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Real Time IOT based Non-invasive Glucobin Monitor for Diabetes Patients

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ABSTRACT

Diabetes mellitus may be a boom thanks to various reasons. About 422 million people have diabetes, the bulk living in low- and middle-income counties and 1.6 million deaths are directly attributed to diabetes annually. In India around 7 million people that suffer from Diabetes Mellitus and out of that around 2 lakh people die per annum. It's a chronic disease where the physical body is lacking the power to dissolve blood sugar properly. Lack of insulin may be a major explanation for Diabetes Mellitus. The common glucose monitoring technique is predicated on the methodology of pricking. Although this system provides an accurate result, it's impossible to prick the patient frequently for measurement. Moreover, people with Diabetes Mellitus have inflamed blood vessels. this might end in production of more red blood corpuscle by the bone marrow. Also, some medication in diabetes can drop the amount of protein hemoglobin which is required to hold oxygen through the blood. Keeping all the above condition in mind we've designed a Glucobin monitor which basically determines the blood sugar and hemoglobin of the patient non-invasively. The measurement technique involves optical technique where we are determining the glucose level and hemoglobin within the blood by analyzing the variation within the intensity of the received signal obtained after reflection. The designed system uses Near Infrared (NIR) spectroscopy to work out blood glucose levels supported transmittance spectroscopy emitting signals of 940nm wavelength. These optical signals are sent through the fingertip and reflected signals are detected by opt 101 sensors placed beside. using google app script it, we will update the values in the google sheet by training app script. and these values can be used anywhere in the world by accessing google sheet. we are using microcontroller Esp.32 and optical 101 sensor for detection of the signals. the developed device is low-cost device, avoids complicated procedures and provides continuous monitoring of glucose and hemoglobin detection.

Key Words: Internet-of-Medical-Things (IoMT), Diabetes, Glucose measurement, Noninvasive measurement, Spectroscopy.

1.Introduction

Glucose is taken into account as vital supply of energy for human beings. The body needs blood glucose of range 80 to 150 mg/dl so as to perform the daily activities. However, the higher or lower level of glucose will result in numerous complications within the body. The glucose is created from the food digestion that enters the blood stream to produce the energy and conjointly helps within the growth. In case, the internal secretion isn't properly generated then blood would accumulate the high glucose concentration. A systematically high blood glucose concentration is feasible if the generation of α cells is larger as compared thereto of the β cells. Owing to this condition, enough insulin isn't secreted within the body for glucose consumption. This condition is referred to as Diabetes mellitus. Diabetes is a chronic disease that occurs when the pancreas is no longer able to make insulin, or when the body cannot make good use of the insulin it produces. Insulin is a hormone made by the pancreas, that acts like a key to let glucose from the food we eat pass from the blood stream into the cells in the body to produce energy. Insulin helps glucose get into the cells. Not being able to produce insulin or use it effectively leads to raised glucose levels in the blood (known as hyperglycaemia). Over the long-term high glucose levels are associated with damage to the body and failure of various organs and tissues. In case of diabetes, the cells of liver, muscles and fat unable to balance glucose insulin effectively. The diabetes is classified mainly in three categories: Type 1 diabetes, Type 2 diabetes and gestational diabetes.

Around 10% of all people with diabetes have type 1 diabetes. Type 1 diabetes is caused by an autoimmune reaction where the bo dy's defense system attacks the cells that produce insulin. As a result, the body produces little or no or no insulin. the precise causes of this aren't yet known, but are linked to a mixture of genetic and environmental conditions. Type 1 diabetes can affect people at any age, but usually develops in. People with type 1 diabetes need daily injections of insulin to regulate their blood sugar levels. If people with type 1 diabetes don't have access to insulin, they're going to die. the danger factors for type 1 diabetes are still being researched. However, having a loved one with type 1 diabetes slightly increases the danger of developing the disease. Environmental factors and exposure to some viral infections have also been linked to the danger of developing type 1 diabetes.

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Type 2 diabetes is that the commonest sort of diabetes, accounting for around 90% of all diabetes cases. It is generally characterized by insulin resistance, where the body doesn't fully answer insulin. Because insulin cannot work properly, blood sugar levels keep rising, releasing more insulin. For a few people with type 2 diabetes this will eventually exhaust the pancreas, leading to the body producing less and fewer insulin, causing even higher blood glucose levels (hyperglycaemia).Type 2 diabetes is most ordinarily diagnosed in older adults, but is increasingly seen in children, adolescents and younger adults thanks to rising levels of obesity, physical inactivity and poor diet.The cornerstone of type 2 diabetes management may be a healthy diet, increased physical activity and maintaining a healthy weight. Oral medication and insulin also are frequently prescribed to assist control blood sugar levels.

Gestational diabetes is related to multiple adverse pregnancy outcomes. Women with gestational diabetes are at subsequent high risk of type 2 diabetes, especially 3 to 6 years after delivery. Exposure to hyperglycaemia within the womb predisposes children to a high risk of becoming overweight or obese, related to the event of type 2 diabetes. Gestational DM (GDM) may be a severe and neglected threat to maternal and child health. many ladies with GDM experience pregnancy-related complications including high vital sign, large birth weight babies and obstructed labour. Approximately half women with a history of GDM continue to develop type 2 diabetes within 5 to 10 years after delivery.

If you've got diabetes, you'll got to have your blood checked regularly for anaemia. It's common for people with diabetes to also find yourself with this blood condition. If you notice anaemia early, you'll better manage the problems causing it. Usually, it happens because you don't have enough red blood cells. which will cause you to more likely to urge certain diabetes complications, like eye and nerve damage. And it can worsen kidney, heart, and artery disease, which are more common in people with diabetes.Diabetes often results in kidney damage, and failing kidneys can cause anaemia.

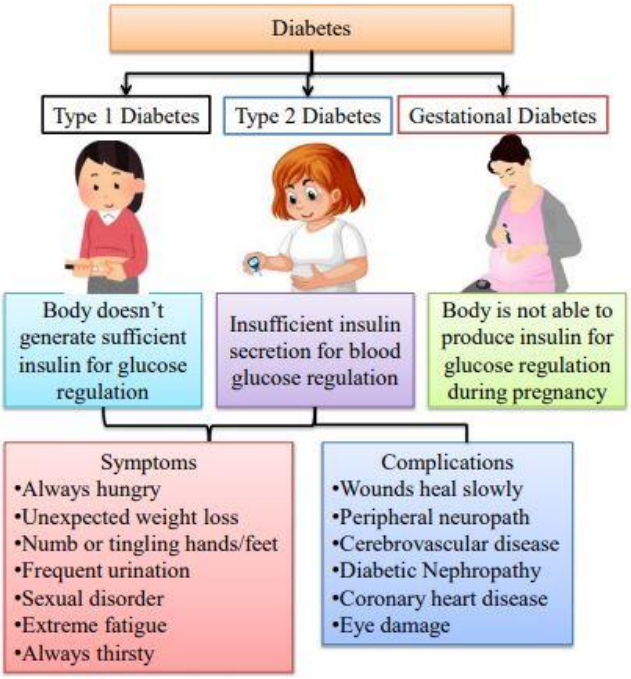

Figure 1: Different types of diabetes and their symptoms

2. Invasive glucose and hemoglobin measurement Technique

Invasive method of glucose monitoring can be done both at home or laboratory. This technique involves drawn of blood using needles. In laboratory-based technique we draw the blood in an empty syringe. Later this blood is used for determining the glucose level by performing HbA1c test on the drawn blood.

In the home-based technique we make use of glucometer which uses a lancet needle, a testing strip and a monitordo determine the glucose levels. The disadvantage in this procedure is discomfort to the patient by blood pricking and it only helps to measure the glucose measurement at that point of time. It is also not very convenient for the user to require out blood samples multiple times during a day and lots of patients are reluctant to opt such sort of solution. For determining hemoglobin, the procedure is again the same as the glucose technique done in laboratory. It has the same disadvantage similar to that of glucose as many patients are sacred of needles.

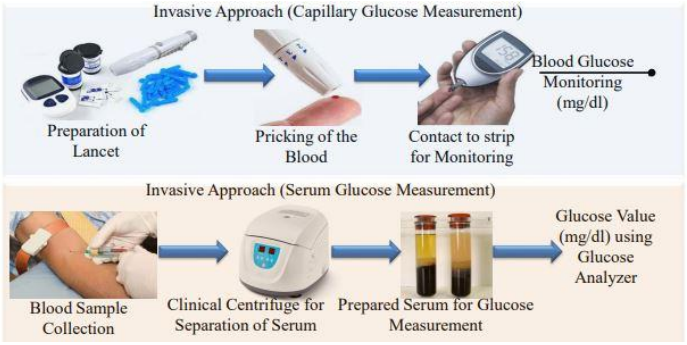

Figure 2: Invasive technique for glucose measurement

3. Methodology

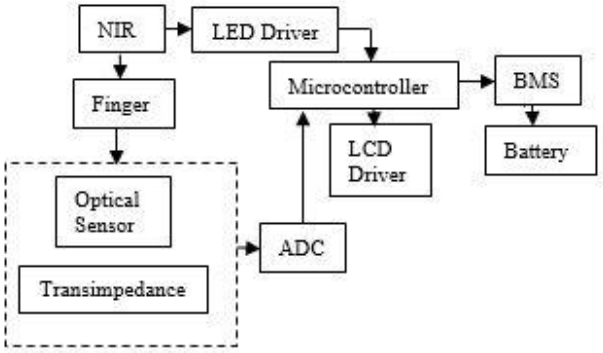

Figure 3: Block Diagram

The image above gives a descriptive idea of our project. Our goal is to non-invasively checkthe different levels of glucose and hemoglobin in diabetic patients. We use near infrared rays to detect sugar and hemoglobin. The LED light source emits light radiation, and we can choosea wavelength of 940nm accordingto ourneeds.The LED driver is used to adjust the power of theLED.Asthe temperatureincreases, the forward voltage of the LED decreases, causing the LED to draw more current. To detect the reflected light, we use the opt 101 sensors (photodiode).The sensor is sensitive to electromagnetic light. We choose the range from 870 nm to 1000 nm. The transimpedanceprocesses the current output of the photodiode intoa voltage formatted as a usable signal output. The output of the optical sensor and the LED driver is provided to the microcontroller. The required output is displayed on the LCD screen. The deceive runs on a battery. A Battery Management system is used for charging the battery.

4. Working Principle

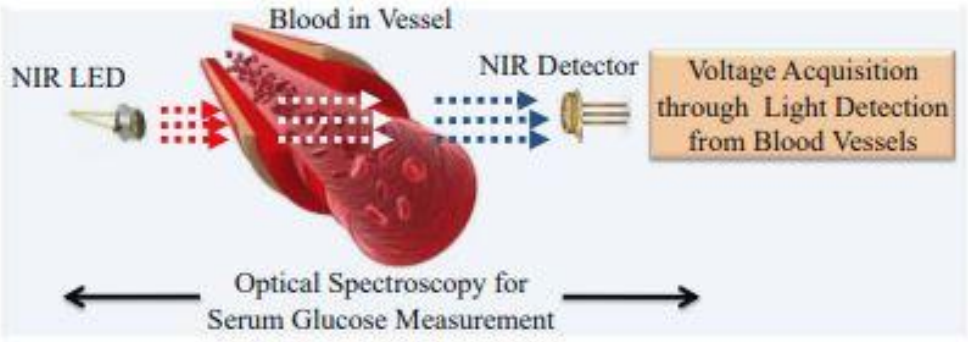

Figure 4: Spectroscopy Mechanism

The physical body emits sturdy electromagnetic wave. The laws of physics state that each one objects emit IR radiation which the intensity of the radiation and spectral characteristics of the physical body determined by its temperature still as by the properties and states of the body. Planck's law describes a relationship between the bright intensity, spectral distribution, and temperature of the physical body. The human body is a wonderful black body emitter of mid-IR lightweight at exactly the proper spectral region. The spectral characteristic of thermal emission is influenced by the individual's tissue composition and analyte concentrations. Kirchhoff's law confirms that for the complete body at a similar temperature and for a similar wavelength, absorptivity is adequateto monochromatic emissivity. Sensors for analyte measurements ought to have the specified sensitivity and property, sterilizability, and long stability. Spectroscopic sensors will meet all of those needs. Among the assorted spectral regions, mid-infrared spectrum analysis offers increased sensitivity and property due to the knowledge content of the fingerprint region. The selectivity of this technology is predicated on a similar principle because the property of the absorption spectrum analysis technique for analyte measurements. glucose has very well-defined spectral options within the fingerprint IR region.

5. Components

1. ESP. 32 Microcontroller

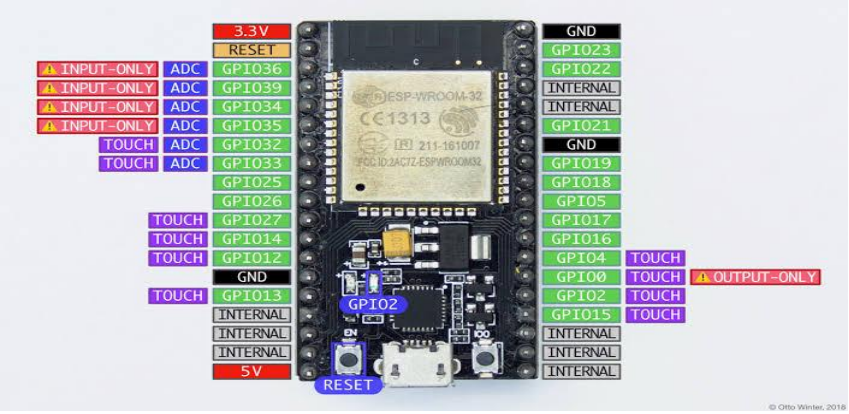

Figure 5: ESP.32 Microcontroller

ESP32 could be a series of low-cost, low-power system on a chip microcontroller with integrated Wi-Fi and dual-mode Bluetooth. ESP32 can perform as a whole standalone system or as a slave device to a number MCU. ESP32 can interface with other systems to produce Wi-Fi and Bluetooth functionality through its SPI / SDIO or I2C / UART interfaces. you'll treat the ESP32 as a supercharged Arduino Uno: faster, better in many aspects.

2.Optical sensor-OPT101

Figure 6: OPT 101 Sensor

The responsibility of an optical sensor is to convert light rays into electronic signals. In our project, the aim of this sensor is to supply higher and classified accuracy for two different parameters those are glucose and hemoglobin concentration. And also, OPT101 is very sensitivity enough thus it might not be affected an excessive amount of by another light from the environment or scattering light. And it also does not produce any irritation to

patients.

3. NIR light source- TSAL6100

Figure 7: TSAL6100 Sensor

The TSAL6100 is a 2-pin high power Infrared Emitting Diode in GaAlAs multi quantum well (MQW) technology with high radiant power. It features good spectral matching with Si photodetectors, ±10° angle of half intensity and 940nm peak wavelength. It is suitable for use in infrared remote-control units with high power requirements, free air transmission systems, infrared source for optical counters and card readers, high reliability, high radiant power, high radiant intensity, low forward voltage.

6. Working Model

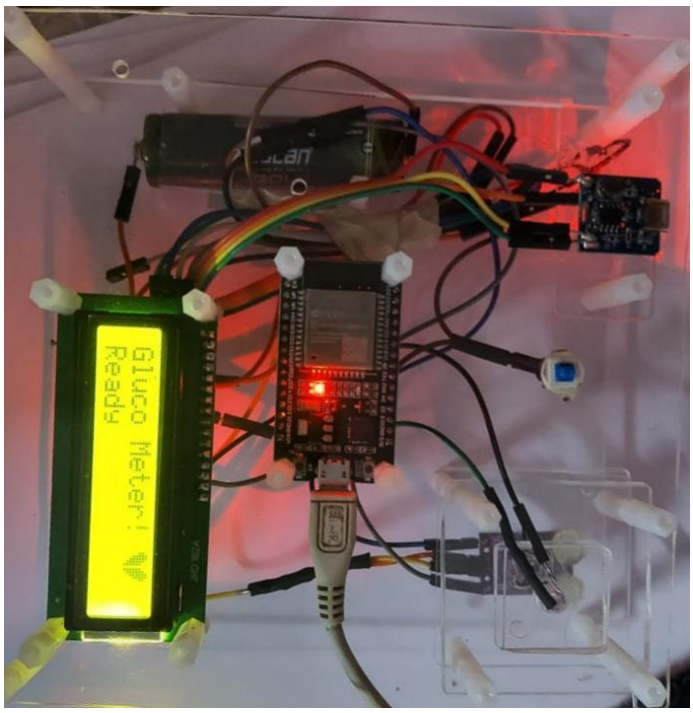

Figure 8: Working Model

NIR light TSAL6100 is that the sensing unit. The patient figure is placed on device. This LED has attenuated scattering light that provides an efficient emitting angle and power for the system. The device determines the Hb and glucose level through the glucose device and Hb device. The peak wavelength of these glucose and Hb reflectivesensors is 940nm and 870 mm. The therefore obtained signals are going to be sent for the amplification and filtration process. we are using microcontroller ESP.32 that encompasses a Wi-Fi port and its lower power mode. Once the reading of the glucose and Hb are determined, the recorded data is saved and connected within the google sheet. For each reading of the patient, the information is saved within the google sheet. This data is often employed by the doctors remotely,additionallythe Hb and glucose is showed on the liquid crystal display for the reference of the patient.We have named this device Glucobin monitor.

7.Test Data and Results

ID	Date	Tag	Value	Unit
1	9/5/2021 23:25:09	Glucose_Level	106	mg/dL
2	9/5/2021 23:25:13	Hemoglobin_Count	12	g/dL
3	9/5/2021 23:26:17	Glucose_Level	105	mg/dL
4	9/5/2021 23:26:26	Hemoglobin_Count	13	g/dL
5	9/5/2021 23:32:39	Glucose_Level	100	mg/dL
6	9/5/2021 23:32:49	Hemoglobin_Count	9	g/dL

We performed the test on few subjects and the results were displayed on the LCD monitor and the data is saved on google sheet as well.

8.Conclusion

This project has recommended hownon-invasive blood glucose testing can be done. With the implementation of NIR occlusion spectrum analysis at a wavelength of 940 nm. Though not as correct as contemporary invasive or minimally invasive techniques for mensuration blood glucose concentrations, however the employment of near-infrared lightprovides how of non-invasive measuring with less pain and discomfort to the diabetic patients and improve the quality of their lives through effective polygenic disorder management. Additional saving the information on the google sheet has more advantage to the project as this could beremotely used. This device is extremely helpful for telemedicine, and due to it cost efficient factor it can be used by all class of people.

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