Non-Invasive Blood Glucose Measurement Using Breath

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***Abstract*— Diabetes is the most chronic disease worldwide, and blood glucose level is the most important part of avoiding diabetes complications and organ damage. The invasive used for blood measurement is painful and causes damage to nerves. Wireless blood glucose monitoring is an alternative solution to this problem. With this device, we monitor blood glucose using a wireless method. With this device, we measure blood glucose using the users breath. Using a gas sensor, we monitor blood glucose through a wireless method. The monitored data by gas sensor users can see the results on the LCD display and on the android application using internet of things technology.**

I. INTRODUCTION

In the world, there are 422 million people with diabetes, and in India, more than 77 million adults (source) are living with diabetes. And researchers say they predict that it will go up to 134 million in the next few years. Also, women have a higher risk than males of developing diabetes, and as both groups grow older, this risk decreases. Furthermore, researchers estimated that 57% of cases go undiagnosed. Diabetes is a very common chronic condition worldwide, and in this condition, it is important to keep monitoring sugar levels in the blood to prevent further health complications. Most patients use a commercially available home testing kit that includes a single-use strip, which requires them to prick their finger, draw a small amount of blood, and feed it into the measurement machine. This old invasive method of blood glucose measurement is harmful every time. It is also a very time-consuming process. So in this project, we developed a device that monitors glucose in the blood wirelessly using a patient's breath. When we searched for different ways to monitor blood glucose wirelessly, we found that acetone concentration in the breath is a great biomarker that has a linear relationship with the amount of blood sugar. This small concentration of acetone (1 ppm) in the breath was measured using expensive equipment in older research publications. In this project, using a microcontroller board and a single gas sensor, we measure volatile organic compounds (VOCs). Acetone is one of the gases that has a sense and the range of this gas is already inserted into that sensor. The user can see the results on an LCD display. We also included the Internet of Things (IOT) so the user can see results on the mobile application and all the data stored on the cloud platform.

II. LITRATURE REVIEW

I. Thomas K. Mathew; Prasanna Tadi, Blood glucose monitoring. Year- August 8, 2022

Blood glucose monitoring observes for patterns in the fluctuation of blood glucose (sugar) levels that occur in response to diet, exercise, medications, and or pathological processes associated with blood glucose fluctuations such as diabetes. Unusually high or low blood glucose levels can potentially lead to acute and or chronic, life-threatening conditions. Blood glucose level (BGL) or blood sugar level (BSL) monitoring undertaken in the home/community are often referred to as capillary blood glucose (CBG) tests, while blood glucose tests carried out at clinical facilities may include CBG, and (plasma glucose) venous blood tests.[1]

II. Amine Rghioui, Jaime Lloret, Mohamed Harane and Abdelmajid Oumnad, A Smart Glucose Monitoring System For Diabetic Patient.Year-22 April 2020.

Technologies and application of the internet of things are advancing considerably in important IOT technical areas, becoming more accessible, available and versatile everyday, allowing faster growth of objects interconnected via the internet. The quality of life of patients is an important objective of intelligent health care and is widespread concern with the construction of new applications in this field. The daily mobile health service is becoming more and more important. Several chronic diseases, like cardiovascular and diabetic diseases, influence the health of living people.

Patient data is very useful. Indeed, data analytics can be applied to identify people who need "proactive care" or who need a lifestyle change in order to avoid deterioration in health. For example, patients at an early stage of certain diseases (like heart failure, which is often caused by certain risk factors such as hypertension or diabetes) should be able to benefit from predictive and preventive care thanks to big data. Patients are also more comprehensive about giving away part of their privacy if this could save their lives or other people's lives.[2]

III. Tayyab Hassan, Talha Rehman, Qasim Abdul Aziz, Ahmad Salman , Breath Analysis. Blood Glucose Level Measurement From Year-1 Aug 2018.
D IABETES is one of the leading cause of death these days, affecting 8.7% of the global adult population .It arises either due to the inability of body to produce insulin (Type-1 Diabetes) or because cells are not responsive to the insulin produced (Type-2 Diabetes). Insulin controls the glucose level in blood and inability of human body to produce sufficient insulin results in increased glucose level in blood which may prove fatal. Thus, diabetic patients are injected with insulin, and their blood glucose level is monitored regularly. The clinical method used for measuring blood glucose level involves piercing the fingertip and collecting a large drop of blood on the test strip. It is then analyzed chemically for concentration of blood glucose. Each reading requires at leastone piercing and sample collection. Type-2 diabetes patients are advised to check glucose level four to seven times a day. The invasive procedure is accurate, but it is painful and may cause infections and bruising. A minimally invasive glucometer was proposed in that uses relatively smaller sample of blood, but its accuracy is low [3].

IV. Anand Thati, Arunangshu Biswas, Shubhajit Roy Chowdhury And Tapan kumar Sau, Breath Acetone Based Non-Invasive Detection Of Blood Glucose Level Year- 1 June 2015.
Non-invasive diagnosis technique is becoming more prominent in diagnosing diseases due to their pain free and simple monitoring methods. Non-invasive detection of blood haemoglobin was already reported by our group in the earlier work. Lieschnegg et al. have developed a sensor to detect failures and material imperfections in total joint prosthesis based on acceleration measurement non-invasively. Diabetes can also be detected using non-invasive methods. Diabetes mellitus is a major health problem world wide .This health condition arises from many complex metabolic disorders leading to high glucose levels in a person. High glucose levels can lead to many health disorders such as kidney failure, blindness, heart diseases and even premature death. Frequent testing and accurate determination of glucose levels is essential for diagnosis, effective management and treatment of diabetes mellitus. Therefore, there have been constant efforts to develop efficient and sensitive techniques for the determination of blood glucose levels.[4]

V. Andrea Tura , Alberto Maran, Giovanni Pacini,Non-invasive glucose monitoring: assessment of technologies and devices according to quantitative criteria, Diabetes Research and Clinical Practice 77 (2007).
Aim of this review was to describe the main technologies for non-invasive glucose monitoring and the corresponding most relevant devices. The review tries to overcome the limitations of previous reviews on this topic, such as the lack of objective criteria for inclusion or exclusion of technologies or devices, and the poor organization of the information, which often does not allow easy comparison between technologies and devices. In this review, the information is concise and organized into specific categories, and hence it becomes easy to compare advantages and disadvantages of the different technologies and devices. For technologies, the categories of information considered are the technology name, the underlying physical principle, the technology limitations and the measurement sites on the human body. For devices, the categories of information are the device name, its approval condition (FDA Approval and/or CE Mark), the technology on which it is based, a device general description, the tests performed on the device, the corresponding results, safety information, aspects affecting usability, current status of the device and the manufacturer, an Internet reference for the device. A total of 14 technologies and 16 devices are included. Conclusions of the review were that, despite some interesting and promising technologies and devices, a satisfactory solution to the non-invasive glucose monitoring problem still requires further efforts.

VI.Saasa, V, Malwela, T, Beukes, M., Mokgotho, M, Liu, C. P, & Mwakikunga, B. Sensing Technologies for Detection of Acetone in Human Breath For Diabetes Diagnosis And Monitoring.2018

The review describes the technologies used in the field of breath analysis to diagnose and monitor diabetes mellitus. Currently the diagnosis and monitoring of blood glucose and ketone bodies that are used in clinical studies involve the use of blood tests. This method entails pricking fingers for a drop of blood and placing a drop on a sensitive area of a strip which is pre-inserted into an electronic reading instrument. Furthermore, it is painful, invasive and expensive, and can be unsafe if proper handling is not undertaken. Human breath analysis offers a non-invasive and rapid method for detecting various volatile organic compounds thatare indicators for different diseases. In patients with diabetes mellitus, the body produces excess amounts of ketones such as acetoacetate, beta-hydroxybutyrate and acetone. Acetone is exhaled during respiration. The production of acetone is a result of the body metabolising fats instead of glucose to produce energy. There are various techniques that are used to analyse exhaled breath including Gas Chromatography Mass Spectrometry (GC-MS), Proton Transfer Reaction Mass Spectrometry (PTR-MS), Selected Ion Flow Tube-Mass Spectrometry (SIFT-MS), laser photoacoustic spectrometry and so on.

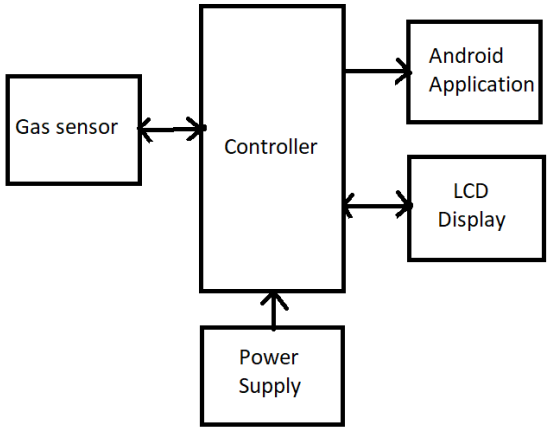
VII. **Marjan Gusev**, Lidija Poposka, Gjoko Spasevski, Magdalena Kostoska, Bojana Koteska, Monika Simjanoska, Nevena Ackovska, Aleksandar Stojmenski, Jurij Tasic, and Janez Trontelj. Noninvasive Glucose Measurement Using Machine Learning and Neural Network Methods and Correlation with Heart Rate Variability. Year-06 Jan 2020.

Diabetes is one of today's greatest global problems, and it is only becoming bigger. Constant measuring of blood glucose level is a prerequisite for monitoring glucose blood level and establishing diabetes treatment procedures. The usual way of glucose level measuring is by an invasive procedure that requires finger pricking with the lancet and might become painful and obeying, especially if this becomes a daily routine. In this study, we analyze noninvasive glucose measurement approaches and present several classification dimensions according to different criteria: size, invasiveness, analyzed media, sensing properties, applied method, activation type, response delay, measurement duration, and access to results. We set the focus on using machine learning and neural network methods and correlation with heart rate variability and electrocardiogram, as a new research and development trend.

III.METHODOLOGY

The purpose of this system is to design a device based on IOT which gives a non-invasive technique to estimate blood glucose level. It has been well-established that the level of acetone in the breath is directly associated to the glucose level of a person. For this purpose, the module collects the sample of the breath when the patient blows into the mouthpiece and senses the level of acetone in the breath. The block diagram of this system as shown in fig (1), as we switch on the power supply the controller connects with IOT cloud platform. Using this application we can measure the level of glucose. And using sensor user can sense the glucose level and the overall data stored on the cloud.

IV.BLOCK DIAGRAM



V.CONCLUSION

We are studying, the applicability of the breath acetone sensing method to the determination of glucose in human blood is demonstrated. We are using acetone gas sensor for monitoring acetone levels in the exhaled breath and compared with actual blood

glucose levels. This device based on IOT which gives a non-invasive technique to estimate blood glucose level.

VI. FUTURE SCOPE

There is no perfect technology, each technology has specific features that work well in definite situations. In this project, we develop our own Cloud mobile application where we can measure the glucose level of blood and doctors can give suggestions regarding health based on data stored on the cloud.

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