Development of Portable Device for Measurement of Blood Glucose, Temperature and Pulse-Oximeter Using Arduino

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Abstract - *This paper is focused on the survey of the methods which are used to predict diabetic patients measurement of the blood glucose concentration, Body Temperature and Pulseoximeter. This system have the characteristics of noninvasive, simple and very fast speed of response. Firstly, the method is use near-infrared light(NIR) irradiation fingers that is the exposure to non-ionizing radiation. The infrared light transmittance can receive a signal about the blood glucose concentration. Then after an amplifier the signal, this signals will transmit to the Arduino. Here, is uses the Arduino Uno board as the CPU to analysis and processing the signal. Second, the sensors used in this work are a body temperature sensor and a blood oxygen sensor. Finally, the method is used enables to show the result of the sensor reading and on the LCD screen in, and it can transmission to laptop for storage data. It is convenient that customers should know the blood glucose reading. It is control the adverse effects caused by high blood glucose when they know their blood glucose levels.*

Key Words: **Arduino, NIR: Near-Infrared system, LCD, wireless body area network, sensor, Pulse-oximeter, Temperature sensor, Blood glucose meter, MATLAB.**

1. INTRODUCTION

The role of blood glucose monitoring and measurement becomes very important for diabetic therapies [1].Diabetes mellitus (DM) is a chronic and normally leading to

Hyperglycemia .which may cause many complications. The number of diabetic patients increases. According to the world health organization (WHO), the number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014.In 2012, an estimated 1.5 million deaths were directly caused by diabetes and another 2.2million deaths were attributable to high blood glucose. WHO projects that diabetes will be the 7th leading cause of death in 2030[2]. Thus, diabetic patients need to measure their blood glucose content at least three every day to avoid serious complications. But currently, the main method used for blood glucose is invasive, which has disadvantages. Near-infrared non-invasive blood glucose technology has the advantages of no pain, no risk of infection, rapid measurement, without any chemical reagents or consumables. In order to design a non-

invasive system, we use the near-infrared light to measure the blood glucose[3], and next step we use the Arduino Uno board as the CPU to analysis and processing the signal. At last, we can show the result in the LCD. The outline of this paper is as follows. And one more thing discuss in this paper is Health services is more important to need of the collect health data from a patient automatically. The wireless body area network (WBAN) is a biomedical sensor network node connected wirelessly to the communication devices, in and near the area of the body. The WBAN is composed of small devices and low-power biomedical nodes to prolong the lifespan of sensor nodes. E-health Sensor V2.0 is a sensor that allows Arduino to conduct biometric and medical applications where body monitoring requires different sensors: sensors for oxygen in the blood (SpO2), body temperature sensors, glucose sensors, galvanic skin response (GSR-sweating) sensors. the effectiveness of health care on the basis of the patient's condition is necessary. The purpose of this work is to implement the protocol of WBAN E-health using body temperature and pulseoximeter libellium sensors to collect and monitor health data remotely (telecare). Data from sensor readings on the serial monitor will be visualized as graphs and stored in a database. The results of the two sensors can be viewed through a website, thus allowing the nurse or physician to monitor the patient's condition. The outline of this paper is as follows. Section 2 proposes our methods to test blood glucose. Section 3 present results and future work about our model. Reference 4 proposes a WBAN system that allows private medical applications developed using personal electronic devices coupled together with the sensor. Reference 5 describes the special features of wireless technologies along with their main advantages, weaknesses and applications in the WBAN.

2 METHODS

We proposed system consists of four parts electrocircuit.

The hardware framework shown in Figure 1.The first part is near - infrared system. when the near-infrared light transmission fingers, through this relationship of the receive near-infrared light sensor signals with the concentration of blood glucose changes, this system can detect the blood glucose levels. The second part of the Arduino is the main control chip, responsible for analysis

and processing the signal of received blood glucose. The third part is the LCD display. The function of this part is to display the result of Arduino processing. The fourth part is the storage function. Main control chip transmit the blood glucose concentration results to software technology that it is convenient for the user at any time to view and analysis.
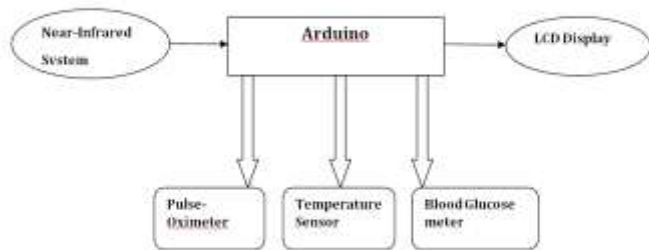

Fig 1.The hardware framework of our system

2.1 Near-infrared system

Near infrared system consists of near-infrared LED

Transmitter, an near-infrared receiver and signal amplifier three parts. Its structure diagram shown in Figure 2.
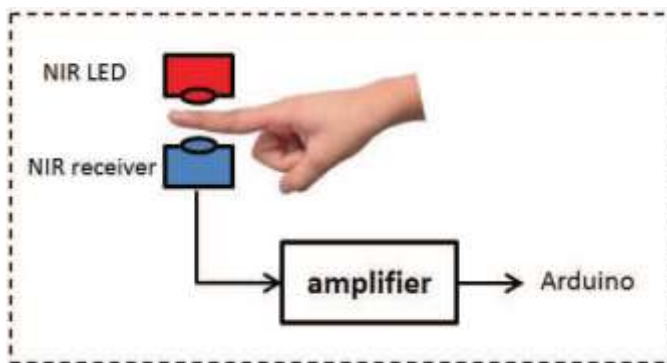

Fig 2.Near-infrared system

Near-Infrared(NIR) is located in the wavelength region of

730nm to 2500nm[4].NIR have many advantages than other media. The advantages and disadvantages of NIR shown in Table 1.

Table 1. The advantages and disadvantages of NIR

	Advantages	Disadvantages
NIR	➢ High S/N ration ➢ Sensitive to blood glucose ➢ Low Absorbance in skin tissue ➢ Nondestructive	➢ Temperature sensitive ➢ High scattering in skin

Many scientists to use NIR because of it has those advantages. Such as Heise, the pioneer of the non-invasive

blood glucose techniques, has tried on many aspects of NIR applied to non-invasive blood glucose measurements[1].Maruo et al. used NIR diffuse-reflectance spectroscopy through fibre optics on the forearms of diabetic patients[2].Thus, the use of the NIR may be the most suitable for non-invasive blood glucose measurement through skin tissue.
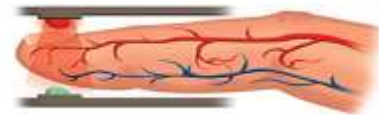
2.1.1 Pulse-oximeter

Fig 3. pulse-oximeter transmission image

A blood-oxygen monitor displays the percentage of blood that is loaded with oxygen. Pulse oximetry is a noninvasive method for monitoring a person's oxygen saturation (SO_2). the safe, convenient, noninvasive, inexpensive pulse oximetry method is valuable for measuring oxygen saturation .In its most common (transmissive) application mode, a sensor device is placed on a thin part of the patient's body, usually a fingertip or earlobe, Pulse oximetry solely measures hemoglobin saturation[5].Reflectance pulse oximetry is a less common alternative to transmissive pulse oximetry. In this system to measure approximetly value.

2.1.2 Blood glucose meter

Blood glucose monitors are used to measure the amount of glucose in blood, especially of patients with symptoms or a history of abnormally high or low blood glucose levels. Diabetes is a condition in which the pancreas of the body ceases to produce insulin, which controls blood glucose levels.in this system to implements a non-invasive approach to blood glucose monitoring. Near-Infrared Spectroscopy is chosen due to its sensitivity, selectivity, low cost, and portability [1]. A wavelength of 1550nm is chosen due to its high signal-to-noise ratio (SNR) for glucose signals. And it is very helpful to operate measureing the glucose level for patient.

2.3 LCD display

LCD display for real-time blood glucose data, user-friendly understanding of blood glucose concentration at this time, to take appropriate treatment.

2.4 Resistance Temperature Detectors(RTD)

RTD's are precision temperature sensors made high-purity conducting metal like platinum and copper.in this temperature sensor are required to be in physical contact with the object being sensed and conduction to monitor changes in temperature of body. It is positive temperature coefficient (PTC) but unlike the thermistor their output is

extremely linear producing very accurate measurements of temperature.
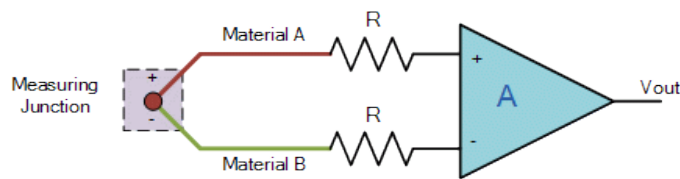
2.5 System Design

Figure shows the system design architecture in this work. The E-health sensor device contains a temperature sensor, a pulseoximeter sensor, blood glucose meter and an Arduino board. The temperature and pulseoximeter sensors read the patient's body condition. The health data will be stored in a PC desktop server, then stored in Matlab. Furthermore, the results from the database can be viewed via in the form of a report. The specifications of the hardware and software used in this work. Near Infrared transmittance spectroscopy is used across the finger or ear lobe to measure glucose. Transmittance spectroscopy involves a light source and a light detector positioned on either side of the finger or ear lobe. Near Infrared (NIR) light is applied onto one side of the ear lobe, while a receiver on the other side receives the attenuated light. This attenuated signal is then sampled and processed. Two LEDs from Thor Labs (LED 1550E) were used as the light source. Since conventional silicon photodiodes have limited spectral bandwidth, they cannot be used for receiving near infrared light. Apart from the level of glucose in blood, the transmittance of NIR light also depends on the amount of blood in the path of the light. The amount of blood can be estimated by measuring the blood oxygen levels [4]. Pulse Oximetry was used to measure blood oxygen. Pulse Oximetry uses Red and Infrared (IR) light to distinguish between Hemoglobin and Oxy-Hemoglobin in the blood, on which further processing is applied to get the oxygen saturation [4].this system application show in diagram .
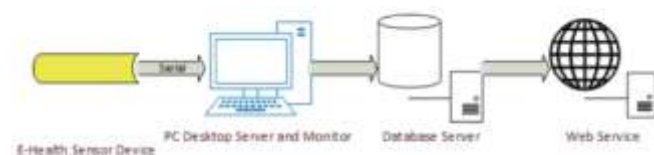

Fig. 1. (Color online) System design architecture.

3. LITERATURE SURVEY

In this paper, various techniques for measuring diabetic, pulseoximeter and body tempreture were studied. The diabetic patient can be predicted by using noninvasive method Analysis, i.e. without blood sample to analysis the sugar level and tempreture rate and pulse rate also by using NIR system. The in detailed survey of these techniques is as below: Diabetes, a metabolic disease that is

characterized by high glucose level in the blood, is a major problem affecting millions of people today. Among the various noninvasive methods of detecting, breath analysis presents an easier, more accurate and viable method in providing comprehensive clinical care for the disease. Another technique to predict diabetes is by analyzing NIR signal , i.e. using near infrared processing system.In their paper, "WHO ,Diabetes Programme: What is Diabetes ?World Health Oraganization ,"(2016) [1],obtained diabetic patient by using noninvasive method from publicly available database and are processed in MATLAB. It is useful in classifying subjects with the disorders using classifier tools present in it. Initially the results obtained from MATLAB are fed into neural network pattern recognition tool and ANFIS tool box which is integrated in MATLAB. These are powerful tool are used for data classification. Relevant extracted features parameters such as mean, standard deviation, entropy are used as inputs to the ANFIS.

All these techniques suffer from various drawback like being invasive, large error deviations, energy computation difficulties and non_uniform result. Behaviour of a diabetic person shows change in his life style, food intake in diet chart, daily blood checkup, and regular meds when as compared to a non-diabetic person. L. Minson, C.Okju, and L.Seul in their paper -   Proc.Int.Conf. Consum. Electron.(ICCE), ed.P.Corcoran(IEEE, 2011)[4] , introduced diabetic recognition through NIR sensor signal features. In this system body temperature, pulse oximeter were also calculated. Graphically and tabular form show the result of person on laptop .LCD display and text features, both individually and combined formed the results on validation dataset.

4. PROPOSED SYSTEM

From above survey, different techniques to predict diabetic are studied. Here we are proposing a system to predict blood glucose by taking reference of above survey. One website is to be developed using noninvasive method which consist of some of above techniques to measure blood glucose. On primary basis, to find out glucose , temperature and pulse oximeter will be added on the website. The main aim to develop such website is that anyone can measure diabetic including doctors at any time. First part analysis can be accessed by any user to check whether he or she is in diabetic or not, by giving answers to the patient. From the total score the user can predict the level of blood glucose level. If the level of glucose is high, user can concern to the doctor. Also the second part, i.e. diabetic prediction using noninvasive method using NIR processing can be used by doctors. The system uses preprocessing techniques like finding blood glucose value, body Temperature and pulse oximeter reading from that body skin and finally all these parameters are given to the report. After training, the system automatically detect whether the person is diabetic or not, when it processes has more libraries than

MATLAB. Unlike MATLAB is easily portable to any operating system.

5. CONCLUSION

In this paper, different ways to predict the diabetics patients to have learned. Among those noninvasive blood glucose measurement techniques can be used easily and accuracy of these methods is higher as compared to invasive analysis. Invasive Analysis for diabeties prediction is also a great research but it is very expensive and painful in real time. So in this paper, First to find patient have diabetic or not , and second is body temperature and pulse oximeter have check also using noninvasive methods NIR system.

This system using Arduino and near-infrared to achieve the measurement of blood glucose concentration. And it has a non-invasive, quick and easy features. And its overall price is not high that easy to satisfy the user's price demand.

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