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AI-driven patient health monitoring system with IoT connectivity for chronic disease management

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Abstract: Chronic diseases like diabetes, cardiovascular, and respiratory conditions require continuous monitoring, which traditional healthcare systems often fail to provide. To address this, the proposed system introduces an AI-powered, IoT-integrated health monitoring solution for real-time, remote tracking. A Raspberry Pi 4 acts as the processing unit, receiving data from a Near-Infrared (NIR) sensor managed by an ESP8266 microcontroller. This setup allows for non-invasive monitoring of key health metrics such as Haemoglobin A1c, insulin levels, caloric intake, and lung function indicators. The system uses a Long Short-Term Memory (LSTM) neural network to analyse time-series data and predict health risks. It classifies a patient's condition as normal or at risk, enabling early detection and timely intervention. Continuous monitoring reduces hospital visits and empowers patients to manage their health independently. Healthcare providers receive real-time, actionable insights for better decision-making. The integration of AI and IoT ensures accurate data collection and intelligent analysis. Overall, the system supports a proactive, patient-focused approach to chronic disease management.

Keywords: AI-based algorithms, diabetes management, esp8266 module, non-invasive monitoring, NIR sensor, raspberry pi 4b, LSTM neural network, remote health monitoring, wireless data transmission, sensor-based systems.

I.INTRODUCTION

Chronic Disease Management (CDM) is a structured and continuous healthcare approach aimed at helping individuals effectively manage long-lasting health conditions that typically persist for months or even a lifetime. Conditions such as diabetes, hypertension, cardiovascular disease, asthma, and chronic respiratory illnesses fall into this category and require ongoing attention rather than one-time treatment.

CDM focuses not only on medical interventions but also on patient education, behavioural changes, and consistent follow-ups to slow disease progression and enhance quality of life. A key aspect of CDM is empowering patients to take an active role in managing their health. This involves learning about their condition, recognizing symptoms, sticking to medication routines, making healthier lifestyle choices, and attending regular health checkups.

Health professional's doctors, nurses, pharmacists, nutritionists, and therapists work together to create personalized care plans tailored to each patient's needs. These care plans may include dietary guidance, exercise routines, psychological support, and monitoring strategies. With the support of technology such as mobile health apps, digital trackers, and telehealth services, patients can stay connected with healthcare providers and receive real-time feedback and guidance. Prevention also plays a major role in CDM by reducing the risk of complications and hospitalizations through early intervention and regular screenings. Effective CDM helps patients avoid emergency visits, lowers healthcare costs, and increases life expectancy.

It is especially crucial in aging populations, where multiple chronic conditions often coexist and require careful coordination. In addition to clinical care, CDM also addresses social and emotional needs, recognizing the impact of chronic illness on mental health and daily living. Support networks, whether through family, caregivers, or community groups, are encouraged as part of a well-rounded approach. CDM promotes long-term engagement rather than temporary solutions, aiming to make sustainable improvements in health behaviours and outcomes. By emphasizing continuity, communication, and patient-centred care, chronic disease management stands as a cornerstone of modern healthcare systems around the world.

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It not only benefits individuals but also reduces the strain on healthcare infrastructure by focusing on maintenance and prevention rather than crisis response. The effectiveness of CDM lies in its adaptability strategies can evolve as patient needs change over time. Ultimately, chronic disease management is about creating healthier lives through consistent support, informed choices, and coordinated care that puts the patient at the centre of every decision.

II.LITERATURE SURVEY

The integration of Internet of Things (IoT) and Artificial Intelligence (AI) technologies has shown significant potential in transforming chronic disease management, offering innovative approaches for diagnosis, monitoring, and treatment.
In [1], the authors provided a comprehensive review of IoT applications in chronic disease management, emphasizing real-time monitoring and enhanced patient engagement through connected health devices. The study outlined how wearable and implantable sensors improve continuous health tracking, particularly in conditions like diabetes and cardiovascular diseases.

Expanding on this, [2] proposed a holistic framework that combines IoT and AI to deliver predictive insights and personalized care. Their approach leverages smart sensors, cloud computing, and machine learning to improve decision-making in chronic care management, highlighting its application in remote monitoring and intelligent diagnostics.
Fog computing was discussed in [3] as a means to address latency and scalability issues in healthcare systems. The authors identified how fog computing supports low-latency data processing and enhances system efficiency, particularly for applications that require real-time analysis of patient data in chronic disease scenarios.

Predictive analytics in chronic disease management was further explored in [4], where an IoT-enabled model was proposed for early detection and intervention. The system integrated real-time sensor data with machine learning algorithms to anticipate disease progression, thereby improving the quality of life and reducing hospital admissions.
In [5], the authors reviewed advancements in the Internet of Medical Things (IoMT), noting its role in the early detection of terminal illnesses. The paper emphasized the growing use of AI-enabled diagnostic tools in chronic care, which can lead to earlier treatment and better outcomes.

Home-based healthcare solutions were introduced in [6], where the authors utilized IoT and deep learning to empower patients with chronic conditions. The study demonstrated how wearable sensors combined with neural networks can monitor vital signs and detect health anomalies, offering a practical solution for continuous care at home.
The use of machine learning and IoT in chronic disease monitoring was examined in [7]. The authors showcased how intelligent models trained on real-time health data can identify patterns and predict complications in diseases such as hypertension and diabetes, enabling proactive interventions.

A broader perspective was provided in [8], where the integration of AI and IoT was reviewed not only for chronic disease management but also for healthcare responses during pandemics. The study underlined the importance of these technologies in enhancing healthcare delivery, optimizing resources, and maintaining continuity of care.
Edge computing was addressed in [9] as a means to improve data processing speed and privacy. The AI-driven edge-IoT architecture presented by the authors offers a scalable and secure framework for managing chronic conditions while reducing reliance on centralized cloud systems.

Finally, [10] proposed a precision management system using AI for chronic diseases, focusing on individualized treatment plans. The framework utilizes large-scale health data and predictive models to support patient-specific interventions and long-term care strategies

III.EXISTING SYSTEM

Conventional healthcare systems primarily rely on manual check-ups, lab-based diagnostics, and patient self-reporting for monitoring chronic diseases. This traditional approach results in infrequent health assessments and often delays medical intervention. Patients suffering from conditions like diabetes or respiratory illnesses are required to make regular clinic visits for procedures such as blood glucose testing, insulin monitoring, and lung function evaluation.

These methods are invasive, time-consuming, and unsuitable for continuous or real-time tracking. While some modern digital health devices like fitness trackers and smart monitors exist, they generally provide only basic metrics, such as heart rate or step count, offering limited insights into chronic disease management.

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These devices do not support disease-specific monitoring or advanced analysis capabilities. Furthermore, the absence of AI-driven prediction and pattern recognition in these tools limits their effectiveness in early detection and proactive healthcare. Most devices also lack the ability to estimate key health parameters non-invasively.

Additionally, the lack of integrated IoT connectivity restricts their ability to support remote monitoring and real-time data sharing with healthcare providers. As a result, these gaps hinder effective, efficient, and patient-friendly chronic disease care. There is a growing need for intelligent, non-invasive, AI-powered, and IoT-enabled solutions that can provide continuous, personalized health monitoring.

IV.PROPOSED SYSTEM

The proposed system introduces an innovative, AI-driven IoT solution designed to revolutionize the management and monitoring of chronic diseases. At the core of the system is a Raspberry Pi 4, which processes real-time health data collected from a Near-Infrared (NIR) sensor.

This sensor communicates wirelessly through an ESP8266 module, enabling continuous, non-invasive tracking of vital health metrics, including Haemoglobin A1c, insulin levels, caloric intake, carbohydrate consumption, and lung function indicators such as FEV1, PVC, and Peak Expiratory Flow Rate.

Unlike traditional healthcare methods that rely on periodic visits and invasive tests, this system offers seamless, ongoing health monitoring in a patient's everyday life. The data is analysed using a Long Short-Term Memory (LSTM) neural network, a deep learning model tailored for time-series data. This enables the system to recognize patterns, predict potential health risks, and issue early alerts, facilitating timely medical intervention.

By integrating AI and IoT, the system provides real-time insights and predictive analytics, making chronic disease management more proactive and efficient. Healthcare providers can remotely monitor patients, receiving immediate alerts for any abnormalities and intervening quickly, which reduces the need for frequent in-person visits. This not only improves patient outcomes but also reduces the strain on healthcare systems by optimizing resources.

The system empowers patients with personalized feedback, fostering better self-management and greater engagement with their health. Doctors gain access to critical data that supports informed, data-driven decisions. Overall, the proposed solution redefines chronic care management by offering a continuous, personalized, and proactive approach, enhancing the quality of care while making it more accessible and efficient.

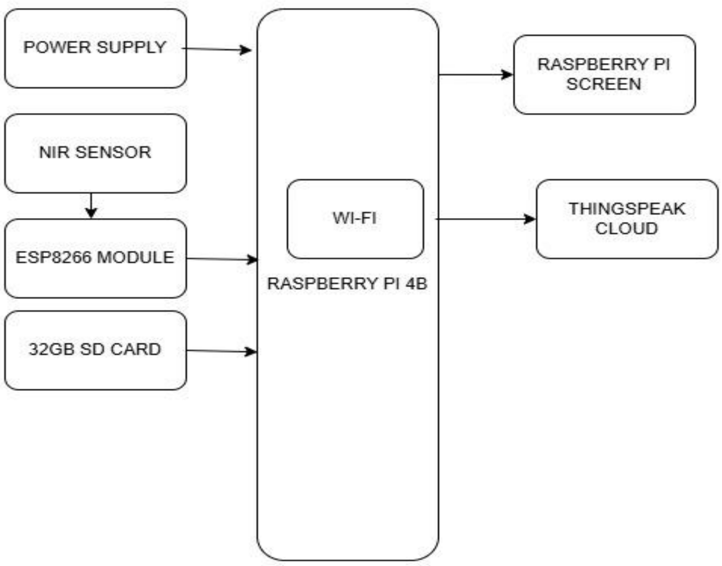

Fig1: Block Diagram of Chronic disease management

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The block diagram illustrates a health monitoring system based on the Raspberry Pi 4B. The key components include a NIR sensor, which detects near-infrared signals from the body, and an ESP8266 module that facilitates wireless data communication. A 32GB SD card is connected to store data locally, and a power supply is used to energize the entire setup. The Raspberry Pi 4B acts as the central processing unit, equipped with Wi-Fi to send data to the Thing Speak Cloud for remote monitoring and display it on a Raspberry Pi screen for real-time feedback.

The working principle of the system revolves around collecting, processing, displaying, and transmitting sensor data using a combination of embedded hardware and cloud technology. A Near Infrared (NIR) sensor first detects infrared signals, which are then sent to an ESP8266 Wi-Fi module that acts as a communication bridge between the sensor and a Raspberry Pi 4B. The Raspberry Pi, powered by a dedicated power supply and equipped with a 32GB SD card, receives this data for local processing and storage. \

The SD card not only holds the Raspberry Pi's operating system but also stores processed sensor data for backup and offline access. A Raspberry Pi screen connected to the device displays real-time sensor readings for local monitoring. Simultaneously, the Raspberry Pi uses its built-in Wi-Fi to transmit the data to Thing Speak Cloud, an IoT analytics platform that allows remote visualization, analysis, and storage of the data.

This cloud connectivity enables users to access information from anywhere, set alerts, and monitor trends over time. The system effectively integrates physical sensing with digital data processing and cloud-based analytics, making it ideal for a variety of IoT applications. It is also scalable and customizable, allowing developers to add more sensors or modify the software for different use cases

Chronic Disease Management has both Hardware and the Software components

A. Hardware components

1. NIR sensor

NIR (Near-Infrared) sensors are valuable tools in chronic disease management, offering non-invasive, real-time monitoring of key health indicators. They help track blood glucose levels in diabetic patients and measure oxygen saturation in those with heart or lung conditions. By detecting how near-infrared light interacts with body tissues, these sensors provide accurate physiological data. When combined with IoT systems like Raspberry Pi and cloud platforms, they enable continuous remote health monitoring. NIR sensor is shown in the fig:

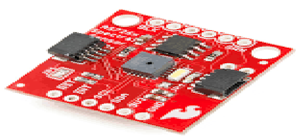

Fig 2: NIR sensor

2. ESP8266 WIFI module

The ESP8266 Wi-Fi module is a low-cost, low-power microcontroller with built-in Wi-Fi capabilities, making it ideal for Internet of Things (IoT) applications. In healthcare and chronic disease management systems, it acts as a wireless bridge between sensors (like NIR sensors) and processing units such as Raspberry Pi or cloud servers. The module collects data from connected sensors and transmits it over Wi-Fi for real-time monitoring, remote access, or cloud storage. Its compact size, ease of integration, and wireless connectivity make it a valuable component for building portable and continuous health monitoring systems. By enabling seamless communication, the ESP8266 helps support early diagnosis, timely alerts, and efficient long-term care which is shown in fig:3

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Fig 3: ESP8266 WIFI module

3. 32GB SD Card

A 32GB SD card is essential for running the Raspberry Pi by storing its operating system. It also saves important files like AI models, Python code, and sensor interfaces. Additionally, it stores sensor data such as NIR signals used for real-time glucose level prediction.

4. Raspberry pi 4B

The below Fig4 shows Raspberry pi 4B receives data from the ESP8266 module, processes the data using a Python-based LSTM model, and potentially displays results or transmits them to a remote location. The Raspberry Pi is a small, affordable computer that can run operating systems and software applications, including machine learning model

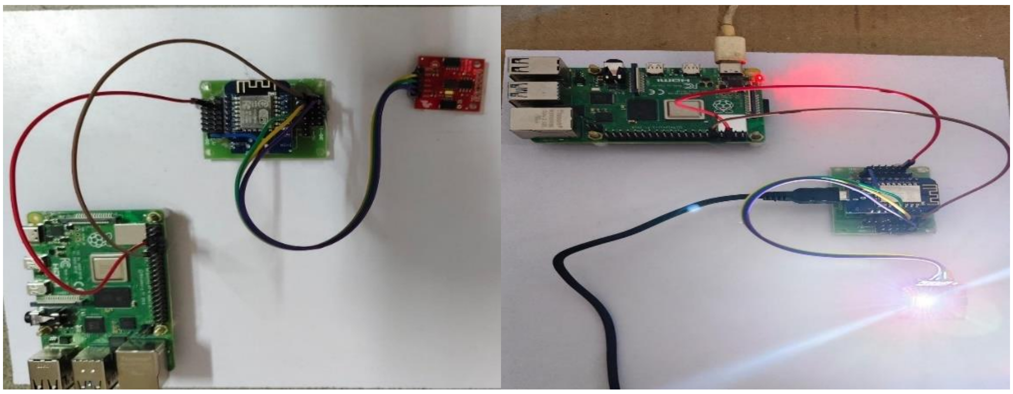
Fig 4: Raspberry pi 4B

B. Software Description

1. Long Short-Term Memory (LSTM):

Long Short-Term Memory (LSTM) networks, a type of recurrent neural network (RNN), are increasingly used in chronic disease management due to their ability to model complex time-series data. These models are particularly effective for analysing long-term trends in patient health indicators such as blood glucose levels, heart rate, and medication adherence. By learning patterns from historical data, LSTMs can predict disease progression, detect early signs of complications, and support personalized treatment planning. For example, in diabetes management, LSTM models can forecast future glucose levels based on past readings, meal patterns, and insulin usage, enabling proactive interventions. Their application holds significant promise for improving patient outcomes and reducing the burden of chronic illnesses through timely, data-driven decision-making.

V.EXPERIMENTAL RESULTS



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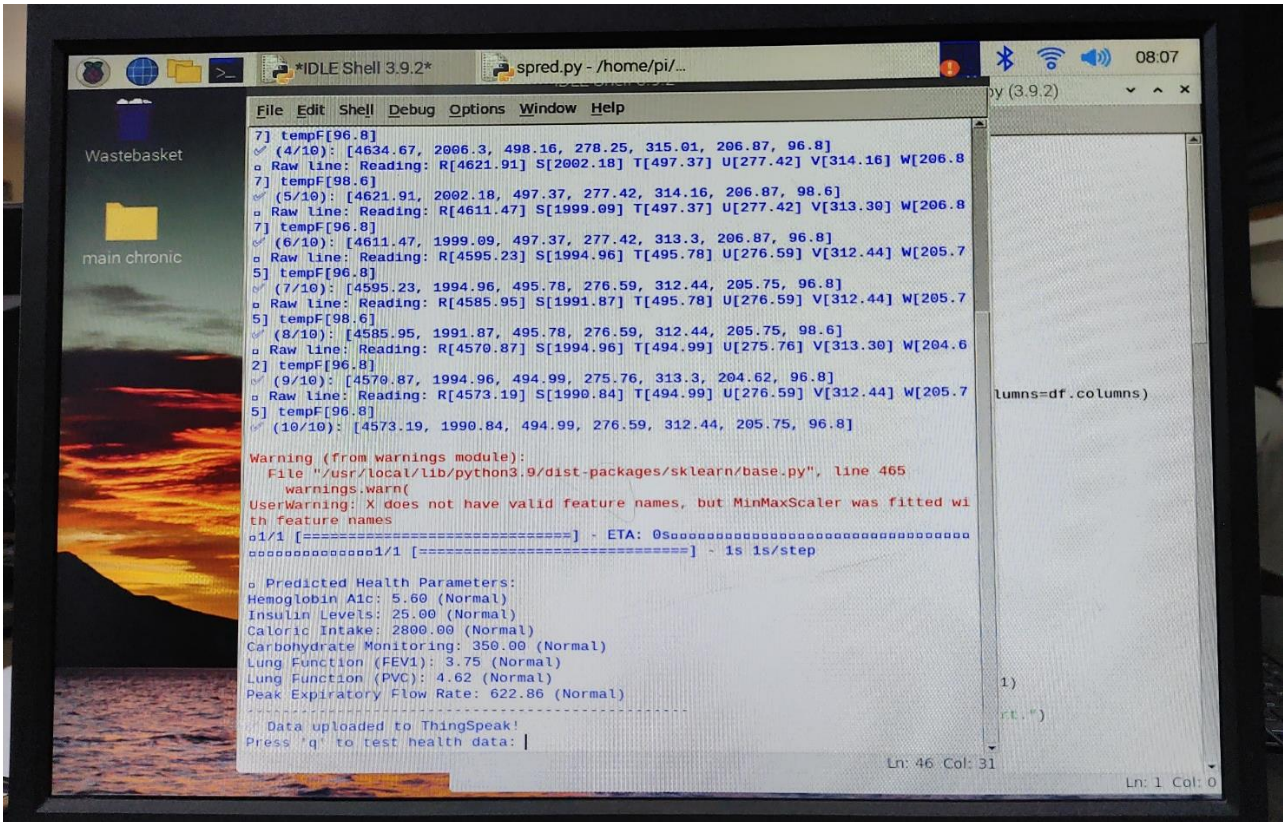

VI.CONCLUSION

The AI-driven patient health monitoring system developed in this project effectively addresses the limitations of conventional chronic disease management by providing a non-invasive, real-time, and intelligent monitoring solution. By integrating Raspberry Pi 4, ESP8266, and NIR sensor technology, the system is capable of continuously collecting critical health metrics such as Haemoglobin A1c, Insulin Levels, Caloric Intake, Carbohydrate Monitoring, and Lung Function (FEV1, PVC, and Peak Expiratory Flow Rate). These parameters are analysed using the LSTM deep learning algorithm, which enables the system to accurately predict whether the patient's health condition is normal or abnormal. The system's ability to operate in real time, coupled with wireless communication between the sensor and Raspberry Pi, makes it a user-friendly and scalable solution for both home and clinical use.

This approach not only reduces the dependency on invasive tests and frequent hospital visits but also supports early detection and personalized treatment. It empowers patients with greater control over their health and enables healthcare providers to make data-driven decisions more efficiently. The system bridges the gap between patient and provider by delivering actionable insights in a timely and accessible manner, ultimately improving health outcomes and quality of life.

VII.FUTURE SCOPE

In the future, this system can be expanded and improved in several key ways. Firstly, a cloud integration module can be added to store historical health records for long-term tracking and advanced analytics. A mobile or web application can also be developed to provide users with an intuitive interface to monitor their health data, receive alerts, and share reports with medical professionals. Additional health sensors (e.g., for ECG, blood pressure, hydration level, or stress monitoring) can be incorporated to make the system more comprehensive.

Advanced deep learning models, like hybrid LSTM-CNNs or transformer-based architectures, could further improve the accuracy of predictions. Personalized AI models that learn from an individual's health patterns over time can enhance the system's adaptability.

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Moreover, integration with Electronic Health Records (EHR) systems and telehealth platforms could allow seamless coordination with doctors and specialists. With continued advancements, this system could become an integral part of future smart healthcare ecosystems, delivering truly predictive, preventive, and personalized medical care.

REFERENCES

[1] Alshahrani, A., & Alzahrani, B. (2021). Use of Internet of Things for chronic disease management: A review. Journal of Healthcare Engineering, 2021, Article ID 8253318.
[2] Ahmed, N., Jabbar, S., Khalid, S., & Kiah, M. L. M. (2023). Leveraging IoT and AI in healthcare: A comprehensive approach to chronic disease management and patient care. Health Information Science and Systems, 11(2), 33–44.
[3] Kumari, A., Tanwar, S., Tyagi, S., & Kumar, N. (2020). Fog computing for healthcare 4.0 environment: Opportunities and challenges. Computers & Electrical Engineering, 72, 105291.
[4] Ramesh, M. V., & Vinayakumar, R. (2021). IoT-enabled predictive analytics for chronic disease management. Transdisciplinary Research in Data and Artificial Intelligence for Smart Healthcare, 2(1), 11–20. [Accessed via journals.threws.com]
[5] Karthika, M., & Mala, G. S. (2022). Prediction and detection of terminal diseases using Internet of Medical Things: A review. arXiv preprint arXiv:2410.00034.
[6] Albahli, S., Albattah, W., & Gumaei, A. (2023). Empowering home care: Utilizing IoT and deep learning for chronic disease management. International Journal of Advanced Computer Science and Applications, 15(12), 788–794.
[7] Liu, Y., Zhang, Y., & Zheng, Y. (2024). Advanced applications in chronic disease monitoring using IoT and machine learning. Frontiers in Public Health, 12, 1510456.
[8] Sharma, A., & Kumar, P. (2024). Harnessing AI and IoT for the future of healthcare: A comprehensive review on chronic disease management and pandemic response. Healthcare Technology Letters, 11(1), 1–10. [Accessed via ResearchGate]
[9] Huang, Y., Chen, Y., & Li, X. (2024). Improvement of an edge-IoT architecture driven by artificial intelligence for smart health. Sensors, 24(24), 7965.
[10] Gao, X., Zhou, Y., & Wang, F. (2024). Precision management in chronic disease: An AI empowered approach. Journal of Personalized Medicine, 14(3), 456–468.