can cause major complications, especially when glucose decreases blood quickly. In this experiment, the finger was chosen as the site for this blood glucose measurement because the capillary network in the finger has a high density no There is break My time, and changes effect on This is amazing Region pace A quick . Bonus on that, Create this Region Empty from the hair They are more appropriate place To measure rate Sugar in the blood.

It was completed registration voltages that happened on her sensor in transmittance mode.

in this Section, And for a study more in detail for behavior sender LED, He was an effort went out Photodiode sensor for every device send sender Also registered at all experiments and environment measurement were dark to test sensor on body without being affected by the distortion that light may produce.

The finger is between the transmitter and the receiver. The appropriate body position for the experiment to put the transmittance is shown as in the figure (23).

The blood sugar level of 20 volunteers was measured using (glucometer) and the data was recorded for the sensor output voltage of a non-puncture meter to obtain the relationship between voltage and glucose concentrations. The scatter graph is used to find the linear regression line .

The relationship between the concentration of glucose in the blood and the resulting voltage on the body in permeable mode is illustrated by the figure (24).

The equation obtained from the linear regression is selected and entered into the code to find the formula for the equation that converts the voltage into its corresponding glucose value with focus and Shown in the figure (25) the code of the Arduino which demonstrates the process.

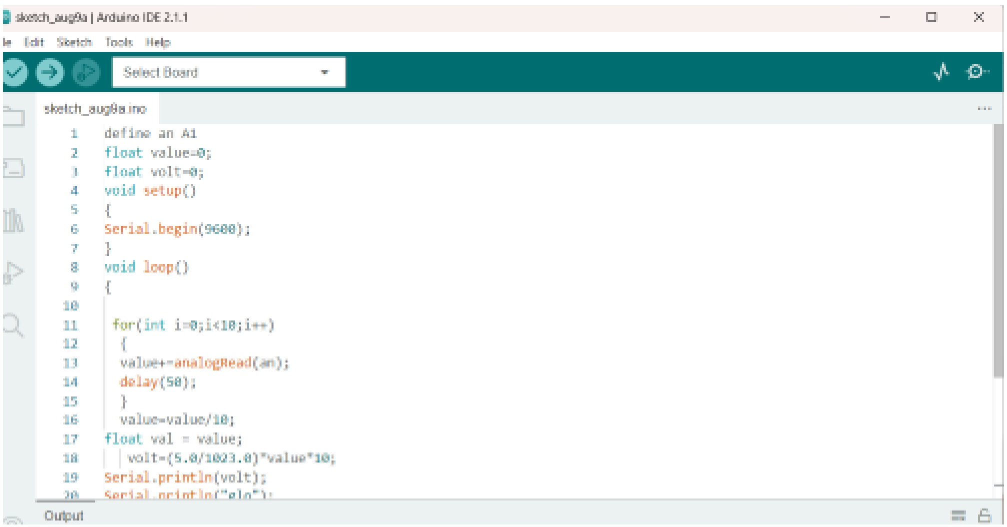


figure (25) the code of the Arduino which demonstrates the process.

Next, to evaluate the proposed device, the blood glucose levels of 10 subjects were measured using the sensor designed to study the behavior of each of the subjects Messengers 1050nm in transmittance mode.

after Enter formula equation Regression that It was completed get on her to code, there option last It was completed the job on him here and he account middle The result final average of ten consecutive readings It was completed get On it from the messengers where will help this in reduction impact data the noise. Represent schedule1Results that It was completed get on her from Prick and non-prick measurement methods. rate The error She was calculated using Equation (1).

It was completed account RMSE by (1), where x is rate Sugar in the blood estimated by Acupressure method and y is concentration glucose Size by method of measurement without pricking, And number samples.

(1) average concentration glucose= middle (t, f).

(2) The error (%) =

$$\frac{|\text{Acupuncture glucose level value} - \text{Glucose level value without twitching}|}{\text{Acupuncture glucose level value}} \times 100$$

(3)Root mean square error=

$$\sqrt{\frac{\sum_{i=1}^{n}(x_i - y_i)^2}{n}}$$

$$\text{Average glucose concentration} = \text{average}\ (f, t) \qquad (1).$$

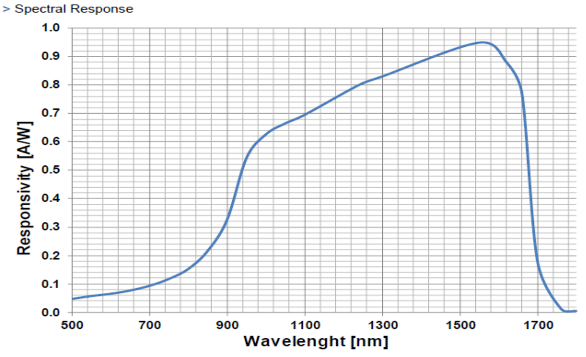
$$\text{Percentage error}\ (\%) = \frac{|\text{Glucose Level}_{\text{invasive}} - \text{Glucose Level}_{\text{non-invasive}}|}{\text{Glucose Level}_{\text{invasive}}} \times 100\% \qquad (2).$$

$$\text{RMSE} = \sqrt{\frac{\sum_{i=1}^{n}(x_i - y_i)^2}{n}} \qquad (3).$$

The following table(1) shows the relationship between concentration glucose and effort The resulting for devices send Same lengths Waveform 1050nm in situation permeability

schedule1:middle Valuableglucose that It was completed get on him from 1050nm transmitter in transmittance mode			
% error	measurement concentration glucose tingling(mg/dl)	measurement concentration Glucose without prick using account(mg/dl)	sample number
2.54	130	133.30	1
1.87	131	133.46	2
7.77	121	130.42	3
2.74	129	132.54	4
8.2	113	122.36	5
19.4	154	124.09	6
24,548	166	125.25	7
10	113	124,30	8
8.04	102	110.2	9
8.35	97	105.1	10
9.35%		middle Results final that It was completed get on her	

Complete evaluation lengths Waveform Based on the results obtained are done to implement this from during a plan response spectral for rays under red receiver Absorbs Photodiode receiver lengths Waveform in Domain 900-1700 nm. Figure(26) show response spectral for the photodiode extracted from paper data own with it



Figure(26) show response spectral for the photodiode extracted from paper data own with it

$$\textbf{RMSE} = \sqrt{\frac{3313.5311}{10}} = \textbf{18.203}$$

Shown as the average percentage error is9.35%, and the mean square root error is 18.203mg/dL This is because when light passes through the tissue of the finger, the optical wavelength absorbed by the receiver may be different with the wavelength of the transmitter Therefore, the possible changes due to the wavelength and wave velocity and can cause side effects of the test case In the occurrence of errors, glucose measurement can be affected by some physiological changes such as variation in body temperature, chemical changes, triglycerides and albumin levels, and environmental variables also enter such as change in temperature, humidity, carbon dioxide, and atmospheric pressure, and these are among the disadvantages of infrared spectroscopy red (NIR).

Schedule2 comparison table of theSPO2_HR For my device and another device:

percentage error	HR_D	HR	percentage error	SPO2_D	SPO2
1,051	94	95	1.03	98%	97%
2.78	105	108	0	95%	95%
8.4	102	106	1.04	97%	96%
2.9	100	103	0	98%	98%
5.3	88	93	1.05	96%	95%
6.9	86	86	1.04	95%	96%
3.42	111	117	1.01	98%	99%
3.77	102	106	2.13	96%	94%
7.22	77	83	2.11	97%	95%
3.81	101	105	1.05	96%	95%
4.57%			1.053%		Total error percentage

Schedule3 Comparison table of the TEMP For my device and another device:

percentage error	TEMP_D	TEMP
1.83	37.5	38.2
0.5	37	37.2
1.6	35.5	36.1
1.89	36.3	37
1.33	37	37.5
2.96	36	37.1
3.01	35.4	36.5
1.94	35	35.3
3.85	37.5	39
0.53	37.8	38
1.944%		total error rate

Results:

I showed results a test reliability that there a an agreement good To measure glucose between both ways(Accu-check And NIR Sensor), which It was completed prove it from difference rate low error(3% -17%)to an acceptable mean error**9.35%**when Both Done comparison measurements glucose For several people of different races and ages, it was noticed that it gives a good and promising response and results for dark skin, like normal skin. We can say that the factor material for individuals may be impact on measurements according all who are they being the individual for him thickness leather different Than impact on breakthrough Signal rays under red and he has being there Factor last because of Spread Signal rays under red in Regions surrounding and he will receive led the couple photosynthesis Less rays.

Schedule 4:Comparison between this study and studies previous

Research	Glucose	Percentage error (%)	RMSE
Our proposed system	Yes	9.35%	18.2 mg/dl
Masab Ahmed [12]	Yes	Not reported	Not reported
Mitra Mohd Addi [4]	Yes	12.5%	Not reported
Chandrakant Datrao Bobade [3]	Yes	Not reported	Not reported
HAIDER ALI [2]	Yes	8-10%	Not reported
Bahareh Javid [5]	Yes	8.27%	18.52 mg/dl

Discussion:

in This is amazing the study, It was completed to examine glucose the blood using analysis spectral x-rays under red And the way visual on respectively, and the experiment was carried out on artificial solutions close to blood sugar and real blood sugar, and for evaluation the system in experiments on the body District And in lab conducted And achieved results promising.

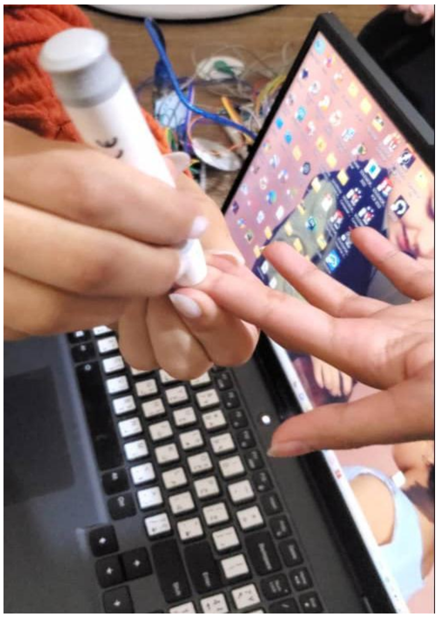
noticed that an effort output in a manner without tingling He increases Effort up concentration glucose in situation Transmittance While these observations may not be proven on artificial solutions, the sensor response varies according to the different wavelength of the transmitter. be

These differences because of several Factors Include curve Calibration that It was completed get on him from measurement solutions glucose Just And being no It contains on any Material other as in the blood Real.

Radiation transmitters with different wavelengths were used to ensure the permeability of the rays for different bodies, ages and colors. The dark skin's response to the rays was observed and good measurement results were obtained.

It is clear schedule 4 Comparison between this study and studies previous.

See that average concentrations glucose in situation permeability He was middle rate wrong with it 9.35 and root mean square The error is 18.204 mg/dL. Therefore, we conclude that non-puncture glucose measurement can be an alternative to traditional acupuncture glucose measurement in the near future.



Chapter 5

Conclusions and Future Works

5.1 Conclusion and recommendations:

1.In this study of a non-puncture glycemic monitoring system, two measurement ideas were used, namely continuous monitoring and multiwavelength average measurement.

2.The experimental result after testing proves that this system has an improved advantage in predicting blood sugar, and the multiple wavelength model of middle Glucose obtained from the average of two transmitter values in permeability mode has contributed greatly to Improved performance and accuracy.

3.Monitoring blood sugar without tingling is not only beneficial for patients diabetes, But also for normal people to maintain glucose level in the normal range to maintain a healthy lifestyle. As a recommendation for future improvements.

4.We recommend using a sensor with a higher light sensitivity and faster response time to further improve performance and obtain better accuracy results than our recommended sensors**FDGA05**And**FGA21**

5.2 Future work

1.We aspire in the future to develop and master the device as an intensive care unit device.

2.We also aspire to add other sensors and integrate all sensors into a better controller.

3. Additionally, we aim to create a treatment unit.

4.Furthermore, we aim to enhance the device to diagnose certain diseases through artificial intelligence.

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Appendix 1

List of datasheet sources for items used

A4988 datasheet, equivalent, microstepping driver. (no date) A4988 Driver Datasheet pdf - Microstepping Driver. Equivalent Catalog. Available at: https://datasheetspdf.com/pdf/788474/Allegro/A4988/1 (Accessed: March 12, 2023).

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Appendix 2

Stages of electronic circuit design

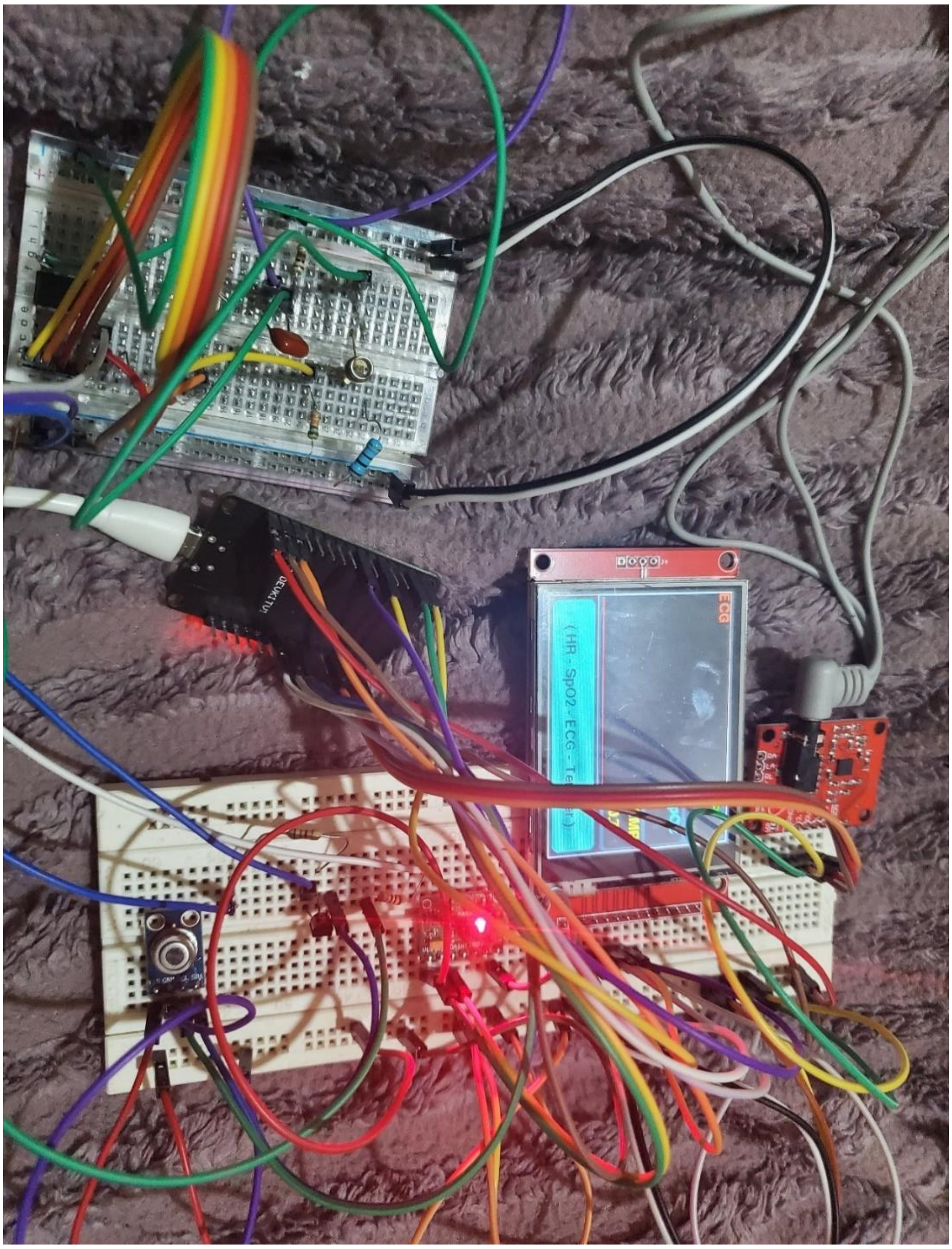

Figure (27):Connecting and implementing the circuit to the white electronic test board

Appendix 3

3D design of the device

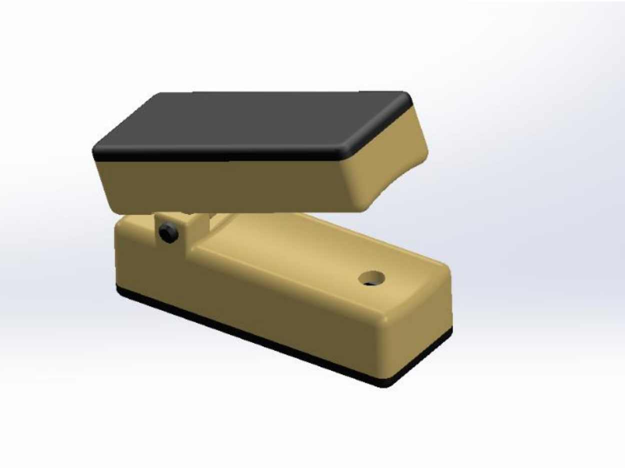

Figure (28): Stereoscopic design for measuring blood glucose

Figure (29): Stereoscopic designSpo2

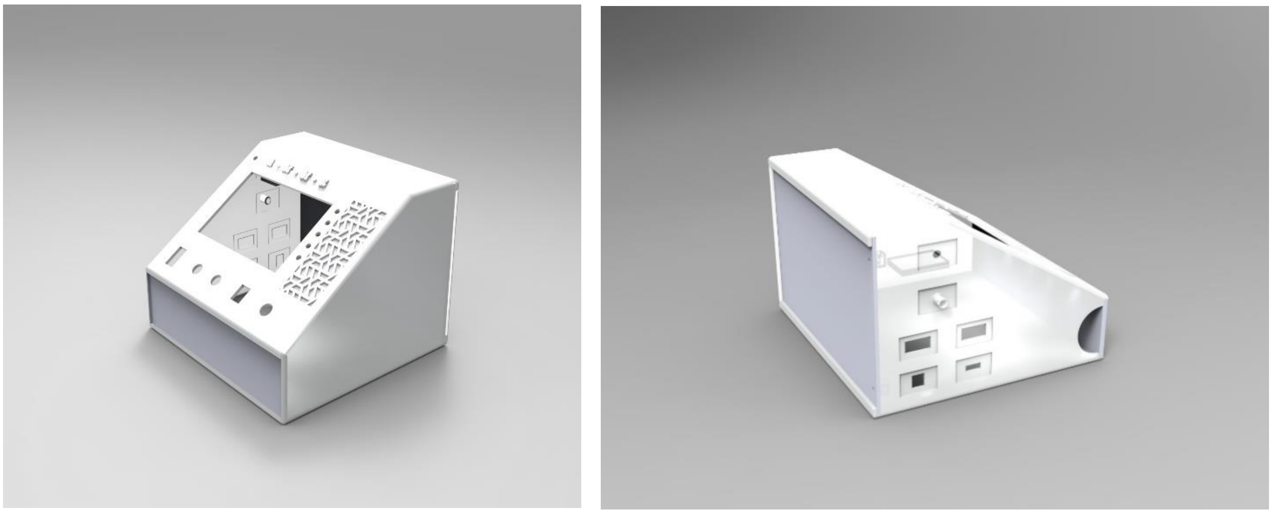

Figure (30): Design of the external structure of the device