

# IMPLEMENTATION OF NON-INVASIVE BLOOD GLUCOSE MONITORING SYSTEM

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**Abstract:** Diabetes is an incurable disorder which produces various problems related to the body. It is a fast-growing disorder, about 500 million people in the world and 50 million people in India are the victims of diabetes. All problems related to diabetes can be reduced through physical exercise, proper and balanced diet, and medication. The current invasive technique which is painful and inconvenient because people have to prick their finger to draw the blood for the measurement of glucose concentration in the blood on a daily basis so it is not recommended for a lifetime. People living in villages (economically poor) do not have facilities to check their blood sugar level regularly because of unavailability of glucose measurement devices and procedural cost. To overcome the difficulties caused by invasive method we are using non-invasive method in our project. In this project we are displaying the glucose value on LCD and this data can be stored in database, and also this data sent to the doctors through web/android application so that patient can get early medications and they can take precautions.

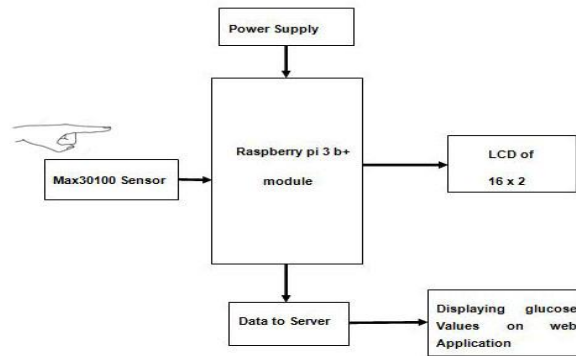
**Index Terms** - Raspberry Pi, Max30100 Sensor and LCD Display.

## I. INTRODUCTION

Diabetes mellitus is a metabolic disorder where the blood glucose swings from normal blood glucose level (90-140 mg/dl). This chronic disease has high morbidity and it is established that the disease is incurable. The increase in sugar level is either due to inadequate production of insulin in blood cells or can be because of improper response of body cells to the insulin or can be because of both the reasons. Diabetes can lead to major complications like heart failure and blindness in the human body. Hence regular monitoring of glucose level is important. There exist three types of diabetes mellitus, which are type 1, type 2 and gestational diabetes. Type 1 comes under most serious type of diabetes mellitus. It occurs mainly when the quantity of beta cell produced in the pancreas was destroyed by the immune system due to which the body fails to produce sufficient amount of insulin. Patients who have been diagnosed with this disease were required to inject the insulin or they must wear an insulin pump. It is usually developed during childhood and adolescence. The most common type of the diabetes mellitus is Type 2. It mainly occurs when excess of insulin is produced within the body and when the insulin is not properly utilized by the body or the cell does not respond to the insulin. It mostly develops in obese and adult people. The gestational diabetes is a third type of diabetes mellitus.

It mostly occurs when pregnant women with no history of the diabetes develop a high blood glucose level. The blood glucose level mainly contains three categories, they are hypoglycemia (low blood sugar level), normal blood glucose level and hyperglycemia (high blood sugar level). The normal range of blood glucose level is between 70mg/dl to 100mg/dl for children while 70mg/dl to 150mg/dl for adults. It is considered hyperglycemia when the glucose level rises above 150mg/dl. which can cause diabetic coma, blindness etc. while it is hypoglycemia when the glucose level is below 70mg/dl. Hypoglycemia can cause stroke, coma, confusion and irreversible brain damage. To avoid complications, blood glucose level needs to be checked on a regular basis. Frequent checking of blood glucose can reduce the odds of diabetic complications.

## II. BLOCK DIAGRAM



Block diagram of proposed work

## III. HARDWARE DESIGN

### A. Raspberry pi 3 Model B+

In this project we are using a Raspberry pi as microcontroller. The Raspberry Pi is known as a single-board computer, which means exactly what it sounds like: it's a computer, just like a desktop, laptop, or smartphone, but built on a single printed circuit board. Various models of Raspberry Pi have been released since the original Model B, each bringing either improved specifications or features specific to a particular use-case, but we are using Raspberry pi 3 Model B+. Fig 3.1 shows the circuit diagram of Raspberry pi 3 model B+. The Raspberry Pi works in the open source environment it runs Linux (diverse distribution), and its principle supported working system, Raspbian, is open source and runs a suite of open source programming. The Raspberry Pi Foundation adds to the Linux part and different other open source extends just as releasing its very own lot programming as open source.

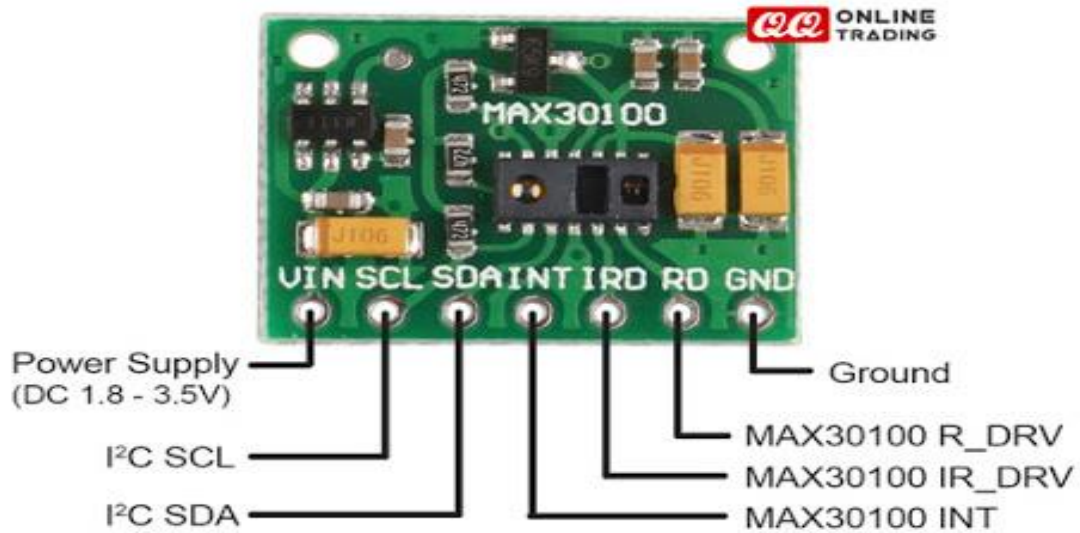


Raspberry pi 3 Model B+

### B. Max30100 Sensor

The MAX30100 is an integrated pulse oximetry and heart rate monitor sensor. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

Max30100 sensor is fully configurable through software registers, and the digital output data is stored in a 16-deep FIFO within the device. It has an I2C digital interface to communicate with a host microcontroller. The pulse oximetry subsystem in MAX30100 consists of ambient light cancellation (ALC), 16-bit sigma delta ADC, and proprietary discrete time filter. It has an ultra-low-power operation which makes it ideal for battery operated systems



Max30100 sensor module

### C.16 X 2 LCD display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi-segment light emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.



16X2 LCD display

## IV. WORKING PRINCIPLE

The main optical principle involved in non-invasive method is NIR spectroscopy, NIR spectroscopy measures the changes in light intensity when a light beam with 750–2500 nm wavelength is transmitted and reflected on the 1–100-mm thick skin tissue. The incident light on the body is partially absorbed and partially scattered, due to its interaction with the chemical components within the tissue. According to light transport theory or to beer-lamberts law, the light attenuation is proportional to the concentration of the medium. In human tissue, light interacts with tissue and attenuation occurs. The attenuation occurs due to absorption and scattering of light. The equation given below

$$A \propto C \text{ -----(1)}$$

Where, A = Absorption  
C= Concentration (mol /L)

At first the patient who wants to determine the glucose level must place his index finger on the sensing spot of the sensor. The IR LED in the sensor (Max30100) transmits the light towards the finger and some part of the light gets absorbed and some part of the light is received by the photodiode in the sensor ,where we obtain the data which is of analog data. During calibration errors due to time delay while measuring the glucose level is minimized by reducing the effect of any light source on the sensing unit. The data from photodetector then goes to Raspberry pi 3 Model B+ microcontroller for processing and determining the blood glucose level. As the photodetector collects the reflected light. The voltage across the voltage divider changes with variation of light. The voltage level is detected by the Raspberry pi 3 model B+ and then convert data into ADC value. Later on, to reduce the line interference, filter circuit can be used.

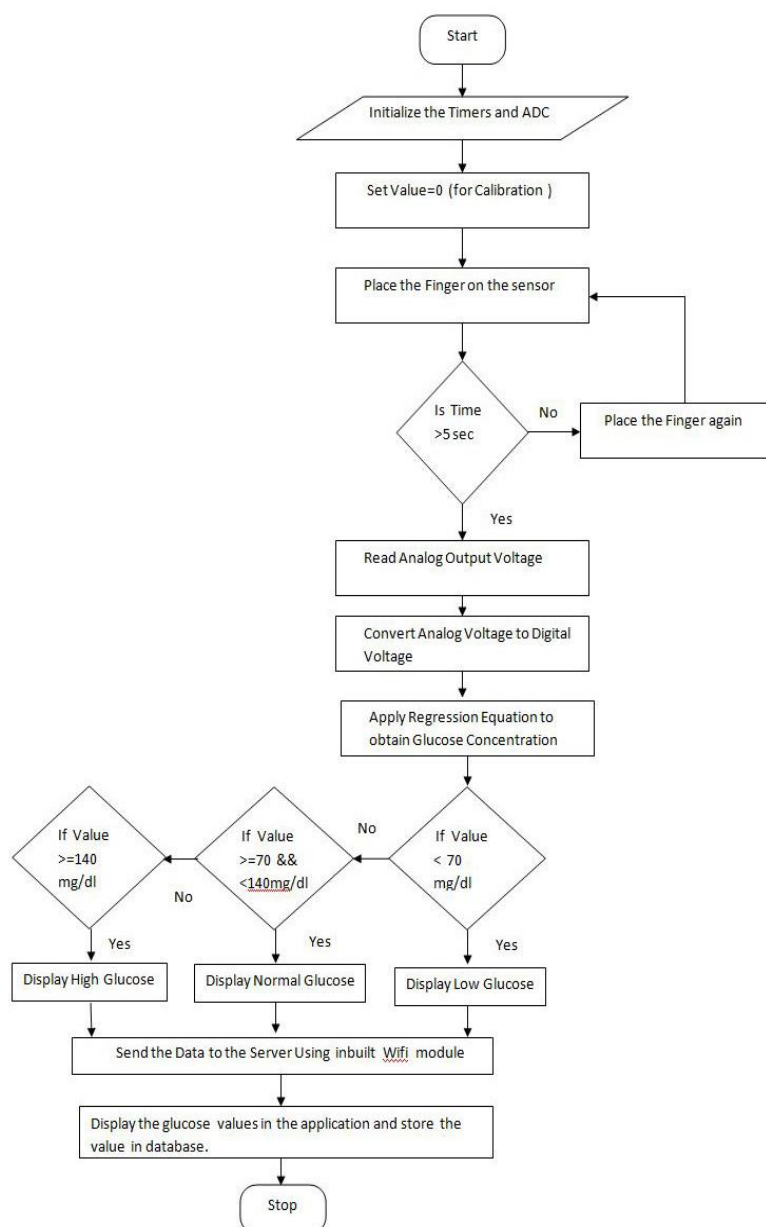
To obtain the glucose concentration accurately experiment need to be conducted on maximum of 20 people for both diabetic and non-diabetic person at different intervals using our designed system and the commercially accepted invasive glucometer (Accu check). Then we would plot the ADC value of the data against glucose concentration determined from the commercially available invasive device. And perform Linear Regression Analysis on the plotted values using Data modelling tools to develop an equation which we used later to determine the blood glucose level by using our designed system.

Equation developed by training the dataset is in the form of

$$y=A*x-B \text{ -----(2)}$$

Where,  $y$ =glucose level,  
 $x$ =ADC value,  
 $A$ =numerical value,  
 $B$ =numerical value

As we have collected data at various intervals of times of the day rather than the conventional way, which is taken only before and after a meal. The patient can measure his/her glucose level at any time of the day, the relationship developed from the data which considers all the factors rather than conventional one, hence accuracy of the data can be improved by training large set of data.



Flow diagram of proposed system

## V. CONCLUSION & RESULT

From the results obtained, it is concluded that the non-invasive type of glucose measurement is possible, and the output of the non-invasive type results are validated with the help of conventional invasive type glucometer's results with minimum error and tolerance. Our approach to medicine not only provides patients with cost-efficient healthcare but also is healthier (Invasive monitors penetrate the skin and Blood Glucose Measurement Based on 2-dimension Photo acoustic Spectrum have a high potential to cause blood-borne infections) than an invasive approach to detecting glucose.

The accuracy of the system can be improved further by obtaining additional measurements at different excitation wavelengths. This should be coupled with improvements in signal denoising to obtain noise-free signals without the need for repeated excitation of the sample. The interfacing of the system with a mobile device and server can enable automated monitoring of blood glucose levels and can provide physicians and healthcare practitioners with an easy way of monitoring the health and well-being of patients under their care. The collected glucose measurements can be used to personalize care by helping ascertain patient response to treatment for adjusting medication dosage and dietary intake. Additional work with larger datasets is needed for implementing these functions and for standardization of the device interconnections under different conditions and system loads. This approach of combining a portable measurement system with a mobile device and IoT services will allow for the collection of detailed health information about a patient and help in delivering personalized treatments that improve their quality of life.

## VI. FUTURE SCOPE

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