International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

SENSOR-BASED BLOOD PARAMETERS MONITOR TO DIAGNOSE BLOOD PATHOLOGY

Haripranesh D[1], Maithreyan S[2], Gopinath P[3], Arul Murugan L[4]

[1,2,,3] UG Scholar, Dept. of Electronics and Communication Engineering, Bannari Amman Institute of Technology
[4] AssistantProfessor, Dept. of Electronics and Communication Engineering, Bannari Amman Institute of Technology

---***---

Abstract -: Diabetes mellitus is a chronic metabolic disorder that affects millions of individuals worldwide. Early and continuous monitoring of blood glucose levels is critical for the effective management of diabetes. This abstract presents a novel approach to diabetes detection and monitoring using acetone detection in breath with the NodeMCU, an Internet of Things (IoT) platform. Acetone is a volatile organic compound that can indicate uncontrolled diabetes when detected in a person's breath. The proposed system leverages the capabilities of the NodeMCU, which is based on the ESP8266 Wi-Fi module, to create a portable and accessible diabetes detection solution. This abstract highlights the potential of using IoT technology, specifically NodeMCU, for non-invasive diabetes detection through acetone analysis in breath. Such a system offers a convenient and accessible solution for individuals with or at risk of diabetes, assisting in the early diagnosis and management of this prevalent chronic condition. Further research and development in this area can potentially enhance diabetes care and improve patient outcomes.

Keywords—: diabetes mellitus, breath analysis, non-invasive diagnosis, nanomaterials, chemo resistive sensors, acetone detection.

1. INTRODUCTION

Diabetes mellitus is a widespread metabolic disorder characterized by elevated blood glucose levels, resulting from either insufficient insulin production or the body's inability to effectively utilize insulin. It affects millions of individuals globally, and its prevalence continues to rise. Early detection and continuous monitoring of diabetes are pivotal for effective management, as uncontrolled diabetes can lead to severe health complications.

Traditionally, blood glucose monitoring has been the gold standard for diabetes management, requiring invasive blood sampling and regular testing. However, emerging technologies and innovative approaches are transforming the way diabetes is detected and monitored, making it more convenient and accessible. This introduction focuses on one such innovative method: diabetes detection through acetone analysis in breath, using the NodeMCU as an enabling IoT platform.

Acetone is a volatile organic compound produced in the human body as a byproduct of metabolism, particularly in individuals with uncontrolled diabetes. Elevated levels of acetone in a person's breath can serve as an indirect indicator of high blood glucose levels. Therefore, the non-invasive detection of acetone in breath has gained attention as a potential tool for diabetes screening and monitoring.

This research explores the integration of the NodeMCU, an IoT platform based on the ESP8266 Wi-Fi module, into a system designed for diabetes detection through acetone analysis. The NodeMCU's capabilities, including Wi-Fi connectivity and data processing, make it a suitable candidate for creating a portable and accessible diabetes monitoring solution.

This project's primary objectives include the development of a gas sensor system for acetone detection, real-time data processing, secure data transmission, and the implementation of intelligent algorithms for diabetes detection based on acetone concentration levels. Additionally, considerations for privacy, data security, and user-friendly interfaces will be addressed to ensure the system's effectiveness and user acceptance. The potential impact of this research is significant, as it promises a paradigm shift in diabetes detection and monitoring, offering individuals a more convenient and less invasive method to manage their health. By enabling early diagnosis and continuous monitoring, this innovative approach has the potential to improve the quality of life for individuals living with diabetes and reduce the risk of diabetes-related complications. Furthermore, it aligns with the broader trend of leveraging IoT and sensor technologies to enhance healthcare delivery and promote proactive health management.

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

2. LITERATURE SURVEY

Technology with Internet of things has revolutionized Health care system. The smart technologies today made easy in Health Monitoring system. Invasive method is painful, and can be unsafe. Therefore, it does not suit everyone, especially in the case where the patient needs several samplings each day in patients with diabetes mellitus, the body produces excess amounts of ketones such as acetone because the body uses fats instead of glucose to produce energy, which are then exhaled during respiration. All other technologies cannot detect the sudden drop in insulin but this technique will allow users to analyze it and storing the data in the app makes it easier. Selected ion flow tube mass spectrometry (SIFT–MS) is also one of the analytical techniques used for the real-time quantification of several trace gases simultaneously in air and breath. It relies on the chemical ionization of the trace gas molecules in air/breath samples introduced into the helium carrier gas using H_3O^+, NO^+ , and O_2^+ precursor ions. Reactions between the precursor ions and trace gas molecules proceed for an accurately defined time, the precursor and product ions being detected and counted by a downstream mass spectrometer, thus affecting quantification. Absolute concentrations of trace gases in single-breath exhalation can be determined by SIFT–MS down to ppb levels with no sample collection and calibration required. The shortfall of SIFT–MS as a potential instrument for monitoring diabetes is its inability to identify compounds in a mixture of gases. SIFT–MS, like GC–MS and PTR–MS, also requires a trained operator, and as already mentioned, diabetes affects old people who perhaps cannot read and write, so such instruments are not suitable for personalized monitoring devices. The other major and common drawback is portability.

3. METHODOLOGY:

3.1 Problem Identification

Common diabetic tests on patients are done on urinary tests and blood ketone tests to monitor for diabetes conditions. However, those methods are considered invasive, inconvenient, and expensive. During emergency and critical situations, we can't find a hospital nearby. Hence this system with easy handling, convenient, and less expensive methods can be used.

3.2 Proposed Work:

Our system has the following features:

A. Ketone Metabolism:

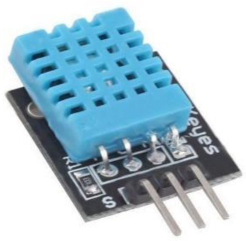
Currently, the diagnosis and monitoring of blood glucose and ketone bodies that are used in clinical studies involve the use of blood tests. This method entails pricking fingers for a drop of blood and placing a drop on a sensitive area of a strip which is pre-inserted into an electronic reading instrument. Furthermore, it is painful, invasive, and expensive, and can be unsafe if proper handling is not undertaken. Further, it requires a skilled medical staff. Human breath analysis offers a non-invasive and rapid method for detecting various volatile organic compounds that are 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 metabolizing fats instead of glucose to produce energy.

B. ESP8266:

ESP8266EX delivers highly integrated Wi-Fi SoC solutions to meet the continuous demands for efficient power usage, compact design, and reliable performance in the industry. With complete and self-contained Wi-Fi networking capabilities, It can perform as either a standalone application or the slave to a host MCU. When ESP8266EX hosts the application, it promptly boots up from the external flash. The integrated high-speed cache helps to increase the system performance and optimize the system memory. Also, ESP8266EX can be applied to any micro-controller design Wi-Fi adapt or through SPI/SDIOorI2C/UART interfaces. ESP8266EX integrates antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, and power management modules. The compact design minimizes the PCB size and allows for minimal external circuitry. Besides the Wi-Fi functionalities, ESP8266EX also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor and on-chip SRAM. It can be interfaced with external sensors and other devices through the GPIOs. Software Development Kit (SDK) provides sample codes for various applications. Espressif Systems' Smart Connectivity Platform (ESCP) enables sophisticated features including fast switching between sleep and wake-up mode for energy-efficiency purposes, adaptive radio biasing for low-power operation, advanced signal processing, spur cancellation, and radio co-existence mechanisms for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

3.2.1 Heart Beat Sensor:

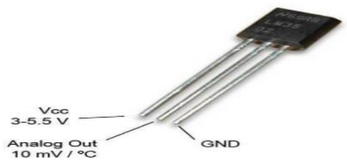
A heartbeat sensor is a device that measures the rate and rhythm of the heartbeat. It can be used in a variety of applications, such as medical devices, fitness trackers, and smartwatches. There are two main types of heartbeat sensors: Electrical heartbeat sensors: These sensors measure the electrical signals generated by the heart. They are typically used in medical devices, such as electrocardiogram (EKG) machines. Optical heartbeat sensors: These sensors measure the changes in blood volume that occur with each heartbeat. They are typically used in wearable devices, such as fitness trackers and smartwatches. Optical heartbeat sensors work by shining a light on the skin and measuring the amount of light that is reflected back. When the heart beats, the blood vessels in the skin dilate, which allows more light to be reflected back. The sensor can then measure the changes in light intensity to calculate the heart rate. Optical heartbeat sensors are becoming increasingly popular because they are non-invasive, comfortable to wear, and relatively inexpensive. They are also becoming more accurate as the technology improves. The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use but requires careful timing to grab data.



3.2.2. Temperature Sensor:

LM35 is a temperature-measuring device having an analog output voltage proportional to the temperature. It provides output voltage in Centigrade (Celsius). It does not require any external calibration circuitry. The sensitivity of LM35 is 10 mV/degree Celsius. As temperature increases, the output voltage also increases. The LM35 is a precision integrated-circuit temperature sensor. It is commonly used to measure temperature in a wide range of electronic projects and applications. The LM35 sensor provides an analog voltage output that is linearly proportional to the temperature in degrees Celsius (°C). Here are some key features and characteristics of the LM35 temperature sensor:

Temperature Range: The LM35 can measure temperatures within a range of -55°C to 150°C. This makes it suitable for a variety of temperature measurement applications. Output Voltage: The output voltage of the LM35 changes linearly with temperature. Specifically, it produces an output voltage of 10 mV per degree Celsius change in temperature. So, for example, if the temperature increases by 1°C, the output voltage will increase by 10 mV. High Accuracy: The LM35 is known for its high level of accuracy, typically within ±0.5°C at room temperature. Low Power Consumption: It operates on a low supply voltage (typically 4-30V) and consumes very low current, making it energy-efficient and suitable for battery-powered applications. Calibrated Sensor: The LM35 is pre-calibrated at the factory, which means that no additional calibration is typically required when using it in a project. Package Options: The LM35 is available in various package options, including TO-92, TO-220, and metal can packages, making it suitable for different mounting and integration methods. To use the LM35 in your project, you'll typically need to connect it to an analog-to-digital converter (ADC) to convert its output voltage into a digital format that can be processed by a microcontroller or computer. The ADC will provide a digital value that corresponds to the temperature, which can then be interpreted and displayed as required.



3.2.3 vibration sensor:

A vibration sensor, also known as a vibration detector or accelerometer, is a device designed to measure or detect vibrations and motion in various applications. These sensors are commonly used in engineering, industrial, automotive, aerospace, and consumer electronics to monitor and measure vibrations for various purposes. There are different types of vibration sensors, including piezoelectric, capacitive, and piezoresistive accelerometers. Here's an overview of these sensor types: Piezoelectric Accelerometer: These sensors use the piezoelectric effect, which generates an electrical charge when subjected to mechanical stress or vibrations.

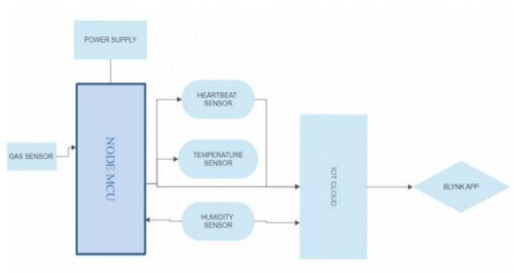
They are widely used in industrial applications and structural health monitoring. Piezoelectric accelerometers are sensitive and can measure a wide range of frequencies. Capacitive Accelerometer: Capacitive accelerometers operate based on changes in capacitance due to motion. They are often used in consumer electronics, including smartphones and tablets, for functions like screen orientation and image stabilization. Piezoresistive Accelerometer: Piezoresistive accelerometers utilize piezoresistive materials that change resistance when subjected to mechanical stress or motion. These sensors are often used in automotive applications for airbag deployment and stability control systems. Vibration sensors can provide data on the magnitude, direction, and frequency of vibrations. This data can be used for various purposes, including: Monitoring machinery and equipment health to detect potential faults or maintenance needs. Ensuring the structural integrity of buildings and bridges. Enhancing the performance of electronic devices through motion sensing and image stabilization. Measuring vibrations in vehicles for safety and performance monitoring. The choice of a specific type of vibration sensor depends on the application's requirements, such as the frequency range, sensitivity, and environmental conditions. Vibration data collected from these sensors can be processed and analyzed to gain insights into the behavior and performance of the system being monitored.

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

3.2.4 Blynk App:

The process that occurs when someone presses the Button in the Blynk application is that the data will move to Blynk Cloud, where data magically finds its way to the hardware that has been installed. It works in the opposite direction and everything happens in a blink of an eye. In designing the smart home, this study used sensors, actuators, NodeMCU, Raspberry Pi, Smartphones, and the Blynk framework. Sensors and actuators are connected to NodeMCU. Each room is installed with one NodeMCU as a client or more depending on the I / O requirements designed. In a house, the entire NodeMCU is connected wirelessly to the Raspberry Pi as a server and is used as a data center and control and bridge between NodeMCU and the internet. With wireless installations, homeowners do not need additional costs for renovation and installation of cables. After connecting to the internet, the homeowner can control and monitor the condition of his home through a smartphone equipped with the Blynk application. The control system and home monitoring design have been completed. This paper is mainly focused on the use of WIFI to minimize installation, and the design prototype can be applied to real-time control of home, automation, monitoring, and remote system control.

3.2.4 PROPOSED WORK MODULES (Flow chart):



3.2.6 OVERALL IMPLICATIONS AND DISCUSSION:

Using acetone detection in a person's breath as a method for diabetes detection, especially when combined with a platform like NodeMCU (an open-source IoT platform based on the ESP8266 WiFi module), the use of acetone detection in breath analysis for diabetes monitoring, especially when integrated with IoT platforms like NodeMCU, holds promise for improving diabetes management and early detection. However, it comes with technical, regulatory, privacy, and ethical challenges that need to be carefully considered and addressed to ensure its safe and effective use in healthcare settings. Additionally, ongoing research and development are essential to refine and enhance the accuracy and usability of these systems. 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 metabolizing fats instead of glucose to produce energy. There are various techniques that are used to analyze 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.

5. CONCLUSIONS

There is always a chance to improve any system as research and development is an endless process. Some more sensors like Blood Pressure Monitoring and Oxygen sensor metering can be added. Contacts of nearby doctors can be added in case of emergency. A diet for prediabetic/diabetic can be added in the app to keep the acetones under control.

ACKNOWLEDGEMENT

I want to express my gratitude to the Mentor as well as the educational institution for their assistance and leadership

REFERENCES

1. Surya S., Salam A.D., Tomy D.V., Carla B., Kumar R.A., Sunil C. Diabetes mellitus and medicinal plants—A review. *Asian Pac. J. Trop. Dis.* 2014;4:337–347. doi: 10.1016/S2222-1808(14)60585-5. [CrossRef] [Google Scholar]
2. Karalliedde J., Gnudi L. Diabetes mellitus, a complex and heterogeneous disease, and the role of insulin resistance as a determinant of diabetic kidney disease. *Nephrol. Dial. Transplant.* 2014;31:206–313. doi: 10.1093/ndt/gfu405. [PubMed] [CrossRef] [Google Scholar]

3. Deng C., Zhang J., Yu X., Zhang W., Zhang X. Determination of acetone in human breath by gas chromatography-mass spectrometry and solid-phase microextraction with on-fiber derivatization. *J. Chromatogr. B Anal. Technol. Biomed. Life Sci.* 2004;810:269–275. doi: 10.1016/S1570-0232(04)00657-9. [PubMed] [CrossRef] [Google Scholar]

4. Banerjee M., Vats P. Reactive metabolites and antioxidant gene polymorphisms in type 2 diabetes mellitus. *RedoxBiol.* 2014;2:170–177. [PMC free article] [PubMed] [Google Scholar]

5. Baynes H.W. Classification, Pathophysiology, Diagnosis and Management of Diabetes Mellitus. *J. Diabetes Metab.* 2015;6:2. [Google Scholar]

6. Poretsky L. *Principles of Diabetes Mellitus.* Springer; Boston, MA, USA: 2010. [Google Scholar]

7. American Diabetes Association 2. Classification and diagnosis of diabetes. *Diabetes Care.* 2015;38:S16. [PubMed] [Google Scholar]

8. Turner C., Walton C., Hoashi S., Evans M. Breath acetone concentration decreases with blood glucose concentration in type I diabetes mellitus patients during hypoglycaemic clamps. *J. Breath Res.* 2009;3:046004. doi: 10.1088/1752-7155/3/4/046004. [PubMed] [CrossRef] [Google Scholar]

9. Lee J., Ngo J., Blake D., Meinardi S., Pontello A.M., Newcomb R., Galassetti P.R. Improved predictive models for plasma glucose estimation from multi-linear regression analysis of exhaled volatile organic compounds. *J. Appl. Physiol.* 2009;107:155–160. doi: 10.1152/japplphysiol.91657.2008. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

10. Hu W. Breath ethanol and acetone as indicators of serum glucose levels: An initial report. *Ethn. Dis.* 2005;15:32–34. [PubMed] [Google Scholar]