SDM COLLEGE OF ENGINEERING AND TECHNOLOGY
DHARWAD

(An autonomous Institution affiliated to
Visvesvaraya Technological University, Belgaum – 590018)

Department of Electronics and Communication Engineering

A report on the Minor-project 1 entitled

"Non-Invasive Glucometer"

Proposed by

Mr. Baibhav Gorai	**USN 2SD20EC023**
Mr. Shounak Herekar	**USN 2SD20E C096**
Mr. Visvajeet Sinha	**USN 2SD20EC119**
Mr. Nayangowda S	**USN 2SD20EC059**

Students of 5th semester

Under the guidance of

Prof. Sunil Mathad

Department of ECE, SDMCET, Dharwad-

Academic Year 2022-2023

S. D. M. College of Engineering & Technology
Dharwad – 580 002

Department of Electronics and Communication Engineering

CERTIFICATE

This is to certify that **Mr. SHOUNAK HEREKAR**, bearing **USN: 2SD20EC096, Mr. VISVAJEET SINHA**, bearing **USN: 2SD20EC119, Mr. BAIBHAV GORAI**, bearing **USN: 2SD20EC023, Mr. NAYANGOWDA S**, bearing **USN: 2SD20EC059, Student of 5th Semester** has satisfactorily completed the **Minor Project 1** entitled **"NON-INVASIVE GLUCOMETER"** submitted to **Department of Electronics and Communication Engineering, SDM College of Engineering and Technology, Dharwad – 580002**.

Prof. Sunil Mathad, **Dept. of E&CE,** **SDMCET, Dharwad - 02**	**Dr. Vijaya C.,** **Prof & Head, Dept. of E&CE,** **SDMCET, Dharwad - 02**	**Dr. K. Gopinath** **Principal,** **SDMCET, Dharwad - 02**

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ABSTRACT

Diabetes mellitus is a complex group of syndromes that have in common a disturbance in the body's use of glucose, resulting in an elevated blood sugar. Once detected, sugar diabetes can be controlled by an appropriate regimen, the most commonly used method to measure glucose level in blood is an invasive method which is painful therefore to overcome this issue we are using the concept of NIR spectroscopy to demonstrate the working of non-invasive method of approximating the glucose in the blood stream. Here we use a sensor and a microcontroller for the working model.

INTRODUCTION

Diabetes mellitus, commonly referred to simply as diabetes, is a metabolic disease that causes high blood sugar. With diabetes, our body either doesn't make enough insulin or can't effectively use the insulin it does make. Untreated high blood sugar from diabetes can damage organs. But educating ourself about diabetes and taking steps to prevent or manage it can help to protect our health.

There are two types of diabetes: Type-1 and Type-2

Health risks are greatly reduced for a diabetes patient if they monitor their blood glucose level as found by recent studies. As reported by WHO, India has an estimated 77 million people (1 in 11 Indians) formally diagnosed with diabetes, which makes it the second most affected in the world, after China. Furthermore, 700,000 Indians died of diabetes, hyperglycaemia, kidney disease or other complications of diabetes in 2020. One in six people (17%) in the world with diabetes is from India. (India's population as calculated in October 2018 was about 17.5% of the global total.). As per survey of National Health Mission, the number is projected to grow by 2045 to become 134 million.

Presently the most commonly used method to monitor the blood glucose is by the invasive method. This method can cause pain and is a painful ordeal since it has to be done on a daily basis. Therefore, we are considering to develop the non-invasive method in which there are various methods either by saliva or sweat and etc, to approximate the glucose value, In this project model we are considering to use the method of NIR spectroscopy to estimate the glucose level.

The device consists of a sensor that can estimate the readings by placing a finger on it and transfer them to the microcontroller for calculation and display. The sensor consists IR emitters and photodiode to estimate the glucose level. This method although available but is considered less precise as compared to the invasive method and therefore still considered to be in development.

PROBLEM STATEMENT

The problem here is the orthodox way of measuring blood glucose itself and the issues include pain and damage to the tissues. Hence forth we are working on a non-invasive glucometer to predict the blood glucose level in a diabetic patient which is a painless, contactless and low-cost solution.

OBJECTIVES

- The main objective of this project is to demonstrate a non-invasive blood glucose monitoring device.
- The device should be able to predict glucose level in the blood using the optical rays and display the results on the LED screen. The use of non-invasive approach will allow us to overcome the disadvantages of invasive approach and continuously monitor the patient's blood glucose levels.

LITERATURE SURVEY

The motivation for this project comes through the real-life experience in which we have seen the grandparents and close relatives go through pain on daily basis while measuring their blood glucose when we ask to them about how they feel, they are very irritated and tired of feeling pain daily, so we decided to look through papers related to this and while referring through the various research papers we got idea for this project and we decided to take this up. We have mentioned the one of the papers which we have referred for the project. This paper also highlights the problems faced by the patients when checking the glucose level.

Title: A Feasibility Study of Non-invasive Blood Glucose Level Detection Using Near-Infrared Optical Spectroscopy.
Authors: Parama Sridevi, A S M Shamsul Arefin, Abu Shahadat Md. Ibrahim.
Publication: Bangladesh Journal of Medical Physics.
Description: In this paper, the authors have proposed a non-invasive technique for measuring glucose level using 940 nm near-infrared (NIR) LED and a corresponding photodiode.

CONCEPT AND BACKGROUND

BEER-LAMBERT'S LAW

This method exploits the principle that absorbance of light by a solution is proportional to concentration of the solution and the length path travelled by the light. The following law can be described as the following equation

$\log (I_o \backslash I) = \varepsilon c l$

Where Io= intensity of incident light

I= intensity of transmitted light

ε= molar absorption coefficient

l= optical path length

c= molar concentration

log (Io\I) = absorbance

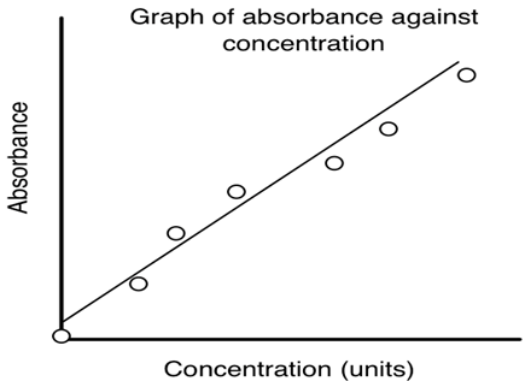


FIG 1

NIR SPECTROSCOPY

In the Near Infrared (NIR) Spectroscopy, glucose cells will produce the weakest NIR absorption signals in the human body as glucose is one of the biological component present inside the human body. In measuring the glucose level, the NIR spectroscopy enables the penetration of signals inside the tissue within the range of 1 to 100 millimetres depth. Penetration depth decreases as the signal wavelength value increases.

When a light ray interact with human body tissues, it is attenuated by scattering as well as by absorption by the tissues. Due to the mismatch between the refraction index of extracellular fluid and the cell membrane, light scattering occurs in tissues. Refraction index of extracellular fluid varies with the glucose concentration whereas the cellular membrane index is assumed to be remain relatively constant. Beer-Lambert Law plays a major role in absorbance measurement which states that absorbance of light through any solution is in proportion with the concentration of the solution and the length path travelled by light ray.

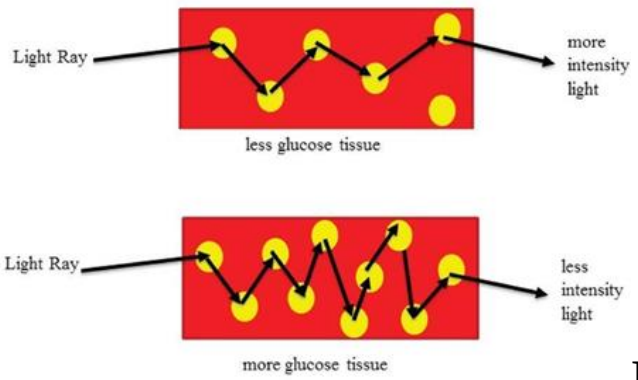


FIG 2

As we can see in the figure, where there is less glucose the scattering of the light is more and vice versa
This will be our main principle in approximating the blood glucose level.

WORKING

The proposed work is based on NIR optical technique. NIR light source of 940 nm wavelength is chosen because it is suitable for measuring blood glucose concentration. The sensing unit consists of NIR emitter and NIR receiver (photo detector) positioned on either side of the measurement site as shown in figure. When the NIR light is propagated through the contacted area (finger- tip or earlobe) in which it interacts with the glucose molecule, a part of NIR light gets absorbed depending on the glucose concentration of blood and remaining part is passed through the earlobe. The amount of NIR light passing through the contact area depends on the amount of blood glucose concentration.

We obtain a output voltage from the IR which is them passed through a an amplifier circuit which contains high pass and low pass filter to filter out all the noise and other unwanted signals from our output voltage and to amplify it to readable values.

The output of this amplification circuit is fed as an input to the A0 pin of the microcontroller. The microcontroller used here is Arduino UNO R3. Regression analysis which gives the relation between input and output parameters is carried out to calculate the glucose levels in mg/dl in microcontroller. The glucose level obtained is displayed on the LCD (16X2 LCD display) which is connected to the digital pins of the Arduino UNO R3 or it can also be displayed on the serial window.

COMPONENTS

HARDWARE COMPONENTS

1.Arduino uno r3

FIG 3

Arduino UNO is a microcontroller board based on the **ATmega328P**. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

2.IR Emitter and Receiver

FIG 4

The **Infrared Emitte**r is used to transmit infrared signals through an infrared LED, while there is an **Infrared receiver** to get the signals on the other side.

The wavelength we require is 940 nm which is readily available in IR emitter are of range 740nm to 1mm

3.Operational Amplifier (LM324)

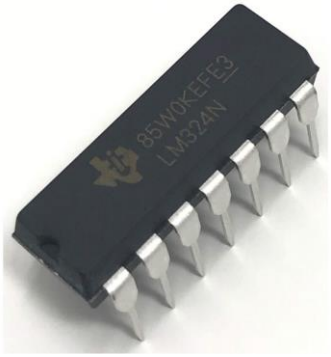


FIG 5

An operational amplifier is a DC-coupled high-gain electronic voltage amplifier with a differential input and, usually, a single-ended output.The LM324 series are low−cost, quad operational amplifiers with true differential inputs. They have several distinct advantages over standard operational amplifier types in single supply applications. The quad amplifier can operate at supply voltages as low as 3.0 V or as high as 32 V.

4.LCD(16X2)

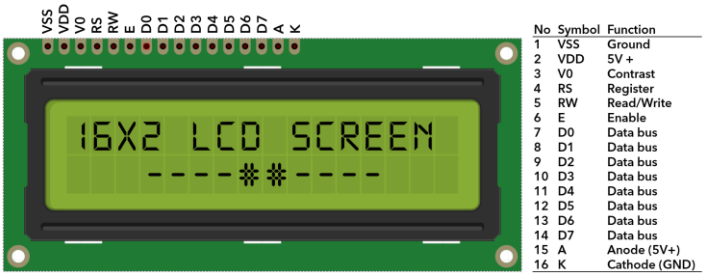


FIG 6

An electronic device that is used to display data and the message is known as LCD 16×2. As the name suggests, it includes 16 Columns & 2 Rows so it can display 32 characters (16×2=32) in total & every character will be made with 5×8 (40) Pixel Dots. So the total pixels within this LCD can be calculated as 32 x 40 otherwise 1280 pixels.

SOFTWARE COMPONENTS

1.Arduino IDE

FIG 7

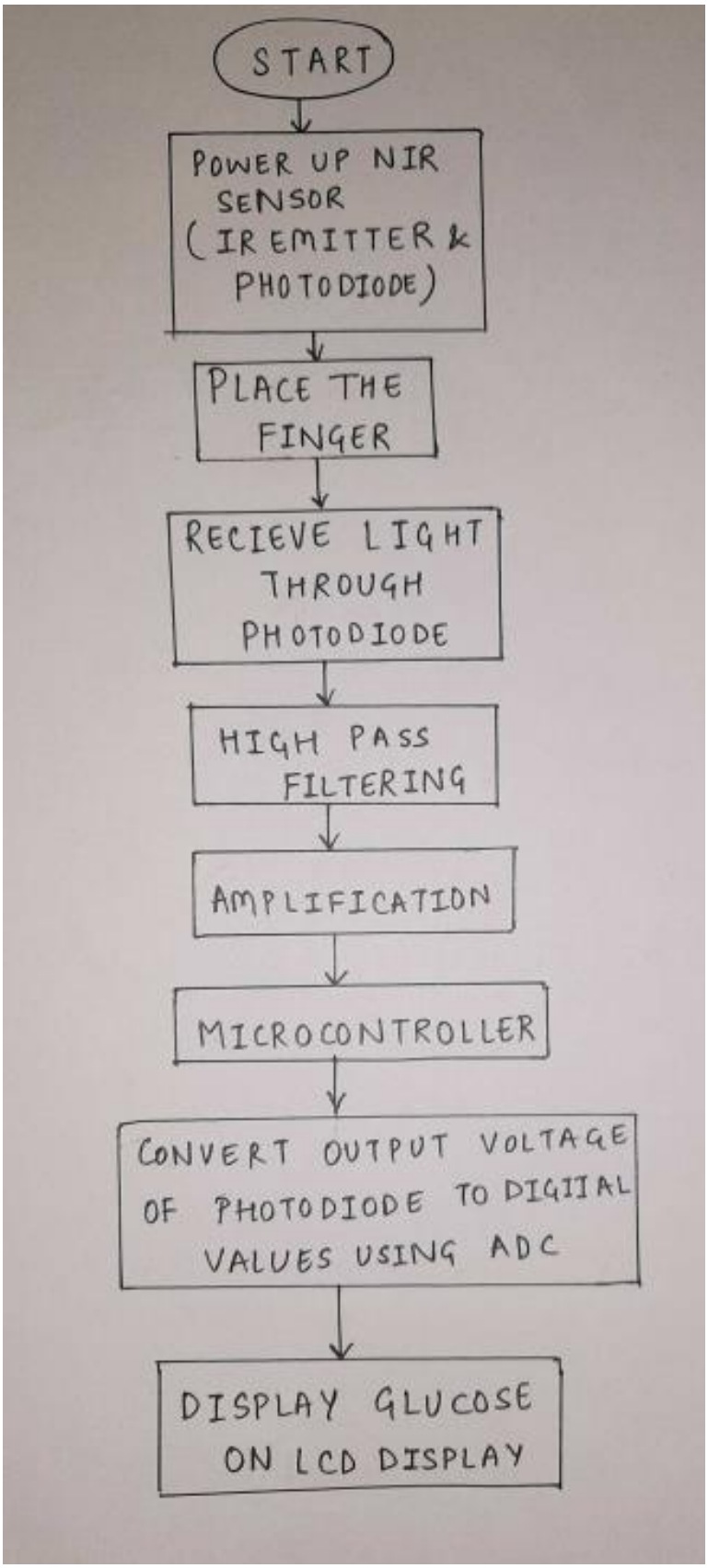
The Arduino integrated development environment (IDE) is a cross-platform application (for Microsoft Windows, macOS, and Linux) that is written in the Java programming language. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programs to an Arduino board.

2.PROTEUS 8

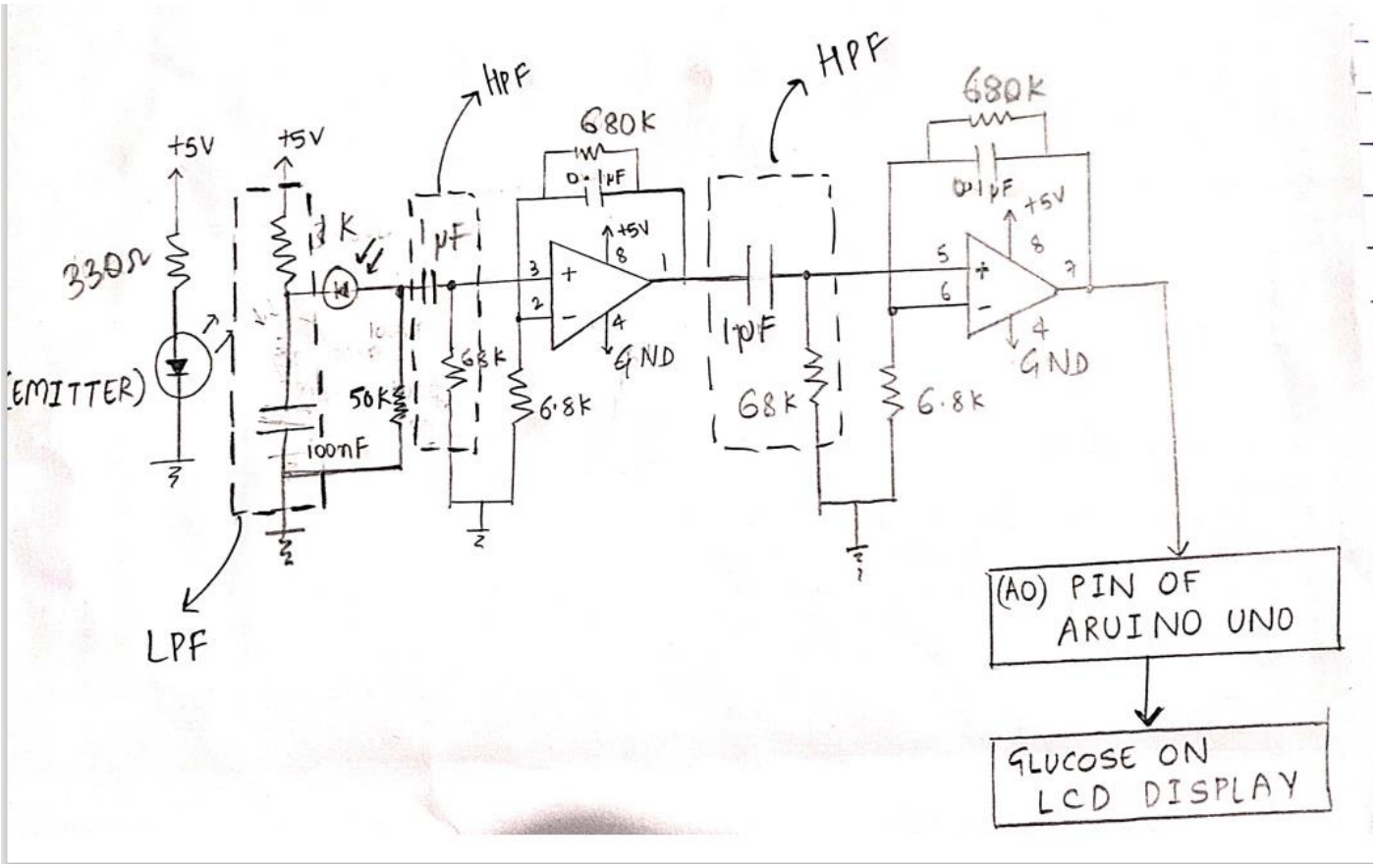
FIG 8

Proteus is a Virtual System Modelling and circuit simulation application. The suite combines mixed mode SPICE circuit simulation, animated components and microprocessor models to facilitate co-simulation of complete microcontroller- based designs. Proteus also has the ability to simulate the interaction between software running on a microcontroller and any Analog or digital electronics connected.

BLOCK DIAGRAM



CIRCUIT DIAGRAM



SPECIFICATIONS

1 LPF CUTOFF FREQUENCY = $1/(2*\pi*R*C) = 1/(2*\pi*1k\Omega*100nF) = 1.5kHz$

2 HPF CUTOFF FREQUENCY = $1/(2*\pi*R*C) = 1/(2*\pi*1k\Omega*1\mu F) = 2.34Hz$

3 Gain (Non-inverting amplifier) $= 1+(R_f / R_{in}) = 1+(680k\Omega/68k\Omega) = 11$

MATLAB CODE

```
clc;clear all;close all;
x=0:1000;
y = (8*10.^-5)*x.^2 + 0.1873*x + 46.131;
plot(y)
xlabel('Analog voltage (mv)')
ylabel('Glucose Level (mg/dl)')
title('Glucose data with analog voltage')
```

OUTPUT RESPONSE

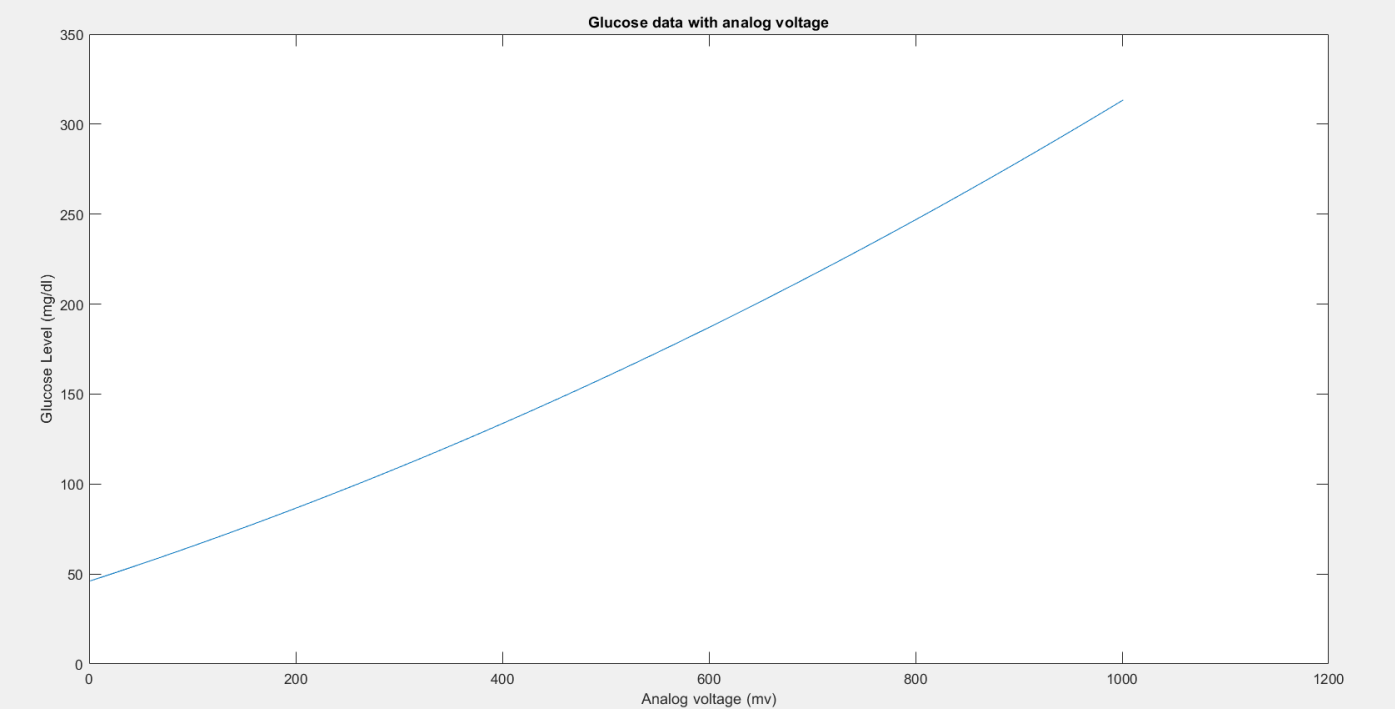


FIG 9

Above is the output of glucose level for corresponding Analog voltages.

RESULT

Observation Table

Name of subject	O/p from invasive glucometer (Eqn-1)	O/p from non-invasive glucometer (Eqn-2)	Error analysis (Eqn2 -Eqn1)
SHOUNAK HEREKAR	100	103	3
VISVAJEET SINHA	103	107	4
BAIBHAV GORAI	108	102	-6
ANURAG	133	138	5
MALIKARJUN	93	97	4
VIVEK	118	128	10
AMRIT	87	93	6
ANKIT	117	112	-5
JAI IRKAL	98	104	6

CONCLUSION

As per our objectives we were successfully able to demonstrate a non-invasive glucometer which can approximate the glucose levels in a painless manner.

FUTURE SCOPE

1. The project can be authenticated by a qualified professional if refined properly.
2. The project is unable to maintain the peak value measurement which we can consider as a approximate glucose level, also unable to hold the peak value output to display, the values are continuously varying.
3. Sensor for the project can be minimised by using PCB design.
4. IOT can be also implemented on this project.

HARDWARE MODEL

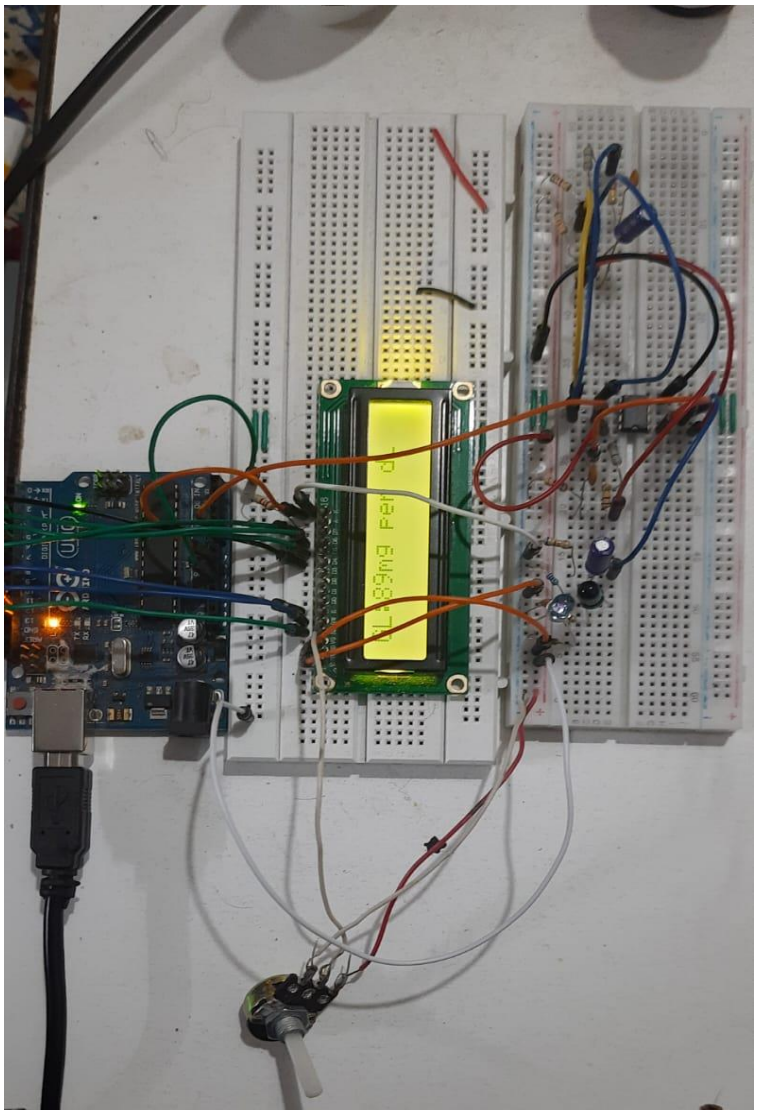


FIG 10

REFERENCES

http://www.kscst.iisc.ernet.in/spp/42_series/SPP42S/02_Exhibition_Projects/167_42S_BE_1719.pdf

Designing and Implementation of Non Invasive Blood Glucose and Hemoglobin Detection using NIR Kalaivani V, Devika E, Arulladakanthan R, Santhoshini Arulvallal

https://www.irjet.net/archives/V7/i6/IRJET-V7I6494.pdf

https://github.com/varanasiroshan2001/non-invasive-glucometer

A Feasibility Study of Non-invasive Blood Glucose Level Detection Using Near-Infrared Optical Spectroscopy Parama Sridevi, A S M Shamsul Arefin and Abu Shahadat Md. Ibrahim

https://www.youtube.com/c/SVViraktamath