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DIABETES DETECTION SYSTEM POWERED BY AI AND SENSOR TECHNOLOGY

Author's Name, G Gayathri[1], S.Aswin [2], K.Dhivagar [3], D.Dinakarraj [4], R.Sivananthan [5]

Affiliation:

1.Assistant Professor, Salem College Of Engineering and Technology, Salem- Attur Main Road, M.Perumapalayam, Selliamman Nagar, Salem.2-5, Students (B.E Bio Medical Engineering), Salem College Of Engineering and Technology, Salem- Attur Main Road, M.Permapalayam, Selliamman Nagar, Salem.

Corresponding Author Name & E-Mail: K. DHIVAGAR,

Abstract:

Diabetes is a chronic metabolic disorder that necessitates continuous monitoring of blood glucose levels for effective management and early diagnosis. This project presents an Artificial Intelligence (AI)-based Diabetes Detection System integrated with advanced sensor technology to enable real-time glucose monitoring and intelligent health analysis. The system employs glucose sensing electrodes to measure sugar concentration levels in the body. The analog signals generated by the sensor are converted into digital form using an Analog-to-Digital Converter (ADC) for accurate processing.

An Arduino UNO microcontroller processes the digitized data and displays the glucose readings on an LCD screen through an I2C communication module. Additionally, a buzzer alert mechanism is incorporated to notify the user when glucose levels exceed predefined threshold limits. The system is powered by a rechargeable Li-ion battery integrated with a Battery Management System (BMS) to ensure stable, safe, and efficient power regulation. To improve diagnostic accuracy and predictive capability,

AI algorithms are implemented to analyze glucose trends, identify abnormal patterns, and predict potential diabetic risks. This intelligent and automated approach enhances early detection, supports preventive healthcare strategies, and enables continuous monitoring. The proposed system is portable, cost-effective, and suitable for real-time health monitoring applications, making it a promising solution for early diabetes detection and smart healthcare systems.

I INTRODUCTION

Diabetes is one of the most common chronic diseases worldwide, affecting millions of people and leading to serious health complications such as heart disease, kidney failure, nerve damage, and vision problems. Early detection and continuous monitoring of blood glucose levels are essential to prevent severe complications and ensure effective disease management. Traditional glucose monitoring methods can be invasive, time-consuming, and may not provide predictive insights about future glucose fluctuations.

With the advancement of sensor technology and Artificial Intelligence (AI), healthcare systems are becoming smarter, more accurate, and more efficient. Smart health monitoring devices can now collect real-time physiological data and analyze it intelligently to assist in early diagnosis and preventive care. This project presents a Diabetes Detection System powered by Artificial Intelligence and Sensor Technology. The system uses glucose sensing electrodes to measure sugar levels, which are processed through an Analog-to-Digital Converter (ADC) and a microcontroller (Arduino UNO). The processed data is displayed on an LCD screen, and a buzzer alert notifies users when glucose levels exceed safe limits. The system is powered by a Li-ion battery integrated with a Battery Management System (BMS) to ensure reliable and safe operation. By integrating AI algorithms, the system can analyze glucose patterns, detect abnormalities, and predict potential diabetic risks. This intelligent approach enhances accuracy, enables early detection, and promotes proactive healthcare management. The proposed system is portable, cost-effective, and suitable for real-time monitoring, making it a valuable solution for modern smart healthcare applications.

II LITERATURE REVIEW

P. Jedhe, S. Bhardwaj, A. Upadhyaya, and N. Yadav, "Non-Invasive Diabetes Assessment Using AI: A Machine Learning Approach to Analysing Physiological and Optical Biomarkers," 2025. Diabetes therapy need frequent blood glucose testing, but standard invasive procedures are sometimes uncomfortable and impair patient compliance. This study investigates AI-powered, non-invasive approaches that use physiological and visual indicators such as photoplethysmography (PPG), near-infrared spectroscopy (NIRS), and heart rate variability.

A Chronic Diseases Detection Integrated Interface With Anti-Drift Normalization and On-Chip Classification Schemes Junyeong Yeom;Minseop Song;June Heang Choi;You Jang Pyeon;Jeonghoon Cho;Hyunjoong Kim;Sanghyeon Cho;Yunsik Lee;Yijae Lee;Jae Joon Kim 2025 An on-chip classifying biochemical multi-sensor integrated interface is presented for diseases diagnosis applications, including diabetes and liver diseases. Against critical problems of sensor drift over time and long settling time from analyte concentration variations, two proposed circuit-level schemes of anti-drift normalization and settling-period detection are designed by utilizing two different detectors of min-max and level-crossing.

"Wearable Electrochemical Sensors for Real-Time Biomarkers Detection David Angira Raymond;Praveen Kumar;Palash Goureshettiwar 2024 An innovative technology that has the potential to revolutionize real-time health monitoring is wearable electrochemical sensors. These tools overcome the drawbacks of conventional techniques like blood draws and biopsies by providing non-invasive, continuous tracking of a broad range of indicators using accessible bio fluids like sweat, saliva, tears, and interstitial fluid. Applications of Technologies Powered by the Internet of Medical Things: An Intelligent Health Environment for Remote Patient Care and the Management of Chronic Illnesses P. Arunachalam;A. Nallathambi;Yammani uma;Devisetty Maheswari;Somarouthu Lakshmi Srija;Yelchuri Vinitha 2025 Internet of Medical Things (IoMT) is transforming the modern healthcare to intelligent, connected, personalized health environments. Through the combination of wearable sensors, medical devices, cloud computing and AI, IoMT has the capacity to change the way chronic diseases are treated and remote patient care is provided. Identification of Retinal Ischemia for Medical Pronouncement Through Fundus Images and Machine Learning Techniques V. Indu;Srinivas Pasupula;Gill Santosh Kumar;Cheekatla Swapnapriya;S NagaMallik Raj;T. Ravibabu 2024 Retinal ischemia is caused by diabetes which affects small arteries including retinopathy. It is a condition marked by the deterioration of the retina's growth.This worse progression of Retinal ischemia may lead to the complete blindness. In this case, early detection of diabetes and retinal ischemia is more crucial to detect the lesions affected and provide the proper guidance and treatment to the patients suffering from diabetes

III METHODOLOGY

The Personalized Learning Path Generator integrates Natural Language Processing (NLP), skill-gap analysis, and interactive chatbot technologies within an intelligent software framework to deliver accurate and personalized career roadmaps. The system begins by initializing its core modules, including the Natural Language Understanding (NLU) engine, the recommendation database, and the user profile management system. When a learner interacts with the chatbot, the system collects essential information such as educational background, existing technical skills, career objectives, and learning preferences. The textual inputs provided by the user are processed using NLP techniques to extract key skill entities and intent patterns, which are then mapped against predefined career role templates stored in the database. Once the target role is identified, the system performs a skill-gap analysis by comparing the learner’s current skill set with industry-aligned role requirements

Conventional diabetes monitoring systems are primarily based on glucometer-based blood glucose measurement techniques. Traditional glucometers operate using electrochemical test strips that require a finger-prick blood sample for glucose estimation. Although these devices provide clinically reliable and accurate readings, they are invasive and may cause discomfort, especially for patients requiring frequent monitoring. Moreover, these systems are not suitable for continuous glucose tracking, as each measurement must be performed manually.

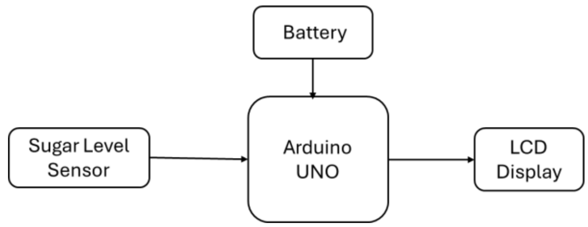

Fig 3.1 block diagram

PROPOSED SYSTEM ARCHITECTURE

3.3.1 Sugar Level Sensor

The Sugar Level Sensor acts as the primary sensing component of the system. It detects glucose concentration levels and generates corresponding analog electrical signals proportional to the measured sugar level.

3.3.2 Arduino UNO Microcontroller

The Arduino UNO functions as the central processing unit. It receives analog signals from the sensor, converts them into digital data using an internal Analog-to-Digital Converter (ADC), and processes the data to determine glucose levels.

3.3.3 LCD Display Module

The LCD display is interfaced with the microcontroller to present real-time glucose readings. It provides a clear and user-friendly visualization of the measured values for easy monitoring.

3.3.4 Battery Power Supply

The battery unit supplies regulated power to all system components. It ensures portability, continuous operation, and reliable performance of the device

. The dependency on user intervention increases the possibility of irregular monitoring and reduces compliance among patients. Additionally, recurring expenses associated with test strips and lancets increase the overall cost of long-term diabetes management.

To overcome the limitations of intermittent monitoring, Continuous Glucose Monitoring (CGM) systems have been introduced. CGM devices utilize minimally invasive subcutaneous sensors that continuously measure interstitial glucose levels and transmit the data to a monitoring device or smartphone application. These systems provide real-time glucose readings, trend analysis, and alerts for hypo- or hyperglycemic events. The availability of continuous data enables improved glycemic control and better clinical decision-making. However, CGM systems are relatively expensive and may not be affordable for all patients. They require periodic sensor replacement, frequent calibration, and regular maintenance to maintain measurement accuracy. Furthermore, slight delays between blood glucose and interstitial glucose readings may affect real-time precision.

In addition to hardware-based monitoring systems, Artificial Intelligence (AI)-based diabetes prediction models have gained significant attention in recent years. These models apply machine learning algorithms such as logistic regression, decision trees, support vector machines, and neural networks to analyze clinical datasets containing attributes such as age, Body Mass Index (BMI), blood pressure, insulin levels, glucose levels, and family history. AI-based systems can identify hidden patterns within large datasets and provide early risk prediction of diabetes. While these approaches are valuable for preventive healthcare and early screening, they primarily rely on historical medical records and structured datasets. As a result, they do not provide continuous or real-time glucose monitoring capabilities. Moreover, the performance of these models depends heavily on dataset quality, feature selection, and model training accuracy.

Despite advancements in conventional glucometers, CGM systems, and AI-based predictive models, an integrated system that combines real-time sensing, portability, affordability, and intelligent data analysis remains an area of ongoing research and development.

IV RESULT

The Personalized Learning Path Generator was implemented by integrating NLP intent recognition, skill-gap analysis, and chatbot-driven alerting functionalities into a single cloud-native platform. The architecture consisted of a Python (Fast API) backend as the core controller, interfacing with a Vector Database for profile storage, a Knowledge Graph for curriculum logic, and a React-based conversational UI. During system operation, when a student approached the device (the web interface), the chatbot automatically activated and captured the live dialogue, which was processed using advanced NLP algorithms. If the intent matched an existing career path with a high confidence score, the system prompted the student to describe their technical background. The parser read the description and compared it to target is a highly reliable process that identifies individuals' missing competencies based on the unique patterns of their current skill vector vs the target market vector. In the smart learning system, this method is used to ensure that the modules recommended are indeed the ones required, thereby preventing redundant or irrelevant learning entries. The system begins by mapping the user's profile against the job market requirements.

During this mapping, the system captures the "distances" between skill points and processes them to extract distinguishing "Gaps." If a match is found for a skill, it is skipped; if not, the gap is recorded with a priority level. This gap-analysis logic is highly reliable due to the uniqueness of every role's requirement, making it an effective solution for dynamic professional environments. For added efficacy, this analysis is combined with another factor such as pedagogical sequencing (Knowledge Graphs), ensuring a logically sound learning path.

V CONCLUSION

The proposed Diabetes Detection System powered by AI and Sensor Technology provides an efficient and intelligent solution for real-time glucose monitoring. By integrating glucose sensors, an ADC module, a microcontroller (Arduino UNO), and an AI-based analysis system, the device is capable of measuring, processing, and predicting glucose levels accurately.

The inclusion of an LCD display ensures user-friendly interaction, while the buzzer alert mechanism provides immediate notification when glucose levels exceed safe limits. The use of a Li-ion battery with a Battery Management System (BMS) enhances portability and ensures safe power management.

Overall, the system offers a cost-effective, portable, and reliable approach to diabetes detection and monitoring. By combining sensor technology with Artificial Intelligence, the project supports early diagnosis, preventive healthcare, and improved patient management.

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