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Pulseguard Pro: A Low-Cost Smart Health Monitoring Wearable for Real-Time Vital Sign Tracking

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***Abstract*—Smart watches are contemporary wearable technological devices designed with the capability to monitor health, communicate and perform smart computing functionalities on a single device worn around the wrist. Due to the increasing advancements of technology, more people are being attracted to the use of smart watches because of the benefits associated with it such as fitness monitoring, heart rate monitoring, managing notifications, GPS and internet connectivity. This research paper provides a detailed analysis of the design of the system, operations of the smart watch, its objectives, methodologies, hardware and software requirements.**

I. INTRODUCTION

Wearables have changed the way we humans interact with computer systems. In wearables, the most commonly used technology by far is that of smart watches as they incorporate the conventional features of a wristwatch along with advanced computing technology.

A smart watch is a handheld electronic gadget that is usually worn around the wrist. It has a connection to other smart gadgets through wireless technologies such as Bluetooth and Wi-Fi technologies. The functions performed by a smart watch include health monitoring, step counting, calories measurement, monitoring of sleep, making calls, sending messages, GPS navigation, and alerts.

Modern day smartwatches come with various kinds of sensors that include heart rate sensors, accelerometers, gyroscopes, temperature sensors, and oxygen measurement sensors. The application of smartwatches in modern healthcare is invaluable as patients' health can be continuously monitored.

Increased fitness consciousness, monitoring of healthcare services remotely, and smart communication systems have led to the swift growth in the market of smartwatches. This paper highlights the working of a smart watch along with the implementation and application of the system

II. OBJECTIVES

To design an innovative smart wear that can monitor our health.

To monitor our physical activities including the number of steps, calories burned, and distance traveled.

To monitor the heart rate and body condition continuously. To alert smartly about calls, messages, and apps.

To design an effective and convenient communication device.

III. METHODOLOGY

Step 1: Data Acquisition

Data related to users is acquired from sensors incorporated within the smartwatch, including information regarding heart rate, body temperature, motion, step count, and sleep activity.

Step 2: Signal Processing

Acquired data is processed by a microprocessor or computer located within the smartwatch.

Step 3: Wireless Transmission

The smartwatch communicates with phones or servers in the cloud through Bluetooth or Wi-Fi connectivity.

Step 4: User Interface Presentation

Processed data is presented on the smartwatch screen in graph form, notifications, fitness data, and health report formats.

Step 5: Monitoring and Notifications
Notifications for any irregularities in health status are delivered to the user through the smartwatch.

IV. HARDWARE COMPONENTS

The PulseGuard Pro smartwatch prototype is built using various hardware components that work together to monitor and display health parameters.
Microcontroller (Arduino/ESP): Acts as the brain of the system, processes sensor data, and controls all operations Heart Rate Sensor: Measures the pulse rate of the user in real time
Temperature Sensor: Detects the body temperature SpO Sensor: Measures blood oxygen saturation levels Stress Detection (via Heart Rate Variation): Calculates stress level using pulse data
LCD Display (2.4 inch): Displays real-time health data to the user
Battery: Provides power supply to the system
Connecting Wires & PCB: Used for circuit connections and assembly
These components are integrated to form a compact and efficient health monitoring system

V. SOFTWARE COMPONENTS

The software part of the PulseGuard Pro smartwatch is responsible for processing sensor data, displaying results, and enabling communication with the web dashboard.
Arduino IDE: Used for writing, compiling, and uploading the code to the microcontroller
Embedded C Programming: Used to control sensors, process data, and manage system operations
Sensor Libraries: Predefined libraries used for accurate reading of heart rate, temperature, and SpO sensors
Web Dashboard: Displays health data remotely using IoT technology
Serial Communication: Used for data transfer between components and debugging
The software ensures smooth functioning of the system, real-time data processing, and user-friendly display of health parameters.

Working Principle
The smart watch operates by continuously collecting data from various sensors attached to the device. The processor analyzes the collected information and displays it on the screen. The device can communicate with smartphones through Bluetooth, allowing users to receive notifications, calls, and messages directly on the watch.

VI. EXPERIMENTAL RESULT

In order to determine the efficiency of the developed system, various experiments were conducted in different environments with various users. The setup was comprised of the following:
ESP32/Arduino Microcontroller
MAX30100 pulse oximeter and heart rate sensor Temperature sensor
LCD display module
Wi-Fi based web dashboard Battery-based power source
The device was worn by users and the readings of vital signs were observed over some minutes while the subject was at rest and performing light activities.
Heart Rate (BPM) Body Temperature (°C)
Blood Oxygen Level (SpO %)
Stress Levels Index
The recorded sensor values were evaluated based on their comparison with normal values for human bodies.

Heart Rate Monitoring Results
The designed sensor accurately detected the real-time heart rate. The values obtained during testing are presented below:

Test No. Heart Rate (BPM) Condition
1.72 Resting
2.78 Normal Activity
3.84 Walking
4.91 Mild Exercise
5.76 Resting Analysis
The heart rate readings were consistent during monitoring. The obtained values fell into the normal range of human heart rate.
Some fluctuations occurred while the user was moving. Accuracy was considered satisfactory for prototype development.

VII. CONCLUSION

This project proves that a wearable device with multiple health parameters could be developed using low-cost components without compromising

the essential features of the medical utility of such products. The prototype was successful in monitoring heart rate, body temperature, SpO,
and the stress indicator, which was measured based on HRV. It could present the readings on a small screen and send them to a web
dashboard for further processing and review. These findings support the design of the hardware and firmware and prove that off-the-shelf sensors
can provide precise enough data when adequately combined and filtered. The project met its goals and serves as a robust foundation for further
improvements. The planned next steps will involve designing a dedicated wristband case, adding a mobile app, implementing artificial intelligence-based
anomaly detection, and performing thorough clinical testing against certified devices

VIII. FUTURE SCOPE

Future smart watches may include advanced AI-based health analysis, blood sugar monitoring, improved battery technology, flexible display technology, better medical emergency detection, and enhanced cloud connectivity with IoT integration. Smart watches are expected to play a major role in future healthcare systems and smart living environments.
Solar charging, GPS & Fall Detection, Cloud Backup

REFRENCES

[1] Pantelopoulos and N. G. Bourbakis, "A survey on wearable sensor-based systems for health monitoring and prognosis," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. 40, no. 1, pp. 1–12, Jan. 2010.

[2] M. Haghi, K. Thurow, and R. Stoll, "Wearable devices in medical Internet of Things: Scientific research and commercially available devices," *Healthcare Informatics Research*, vol. 23, no. 1, pp. 4–15, 2017.

[3] S. M. R. Islam, D. Kwak, M. H. Kabir, M. Hossain, and K. S. Kwak, "The Internet of Things for health care: A comprehensive survey," *IEEE Access*, vol. 3, pp. 678–708, 2015.

[4] J. Patel, H. Park, P. Bonato, L. Chan, and M. Rodgers, "A review of wearable sensors and systems with application in rehabilitation," *Journal of NeuroEngineering and Rehabilitation*, vol. 9, no. 21, pp. 1–17, 2012.

[5] G. Yang, B. Xie, M. Mantysalo, X. Zhou, Z. Pang, L. Xu, S. Kao-Walter, Q. Chen, and L. R. Zheng, "A Health-IoT platform based on the integration of intelligent packaging, unobtrusive bio-sensor, and intelligent medicine box," *IEEE Transactions on Industrial Informatics*, vol. 10, no. 4, pp. 2180–2191, Nov. 2014.

[6] H. He, J. Tan, and Y. Chen, "A smart wearable device for remote health monitoring," *International Journal of Distributed Sensor Networks*, vol. 11, no. 10, 2015.

[7] D. Dias and J. P. S. Cunha, "Wearable health devices—Vital sign monitoring, systems and technologies," *Sensors*, vol. 18, no. 8, pp. 1–28, 2018.

[8] A. Kumar and G. P. Hancke, "Energy efficient environment monitoring system based on the Internet of Things," *IEEE Sensors Journal*, vol. 18, no. 1, pp. 1–9, 2018.

[9] Arduino, "Arduino Official Website." Available: Arduino Official Website

[10] IoT For All, "Internet of Things (IoT) Overview." Available: IoT for All

[11] World Health Organization, "Digital Health and Wearable Technology." Available: World Health Organization

[12] Analog Devices, "MAX30100 Pulse Oximeter and Heart-Rate Sensor Datasheet." Available: Analog Devices

[13] Texas Instruments, "Temperature Sensor Applications Guide." Available: Texas Instruments