Detection of Diabetes by Monitoring Pancreas using NIR Sensor

K.Senthil Kumar, G.Kavitha

Abstract: ***Diabetes is a common chronic disease in recently developing world. Diabetes is an incurable disease. Control of glucose level is necessary for diabetes. The measure of glucose level is two or three times a day. Invasive or Non-invasive methods involve in measuring glucose level. Invasive method damage the finger tissue as a measurement of glucose is frequent. As an alternative, the non-invasive method facilitates regular testing, relieves pain and discomfort caused by repeated finger pricks. A non-invasive method of glucose level measurement proposed in this paper using a NIR sensor. NIR sensor determines pancreas shrinkage. Pancreas shrinks for all diabetic patients. The variation in the intensity of NIR light received from the photodetector after passing through the finger determine the glucose level in blood. LCD helps in displaying the glucose level.***

Key Words: Diabetes, NIR sensor, Non-invasive, Glucose level

I. INTRODUCTION

Diabetes is a metabolic disease qualified of chronically elevated blood glucose levels and an inability to maintain BGL homeostasis. Nanotechnology in diabetes research has facilitated the development of novel glucose measurement using a NIR sensor. The non-invasive method of detecting reduces the risk of infections through the medical strips. Individuals with Type-I Diabetes cannot produce insulin because of the destruction of β cells [1]. Individuals with Type-II Diabetes result as a deficiency of insulin. Pancreas shrinkage is familiar in diabetic patients. High glucose known as hyperglycemia causes symptoms like thirst, nausea and shortness of breath. Low glucose known as hypoglycemia causes shakiness, dizziness and loss of consciousness.

Different sensors with various wavelengths employ nanotechnology in NIR sensors. NIR sensors with wavelength 850nm, 950nm, 1300nm and 1450nm used in glucose level measurement [2]. The blood assimilates NIR light with different absorption coefficients. We can measure haemoglobin using NIR spectroscopy. The proposed system is the measurement of blood glucose level in a non-invasive method.

II. RELATED WORK

Stefania Guerra (2012) proposed a minimally invasive continuous glucose monitoring (CGM) sensors for diabetes management.

A needle electrode in the subcutaneous tissue measures an electrical current based on the glucose-oxidase principle. The measured voltage transforms to glucose levels on self-monitoring blood glucose (SMBG) samples. CGM sensors assess glucose in the interstitial fluid rather than the blood. Linear regression model compares real data and SMBG samples. Robustness in the method and uncertainty in the blood-to-interstitial fluid are the drawbacks in the paper [3].

Patricio Colmegna (2014) suggested a method to reduce the endanger of hyperglycemia and hypoglycemia in type 1 diabetes mellitus (T1DM). The block diagram comprises of an H∞ robust controller, an insulin feedback loop (IFL), and a safety mechanism (SM). A metabolic simulator calculates glucose level. The SM forbids the risk depending on a prediction of future glucose levels. IFL change the loop gain to reduce hypoglycemia risks [4].

Yue Ruan (2017) developed a subcutaneous insulin delivery model for continuous glucose monitoring. Monte Carlo approach calculates model parameters like insulin sensitivity, time-to-peak insulin action, time-to-peak gut absorption, and carbohydrate bioavailability, and good model fit. A linear Bayesian hierarchical approach executes a 12-week glucose-insulin relationship with raw clinical data. The model uses silicon testing for the development of closed-loop insulin delivery system [5].

Kamuran Turksoy (2017) proposed a method of continuous glucose monitoring for calculating insulin in artificial pancreas control. Multivariable statistical monitoring method detects faults in glucose concentration using a subcutaneous glucose sensor. An unscented Kalman filter estimate parameters of the nonlinear model. Principal component analysis models observe dynamic changes. K-nearest neighbour classification algorithm diagnosis the faults. Data from 51 samples assess the performance of the algorithm. The output shows 84.2% sensitivity [6].

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III. METHODOLOGY

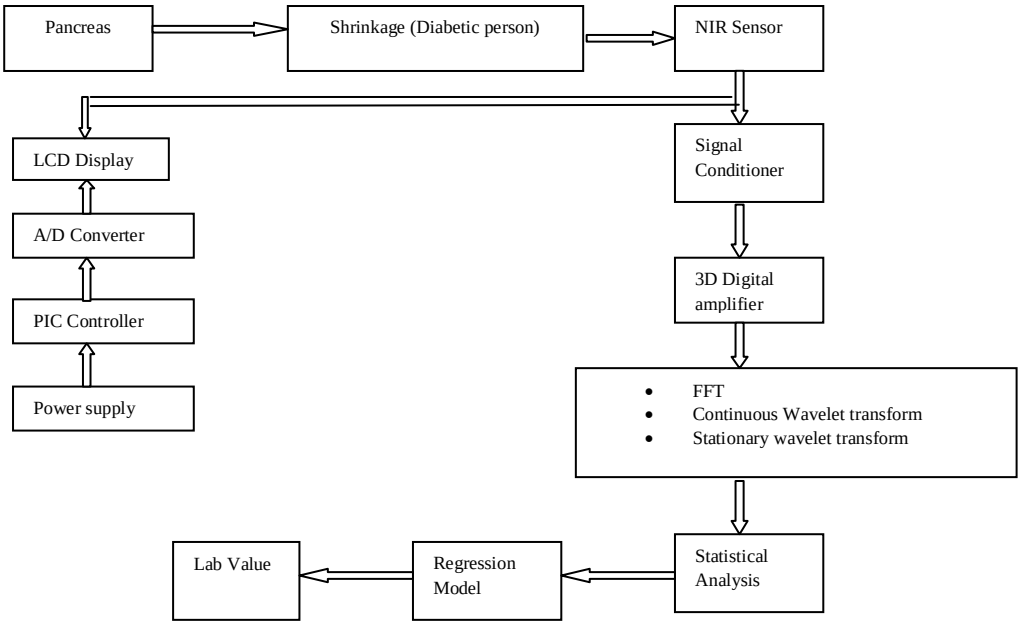

Fig. 1 Block Diagram for Detection of Diabetes using a NIR sensor

NIRS is a spectroscopy method uses near infrared region of the electromagnetic spectrum from 700 nm to 2500 nm. In this paper, a NIR sensor of 700 nm wavelength placed in pancreas determines the shrinkage for both diabetes and non-diabetes patients. NIR sensor has high sensitivity. Signal conditioning circuit manipulates signal for the next stage of processing. Analog to digital conversion process takes place. The 3D digital amplifier amplifies the converted digital signal. Fourier, stationary and continuous wavelets transform determines the shrinkage. Biological parameters of the beta cells vary the intensity of the reflected NIR signal. The signal conditioner picturise the clear view of both diabetic and non-diabetic signal using SIGVIEW. Spectrographic view and the 3D views determined using SIGVIEW and MATLAB. Regression model compares the lab values with simulated values. The sensor connected with the programmed PIC microcontroller (16F877A) to display the result directly using the analog to digital converter and showed in the LCD. It mainly configured in a sense to avoid the risks of infections from the strips used in the medical fields. Sensors are highly facilitated to attain highly accurate, rapid and highly sensitive glucose measurements. Reflected NIR signals examine an insufficient secretion of insulin. Fig.1 shows the block diagram of diabetes detection using a NIR sensor.

IV. RESULTS AND DISCUSSIONS

The time domain is the analysis of mathematical functions, physical parameters of time series of data concerning time. In the time domain, the signal function's value is known for all real numbers for continuous time or at various separate instants in case of discrete time. NIR sensor help in observing the signal using MATLAB. Signal view in the time domain of non-diabetic and diabetic person shown in Fig.2 and Fig.3

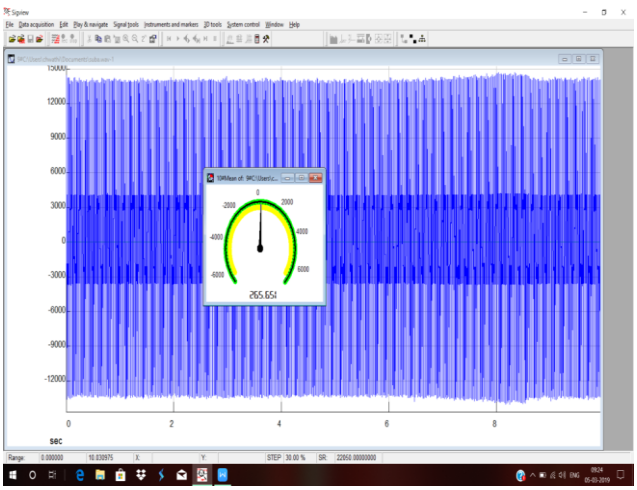

Fig. 2 Signal View of Non-Diabetic Person

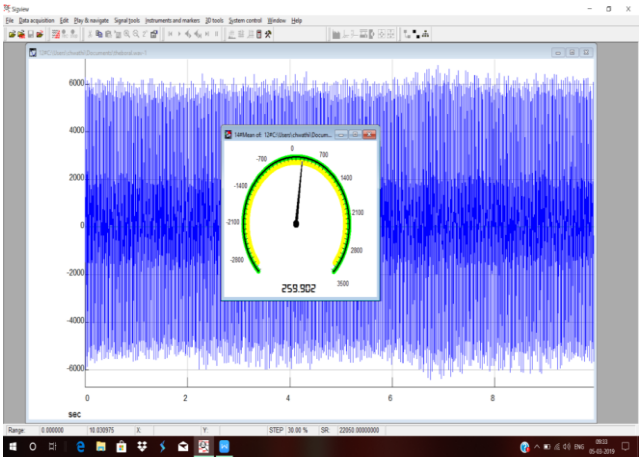

Fig. 3 Signal View of Diabetic Person

A Fast Fourier transform is an algorithm that computes the discrete Fourier transform of a sequence or its inverse. Fourier analysis converts a signal from its original domain to the frequency domain and vice versa. FFT algorithms are more accurate than evaluating the DFT.FFT provides a better analysis of the signal. FFT variation of signal for the non-diabetic and diabetic person shown in Fig.4 and Fig.5.

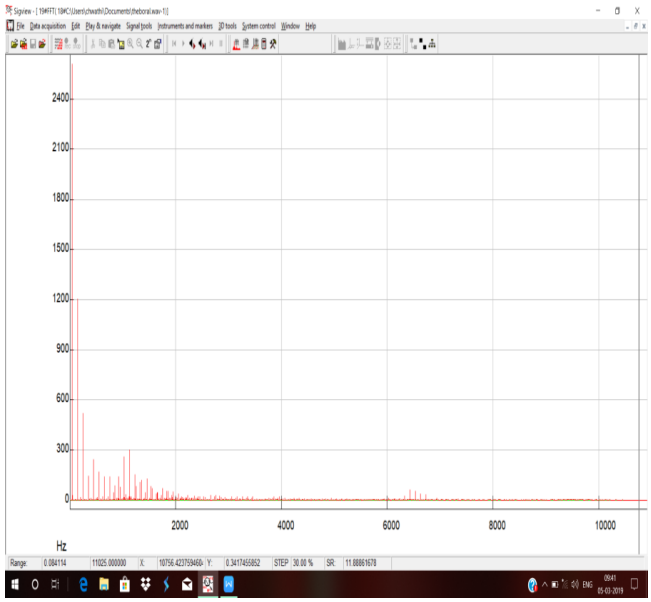

Fig. 4 FFT Variation of Non-Diabetic Person

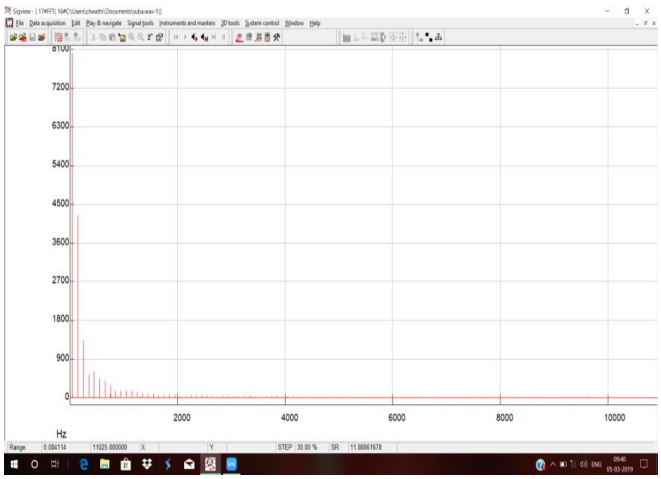

Fig. 5 FFT Variation of Diabetic Person

In protracted secretion of pancreatic juice, the concentration of three enzymes undergoes a diminution. Diminution is the reduction in size regular in a diabetic person. Exocrine pancreas shrinks because of the loss of the trophic effect of insulin on the acinar cells. Decrease in non-diabetic and diabetic person shown in Fig.6 and Fig.7

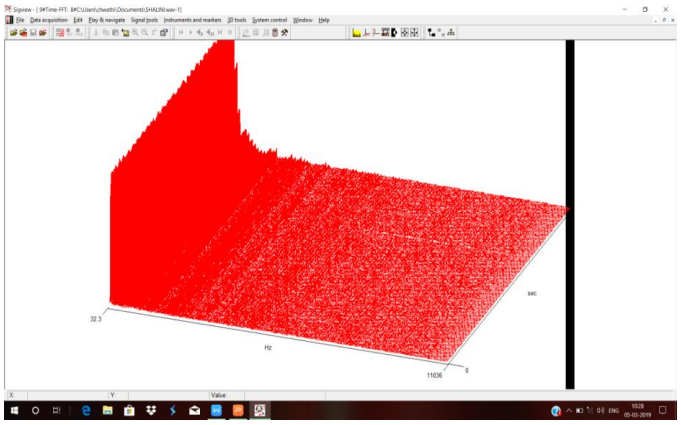

Fig. 6 Diminution in Pancreas of Non-Diabetic Person

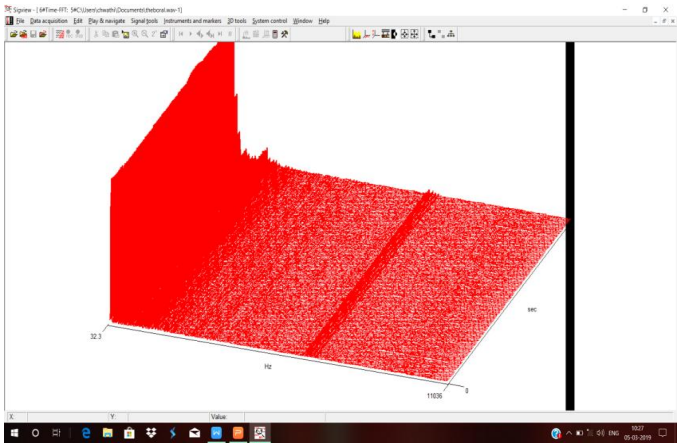

Fig. 7 Diminution in Pancreas of Diabetic Person

The hardware set up of the proposed system shown in Fig.8.

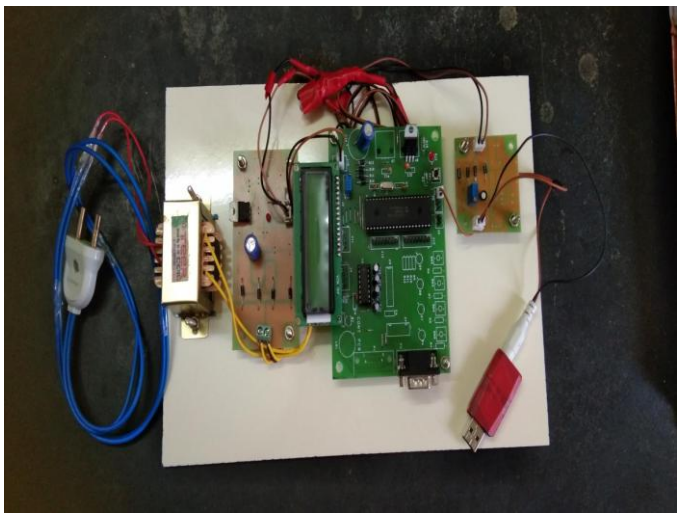

Fig. 8 Hardware image of the block diagram

V. CONCLUSION

Diabetes, a common chronic disease is an incurable disease. The measure of glucose level is two or three times a day. Control of glucose level is necessary for diabetes. Invasive or Non-invasive methods involve in measuring glucose level. Invasive procedure are in the hands of risk by

promoting infections through strips. Invasive method damage the finger tissue as a measurement of glucose is frequent. The non-invasive method facilitates regular testing, relieves pain and discomfort caused by repeated finger pricks. Non-invasive technique of glucose sensing through pancreas proposed in this paper with a NIR sensor. NIR sensor determines pancreas shrinkage. Pancreas shrinks for all diabetic patients. A body dependent content determines the diminution in the pancreas and the secretion glucose. The variation in the intensity of NIR light received from the photodetector after passing through the finger determine the glucose level in blood. LCD helps in displaying the glucose level. This non-invasive method implied for all types of diabetes. The realization of the sensor does not require repeated finger pricks to draw blood for glucose testing. Pain tissue damage and patience non-compliance associated with the clinical standards are highly desirable in the non-invasive method. This method relieves the patient's burden of continuously managing their diabetes and improves their long term health outcomes.

REFERENCES

1. Medical Management of Type 1 Diabetes, “F. R. Kaufman, Alexandria” American Diabetes Association, 2012.
2. Simulation models for in silicon testing of closed-loop glucose controllers in type 1 diabetes, “M. Wilinska and R. Hovorka”, Drug Discovery Today: Disease Models, Volume: 5, Issue: 4, Page: 289–298, 2008
3. Enhancing the Accuracy of Subcutaneous Glucose Sensors: A Real-Time Deconvolution-Based Approach, “ Stefania Guerra , Andrea Facchinetti , Giovanni Sparacino ,Giuseppe De Nicolao , Claudio Cobelli” IEEE Transactions on Biomedical Engineering , Volume: 59 , Issue: 6 , June 2012
4. Reducing Risks in Type 1 Diabetes Using H∞ Control, “Patricio Colmegna, Ricardo S. Sanchez Pena, Ravi Gondhalekar, Eyal Dassau, and Francis J. Doyl” IEEE Transactions on Biomedical Engineering, Volume: 61 , Issue:12, December 2014
5. Modeling Day-to-Day Variability of Glucose–Insulin Regulation Over 12-Week Home Use of Closed-Loop Insulin Delivery, “Yue Ruan , Malgorzata E. Wilinska , Hood Thabit, Roman Hovorka” IEEE Transactions on Biomedical Engineering, Volume: 64 , Issue: 6 , June 2017
6. Real-Time Model-Based Fault Detection of Continuous Glucose Sensor Measurements, “Kamuran Turksoy ,Anirban Roy , Ali Cinar” IEEE Transactions on Biomedical Engineering, Volume: 64 , Issue: 7 , July 2017

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