

A Non Invasive Diabetes Diagnosis using a Motor Device



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Abstract- Along with the advancement in Biomedical technology to cure many commons, but there is certain lethal disease spanned in the world which has no cure for it. One such is Diabetes, although it does not have any remedy, at least it has controlling and diagnosing methods. It is a type of disorder in body metabolism where there is a high blood sugar level for sustained period. Diabetes is a condition in which there happened to be high blood sugar levels over a longtime. Symptoms are repeated urination, thirst, and hunger. If left unchecked, it may cause many complications. Acute complications include ketoacidosis, or death. The Diabetes can be analysed by gaining a drop of blood from test subject and blending it with biosensor. This method is compact and modest, but it happens to be an intrusive and contaminant method as it deals with the usage of blood. This assumption sparked us to progress a non-invasive method of diagnosing the diabetes level for a patient using their foot sensitivity. This advancement helps one to obtain the same test result but with a non-invasive practise, which gives a painless and non-contaminant diagnosis.

Keywords—Diabetes, Diagnosing, Non-invasive, blood glucose

I. INTRODUCTION

Diabetes is either because of pancreas not generating insulin in a required amount, or the cells not properly responding to the insulin produced in the body. There are three types of diabetes mellitus: Type 1 DM results from the pancreas' inability to produce insulin in the required amount due to lack of beta cells. This form is initially called as "insulin dependent diabetes mellitus" or "juvenile diabetes". The cause is still not found. [1] The Type 2 DM rests with the state of insulin resistance, a situation where proper response to the insulin by the cells be unsuccessful. As the disease develops, absence of insulin may also be developed. This system was formerly said as "non-insulin dependent diabetes

mellitus". The common reason is obesity. Gestational diabetes happens when pregnant women without any previous history of diabetes develop high blood sugar levels. By 2015, an expected 400 million people suffered diabetes worldwide, with type 2 DM creating about 90% of the people. This represents 8.3% of the adult population, with equal rates in both genders. As of 2014, studies suggested that the rate would continue to increase. From 2012 around 1.5 to 5.0 million deaths occur each year for of diabetes. The worldwide economic cost of diabetes in 2014 was predicted to be US\$612 billion. In the United States, people spend about \$245 billion for diagnosis in 2012. The symptoms of diabetes were sudden weight loss, excessive urination, excessive thirst, and excessive appetite. Symptoms may develop rapidly in type 1. Overview of the most significant symptoms of diabetes are slower and may be subtle or even absent in type 2 Diabetes. Few more indications could indicate the beginning of diabetes although they aren't accurate to the disease. Also according to above the symptoms include blurry vision, headache and itchy skin. If the situation prevails it can lead to glucose absorption in the lens of the eye, which causes changes in the shape and sight changes [2]. Chronic sight loss can also be caused because of diabetic retinopathy. Diabetic dermatomes are rashes in skin surface which occurs due to diabetes [3]. As mentioned before the Type 1 diabetes mellitus is caused due to lack of the beta cells which produces insulin in the pancreas which in turn leads to shortage in insulin production. The above situation can also be classified into two different types-immune-mediated and idiopathic. The main cause for the occurrence of type 1 diabetes is of the immune-mediated nature, where auto immune attack occurs mediated by the T-cells leading to loss of beta cells and thus insulin. At the initial stage of the disease people seems to be healthy with normal weight and indexes. Sensitivity to insulin is usually normal, especially at beginning stages. Type 1 diabetes usually reaches out children and adults, and thus it is habitually termed "juvenile diabetes" because a majority children get affected by this disease [8]. As mentioned above the Type 2 DM is defined by insulin resistance, which may be combined with reduction in insulin secretion. These insulin receptors are involved with the defective responsiveness of body tissues to production of insulin. Still, the specific defects for this disease are still not known. Diabetes mellitus cases due to the identified defects are classified separately. Type 2 DM is the frequently occurring diabetes mellitus. Reduced insulin sensitivity is the leading abnormality in the initial stage of type 2 DM. At this state, high blood sugar can be kept under control by various types of measures and medications for the improvement of insulin sensitivity and reduced liver's glucose production [12].

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The another important cause for the threat of developing type 2 DM is dietary issues. Intake of the sweet drinks in excess is connected to high risks. The fats present in the diet is also significant, the polyunsaturated and monounsaturated fat does not involve risk for type 2 Diabetes whereas the saturated fat and trans fats increases the threat for type 2 diabetes in adults. Extra intake of rice, and starch risk product, may also surge the risk of diabetes. Lack of physical activities is believed to cause increased amount of this disease [8]. Gestational Diabetes is more like the type 2 diabetes in several features, which carries the cause of insufficient secretion of insulin and responsiveness. At most 7% of total pregnancy has the chance of occurrence. Whereas after the gestational period only 5-6 % are happened to suffer from diabetes and that to Type 2 diabetes. [7] With appropriate direction of treatment and assistance the Gestational diabetes is completely correctable. The treatments involve dietary procedures, blood glucose level monitoring, and in some situations insulin injection is also necessary. Although it happens to be a temporary disease, if not treated Gestational Diabetes can damage the healthiness of either the baby or the mother. Increased birth weight [9] inherited heart and disorders involved with the central nervous system are the various risks involved with the baby. Red blood cell destruction may also occur if there is an increase in amount of blood bilirubin level [10] In severe situations, it may also cause death in patients as a result of improper placental perfusion due to vascular impairment. [8,13]

II. PROBLEM FORMULATION

Although the current medical trends gave us convenient and simple way of diagnosing Diabetes but nevertheless it remains to be invasive method. The blood sample is needed to be acquired from the person each and every time while diagnosing. This habitual method of obtaining blood sample may lead to the following problems- The biosensor strip, lancet used to collect blood sample need to be properly heaved and disposed failing which might lead to contamination of the surrounding environment [4][5]. The lancet used for pricking may cause blood contamination with foreign elements if it is not sterile. [6] Moreover, it is an aching method as the pricking of fingers with the needles involves lot of pain.

III. MATERIALS AND METHODS

The primary objectives include- Construction of a device that is relatively small and light weight; Developing the software in such a way that patients receive their medication reliably and safely as the way the device is designed. [11] Obtaining a cost effective motor controlled device. Developing a device that can perform all the necessary functions related with diagnosis. Creating a safer diabetes diagnose than the current models, which involves Example of a figure caption lancet and strip; Creating a device that requires minimum user input to setup, if possible only switching on the device; Remote accessing of details and data obtained from the device and to infer the result. Fig. 1. indicates the design of the device has been constructed, the Hardware indicates the microcontroller that is used. Components used are described as follows.

A. Microcontroller

The microcontroller is the main portion of the device. It is essential for performing all the read and write operations in and out of the device. The microcontroller used for this device is My DAQ as this device runs on LabVIEW program it would be perfect if the custom microcontroller is used for it. The microcontroller is selected on the basis of various parameters of the project like-peripheral devices used, required power supply, software used for the device functioning. The microcontroller consists of few Input and output ports to interface the display unit, motor and knob. Interrupts enables the user to interact with the system for programming.

B. DC Motor

The DC Motor is the working component of this device it keeps on driving on the patient’s foot, only when the patient feels the sensitivity the next motor is turned on. It keeps on running for all the seven motors, thereby helping us to acquire the data.

C. Graph Display

The graph display gives us the output in the form of graph. The output is displayed with reference to the graph of a non-diabetic patient which can be used to compare the severity of the diabetic patient.

D. Latch

The latch is used for controlling the actions of motor and switch to the next motor. The patient presses the knob once he felt the sensitivity of motor which makes the next motor to run.

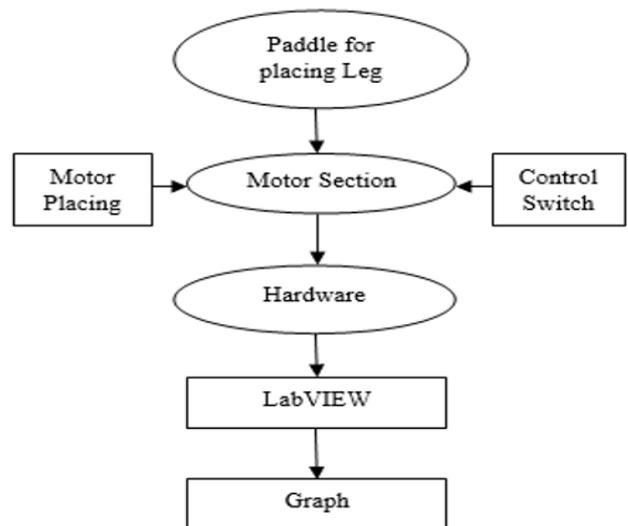


Fig. 1. Block Diagram of the Proposed Device

E. LabVIEW

Lab VIEW software is used for the programming of the device as it is easy to architect the program. The LabVIEW is graphical interfacing software and hence make the architect of program to be simple and easy. LabVIEW runs in a VI basis every program that is architected is saved as a VI.

It is easy to load the VI especially with the custom microcontroller being used for the device. Another advantage of using the LabVIEW is that it requires less memory or storing and running. Also the errors in the program can be easily identified and rectified. Overall the software is user friendly for both the user and device as it reduces complexion.

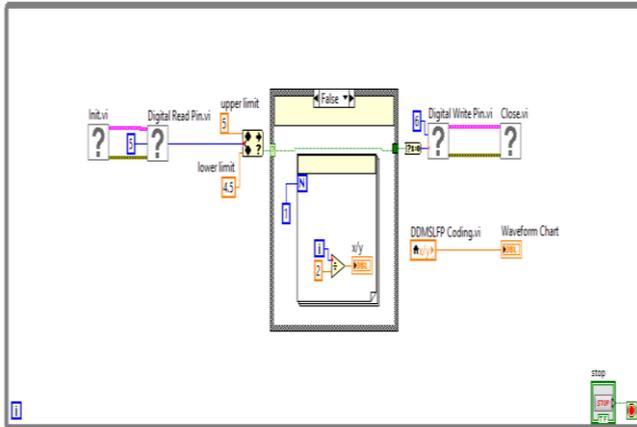


Fig. 2. Program in which the device runs

The output of the project has been obtained as a graph in which the graph value keeps increasing as a steep straight line until there is a response from the patient, once the response is obtained, the graph stops and starts again from zero to continue the same process. This action is repeated for all the motors. The time taken for each peak obtained is compared with the normal person and the degree of increased time is analyzed to conclude the severity of the diabetes. LabVIEW and myDAQ is used for acquisition and interference of the signal and graphs. Now with this method the hospitals can analyze the severity without usage of invasive equipments.

IV. CONCLUSION

The proposed device would be helpful for the type 2 and type 1 diabetes patient, above all it will reduce the loss of blood, contaminated compounds, and reduces pains. Hereafter large number of patients can diagnose easily in outpatient sections, reducing wastage of time, and cost efficient. In future further it can be developed to have accessible mobile app for examining graph and interfering the result, this results can be easily transferred to the care takers and doctors for further analysis and diagnosis. The device will be further developed to become handy and can be used in our home.

REFERENCES

1. Shafiee G, Nasli-Esfahani E, Bandarian F, Peimani M, Yazdizadeh B, Razi F, et al.(2016)Iran diabetes research roadmap (IDRR): the study protocol. *Journal of Diabetes & Metabolic Disorders*.15(1):Vol. 58. 2.
2. Danaei G, Finucane MM, Lu Y, Singh GM, Cowan MJ, Paciorek CJ, et al. National, regional, and global trends in fasting plasma glucose and diabetes prevalence since 1980: Systematic analysis of health examination surveys and epidemiological studies with 370 country-years and 2.7 million participants. *Lancet*378(9785):pp31–40.
3. Chen Y, Zhang X, Pan B, Jin X, Yao H, Chen B, et al(2010). A modified formula for calculating low-density lipoprotein cholesterol values. *Lipids Health Dis*.9(1) Vol. 52.

4. International Organization for Standardization. ISO 15197 (2003) - In vitro diagnostic test systems – Requirements for blood-glucose monitoring systems for self-testing in managing diabetes mellitus.
5. International Organization for Standardization (2013). Determination of performance criteria for in vitro blood glucose monitoring systems for management of human diabetes mellitus. ISO 15197. Geneva: International Organization for Standardization;.
6. Kristensen GB, Nerhus K, Thue G, Sandberg S(2016). Standardized evaluation of instruments for self-monitoring of blood glucose by patients and a technologist. *Clin Chem*. 2004;50(6):1068–71. Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4.4 million participants. NCD Risk Factor Collaboration (NCD-RisC). *Lancet*. Vol(9);pp387
7. Tandon Ajay, Jeremy A. Lauer, David B. Evans, and Christopher JL. Murray. (2003). “Health System Efficiency: Concepts.” *Health Systems Performance Assessment: Debates, Methods and Empiricism*. Edited by Christopher JL Murray and David B. Evans. Chapter 50, pp. 683-691.
8. Bekkering P, et al., (2013) The intricate association between gut microbiota and development of type 1, type 2 and type 3 diabetes. *Expert Rev Clin Immunol.*;Vol.9(11): pp 1031–41.
9. Million M, et al., (2012) Comparative meta-analysis of the effect of Lactobacillus species on weight gain in humans and animals. *Microb Pathog.*;Vol.53(2): pp 100–8.
10. Xiao JZ, et al.(2003) Effects of milk products fermented by Bifidobacterium longum on blood lipids in rats and healthy adult male volunteers. *J Dairy Sci.*;Vol.86(7): pp 2452–61.
11. Bell RA, Suerken CK, Grzywacz JG, Lang W, Quandt SA, ArcuryTA.(2006) Complementary and alternative medicine use among adults with diabetes in the United States. *Altern Ther Health Med.*;Chapter12: pp 16–22.
12. Queiroz MSR, Janebro DI, Cunha MAL, Medeiros JS. AUO Sabaa-Srur, Diniz MFFM, et al. (2012) Effect of the yellow passion fruit peel flour (*Passiflora edulis f. flavicarpa deg.*) in insulin sensitivity in type 2 diabetes mellitus patients. *Nutri J.*; Vol.11(89): pp 1–7.
13. McCune C, Maynard S, McClements B, Lindsay JR.(2015)HbA1c for Diabetes Screening in Acute Coronary Syndrome: time for a reappraisal of the guidelines *Ulster Med J.*; Vol 84: pp 154–6
14. Eiken FL, Pederson BL and Eiberg PG (2019) on Diagnostic methods for measurement of peripheral flow during exercise in patients with type 2 diabetes with type 2 diabetes and peripheral artery disease.
15. Nina Jentrick, Annette Baumstark and Stefan Pleus (2018) on Assessment of System Accuracy, Intermediate Measurement Precision, and Measurement Repeatability of a Blood Glucose Monitoring System Based on ISO 15197.