

Non-Invasive Blood Glucose Level Monitoring System for Diabetes Patient using Near Infrared Spectroscopy

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Abstract

Diabetes is one of the leading non communicable diseases affecting public health. Though it is termed as a deficiency rather than a disease, uncontrolled diabetes will lead to complications resulting in renal failure/liver failure/ heart-attack/loss of sight or foot problems leading to amputation if not diagnosed, monitored and treated on time. In order to avoid these complications blood glucose level should be periodically monitored. Conventional methods used for this purpose uses sharp needle which leads to loss of blood and has a risk of infections to the patients. In order to overcome such problems, a non-invasive glucose monitoring system is necessary. In this study, we propose a design, a cost effective and non-invasive glucose monitoring device using near infrared spectroscopy techniques.

Keywords— Diabetes; Blood glucose; NodeMcu; Non-invasive method; Near-infrared spectroscopy

I. INTRODUCTION

Diabetes is one of the biggest challenges faced by the people in the 21st century which has affected millions of people worldwide. It is responsible for the cause of blindness, heart disease, stroke, obesity and adrenal failures. Blood glucose is the main source of energy in our body. Glucose is produced from the food we eat. Diabetes affects body's ability to produce insulin which is a hormone that is needed to process blood glucose in our body. Diabetes is caused when our body's sugar level or glucose level is high. Insulin is a hormone produced by pancreas which helps the blood to carry glucose to all cells in our body. Sometimes our body doesn't produce enough insulin causing glucose to stay in our blood without reaching the body's cells. Thus blood glucose levels in our body gets too high causing diabetes. As a result, blood sugar level should be kept under control by following strict diet and insulin injections. Periodic and self monitoring of blood glucose level is necessary for the patients suffering from diabetes. There are mainly three types of diabetes namely, type 1, type 2 and gestational diabetes. In type 1 diabetes, pancreas cannot produce enough insulin as the β cells in pancreas are destroyed, so the pancreas cannot produce sufficient insulin needed by the body, It is also known as insulin dependent diabetes or Juvenile diabetes. In type 2 diabetes, the body is unable to use the secreted insulin since the cells cannot absorb glucose because of the problems with receptors. It is also known as non-insulin dependent or adult onset diabetes. Gestational diabetes occurs during pregnancy, which leads to type 2 diabetes after delivery. Gestational diabetes occurs during pregnancy as a result of hormonal changes in the pregnant mother, it develops during the middle stage of pregnancy

II. LITERATURE SURVEY

Sr. no.	Paper Name	Author name, year	System proposed	Remark
1	Non- invasive monitoring of blood glucose using saliva as a diagnostic fluid	SreekalaSuseela and Parveen Wahid, IEEE 2018	A constant heart rate monitoring is produced thinking about the cost, simplicity of use, exactness, and information security. The system is conceptualized to give an interface between the specialist and the patients for two-way correspondence. The fundamental motivation behind this investigation is to encourage the remote cardiovascular patients in getting most recent medicinal services administrations which probably won't be conceivable generally because of low specialist to-persistent proportion.	The proposed system is dependable and accommodating because of fast processing. It is solid and guarantees information security requiring little to no effort

2	The accuracy of a non-invasive glucose monitoring device does not depend on clinical characteristics of people with type 2 diabetes mellitus	Tamar Lin, YuliaMayzel& KarnitBahartan , 2018	ZigBee is used in this paper for improving existing systems based on microcontroller for wireless heartbeat and temperature monitoring.In any basic condition the SMS is send to the specialist or any relative.	This system can be utilized just when the patient is on ICU. The system is created for home use by patients that are not in a basic condition but rather should be steady or occasionally observed by clinician or family.
3	GSM based Needleless Blood Glucose	Mohi-ud-din Q, Journal of Bioengineer in	The sensors joined with the patient's body are interfaced to a transmitter unit related with a	The beneficiary is associated straightforwardly to the

	Monitoring System	& Biomedical Science, 2017	ZigBee or GSM module. The transmitter transmits the information remotely to a recipient that is additionally connected with a ZigBee or GSM module. The neighborhood observing unit shows the last information.	USB port of a nearby observing unit (which is a Laptop with LabVIEW programming in it).
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II. METHODS OF MONITORING BLOOD GLUCOSE

Blood glucose monitoring is very important to keep glucose level under check, but diabetes cannot be cured. blood glucose monitoring methods can be classified into two methods; they are invasive glucose monitoring method and non-invasive glucose monitoring method. Invasive glucose monitoring method is the most common method used for monitoring blood glucose level. It involves pricking of hands or fingers to monitor glucose level. The blood from the patient is taken and given to disposable test-strip, which calculates the blood glucose concentration. Non-invasive glucose monitoring method is the most recently advanced method for glucose monitoring which is being studied and further researches are carried out. Polarimetry, Raman spectroscopy, photo acoustic spectroscopy, Mid-infrared spectroscopy and Near infrared spectroscopy, Fluid extraction from skin Optical rotation of polarized light are some common methods used for non-invasive blood glucose monitoring.

III. GLUCOSE MEASUREMENT BY NEAR-INFRARED SPECTROSCOPY

Non-invasive Near-Infrared Spectroscopy (NIR) has been applied for monitoring blood glucose level. NIR has been applied in medical field for glucose monitoring. It uses light within the range of 750-2500nm. NIR radiation at 1500 nm was used because of the minimum attenuation of optical signal by constituents like water etc. at this wavelength range and desired depth of penetration can be obtained. LED sensor is used instead of laser as it overcomes all limitations by laser. The Near-infrared radiations have been applied to measure glucose concentrations of blood of the patients. Near Infrared transmittance spectroscopy is used across ear lobe of a light source and light detector placed on either sides of ear lobe or finger. The ear lobe was chosen because of its small thickness and also because of the absence of bony tissues or finger to measure glucose level. Transmittance spectroscopy consists.

IV. METHODOLOGY

This design uses near infra-red spectroscopic technique to detect the amount of glucose in blood. A sensor giving infra-red radiation of 1550 nm wavelength, which penetrate through the tissue and the attenuated signal get detected by the photo-detector. The digital sensor with inbuilt analog to digital converter has an infra-red transmitter and infra-red receiver. The sensor is used on finger-tip or ear

lobe to measure glucose concentration of blood. The attenuated signal which the sensor detects is passed through RC filter to remove the noise. The signal is then amplified, and processed by microprocessor and the output is shown on LCD. In addition of displaying glucose levels, the data can be shared by a NodeMcu and can be sent to the doctor for patient investigations. When the glucose sensor begins to operate, the 230v ac voltage is converted into 12v by step down transformer and is converted into 12vdc voltage by bridge amplifier and voltage regulator. The glucose concentration is detected by the amount of light attenuation after interacting with the tissue. The detected voltage signal is amplified and passed into microprocessor. Glucose absorption coefficients and scattering coefficients are calculated. The programs in at89s52microprocessor are executed in embedded c. The programs are executed continuously and the resultant glucose level is displayed on a display

V. RESULT

The non-invasive blood glucose monitor designed contains a sensor unit, processing unit and display unit. The sensor unit also acts as transducer which detects the signal from the patients and converts it to the electrical form and transmit it to the processing stage. The processing stage sends the processed data to the output unit to display the results. The sensor used here is an optical IR digital sensor which is clipped with finger of the patients. The sensor contains transmitter and receiver on both the ends respectively.

VI. WORK FLOW OF NON-INVASIVE GLUCOSE MONITORING

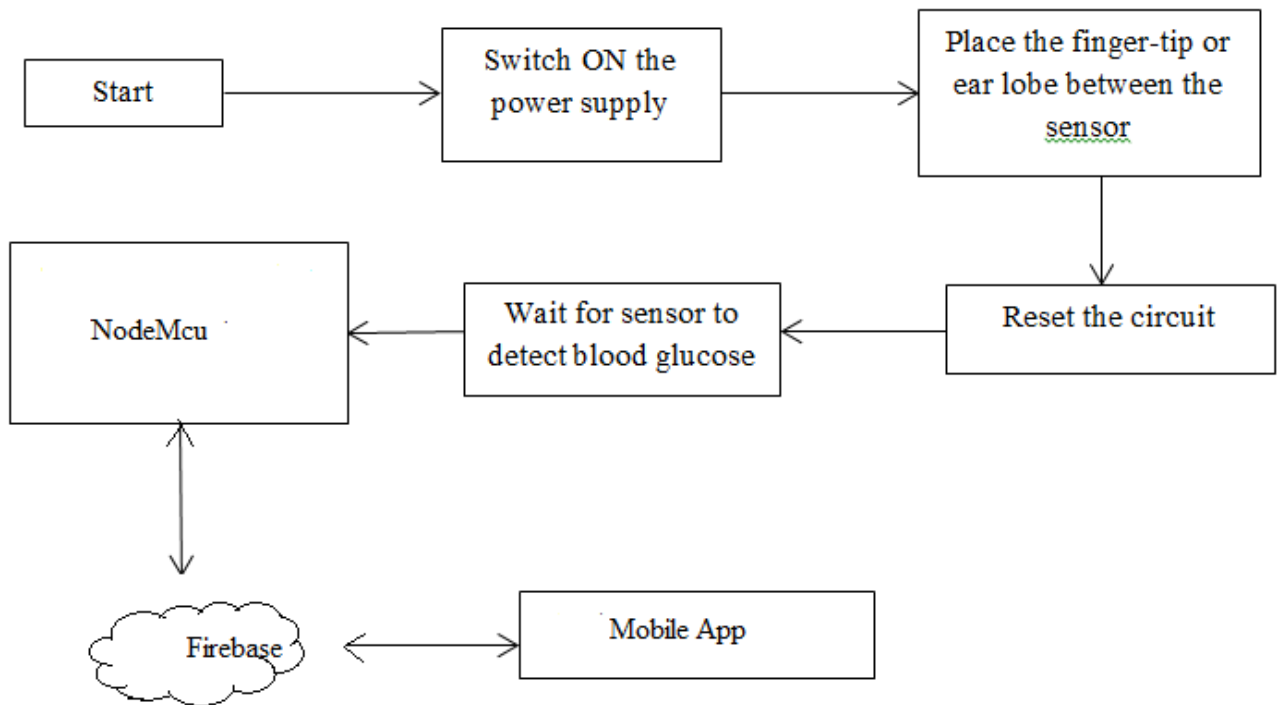


FIG1:WORK FLOW OF NON-INVASIVE GLUCOSE MONITORING

After the design, we have to check its accuracy. For its accuracy, we measured the glucose level of the patients both invasively and noninvasively. Around 15 patients were checked for their glucose levels before meals (both invasive and non-invasive) followed by 90 minutes after meals (both invasive and non-invasive). Below figure 2 shows graphical representation of both invasive and non-invasive glucose level results of patients before meal. Invasive and non-invasive results of patients after meal are given in figure 3. both invasive and non invasive

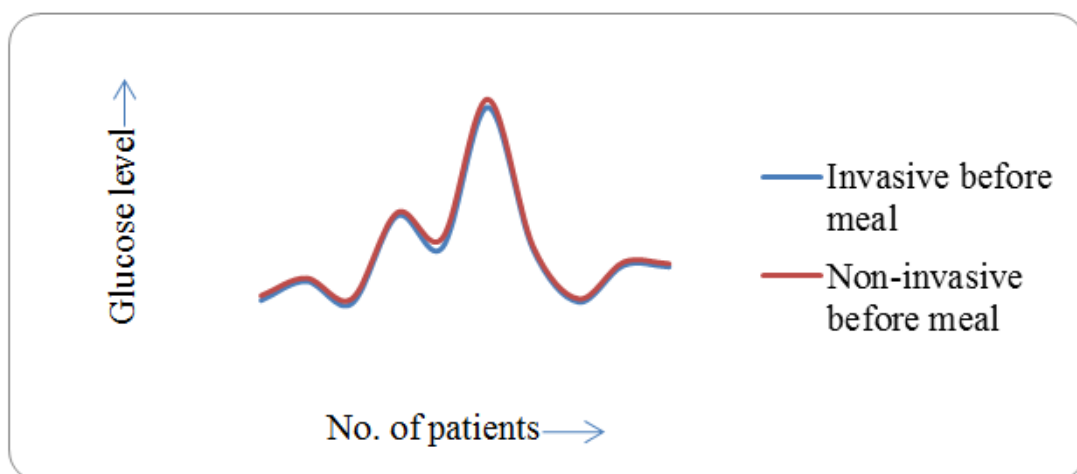


FIG2: GRAPH OF INVASIVE BEFORE MEAL AND NON INVASIVE BEFORE MEAL

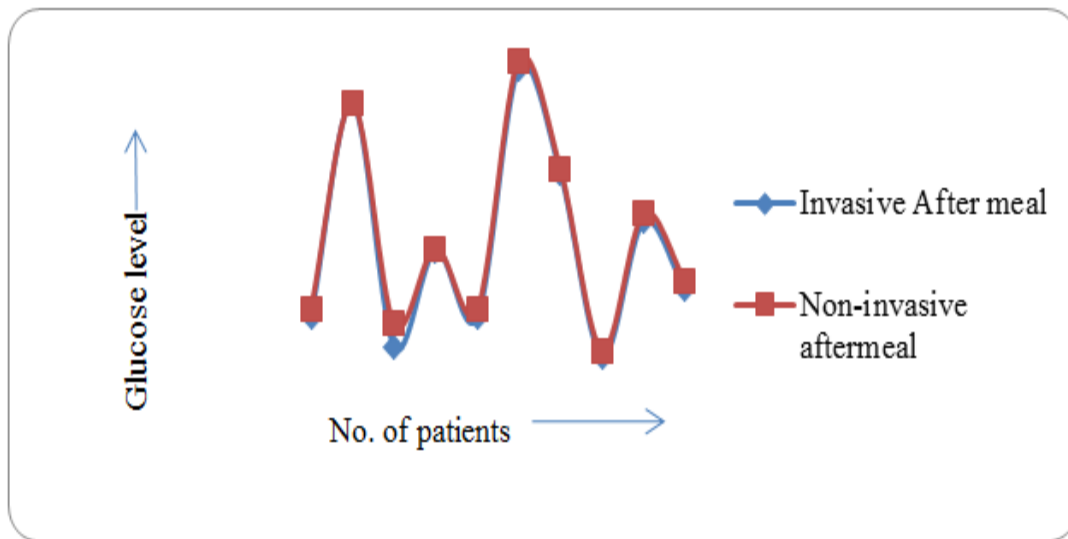


FIG3:GRAPH OF INVASIVE AFTER MEAL AND NON –INVASIVE AFTER MEAL

VII. CONCLUSION

This technique eliminates the risk of spreading infections by finger pricking and is more comfortable and low cost than invasive technique. It provides an easy way of measuring blood glucose levels of the diabetic patients at home and even without the need of a specialist to monitor blood glucose level. Current invasive methods cause lots of pain and cannot be used for continuous blood glucose monitoring. Continuous blood glucose monitoring is possible without even finger pricking easily by just placing the sensor on the finger-tip. Our design provides the data sharing facility to transmit the patient glucose level and location to the doctor for patient investigations. The accuracy of the design is similar to that of the currently available invasive methods.

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