IOT Based Portable Non Invasive Blood Glucose Monitoring System

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***Abstrac*t— This paper introduces a new method of non-invasive blood glucose monitoring based on four near-infrared spectrums and Gaussian theorem dependent. As transmitting spectrums, we pick four near-infrared wavelengths, 820 nm, 875 nm, 945 nm, 1050 nm, and catch four fingers transmitting PPG signals at the same time. The algorithm wavelet transform is used to strip baseline drift, smooth signals, and extract eight of each PPG signal's values. The Eigen values are the input parameters of Arduino and Raspberry Pi.Use of accurate sensor and IoT base with prediction algorithm to improve the accuracy of the measurement.**

Experiments show that the root mean square error of the estimate is between 0.97 mg /dL-6.69 mg / dL, the average of root mean square error is 3.80 mg / dL.

***Keywords*— Research Paper, Scientific Writing, Science, Engineering and Technology**

I. Introduction

Diabetes is a condition impossible to treat, only to regulate blood glucose with diet or insulin injections. You need to know their blood glucose for the patients in real-time and reliably. The current method for measuring blood glucose, however, is primarily direct blood drawing from patients, an electrochemical process. Using invasive methods for long-term measurement of blood glucose, patients suffer from extreme physical discomfort and the risk of infection increases. All sorts of intrusive blood glucose test strips are costly disposable consumables.These factors are not conducive to patients to facilitate and timely understand their blood glucose condition (Ramachandran et al. 2012) [3] Follow The non-invasive blood glucose measurement has become a popular academic research subject to address the drawbacks of invasive blood glucose (Ferrante do Amaral and Wolf 2008, Vashist 2012) [4] [5]. Research into the use of near-infrared spectroscopy for non-invasive measurement of blood glucose is also growing recently (Unnikrishnan Menon et. al.2013, Ramasahayam et al. 2013) [3] [6]. But on the choice of near-infrared wavelengths, these studies generally use single wavelength or similar wavelengths. For e.g., high-absorptive NIR lights are often taken as transmission or reflectance spectrum (Lam et al. 2010, Maruo et al. 2003, Malin et al. 1999) [7]-[9]. This study proposes using the transmission wavelengths as 4channel 820 nm, 875 nm, 945 nm and 1050 nm of infrared light. After the wavelet transform algorithm extras the own values of each signal.

II. LITERATURE REVIEW

A chemical Reaction induces an electrical reaction current that the glucose meter recognizes as a concentration value, based on the strength of the signal. Despite the advances of invasive glucose meters, there are still many challenges in ongoing research for attaining a reliable non-invasive measure .Studies the addition of pulse oximeter to aid in the detection of blood glucose by calculating blood oxygen saturation. [Igor, 6] shows there is a spectral gap where the water and haemoglobin absorption, the major light absorbers in the tissues are relatively long and there is a strong light scattering.

Bhaskar Mohan Murari et.al [1] proposed various methods of glucose monitoring, and the overall emphasis is placed on the development of non-invasive glucose monitoring based on NIRS (near-infrared spectroscopy). The purpose of this analysis is to demonstrate the opportunities, limitations, and technical challenges for NIRS based non-invasive blood glucose measurement system creation.

Bahareh Javid, Faranak Fotouhi-Ghazvini, Fahime Sadat Zakeri et.al [2] presented Methods. It includes a sensor for measuring non-invasive blood glucose and bilirubin with near-infrared spectroscopy and optical processes, respectively, communicating with smart phones.

Aminah Hina, Hamza Nadeem, Wala Saadeh et.al [3] presented A Single LED Photoplethysmography-Based Non-invasive Glucose Monitoring Prototype System. They proposed that digital backend extracts 10 discriminating features of the PPG signal to predict blood glucose levels using machine learning regression (Exponential Gaussian Process).A novel, two- dimensional structure of 256-point Fast

Fourier Transform (FFT) is implemented to realize the Function extraction on FPGA, achieving a 47 percent reduction in complex multiplications compared to the traditional Radix2 algorithm. The output of the proposed device is validated using PPG records of 200 patients and glucose levels measured via a commercial glucometer. The glucose level with an absolute relative mean difference (mARD) of 8.97 percent is predicted successfully.

J.YADAV, V.SINGH et.al [4] presented Diabetes is a chronic metabolic disorder which can lead to severe complications and affect all vital organs. Complications d u e to diabetes can be avoided by daily monitoring and maintaining the amount of blood glucose within the normal range. Much of the marketable glucose monitoring instruments are invasive or minimally invasive.

Rahul R. Sharma, Akshay Sanganal, Sandhya Pati et.al[5] presented Li-Fi stands for Light-Fidelity.LiFi is data transmission using visible light by transmitting data through an intensity varying LED light bulb faster than the human eye can track. When the LED is on, a binary is registered by the photo detector; otherwise, it is a binary zero. This paper deals with the implementation of the most basic Li-Fi based system to transfer data from one computer to another.

The main components of this communication device are high visibility LED that acts as a source of communication and a photodiode of silicone that serves as the receiving portion. The sender's data is transformed into intermediate data representation, i.e. byte format, and then translated into light signals that the transmitter would then emit. The photodiode receives the light signal at the receiver side. The reverse-phase is carried out on the destination device to get the data back from the obtained light.

III. METHODS AND MATERIAL

A. *Hardware Implementation*

The figure illustrates the block diagram for the proposed IOT based, noninvasive, portable glucose monitoring Device

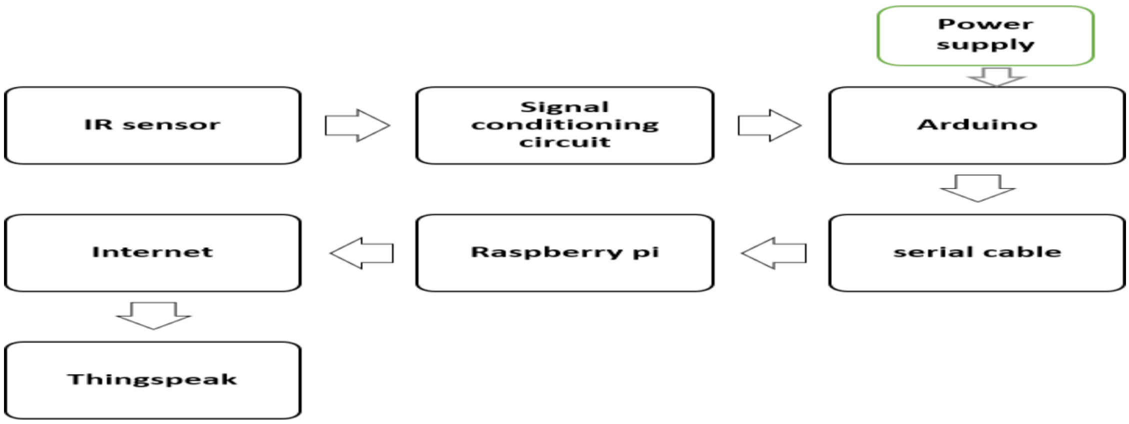

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Figure 1 Block Diagram Of System

Figure 1: Block diagram of the proposed system. The system's key hardware components include a Transmitter, photodiode, operational amplifier (OP491), microcontroller (Arduino Uno), Raspberry pi, and one more are Thingspeak to internet-based data held. The NIR detection circuit consists of a transmitter circuit and a receiver circuit with both transmitter and receiver positioned side by side and points to a reflective surface both the transmitter and the receiver run at 5V and the Arduino microcontroller is driven. The receiver circuit consists of a photodiode, a noise filter system, and an amplifier for operations. A low pass filter is connected to the voltage source to reduce the noise frequency from the source.

B. *Software Development*

The main focus of software development is on the algorithm design of the microcontroller. The control system of the device uses the Arduino Uno which is a microcontroller board based on Atmega328 with fourteen (14) digital input and output pins. It can be operated by a (5 V-12 V) or serial connection to the device. Both transmitter and photodiode are supplied by the microcontroller with bias voltages.
The photodiode/amplifier output is attached to the microcontroller's analog board.
Arduino block diagram and detection circuit Figure.1.The microcontroller algorithm is intended to measure the glucose concentration. The output voltage obtained from the photodiode is used as a parameter to determine the glucose concentration by using Raspberry pi and fitering.then it gets compared with a trained database which is already stored. After the classification finds the best value for calculation. Then we are going to know that what glucose concentration present in the patient's blood is. Software development uses two software namely Arduino IDE for Arduino Uno and the other one is Python IDE which is for Raspberry pi algorithms.

IV. RESULTS AND DISCUSSION

Glucose concentrations were generally overestimated in hypoglycaemic areas.One possible explanation for the "strong" predictions in hypoglycaemia areas is due To the limited incidence of hypoglycaemic events Withi nthe training results.The entire 18patient dataset (consist ing of 18,400 glucose values) had a relatively low rate of hypoglycemia (1460 CGM values = 70 mg / dl), corresp onding to around 7.9% of the dataset.On the contrary, hyperglycemias comprised approximately 35.7% of the dataset (6560 CGM values =180 mg/dl), and euglycemic values allotted for 56.4% of the dataset (10,380 CGM values >70 and <180 mg/dl).
Results also show that an increase in predictive Window contributes to a reduction in the neural Network model's predictive accuracy.
It is hypothesised that hyperglycaemic conditions are underestimated due To expansion of the predictivewindow and the resulting Failure of the neural network to assess oscillations and the patterns in glycaemia, as well as other relevant input of the events. Such as lifestyle, emotional states, insulin dosages, and meals, which may occur within the predicted time window and may impact or change neural network weights.

A. Device operation

The operation of the device begins if an infrared signal is emitted by the transmitter that is exposed to the glucose solution or blood sample, or by the eye.

In the glucose solution or blood sample the glucose molecule represents the receiver's (photodiode) infrared signal.

The photodiode receives the conversion of the infrared signal to an equivalent voltage value.

The Arduino Uno microcontroller uses these voltage values as a parameter to calculate the glucose concentration or it can be also useful to determine the insulin dose needed corresponding to the user's body mass index (BMI).

Then it is given to the Raspberry pi so that it will compare this data with already stored data which is nothing but a trained database.

After the classification of data find the best value by calculation and we are going to what s the glucose concentration of the patient's blood. After that we can use this for further operation and also for index.

Finally, the measured concentration of glucose and the dose of insulin will be displayed on the LCD screen, and data will be stored on the database or stored on mobile applications as well.

B.Flow Diagram of Device

Figure 2 illustrates the block diagram of the proposed IOT based portable non-invasive glucose monitoring system.

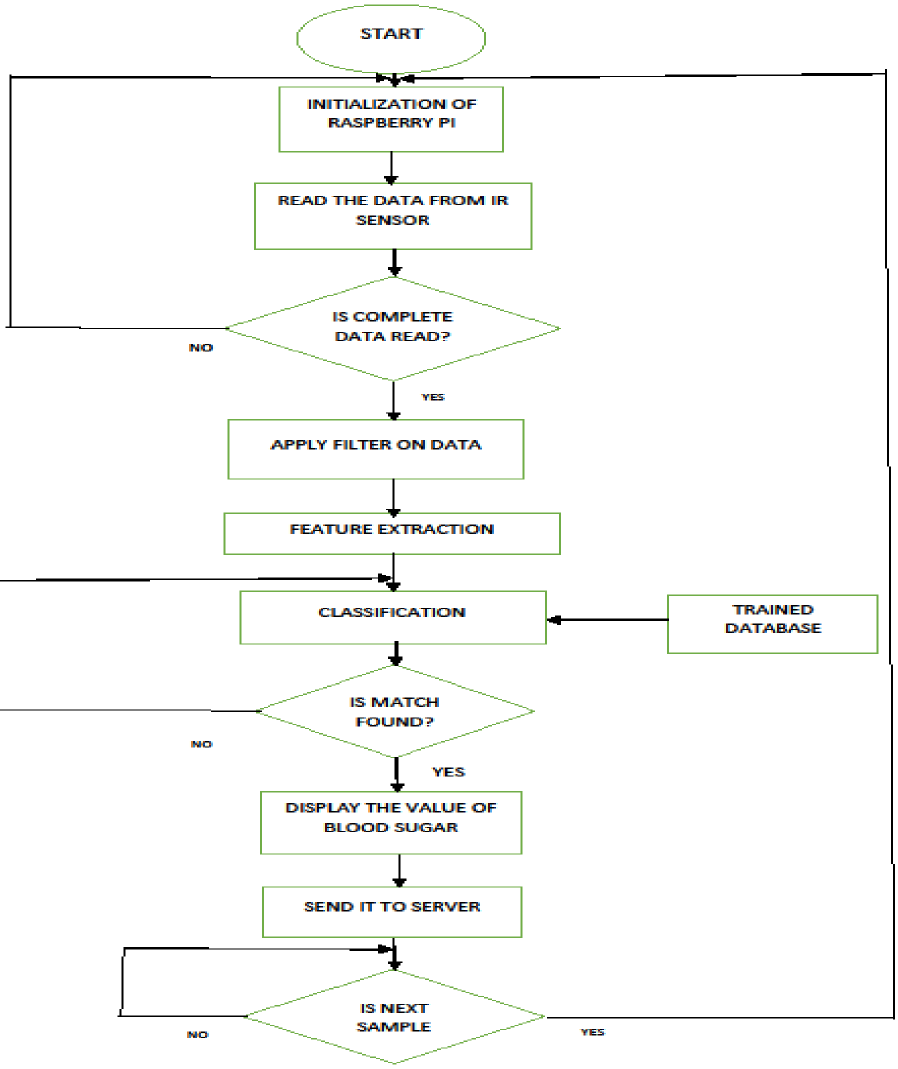

Fig 2: Flowchart of the control circuit

V .Conclusions

The invasive method of glucose measurement is painful, costly, and discomfort. It also has a risk of infection and is not used for continuous monitoring. To overcome the above disadvantages, a non-invasive method for blood glucose measurement using near- infrared LED is proposed in this paper. The glucose level in the blood which is obtained from the photo detector is displayed in both the LCD and the developed mobile app. The proposed method is validated using error grid analyses. This portable non-invasive blood glucose monitor provides a very effective means for assisting the health care management of diabetic patients. This can be used for monitoring the blood glucose level of the patients in the home as well as health care centers.We use the wavelengths of 820 nm, 875 nm, 945 nm, and 1050 nm as near-infrared light as transmitted wavelengths, collect four fingertip PPG signals, and develop a series of non-invasive blood glucose measurement method in compliance with Lambert Beer's legislation. And Double artificial neural network algorithms are used for model construction with specific PPG signals. We will increase the number of test subjects in future studies and include more variables such as humidity in the environment, the temperature during the experiment.

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REFERENCES

[1] Garcia-Compean, D., Jaquez-Quintana, J.O., Gonzalez, J.A. and Maldonado-Garza, H. (2009) Liver Cirrhosis and Diabetes: Risk Factors, Pathophysiology, Clinical Implications and Management. World Journal of Gastroenterology, 15, 280-288

[2] Mitrovic, M., Popovic, Đ.S., Naglic, D.T., Paro, J.N., Ilic, T. and Zavišic, B.K. (2014) Markers of Inflammation and Micro vascular Complications in Type 1 Diabetes. Central European Journal of Medicine, 9, 748-753

[3] Ramachandran, A., Snehalatha, C., Shetty, A.S. and Nanditha, A. (2012) Trends in Prevalence of Diabetes in Asian Countries.World journal of Diabetes, 110

[4] Ferrante Do Amaral, C.E. and Wolf, B. (2008) Current Development in Non-Invasive Glucose Monitoring. Medical Engineering & Physics, 30, 541- 549.

[5] Vashist, S.K. (2012) Non-Invasive Glucose Monitoring Technology in Diabetes Management: A Review. Analytical Chemical Act, 750, 16-27.

[6] Unnikrishna Menon, K.A., Hemachandran, D. and Abhishek, T.K. (2013)a Survey on Non-Invasive Blood Glucose Monitoring Using NIR.2013 International Conference on Communications and Signal Processing (ICCSP), 1069- 1072.M. Shell. (2002) IEEEtran homepage on CTAN. [Online]. Available: http://www.ctan.org/tex-archive/macros/latex/contrib/supported/IEEEtran/

[7] Lam, S.C.H., Chung, J.W.Y., Fan, K.L. and Wong, T.K.S. (2010) Non-Invasive Blood Glucose Measurement by Near Infrared Spectroscopy: Machine Drift, Time Drift and Physiological Effect. Spectroscopy, 24

[8] Maruo, K.,Tsurugi, M., Chin, J., Ota, T., Arimoto, H., Yamada, Y., Tamura, M., Ishii, M. and Ozaki, Y. (2003) Non-invasive Blood Glucose Assay Using a Newly Developed Near- Infrared System. IEEE Journal of Selected Topics in Quantum Electronics, 9, 322-330.

[9] Malin, S.F., Ruchti, T.L., Blank, T.B., Thennadil, S.N. and Monfre, S.L. (1999) Noninvasive Prediction of Glucose by Near-Infrared Diffuse Reflectance Spectroscopy. Clinical Chemistry, 45, 1651-1658. [10]Elgendi, M. (2012) On the Analysis of Fingertip Photoplethysmogram Signals. Current Cardiology Reviews, 8, 14

[10] Elgendi, M. (2012) On the Analysis of Fingertip Photoplethysmogram Signals. Current Cardiology Reviews, 8, 14