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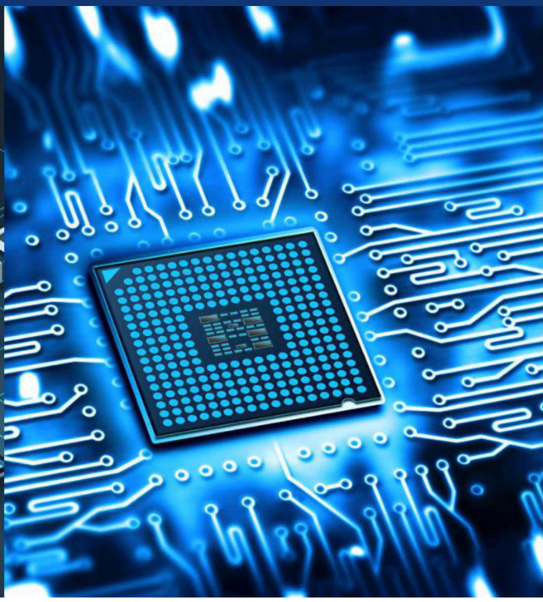


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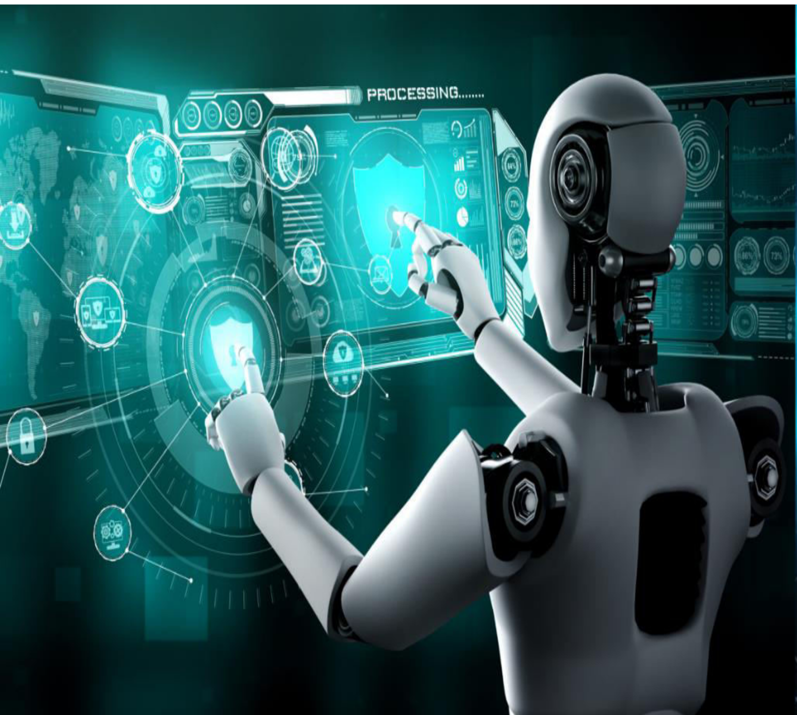

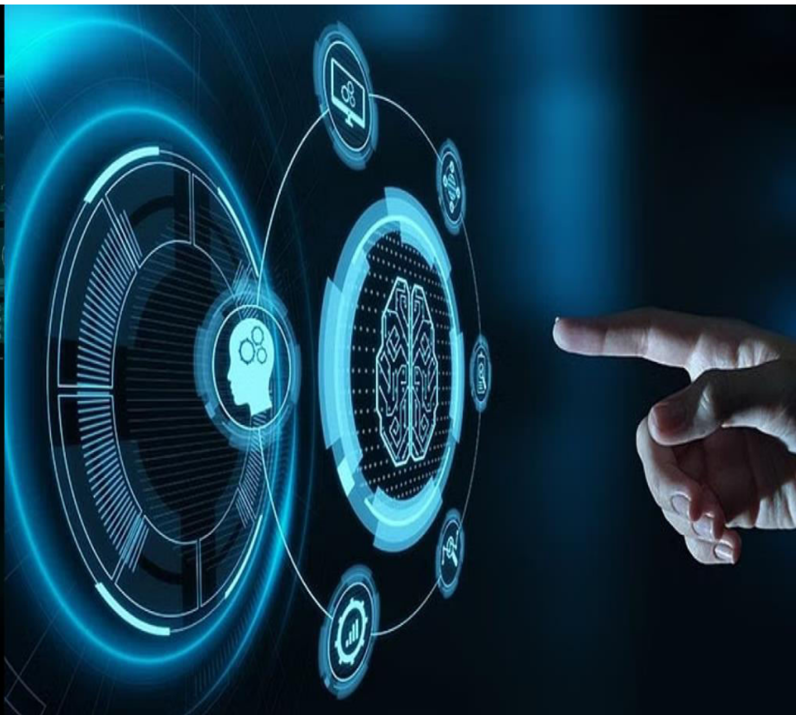

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Wearable ECG Monitoring System for Prediction of Cardiovascular Diseases

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ABSTRACT: Wearable sensing is making health revolutionized due to the ability to continuously monitor physiological data-real time rates of heart and the level of activities, to help proactive management of their health, especially in the prevention and control of CVD, which is the main cause of death. Our study focuses on this wearable electrocardiogram system, which provides continuous cardiac health tracking, and early detection of any abnormality, such as arrhythmias, for prompt interventions. Advanced machine learning analyses ECG data for reliable, real-time insights, displayed via a smartphone app. This system reduces hospital visits, offers preventive care, and improves patient outcomes, making it a key tool in future cardiac health management. systems.

KEYWORDS: wearable sensing devices, real-time monitoring, heart rate, activity levels, proactive management, CVD, prevention, control, electrocardiogram system, continuous cardiac health tracking, early detection, arrhythmias, advanced machine learning, ECG data, real-time insights, smartphone app, hospital visits, preventive care, patient outcomes, cardiac health management.

I. INTRODUCTION

Cardiovascular diseases (CVDs) have been the top cause of mortality globally for centuries, despite recent improvements in the medical world. Millions of deaths are recorded yearly due to various CVDs. Amongst the key contributing factors is that heart problems tend to be discovered late in a patient's life, hence their inability to be treated early in the course of the disease. The methods for monitoring CVDs through frequent check-ups hardly offer a moment-to-moment view of one's heart conditions. This limitation has made it urgent to find new ways to fill the gap in early detection and monitoring, especially for those who are at higher risk of heart conditions.

The wearable ECG monitor is an emerging solution that addresses this critical need. With advanced biosensors and real-time data processing capabilities, these devices can continuously monitor the heart and give actionable insights into heart activity. The wearable ECG monitor will empower people to take control of their cardiovascular health by providing early detection and immediate feedback. Healthcare providers will also be able to intervene at the right moment. This technology, therefore, transforms early diagnosis but also leads to better long-term outcomes in the global fight against heart disease.

II. LITERATURE REVIEW

1. In 2023 the author Muhammad Nazrul, Asim, Oshin Putu ET AL proposed "An Iot and machine learning based system to predict risk level of cardio-vascular diseases". The project targets the An IoT and machine learning-based system predicts cardiovascular disease risk by continuously monitoring heart rate, blood pressure, sleep patterns, and activity levels through smart devices. Machine learning processes data to identify risk factors early, enabling timely interventions. Mobile apps provide alerts, enhancing communication and decision-making between patients and healthcare providers.

2. On 2023 the author K Sumwiza, C Twizere ET AL proposed "Low-Cost Iot based wearable system for cardiovascular disease detection and monitoring". This research work focuses CVDs are challenging due to high morbidity and mortality, but early detection and intervention improve outcomes. IoT devices like Enable Cure enable real-time data transfer to doctors, allowing remote monitoring and timely care. Telemedicine and adaptive IIoT models enhance diagnosis, energy efficiency, and cost-effectiveness, making early CVD detection more accessible.

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3. On 2022 the author Bipas Mukherjee, ET AL proposed "Application of Machine Learning Algorithm for Cardiovascular disease detection". The project presents an Machine learning is used in early detection of CVD, especially by the analysis of medical histories, images, and data collected through wearables. Techniques like decision trees, SVM, and neural networks help enhance the diagnostic precision and provide personal treatment. Introducing ML to wearables leads to continuous monitoring, thereby increasing the early intervention, reduced mortality, and less expensive treatments.

4. On 2021 the author M Ganesan, ET AL proposed "Iot based heart disease prediction and diagnosis model for healthcare using machine learning". This project aims to IoT and machine learning will revolutionize the monitoring and diagnosis of heart disease through wearable sensors, cloud systems, and real-time data analysis. It will enable early detection, timely intervention, and remote patient tracking. This improves emergency care, reduces hospital visits, and allows healthcare providers to make informed decisions regardless of location.

III. METHODOLOGY

A. Hardware

1. ESP8266 Micro Controller

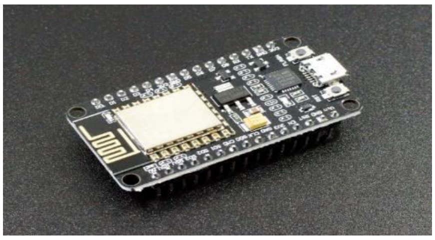

Fig.1: ESP8266 Micro Controller

The ESP8266 microcontroller in this wearable health monitoring system collects, processes, and transmits data from sensors such as heart rate, ECG, temperature, and humidity to a cloud platform. Its Wi-Fi capability allows real-time data transmission, so healthcare providers can monitor health metrics and receive alerts for anomalies, thus allowing continuous, portable, and energy-efficient monitoring.

2. AD8232 Sensor

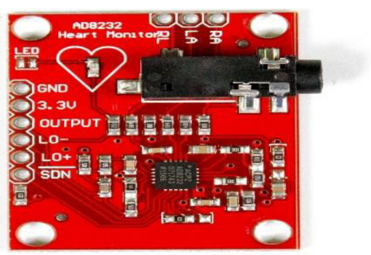

Fig.2: AD8232 Sensor

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The AD8232 IC amplifies and filters weak ECG signals for heart rate and rhythm monitoring in wearable devices. It enables real-time detection of heart abnormalities like arrhythmias, ensuring early intervention. Low power consumption and single-lead configurations make it ideal for continuous, battery-powered health monitoring and cloud-based analysis.

3. HW-605 Sensor

Fig.3: HW-605 Sensor

This is the HW-605 sensor that measures temperature and humidity, vital for wearable health devices and environmental monitoring. Data is converted to electrical signals that are processed in a microcontroller, such as the ESP8266. Its low power consumption tracks environmental factors that impact health, which would be useful for monitoring conditions such as asthma or cardiovascular issues.

4. DHT – 11 Sensor

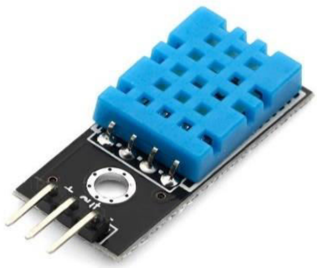

Fig.4: DHT – 11 Sensor

The DHT11 is an inexpensive temperature and humidity sensor. It can measure temperatures between 0°C and 50°C and humidity between 20% and 90%. Digital data is available for easy inclusion in microcontrollers like ESP8266. It's suitable for wearable and environmental monitoring applications due to minimal power consumption and sampling rate of 1Hz.

5. OLED Display

Fig.5: OLED Display

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An OLED display uses organic compounds to emit light when an electric current passes through it. Brilliant colours with high contrast are the results. It does not require any backlight; hence, it is thinner and more energy efficient than other types of displays. The common use of OLED displays in small screens in modern times has been in smartphones, wearables, and IoT projects.

B. Software

1. Java Script

It tracks patient vital signs in real time, integrates with data visualization and alerts, fetches health data from Google Spreadsheet and incorporates weather data for a holistic view. Secure login, 10-second data updates, diverse visualization, intelligent analysis, automated Telegram alerts for abnormal parameters, and remote monitoring for healthcare professionals are the other features.

2. HTML

This design of the Health Monitoring System's HTML is clean and modern, with a responsive container, a soft gradient background, and subtle box-shadow. The centered header has a medical emoji, a main section with a blue accent that showcases information, and a well-established footer. Generally speaking, this design prioritizes readability, aesthetics for a professional feel, and user experience.

IV. WORKING

A. Block Diagram

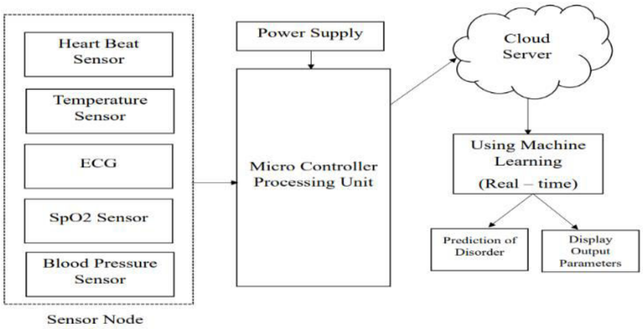

Fig.6: Block Diagram for the system

B. Circuit Diagram

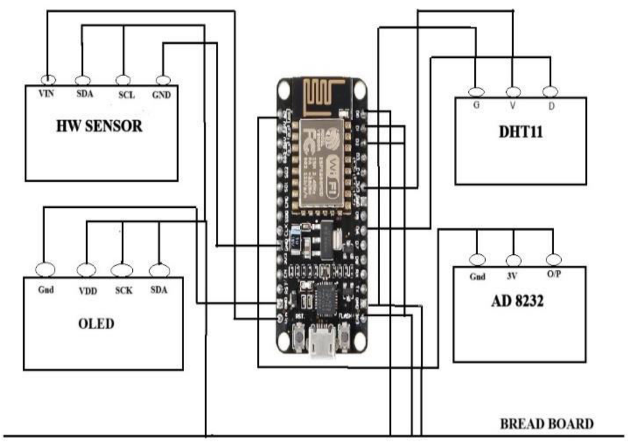

Fig.7: Internal Circuit Diagram of the system

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The system integrates various sensors such as heart rate, temperature, ECG, SpO2, and blood pressure sensors to continuously collect vital physiological data from the user. This raw data is sent to the microcontroller processing unit for filtering and preparation before being further analysed. The system includes a power supply for continuous uninterrupted operation and enables long-term monitoring. These datasets are sent through to a cloud server for safe storage and allow real-time accessibility from anywhere around the world. Real-time prediction of possible diseases, including potential cardiovascular diseases due to patterns discovered, is used in the processed data through applying machine learning algorithms. Early indication of disorders to the cardiac areas facilitates timely intervention of the problem in the system. Finally, an analytical result involving parameters such as heartbeat, blood pressure, ECG readings can be shown through the user interface, which delivers a clear result of the present health status in the individual.

C. Flowchart

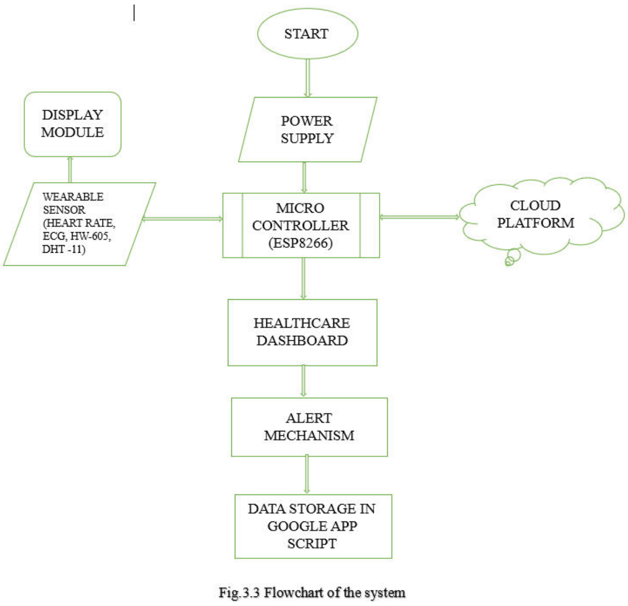

Fig.8: Flowchart of the System

The wearable health monitoring system actually functions by continuously taking all the relevant vital health information that is acquired through sensors including heart rate, ECG, temperature, humidity, and so many others. These sensors are implemented in the wearable device. A good supply of power from a power supply source that ensures non-stop operation provides constant power for these sensors. Data is thereafter processed and communicated to a cloud platform through the ESP8266 microcontroller. All data are monitored and analysed in the cloud platform so that the user or healthcare professionals can check on vital signs in real time. From the dashboard, any abnormal readings or inconsistencies will be flagged and the relevant user and healthcare providers will be alerted so that timely intervention can be made. Secondly, with Google Apps Script, data is well maintained and can easily be accessed so making retrieval easy for further analysis. The health is therefore monitored in an integrated system to ensure that every emerging health problem is detected at its early stages.

V. RESULT

The Health Monitoring System dashboard shows real-time vital signs with color-coded icons and multiple visualization methods, including individual graphs and composite line charts. Data refreshes every 10 seconds, providing comparative analysis. An intelligent alert system sends Telegram notifications for abnormal readings, ensuring quick medical intervention. The interface is responsive and professional.

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A. Dashboard Output

Fig.9: Real-Time Health Data Dashboard

Fig.10: Sensor Data Representation for Health Monitoring

Fig 11: Disease Prediction Interface

The system predicts Hypoxemia (low blood oxygen), Hypertension (high blood pressure), and Hypothermia (low body temperature) based on sensor readings. Machine learning models analyse SpO2, blood pressure, and temperature data to identify conditions, providing early detection for timely medical intervention.

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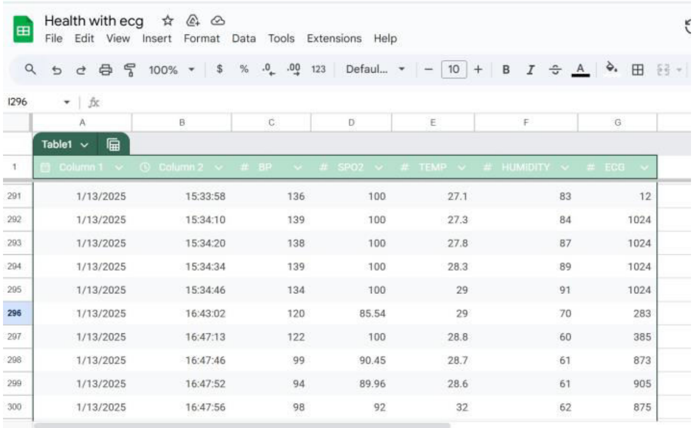
B. Google Script Storage & Telegram Notification



	Column 1	Column 2	BP	SPO2	TEMP	HUMIDITY	ECG
291	1/13/2025	15:33:58	136	100	27.1	83	12
292	1/13/2025	15:34:10	139	100	27.3	84	1024
293	1/13/2025	15:34:20	138	100	27.8	87	1024
294	1/13/2025	15:34:34	139	100	28.3	89	1024
295	1/13/2025	15:34:46	134	100	29	91	1024
296	1/13/2025	16:43:02	120	85.54	29	70	283
297	1/13/2025	16:47:13	122	100	28.8	60	385
298	1/13/2025	16:47:46	99	90.45	28.7	61	873
299	1/13/2025	16:47:52	94	89.96	28.6	61	905
300	1/13/2025	16:47:56	98	92	32	62	875

Fig.12: Google Apps Script Storage

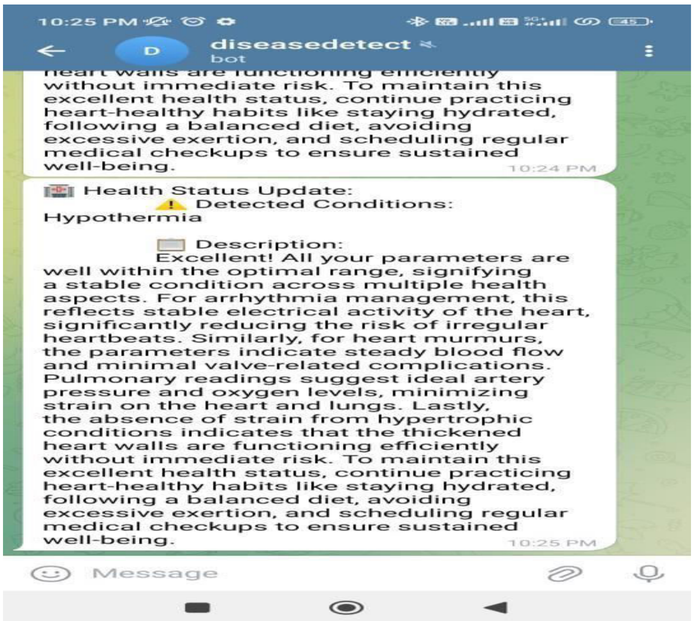


Fig.13: Telegram Notification System for Disease Prediction

VI. FUTURE SCOPE

1. Integration with Advanced AI Models: Enhance prediction accuracy by using more sophisticated machine learning and deep learning models capable of analysing complex health patterns and anomalies.
2. Multi-Disease Prediction: Expand the system to predict other chronic diseases like diabetes, sleep apnea, or respiratory disorders using additional sensor inputs and data.
3. Enhanced Alert Mechanism: Improve alert systems by integrating with IoT devices like smart home assistants, enabling voice or visual notifications, and linking with emergency services for critical cases.
4. Real-Time Data Analytics: Implement real-time big data analytics to process and analyse larger datasets for population health studies and personalized insights.

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VII. CONCLUSION

This project integrates IoT, machine learning, and wearable tech to predict and monitor cardiovascular diseases like Hypoxemia, Hypertension, and Hypothermia. Real-time sensor data, advanced analytics, and automated alerts via Telegram provide early detection. Its user-friendly interface and scalability make it suitable for both personal and clinical health management.

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