IoT-Enabled Real-Time Health Monitoring System Using Fingertip Sensors

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Introduction

The integration of the Internet of Things (IoT) into the healthcare sector enables the acquisition in real-time and remote monitoring of a patient's health status. This paper presents the design of an affordable IoT-enabled real-time health monitoring system using fingertip sensors to track vital and critical health parameters such as heart rate, blood oxygen levels (SpO_2), and temperature. The system employs a microcontroller to process and wirelessly transmit collected data to a cloud-based platform for remote access and analysis. The temperature readings of the system, when compared against a standard thermometer reading indicate the smallest deviation of 0.45% and the largest deviation of 2.01%, indicating a relatively high accuracy and reliability. The system also provides affordable and user-friendly data visualisation, thus enabling medical professionals to monitor patients in real time, reducing response times for critical conditions, and supporting preventive care.

Methodology

The IoT-Enabled Real-Time Health Monitoring System utilised fingertip sensors to acquire patients' health parameters. While DS18B20 is employed to acquire body temperature, an optical-based pulse oximeter, MAX30100, is used for the heart rate and blood oxygen levels. A Microcontroller Unit (ESP8266) is used to collect and process the sensor's data and wirelessly transmit the results via Wi-Fi module to the IoT Cloud Platform (Ubidot) for real-time visualisation and analysis. An automated alert system is also integrated to notify users or healthcare providers via SMS or email.

Results and discussion

A system prototype was developed and tested to measure the heart rate (BPM), blood oxygen saturation (SpO_2), and body temperature of multiple healthy individuals. For evaluation purposes, the temperature readings from the IoT system are compared against a standard clinical thermometer reading to assess its accuracy. The data collected is shown in Table 1. The results indicate that the system recorded the temperature accurately with the smallest deviation of 0.45%, and the largest deviation of 2.01%, showing that the system maintains high accuracy. Most of SpO_2 values are within the healthy range limit (95–100%), and the BPM measurements likewise fell within the predicted resting heart rate range (60–100 BPM). The effectiveness of the IoT system for real-time health monitoring applications is demonstrated by this.

Table 1: IoT Monitoring System comparison with Standard Thermometer readings

S/N	SpO_2	BPM	IoT (^{0}C)	Clinical Thermometer (^{0}C)	Deviation in Temperature(%)
1.	71	95	36.73	37.44	1.9
2.	68	95	37.47	37.73	0.69
3.	76	100	36.08	36.55	1.29
4.	63	97	36.82	36.58	0.66
5.	64	98	37.40	37.57	0.45
6.	98	98	36.05	35.34	2.01

Conclusions

The IoT-enabled health monitoring system effectively and accurately detects the human body temperature, Spo2, and BPM. The comparison with a clinical thermometer demonstrates that the temperature readings are accurate and rarely deviate. Applications for this technology could include continuous patient monitoring and telemedicine.

Keywords

Fingertip sensors, IoT in healthcare, Preventive healthcare, Real-time health monitoring, Remote patient monitoring, Vital signs monitoring.