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Non-Invasive Glucose Monitoring Device

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ABSTRACT

A non-invasive blood glucose monitoring system is a new technology for people with diabetes. These devices do not require blood or other invasive methods to measure blood glucose. They are designed to give patients a safe and accurate way to monitor their blood glucose. Non-invasive blood glucose monitoring devices measure blood glucose using transdermal sensors placed on the skin. These sensors transmit data to the monitor, allowing the patient to monitor their glucose levels in real time. The accuracy of this method has been shown to be similar to that of analytical glucose testing methods. Infrared sensor and Arduino UNO are the components used in this device that provides natural solution for non-invasive glucose monitoring. An innovative way to accurately monitor blood glucose levels without any intervention is to connect the sensor to an Arduino. To determine if there is glucose in the blood, the system uses an infrared sensor. Then, this data is sent to the Arduino microcontroller for real-time processing and display. The system is designed to be easy to use and requires no user intervention. It also provides an affordable solution to the problem of blood glucose monitoring, making it a desirable option for both patients and health professionals. The device provides an effective and economical solution for monitoring blood glucose. In addition to storing and receiving data from a secure database, Arduino is used to process sensor signals. The system is designed to provide continuous monitoring of the user's blood glucose levels. This system can be used to alert the operator of any changes in blood glucose levels and to provide the patient with the information he or she needs to better manage his or her condition.

Keywords: Blood – Glucose Monitoring, Real-Time processing, IR sensor.

INTRODUCTION

Diabetes is a poor disease that does not occur when the pancreas is perfect or when the body cannot use insulin it produces. Insulin is the hormone that controls blood sugar. Hyperglycemia, also called as high blood sugar, is a common side effect of uncontrolled diabetes that, over time, causes serious damage to many of the body's systems, especially nerves and blood vessels. In 2014, 8.5% of adults aged 18 and over had diabetes. In 2019, diabetes was the cause of 1.5 million deaths and 48% of all diabetes deaths occurred before the age of 70. More than 460,000 deaths from kidney disease were caused by diabetes, with high blood sugar responsible for approximately 20% of deaths. Between the years 2000 and 2019, the number of people dying from age-related diabetes increased by 3%. In low-income countries, the number of people dying from diabetes has increased by 13%. In contrast, the risk of dying from one of four non-communicable diseases (heart disease, cancer, chronic respiratory disease or diabetes) between the ages of 30 and 70 decreased by 22% worldwide between 2000 and 2019.**[11]** The non-destructive glucose testing system provides a substitute for blood glucose monitoring.**[4]** Using sensors

as a primary source this technology can monitor the body's glucose level without the need for invasive procedures methods such as blood or fingerprints. This helps monitor glucose levels simple and effective for people with diabetes. Blood glucose monitoring can be used to detect and warn users of unsafe products. This technology is popular and helpful improve the quality of life of diabetics. A new way to find out better checking blood glucose without breaking the cycle is the solution. A non-invasive glucose monitoring system using an infrared sensor and Arduino.**[5]** The system uses an infrared sensor to determine the blood glucose level. Then this data is sent to the Arduino microcontroller for direct processing and display. The process done is easy to use and does not require user intervention. This method monitors the body's glucose level without the need for a blood sample using infrared sensors, OLED displays and Arduino Uno. An infrared sensor picks up changes in the patient's glucose levels.**[8]** The Data is stored on the Arduino Uno and displayed on the OLED screen. For diabetics who need to check their blood sugar regularly, this device is very useful. It is reliable, cheap and easy to use. This provides a non-invasive method of blood glucose testing. The below table displays the diagnostic criteria for diabetes and prediabetes.

Parameter	Normoglycemia(mg/dl)	Prediabetes(mg/dl)	Diabetes(mg/dl)
FPG	< 110	110 – 125 (IFG)	≥ 126
2 – h PG	<140	140 – 199 (IGT)	≥ 200

Table.01.WHO Diagnostic Criteria for Diabetes and prediabetes

MATERIALS & METHODS

The necessary components were Arduino UNO, IR sensor and Display. Designing the system was the initial stage in creating a non-invasive glucose monitoring system. Determining the overall system architecture, hardware elements and data processing algorithms were all included in this. Considerations for reliability and safety were also part of this design. The non-invasive glucose monitoring system's sensors were chosen in the following stage. For the system's design, this entailed taking into account elements such as accuracy, precision, sensitivity, cost, and compatibility. The signals from the chosen sensors had to be processed and analyzed in order to learn more about the glucose levels. Algorithms for signal conditioning, filtering, and feature extraction were used in this process. The information being processed was kept in a secure database and subjected to appropriate algorithms, such as Beer Lambert's law and fizzy algorithms, etc. Artificial neural networks or other machine learning techniques were used in this analysis to find patterns and correlations between the data and glucose levels. The creation of the user interface, which enabled people to access and analyze the data, was the last phase. This might have included mobile applications, websites, or other user-friendly user interfaces. The non-invasive measurement of blood glucose levels was done using an infrared (IR) sensor. The IR sensor measured the amount of infrared radiation that was absorbed by the blood's glucose molecules using a light source and detector. When IR radiation interacted with blood glucose molecules, some of the radiation was absorbed and some of it was reflected back. The amount of radiation that was reflected was subsequently measured by the detector, and this amount was directly proportional to the blood glucose level. By scanning the skin for infrared light that was absorbed by the glucose molecules in the blood, the IR Sensor was used to assess the blood glucose level non-invasively. Using their respective libraries and the proper connections, the sensors were interfaced to the Arduino. The device generated the results using an algorithm based on Beer Lambert's law. The embedded C program was subjected to the difference operation. The value of the

human blood glucose level was finally produced by the differential between the sensor data. For non-invasive blood glucose detection, 100 samples from different regions were counted with differences in age, gender and location.

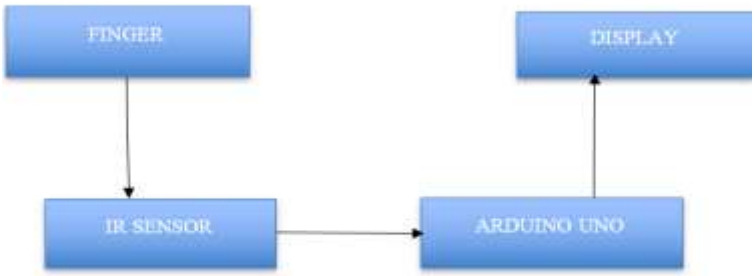

Figure. 02. Block Diagram of the Device

RESULT

Non-invasive blood glucose monitoring using infrared light is regarded as a valuable and dependable method for measuring blood glucose levels during everyday tasks. The infrared-based glucose monitoring principle relies on the different absorption levels of infrared light waves by blood, depending on the concentration of glucose. The recommended system using 940 nm infrared (IR) light source appeared to be capable of generating detectable signals. These findings align with the research conducted by Dr. R. Kavitha *et al.*, who advocated for the utilization of the IR principle to enhance the sensitivity of the measurement and emphasized the precision of this approach in distinguishing between various categories of potential patients. The overall results obtained is displayed below. Out of 100 samples, 30% of samples gave atypical glucose results.

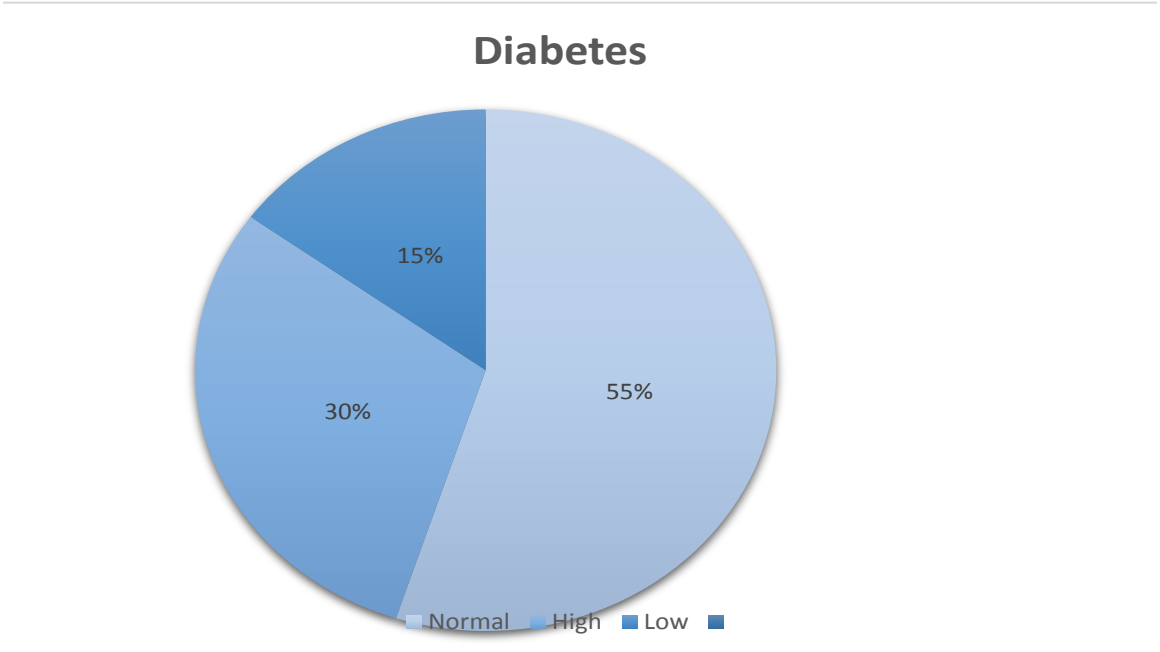

Figure 02. Data analysis of diabetes range

DISCUSSION

When light rays pass through living tissue, they are absorbed and scattered by the tissue. Heat diffusion occurs in living tissue due to a mismatch between the flow rates of extracellular fluid and cell membranes. Changes in blood glucose levels affect the intensity of light scattered throughout the

body. The Beer-Lambert law plays a major role in measuring absorption, which states that the density of light from any solution is proportional to the concentration of the solution and the length of the path that the light ray travels [10]. The device will provide glucose measurements painlessly, without a blood sample or finger pricks, within a few seconds.[5] Based on analysis of 100 subjects, 55 subjects showed satisfactory values according to the table below.

Parameter	Ideal	Satisfactory	Unsatisfactory
FPG	80 – 110	111 – 125	>125
2 – h PG	120 - 140	141 – 180	>180

Table 0.2. Target recommendation for control in diabetes

CONCLUSION

Because of its precision and convenience, non-invasive glucose monitoring systems hold great potential for individuals with diabetes or those at risk of developing the condition. Instead of extracting blood, these devices utilize sensors or alternative technology to identify glucose levels. Non-invasive glucose monitoring systems have the ability to enhance patient adherence and streamline diabetes management by eliminating the necessity for finger pricking. Ultimately, they can improve the quality of life for individuals with diabetes by simplifying the process of monitoring and controlling blood sugar levels.

Declaration by Authors

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REFERENCES

1. K. Wang and P. K. Singh, "Noninvasive Glucose Monitoring: A Comprehensive Review of Techniques, Analytical Methods, and Clinical Performance," Sensors, vol. 17, no. 3, p. 564, Mar. 2017.
2. R. J. Gordon, T. C. Thompson, and J. M. Thornton, "Noninvasive Glucose Monitoring: Developments, Challenges and Opportunities," Trends in Biotechnology, vol. 35, no. 5, pp. 434–443, May 2017.
3. M. F. de Azevedo and T. M. Cunha, "Noninvasive Glucose Monitoring: Current and Future Prospects," Frontiers in Physiology, vol. 8, no. JAN, p. 376, Dec. 2017.
4. R. B. Zor, M. Koutsonikolis and G. M. Anastassov, "Noninvasive Glucose Monitoring: Principles and Technologies," IEEE Reviews in Biomedical Engineering, vol. 8, pp. 1–14, Apr. 2015.
5. Dr. R. Kavitha, M.S. Janani, K Dhanalakshmi," Detecting glucose level using IR sensor": International journal of computer trends and technology, volume 69 issue 3,88-91, march 2019.
6. Abdallah Kassem and Mustapha Hamad, George G. Harbieh and chady El Moucary," A Non-invasive blood glucose monitoring device": 2020 IEEE 5th Middle east and Africa conference on Biomedical engineering (MECBME).
7. G Gunawan, Budi Harianto, Marina Elsera, Ferry Fachrizal; "Analysis of infrared sensors as a non-invasive glucose measuring by applying fuzzy algorithm": 1st International conference of SNIKOM 2018, Journal of physics; conference series.
8. Soumyasanta Laha, Aditi Rajput, Suvra S. Laha and Rohan Jadhav, "A concise and systematic review on Non-invasive glucose monitoring system for potential diabetes management ". Biosensors 2022,12,965.
9. Betty Elisabeth Manurang, Hugi Reyhandani Munggaran, Galiah Fajar Ramdhan, Allya Paramita Koesoema institute technology Bandung:" Non – invasive blood glucose monitoring using Near-Infrared spectroscopy based on internet of things using machine learning",2019 IEEE Region 10 Humanitarian Technology conference Depok, Indonesia, November 12-14,2019.
10. P. Daarani and A.Kavithamani,"Blood glucose level monitoring by Non – invasive method using Near -Infrared sensor": International Journal of latest trends in engineering and technology.
11. ICMR guidelines for management of type 2 diabetes 2008[internet] https://main.icmr.nic.in/sites/default/files/gu

idelines/ICMR_GuidelinesType2diabetes2018_0.pdf .
12. Centers for Disease Control and Prevention. Diabetes Public Health Resource: Incidence ang Age at Diagnosis. 2013. [2015 January 27]. http://www.cdc.gov/diabetes /statistics/incidence_national.htm .
13. Global report on Diabetes [Internet]. https://apps.who.int/iris/bitstream/handle/10665/204871/9789241565257_eng.pdf
14. Olson DE, Rhee MK, Herrick K, et al. Screening for diabetes and pre-diabetes with proposed A1C-based diagnostic criteria. *Diabetes Care*. 2010;33(10):2184–2189. [PMC free article] [PubMed] [Google Scholar]
15. Gregg EW, Cheng YJ, Saydah S, et al. Trends in death rates among U.S. adults with and without diabetes between 1997 and 2006: findings from the National Health Interview Survey. *Diabetes Care*. 2012;35(6):1252–1257. [PMC free article] [PubMed] [Google Scholar]
16. Asghari S, Courteau J, Carpentier AC, Vanasse A. Optimal strategy to identify incidence of diagnostic of diabetes using administrative data. BMC Med Res Methodol 2009;9:62. CrossRefexternal icon PubMedexternal icon
17. Eui Chul Lee, Hyunwoo Jung, and Daeyeoul Kim, 2011, New Finger Biometric Method Using Near Infrared Imaging, Sensors (Basel). 2011; 11(3): 2319–2333.
18. P. D. Minns, C Programming For the PC the MAC and the Arduino Microcontroller System. Author House, 2013. [2] M. Banzi, Getting Started with arduino.
19. "O'Reilly Media, Inc.", 2009. [3] Arduino, "Arduino uno." Last visited on 06/09/2014. [4] A. M. Gibb, New media art, design, and the Arduino microcontroller: A malleable tool. PhD thesis, Pratt Institute, 2010.
20. A. U. ARDUINO UNO, "Front. arduino uno board," 2012.
21. B. Stroustrup et aI., The C++ programming language. Pearson Education India, 1995.

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