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Non-invasive Glucometer

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Abstract: Non-invasive glucometers are devices that measure blood glucose levels without the need for a blood sample. These devices have the potential to revolutionize the management of diabetes by providing a more convenient and painless method of glucose monitoring. This abstract will discuss the technology behind non-invasive glucometers and their potential benefits and drawbacks. Non-invasive glucometers work by measuring glucose levels in body fluids other than blood, such as saliva, sweat, or interstitial fluid. This is done using various technologies, such as infrared spectroscopy, Raman spectroscopy, or optical coherence tomography. The device then calculates the blood glucose level based on the measurement of the body fluid. One of the main benefits of non-invasive glucometers is the reduction in pain and discomfort associated with traditional blood glucose monitoring methods. This can lead to increased compliance with glucose monitoring and ultimately better diabetes management. Additionally, non-invasive glucometers may reduce the risk of infection or other complications associated with finger pricks. However, non-invasive glucometers are not without their drawbacks. They may be less accurate than traditional methods, particularly in situations where glucose levels are rapidly changing and expensive than traditional methods.

Keywords: Non-Invasive; NIR Spectroscopy; Hyperglycemia, Hypoglycemia.

I. INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by high blood glucose levels. The condition is caused by a defect in insulin secretion, insulin action, or both. Insulin is a hormone produced by the pancreas that regulates blood glucose levels by allowing glucose to enter cells for energy production. In diabetes, the body cannot properly utilize glucose, leading to high blood glucose levels.\

There are two main types of diabetes: type 1 and type 2. Type 1 diabetes occurs when the body's immune system destroys the cells in the pancreas that produce insulin. Type 2 diabetes, on the other hand, occurs when the body becomes resistant to insulin or does not produce enough insulin to meet its needs.

There are two conditions of diabetics namely, Hyperglycaemia and Hyperglycaemia. Hyperglycaemia occurs when there is too much glucose in the blood. Hypoglycaemia, on the other hand, occurs when there is too little glucose in the blood. Both hyperglycemia and hypoglycaemia can be managed through appropriate diabetes management strategies, including medication, diet, exercise, and regular monitoring of blood glucose levels.

II. LITERATURE SURVEY

To determine an individual's blood glucose level non-invasively, A. M. Joshi et al [1] advised a model. This study presented the “wearable consumer device iGLU 2.0 for continuous glucose tracking” in diabetics. It is founded on the idea of optical detection, and an efficient regression model is designed to accurately estimate blood glucose. The device is tested on pre-diabetic, diabetic, and healthy people ranging in age from 17 to 80 using real healthcare data. Avge and Mard offer improved calibration and authentication results for serum glucose when linked to capillary glucose. In zone A, the predicted serum glucose sample levels are seen at 100%. The suggested glucometer is an accurate and economical option for measuring blood glucose in the 80–420 mg/dl range. The potential aimed at the proposed iGLU 2.0 to offer a self-monitoring solution for smart healthcare is quite high.

J K. Bagais et al [2] have suggested a non-invasive way of detecting the concentration of the glucose level. They have specified various other non-invasive methods and the advantage of using nir spectroscopy method over other principles. LED1550E is used as a transmitter and FGA10 is used as a receiver. Amplifiers and noise filters are used to make the signal compatible with the Arduino, which is used to process the received signal. The results will be displayed on the LCD. Fresnel Equations are used to determine the transmitted light. The experiment is performed several times with the transmitter wavelength at 1550nm and it shows the linear association between the glucose concentration and the voltage level of the received signal.

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For a method of non-invasive blood glucose measuring,
S. Raj et al [3] have developed a model for a new design of a "CSRR-loaded truncated patch antenna". The truncated microstrip patch antenna presented in this study is a unique design for a device monitoring blood glucose in a non-invasive manner. It is advised to utilize two 20 mm by 15 mm by 1.524 mm CSRR-loaded antennae as a biosensor. With a 10% increase in the blood's dielectric constant, the variation in the S21 value is visible. The suggested antenna's sensitivity is adequate to detect little variations in the dielectric characteristics of blood. For real-time access to blood glucose levels, the suggested biosensor may also be used in the 5G band between 27.6GHz and 29.6GHz.

Adnan Hossain Khan et al [4] have presented a non-invasive blood glucose measurement technique. This study uses the diffused reflectance technique to compute blood glucose levels. They have established a correlation between diffusion reflectance and glucose concentration, and their device, which is based on near-infrared LEDs, is intended to measure blood glucose levels. The suggested system makes use of an Arduino, a photodetector, and NIR LED. The light that was detected is processed using MATLAB. Error analysis is performed using the Clarke Error Grid Analysis. Test data exhibits an inaccuracy, despite being within the Clarke grid analysis's permitted range. The suggested technology may be made into a wearable device because of its low cost and simplicity.

Y.N.R. Reddy et al [5] have proposed a system that determines glucose levels in Non-invasive. Microwaves can be used for non-invasive blood glucose testing if they are operated in the linearity range (6-8GHz) and complicated permittivity values are calculated using transmission characteristics. A precise model to suit the dielectric values of human tissues is produced using the "third-order Cole-Cole equation". The CST program feeds the data collected using the equations previously described into the model at various frequencies. The model is subjected to a broadband sweep to look for an area of linearity. Because the conductivity and dielectric constant drop as frequency rise, the discrepancies are more pronounced at higher frequency ranges. This can propose an exact amount of insulin to be consumed by the body and is utilized to warn patients during hyperglycemia circumstances.

III. METHODOLOGY

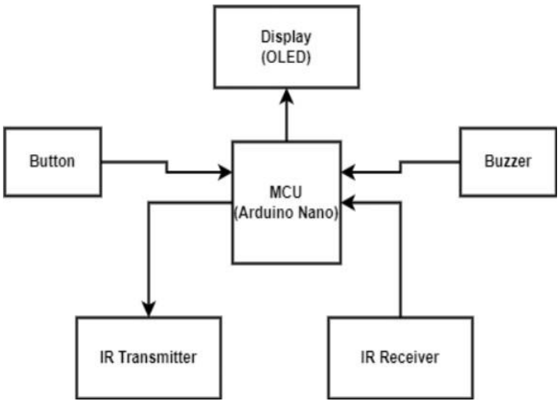

Figure 2: Block diagram of Non-Invasive Glucometer

The Gluco Sensor model consists of an IR transmitter, an IR receiver, a push button, a buzzer and a display interfaced with a microcontroller (MCU). When enabled by the microcontroller, the IR transmitter transmits Infrared of a specific wavelength. The IR receiver which is based on a photodiode placed in front of the transmitter receives this radiation, converts it into an electrical signal, and sends it to the microcontroller.

The program on the microcontroller willbe able to measure the strength of the received radiation. Thebutton, buzzer, and display together form a user interface thatwill enable the user to control the device. To start the glucose measurement procedure, the user needs to place a finger in between the IR transmitter and receiver and press the button. This will trigger the microcontroller to measure the strength of the received IR radiation from the receiver.

After capturing the data for a fewseconds and averaging it, the glucose value is calculated using the programmed calibration factors and constants. Thisvalue is finally displayed on the OLED. The buzzer is used togive the user feedback on the start and end of the procedure. Based on the value obtained, "HIGH" will be displayed to indicate 'hyperglycemia' (high sugar level), "LOW" will be displayed to indicate 'hypoglycemia' (low sugar level) and "NORMAL" will be displayed to depict normal condition.

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IV. RESULT

We have tested the system and based on the values we obtained, we have included the calibration factor by comparing with the invasive glucometer readings. We have made the output more accurate and precise. As we have seen the working model, we have undergone series of tests as mentioned below.

By estimating the % error, we may use the results for analysing the planned approach. By applying the formula below, percentage error is computed.

Percentage error = [(Measured value – Actual value)/ Actual value]*100

Sl no.	Invasive Method (mg/dl)	Non-Invasive Method (mg/dl)	Percentage Error
1	98	91.88	6.67
2	104	99.52	4.50
3	107	101.93	4.97
4	103	105.11	-2.01
5	90	95.99	-6.24
Mean	100.4	98.886	1.53

The table's interpretation is that the intended system produces +6% to -6% percentage mistakes. The average percentage inaccuracy is less than 2%. So, we may deduce that the intended approach accurately predicts glucose levels when compared to the finger prick method. Also, if there is a larger data set, this mistake may be reduced much more.

V. CONCLUSION

Non-Invasive glucometers have the potential to revolutionize diabetes management by providing a pain-free and convenient way to monitor blood glucose levels. Although there are some challenges to overcome, such as accuracy and cost, the advantages of non-invasive glucometers, including convenience and non-invasiveness, make them an attractive alternative to traditional blood glucose monitors.

As technology continues to improve, it is likely that non-invasive glucometers will become even more accurate and useful, leading to better diabetes management and improved quality of life for people with diabetes. It's important to consult with a healthcare professional to determine whether a non-invasive glucometer is right for you and to discuss appropriate diabetes management strategies.

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