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Holistic Health Guardian System Using Iot

Prof. Priti Shivaji Dhaygude[1], Madhuri Tanaji Sarpale[2], Pradnya Dasharath Vanarase[3], Siddhi Somnat Sutar[4], Pratiksha Popat Choudhari[5]

[1,2,3,4,5]Department of E&TC Engineering, Navsahyadri Group of Institutions, Savitribai Phule Pune University, Pune, Maharashtra, India

ABSTRACT

Nowadays, wearable health devices are very important for tracking our daily fitness. Hospitals and regular people use these gadgets to check things like heart rate and body temperature. However, most common watches only look at physical data. They often ignore how our body reacts to mental stress or emotional changes. This means they can tell us wear entire, but they can't always tell if we are stressed or anxious.

A big problem is that these devices can get confused. For example, if your heart rate goes up while you are sitting still, a normal watch might just think you are moving. It doesn't have a way to understand "Stillness"—which is when your body is under stress even though you aren't exercising. This makes it hard to get a full picture of someone's health, especially their mental well-being.

This research introduces a new system called the Holistic Health Guardian (HHG). It uses a smart mini-computer (the ESP32-S3) and several sensors to track health in a better way. We used the MAX30102 sensor for heart rate and oxygen, the MLX90614 for body temperature, and an Accelerometer to track movement. By using Artificial Intelligence (AI) directly on the small device, the system can calculate a "Stillness Index."This helps the device know the difference between physical exercise and mental stress. This project shows that we can build a low cost and private health tracker that looks at both the body and the mind. It is a powerful tool for catching health problems early and helping people manage their stress better in real-time.

Keywords: Internet of Things (IoT),Edge AI, Tiny ML,ESP32-S3,Multi Sensor Fusion, Heart Rate Variability(HRV),Wearable Devices, Stillness Index, Predictive Healthcare

1. INTRODUCTION

In recent years, smart wearable devices like fitness trackers and smart watches have become a part of our daily lives. These tools help us keep track of our health by monitoring things like heart rate and how many steps we take.However,mostofthesedevicesonlyfocusonourphysicalbodies.Theyoftenignoreourmentaland emotional health, even though our mind and body are closely connected.

A major problem with current health trackers is that they cannot tell the difference between physical exercise and mental stress. For example, if you are running, it is normal for your heart rate to go up. But if your heart rate goes up while you are sitting still, it could be a sign of anxiety or a health problem. Most simple trackers don't know the difference because they don't look at "Stillness."This can lead to wrong information or missed warnings about a person's stress levels. To solve this, our project introduces the Holistic Health Guardian (HHG).This is a smart we are able system that looks at the "whole" person. It uses a small, powerful computer called the ESP32-S3 Mini and a group of sensors to track four areas: physical, mental, emotional, and spiritualhealth.WeusetheMAX30102sensorfor heart rate, the MLX90614 for body temperature, and an Accelerometer to track movement.

What makes this system special is that it uses Edge AI. This means the "thinking" happens directly on the device, not on a far-away server. This keeps the user's data private and fast. By combining data from all the sensors, the system creates a" Stillness Index" to accurately detect stress .If the system finds a problem, it alerts the user immediately with a color-changing LED and a mobile app. The goal of this research is to create a low-cost, easy-to-use device that helps people understand both their body and their mind in real-time. This paper will ex plain how we built the device, how the sensors a rewired together, and how the AI logic works to protect the user's health.

2. LITERATURE REVIEW

3. Methodology

Sr.No.	Author(s) &Year	Working Summary	Future Scope
1	Omar Cheikhrouhou et al., 2023	Proposed blockchain + fog computing for secure remote patient monitoring with enhanced data integrity and responsiveness.	Integrate with edge AI for real-time anomaly detection and scalability.
2	Vaishnavi Patil, 2024	Integrated Raspberry Pi 3 + IoT + AI for remote monitoring of vital parameters with real-time analysis to detect health risks.	Enhance scalability, add advanced analytics and heterogeneous sensor support.
3	Authors in Smart Health Monitoring (STM Journals), 2024	IoT with biomedical sensors for continuous patient monitoring focusing on real-time physiological data collection & cloud connectivity	Explore deep learning models for automated health state prediction.
4	Smart IoT-based Vital Sign Monitoring, 2024	Literature review highlights IoT-driven vital sign systems emphasizing sensor tech and data acquisition in remote health.	Address gaps in qualified data acquisition and AI-enabled insights
5	Smart Health Monitoring for Elderly (Preprints), 2024	Used ESP32 + sensors (MAX30100, ECG, DS18B20) with MQTT broker for real-time health streaming.	Expand to integrate fall detection & emergency alerts via mobile notifications.
6	IoT Patient Health Monitor (P. Shanvitha Reddy), 2025	ESP32-based system measuring vitals (heart rate, temp, humidity), uploading to ThingSpeak with calibration & error handling.	Add SpO_2/ECG/blood pressure modules and improve error resilience.
7	Buvaneshwari S, 2025	Proposed an IoT health monitoring system using Raspberry Pi 4 & sensors (MAX30100, AD8232, DHT11) with cloud upload and Random Forest ML for anomaly detection.	Integrate more sensors, improve ML model accuracy, develop caregiver mobile app.
8	Hemalatha R J et al., 2025	Developed IoT-based ECG/ESP32 hemodynamic surveillance with Wi-Fi data transmission to smartphone.	Focus on energy optimization and multi sensor fusion algorithm.

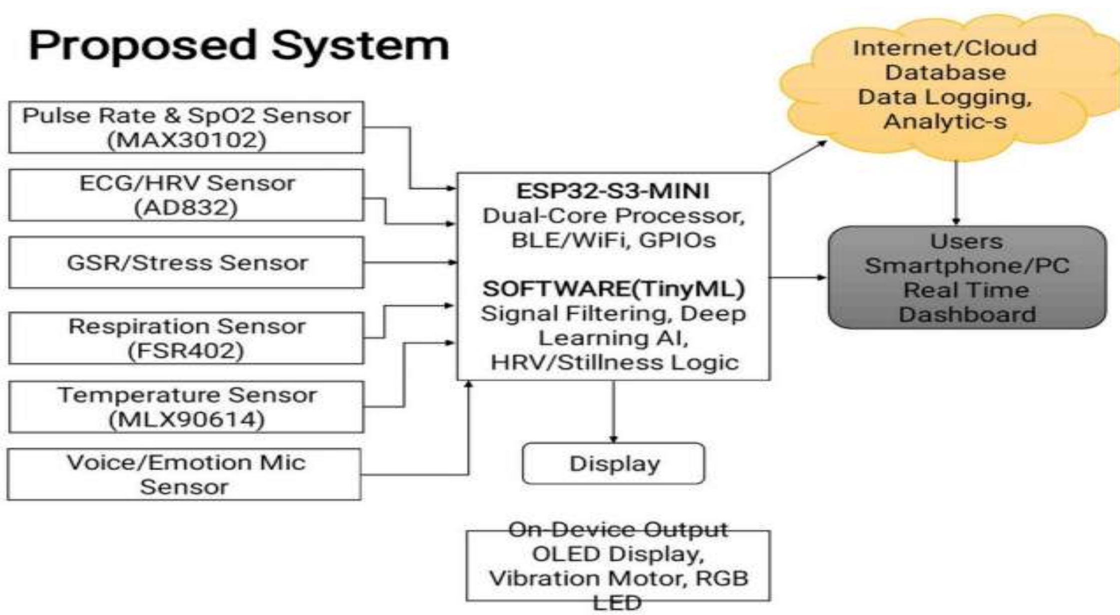

Fig 1. Proposed Methodology

The methodology of this research focuses on creating a low-latency ,"Edge- first" architecture that processes multi-dimensional health data locally on the wearable device.

Research Design:
The research follows an experimental and prototyping design. The system is divided into three layers: the Hardware Layer (data acquisition), the Edge Processing Layer (signal conditioning and AI), and the Application Layer (user interface). The core of the design is "Sensor Fusion," where data from the pulse, temperature, and motion sensors are combined to create a single health status output. This design ensures that the device can operate independently of an internet connection for its primary diagnostic functions.

Hardware Configuration and Tools:
The system is built using the ESP32-S3 Mini microcontroller, selected for its dual-core processor and built-in AI acceleration instructions. The hardware development utilized a breadboard prototyping method, employing a "Daisy-Chain" wiring strategy with Female-to-Male (F-M) and Female-to-Female (F-F) jumper wires to minimize space.

Sensors: The MAX30102 (PPG) and MLX90614 (Infrared) sensors were interfaced via the I2C protocol using GPIO 8 (SDA) and GPIO 9 (SCL).

Software Tools: The firmware was developed using VSCode with the Platform IO extension. The mobile dashboard was built using the Flutter framework to ensure cross-platform compatibility.

Data Pre-processing and Algorithms:
Before analysis, raw sensor data under goes "Signal Conditioning" to remove electrical noise caused by movement. The system utilizes a Moving Average Filter to smooth the heart rate and temperature data.

The primary algorithm used is a Decision-Tree Logic combined with a Tiny ML (Tensor Flow Lite Micro)model. The Tiny ML modelisa1DConvolutionalNeuralNetwork(CNN)trained to recognize patterns in Heart Rate Variability (HRV). This allows the system to classify the user's state into one of four categories: Normal, Elevated Stress, Physical Activity, or Abnormal Fever.

Stillness Indexing Logic
A unique algorithm was developed to calculate the Stillness Index (SI).The algorithm compares motion data
(M) from the accelerometer with the heart rate (HR).
If M is low and HR is high, SI triggers a Mental Stress Alert.
If M is high and HR is high, SI classifies the state as Physical Exercise.

5. CONCLUSION

The outcome of project has showed that it works on real time monitoring and when abnormalities occurred, message Alert goes to registered number through an app. Hence, we can avoid critical situations and can be able to give treatment on time

REFERENCES

[1]. Augustus E. Ibhaze, MNSE, Francis E. Idachaba, “Health Monitoring System for the Aged” 2016 IEEE, International Conference on Emerging Technologies and Innovative Business Practices for the Transformation of Societies (EmergiTech), 978-1- 5090-0706-6/16/$31.00 ©2016 IEEE

[2]. Lakmini P. Malasinghe et al ,(2017) “Remote patient monitoring: a comprehensive study”, Springer, DOI10.1007/s12652-017-0598-x .

[3]. Gifari, M. W., Zakaria, H., & Mengko, R. (2015). Design of ECG Homecare:12- lead ECG acquisition using single channel ECG device developed on AD8232 analog front end. 2015 International Conference on Electrical Engineering and Informatics (ICEEI).doi:10.1109/iceei.2015.7352529.

[4]. Zehender, M., Meinertz, T., Keul, J., & Just, H. (1990). ECG variants and cardiac arrhythmias in athletes: Clinical relevance and prognostic importance. American Heart Journal, 119(6), 1378-1391. doi:10.1016/s0002-8703(05)80189-9 .

[5]. Abhilasha Ingole, Shrikant Ambatkar, Sandeep Kakde,“Implementation of Health-care Monitoring System using Raspberry Pi”, IEEE ICCSP 2015 conference., 978-1-4799- 8081- 9/15/$31.00 © 2015 IEEE.

[6]. Mansor, H., Shukor, M. H., Meskam, S. S., Rusli, N. Q., & Zamery, N. S. (2013). Body temperature measurement for remote health monitoring system. 2013 IEEE International Conference on Smart Instrumentation Measurement and Applications (ICSIMA) doi:10.1109/icsima.2013.6717956.

[7]. Skraba, Andrej, et al. "Prototype of Group Heart Rate Monitoring with NODEMCU ESP8266." 2017 6th Mediterranean Conference on Embedded Computing (MECO), 2017,doi:10.1109/meco.2017.7977151.

[8]. D. Hasan and A. Ismaeel, "Designing ECG Monitoring Healthcare System Based on Internet of Things Blynk Application," J. Appl.Sci. Technol. Trends, vol.1, no.3, pp. 106–111, Jul. 2020, doi:10.38094/jastt1336.

[9]. F. Bamarouf, C. Crandell, S. Tsuyuki, J. Sanchez, and Y. Lu, "Cloud-based real- time heart monitoring and ECG signal processing," in 2016 IEEE SENSORS, Orlando, FL, USA, Oct. 2016 ,pp.1 Doi:10.1109/ICSENS.2016.7808911

[10]. Ebrahim Al Alkeem1, Dina Shehada1, Chan Yeob Yeun1,M. Jamal Zemerly, Jiankun Hu "New secure healthcare system using cloud of things", Springer Science+Business Media.