Section A-Research paper

COMPARISION OF INVASIVE AND NON-INVASIVE BLOOD GLUCOSE MONITORING

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***Abstract*—** The blood glucose monitoring (BGM) techniques were invasive, require a blood sample of the diabetic patient that creates the risk of infection. It was very essential to avoid complications arising due to abnormal blood glucose levels in diabetic patients. This paved the proposed system developed a non -invasive monitoring technique. In this paper, the blood glucose level is noninvasively measured by passing the suitable wavelength of red laser light through human finger. The 650nm wavelength of red laser was passed to the human finger, analyze the transmitted and absorbed blood samples to determine the glucose level (mg/lit). In this proposed method, the mathematical equation was used to calculate the glucose level from the obtained voltage level. The corresponding values were investigated to determine the glucose level in blood. The hardware implementation of this blood glucose monitoring device was designed and the glucose level was calculated by the mathematical equations. The blood glucose level for both invasive and the noninvasive method had been recorded and glucose level was calculated using the formula.Error % = IV (mg/dL) – NIV (mg/dL) X 100/IV (mg/dL)

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Index Terms— Glucose Monitoring, Non-invasive Method, Diabetic Patient, Blood Sample, Glucose Level

I. INTRODUCTION

Diabetes Mellitus is one of the common life threatening diseases in the world. Diabetes in general is known to increase blood glucose concentration, further introduces variations in the individual's metabolic pathways. The change in metabolism affects directly or indirectly the electrochemistry of various body fluids such as saliva, urine and tears. The main cause of diabetes mellitus is still unrevealed, it is closely related to body weight, gender, diet, genetic and physical activities. The effects of diabetes can only be seen between six (6) to twelve (12) months after having continuous high level of glucose in blood, can further lead to other major health problems such as kidney failure, heart disease, blindness, stroke and neuropathy.

Glucometer is working on the principle of electrochemical detection. The major drawback associated with this kind of disease is blood dependency, makes it an invasive approach and also increases the risk of infection for the patient. In order to reduce the discomfort to the patient various methods on non invasive approach is used such as reverse ionophoresis, bio impedance spectroscopy, absorption spectroscopy, fluorescence spectroscopy, electromagnetic sensing, Raman spectroscopy and thermal emission spectroscopy to measure blood glucose.

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Increase in signal to noise ratio is the major concern for all non-invasive monitoring.

Comparison of Self-monitoring blood glucose device readings and venous blood glucose levels [1] have been done and observed that there are certain gaps between SMBG device readings and venous blood glucose levels. The real-time Continuous Glucose Monitoring, Flash Glucose Monitoring has been done for the diabetes patients and compared with the self-monitoring of blood glucose[2].Comparison of flash glucose monitoring with real time continuous glucose monitoring in children and adolescents with type 1 diabetes treated with continuous subcutaneous insulin infusion is performed [3]. Frequent glucose monitoring [4] allows the adjustment of insulin therapy to improve metabolic control with near-normal blood glucose concentrations. Advances towards non-invasive and continuous glucose monitoring devices[5], with a particular focus placed on monitoring glucose concentrations in alternative physiological fluids to blood has been observed. Focuses [6] on non-invasive sensors using physiological parameters related to physical exercise that were used to improve glucose monitoring in type 1 diabetes (T1DM) patients. Continuous Glucose Monitoring Versus Self-monitoring of Blood Glucose in Type 2 Diabetes Mellitus compared[7]

Based the review on different research paper, glucose monitoring system is designed based on microprocessor. In those days, glucose levels can be monitored by GBP coated sensors such as on-body CGM devices. CGM devices typically have glucose sensors including a needle or probe that is inserted into the tissue of a user to measure the glucose levels in the surrounding tissue fluid. This monitoring is also done by the designing of detection of blood glucose levels in non-invasive based on microcontroller. The major drawback in testing blood glucose levels is still using invasive technique shot with a patient's blood using a syringe. In addition, the result of such testing requires a long time (± 2 hours). The main objective of this project is to design a portable noninvasive blood glucose monitoring device. The device should be able to detect glucose level in blood using red laser. In addition, it can determine glucose level and displaying the glucose level on the LCD screen. Hence, analysis performed to detect and an early checks aims to avoid blindness and mortality due to diabetes mellitus.

II Materials and methods

The purpose of our system is to propose a non-invasive blood glucose monitoring device. The main objective is that to produce a pure non-invasive method for measuring the blood glucose value. The main principle behind the theory is use of phototransistor behind the measurement of glucose level. It uses a fingertip laser for emission and collection of laser light. An Adriano UNO is used as a microcontroller to control the GSM module and driver module. GSM module is used to provide alert message to a mobile or hand held device. In this, the blood glucose level is noninvasively measured by passing the suitable wavelength of red laser light through human finger. The 650nm wavelength of red laser is passed to the human finger which analyze the transmitted and absorbed blood samples to determine the glucose level (mg/lit). In this proposed method, the mathematical equation is derived to calculate the glucose level from the obtained voltage level. The corresponding values are investigated to determine the glucose level in blood. The hardware implementation of this blood glucose monitoring device is designed and the glucose level is calculated by deriving the mathematical equations.

The block diagram of the following noninvasive blood glucose monitoring is explained in detail below.

The figure 1 shows the block diagram of the entire system in a simplified manner. The block diagram starts with the finger tip on sensor which is the entry gateway of the system. It senses the

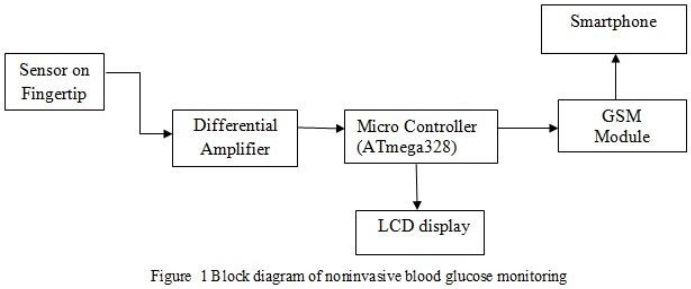

Figure 1 Block diagram of noninvasive blood glucose monitoring

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Monitoring

input signal and sends it to the differential amplifier where the signal gets amplified and send to the main part of the network which the microcontroller used which is Audrino IDE. The sensed signal can be send to mobile device or any other communication system via GSM module. The LCD display finally displays the obtained glucose value in terms of numerical expressions.

The sensor is placed over the device setup which is shown in figure 2 and it is used to acquire the level of blood glucose inside the blood. Software is added to the system to provide alert to the patient with diabetes when his blood

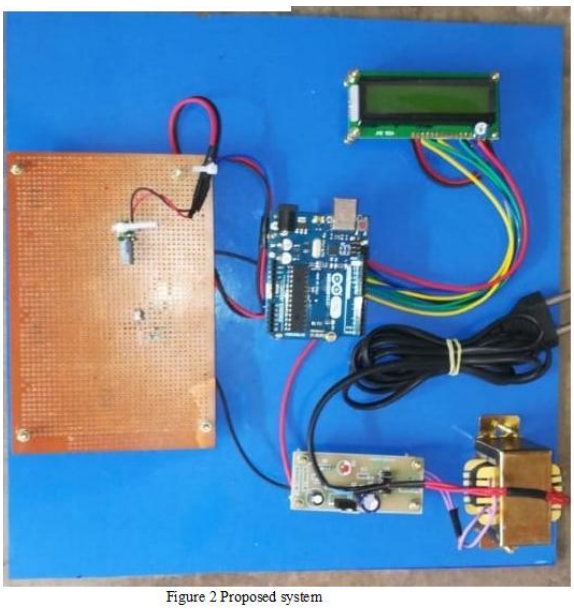

Figure 2 Proposed system

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S.No	Glucose concentration non-invasive method[mg/DL]	Glucose concentration invasive method[mg/DL]	Error percentage %
1	60	63.34	3.7
2	72	74.92	2.702
3	81	85.112	3.57
4	140	146.22	4.10
5	194	196.71	1.020
6	215	220.26	2.38

glucose is above or below normal level .The abnormal level of glucose in the blood is measured and a mechanical setup, is used to alert at the particular period of time. The software set up displays the obtained blood glucose level in the LCD monitor.

III Results and discussion

The blood glucose level in non-invasive and invasive method has been done for 6 different subjects. The blood glucose concentration in non-invasive and invasive method has been tabulated. The error between these two methods is also tabulated in table 1.

The figure 3 shows comparison of blood glucose value of invasive and non-invasive approaches. Thus the design of blood glucose monitoring device is implemented and tested successfully. The glucose concentration for different patients are measured using the detection sensor.

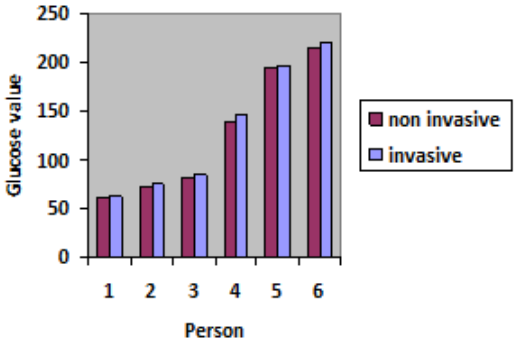

Figure 3. Comparison of invasive and non-invasive approaches

Hence from the graph, can see a slight difference between the glucose values obtained from both invasive and non-invasive approaches. Only a few percentage of error is seen. This can be improved from further calibration of system. Hence they find usefulness in laboratory areas, hospital units and also as a personal health care monitors.

IV Conclusion

A non-invasive method of measuring blood glucose using IR sensor is designed. This system provides several advantages as compared to the

previous methodologies. This system is used to detect the blood glucose value and display the range of glucose level in the LCD screen. Thus this method reduces the need of measuring the blood glucose value in an invasive approach. This system is designed as a prototype and it is extended as a device. The testing has shown great accuracy and has been tested to various people with different ages. The acquisition time has been improved from the previous systems. This device has been designed only for a single patient and this can be extended up to multiple patient evaluation at single time. The proposed system will be useful in medical care, patient care and personal health care areas. They can also be introduced with continuous monitoring of blood glucose over a period of time with help of storage of glucose value in a memory device which needs to be built in with the system. They help in analysis of patient glucose level and helps in both diagnostic and therapeutic applications. They can also be designed as a mini gadgets which are portable and can be carried wherever the patient goes.

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