Journal of Telecommunication, Electronic and Computer Engineering
ISSN: 2180 – 1843 e-ISSN: 2289-8131 Vol. 18 No. 2 (2026) 15-21
jtec.utem.edu.my
DOI: https://doi.org/10.54554/jtec.2026.18.02.003

Multi-sensing Fusion with Blynk Interface of Internet-of-Things for Health Monitoring System

Norhalida Othman*, Puteri Nur Athirah Mohd Hizal, Nur Amalina Muhamad, Noor Hasliza Abdul Rahman and Noor Hafizah Khairul Anuar

Faculty of Electrical Engineering, Universiti Teknologi Mara (UiTM) Cawangan Johor, Kampus Pasir Gudang, Jalan Purnama, Bandar Seri Alam, 81750 Masai, Johor

Article Info

Article history:
Received Feb 24th, 2026
Revised May 6th, 2026
Accepted Jun 3rd, 2026
Published Jun 30th, 2026

Index Terms:
Multi-sensing Fusion
Blynk
Internet-of-Things
Health Monitoring

Abstract

The rapid expansion of the Internet of Things (IoT) has significantly influenced on the development of wearable health monitoring devices, particularly for fitness and personal wellness applications. IoT-enabled wearable systems facilitate continuous, real-time monitoring of physiological parameters, such as heart rate and body temperature, providing improved accuracy and consistency compared with conventional periodic assessment methods. Although recent developments have shifted from wrist-worn devices to smart garments for enhanced user comfort and sensor integration, existing systems primarily focus on sensor performance and data transmission, with limited attention given to user interaction and integrated garment design. Furthermore, challenges related to power consumption, system complexity, and implementation cost continue to limit the development of affordable wearable solutions. This study presents the design and implementation of an Arduino-based IoT Fitness Jacket for real-time heart rate and body temperature monitoring. The proposed system integration a photoplethysmography (PPG) pulse sensor, an LM35 temperature sensor, an LCD display, an HC-05 Bluetooth module, and a smartphone interface within a wearable platform. Experimental validation involving eight healthy participants demonstrated an average heart rate measurement error of 4.53% and an average body temperature measurement error of 0.65% compared with certified commercial medical devices. The developed system also stable Bluetooth communication for real-time physiological data transmission. These results demonstrate that the proposed IoT Fitness Jacket provides a practical, low-cost, and reliable wearable solution for everyday health and fitness monitoring.

This is an open access article under the CC BY-NC-ND 4.0 license.

*Corresponding Author: halida8142@uitm.edu.my

I. INTRODUCTION

The rapid development of the Internet of Things (IoT) has accelerated the development of wearable monitoring systems and smart healthcare technologies for healthcare delivery [1]. The IoT-enabled wearable wireless devices facilitate remote, real-time monitoring of physiological parameters, thereby improving treatment outcomes, promote preventative healthcare and enhancing patients' quality of life. Recent advances in low-power sensors and miniaturized embedded systems [2], including Arduino-based platforms have enabled the continuous, non-invasive acquisition of physiological data in portable and cost-effective devices. These technologies empower individuals to monitor their health status and optimize their physical fitness through continuous physiological assessment [3].

Commercially wearable devices, such as smart watches and fitness bands, are now widely available for monitoring basic physiological parameters, including heart rate and physical activity. However, several challenges continue to limit their widespread adoption. Many existing commercial solutions are expensive, offer limited customization, or exhibit technical limitations that affect measurement reliability. Furthermore, conventional fitness garments lack integrated physiological sensing capabilities, preventing continuous real-time health monitoring during physical activity and reducing user convenience [1].

Furthermore, low-cost wearable monitoring systems often experience significant technical challenges, including signal instability, motion artefacts, and or inaccurate sensor measurements caused by environmental interference or inherent sensor limitations. These issues highlight the need for improved sensing technologies and robust calibration techniques to ensure reliable physiological monitoring. Moreover, integrating sensing, signal processing, and wireless communication a wearable textile platform while maintaining low power consumption remains a complex hardware design challenge. Many existing systems also rely on multiple standalone devices rather than an integrated

garment-based solution, resulting in reduced user comfort and a less seamless monitoring experience.

These limitations demonstrate the need for a compact, low-cost, and reliable IoT-enabled wearable health monitoring system capable of providing accurate real-time physiological measurements while ensuring accessible and ease of use.

In this study, the design and implementation of an IoT based fitness jacket with heart rate and body temperature monitoring utilising Arduino Uno microcontroller are presented. The system integrates a photoplethysmography (PPG)-based pulse sensor [4]-[6], an LM35 temperature sensor, a local LCD for real-time display, keypad-based user control and HC-05 Bluetooth connectivity into a single embedded garment platform. Most existing systems are limited to monitoring through mobile applications only or rely solely on cloud-based platforms. In contrast, the proposed system combines real-time local display and wireless data transmission in a single embedded architecture at a cost-effective implementation.

II. LITERATURE REVIEW

The rapid development of Internet of Things (IoT) technology has significantly accelerated the advancement of wearable health monitoring devices, particularly in the fitness and personal well-being sectors [7], [8]. Sensors, embedded systems and wireless communication technologies are integrated to provide continuous, real-time monitoring of vital physiological parameters including heart rate, body temperature and physical activity in IoT-enabled wearable devices. Unlike traditional fitness tracking approaches, which frequently rely on self-reporting or intermittent assessments, IoT-based devices provide objective and continuous physiological data. This enables the early detection of unhealthy conditions and encourages users to adopt healthier lifestyles.

A major trend reported in [7], [9], [10] is the shift from wrist-worn devices to smart garments, such as jackets and vests, which enable a more natural and distributed deployment of sensors. These wearable garments improve both user comfort and functionality, especially during prolonged periods of physical activity.

Arduino platforms have become popular in wearable health monitoring research due to their low cost, open-source architecture, and compatibility with a wide range of biomedical sensors. Studies in [11], [12] have demonstrated that Arduino-based microcontrollers can acquire and process physiological data, such as heart rate and body temperature, and transmit the information in real-time using Bluetooth or Wi-Fi. These systems have been applied in various fields, including fitness tracking, patient monitoring, occupational safety, and military applications. However, current research focuses on sensor functionality and data transmission, with limited attention given to user interaction, control mechanisms, and the integration of the complete garment. Moreover, many of these systems remain at the conceptual or prototype level and have not been extensively validated in real-world garment-integrated applications.

Recent advances in smart fabrics and wearable electronics have introduced flexible sensors and more sophisticated data processing techniques that improve measurement accuracy and user comfort [13], [14]. However, despite these advancements, challenges such as system complexity, power consumption, sensor calibration, and implementation cost remain, particularly in low-cost and educational applications. Although cloud computing, sensor fusion and machine learning enhance the capabilities of wearable monitoring systems, they also increase computational requirements and implementation complexity, making them less suitable for simple fitness monitoring applications.

These challenges highlight the need for a practical, low-cost, and garment-integrated IoT wearable system that emphasizes essential physiological monitoring without unnecessary system complexity [8], [15]. To address this needs, the present work proposes an Arduino-based IoT fitness jacket capable of monitoring heart rate and body temperature in real time, providing a simple, wearable and accessible solution for everyday health monitoring.

III. METHODOLOGY

A. Systematic Architecture

This study adopted a systematic design and experimental approach to develop and validate an Internet of Things (IoT)-based Fitness Jacket for real-time physiological monitoring. The methodology consisted of system architecture design, hardware development, software implementation, wearable integration, and experimental validation. The overall objective was to develop a low-cost, portable, and reliable wearable system capable of monitoring heart rate and body temperature during daily activities.

The proposed system architecture was divided into three main subsystems, namely the sensing module, controller module, and output module, as illustrated in Figure 1. The sensing module consisted of a pulse sensor for heart rate detection and an LM35 sensor for body temperature monitoring. The acquired physiological signals were processed by an Arduino Uno microcontroller, which functioned as the central processing unit of the system. The processed data were then transmitted wirelessly through the HC-05 Bluetooth module and displayed on both the LCD module and smartphone application.

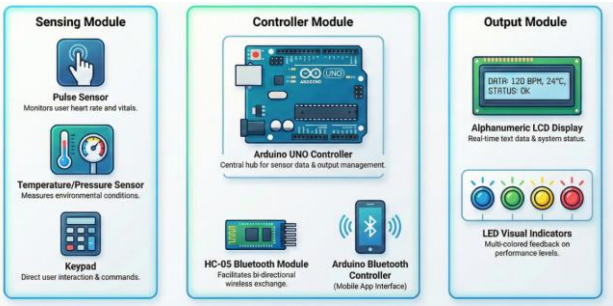


Figure 1. IoT Fitness jacket architecture

The hardware circuit was designed and simulated using Fritzing software prior to physical implementation to ensure proper connectivity among all components. The developed circuit integrated the Arduino Uno microcontroller, pulse sensor, LM35 temperature sensor, HC-05 Bluetooth module, keypad module, LED indicator, and LCD display. The finalized circuit was fabricated on a printed circuit board (PCB) to improve electrical stability and enhance the compactness of the wearable system.

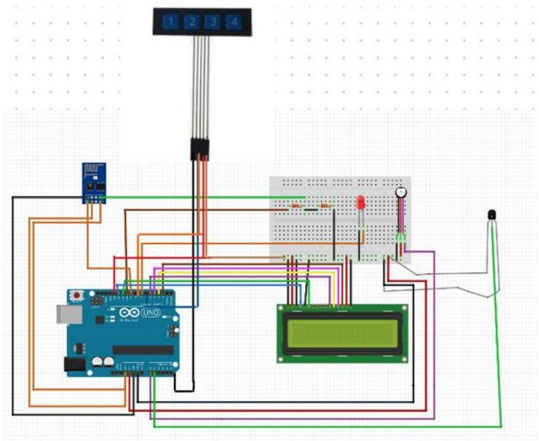


Figure 2. Circuit design using Fritzing

The printed circuit board (PCB) was designed and fabricated to integrate all system components into a compact and stable hardware platform. As shown in Figure 3, the PCB accommodates the Arduino Uno microcontroller, pulse sensor interface, LCD module connection, and power source. Proper routing techniques were applied to ensure organized signal pathways and minimize electrical interference [16]. Jumper wires were used to establish secure connections between the microcontroller and peripheral components, including the LED indicator and LCD display module. The PCB layout was arranged to maintain clear separation between signal and power lines, thereby enhancing system stability and reducing noise. Additionally, connectors were strategically positioned to facilitate easy sensor interfacing and future expansion. The assembled PCB demonstrates reliable electrical connectivity and stable operation during experimental validation, confirming the effectiveness of the design and fabrication process.

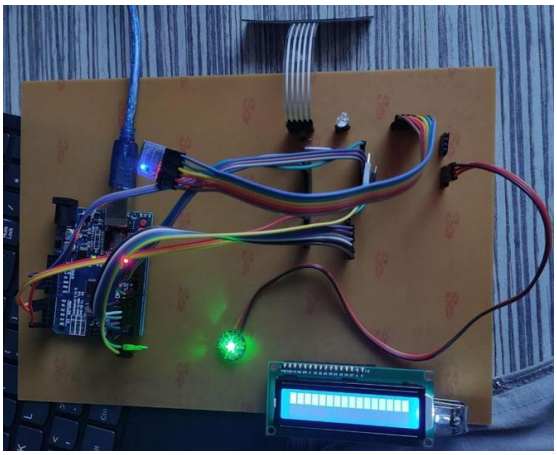


Figure 3. PCB hardware connection

Figure 4 illustrates the flowchart of the operating logic of the health monitoring system. The process begins when the user enters a command using the keypad. Upon activation, the device simultaneously acquires data from the pulse and temperature sensors and provides visual feedback through an LED indicator. These physiological parameters are then processed and transmitted to a mobile device and the integrated LCD module for real-time display. Finally, the monitoring process terminates only when the user enters a termination command, ensuring a controlled completion of the data acquisition process.

The firmware was developed using the Arduino Integrated Development Environment (IDE). The program initializes the system components, periodically acquires sensor data, performs simple signal conditioning to reduce noise, calculate the heart rate (BPM) and body temperature values, and transmits the processed data through serial connection [17]. A 16×2 LCD module was assembled for real-time local visualization and an HC-05 Bluetooth module was used to wirelessly transmit data to a smartphone application. The communication baud rate was configured at 9600 bps to ensure reliable data exchange.

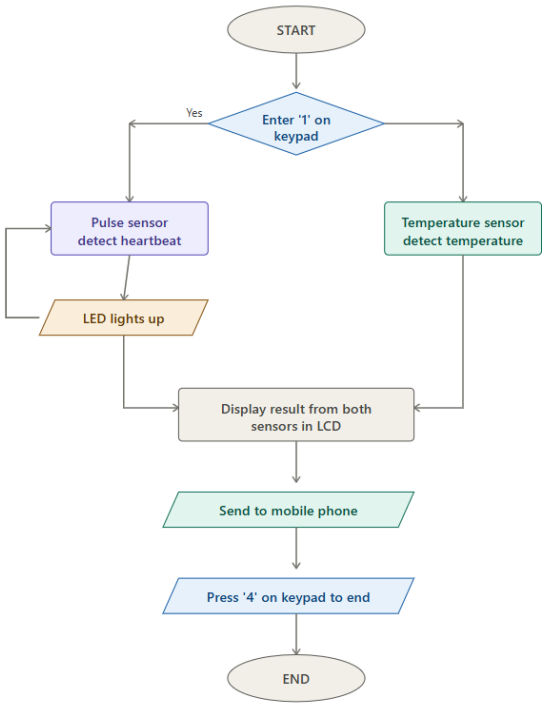


Figure 4. Flowchart IoT Fitness jacket

Figure 5 shows the integration of all electronic components into a commercially available jacket using flexible wiring for wearable implementation. The sensors were strategically positioned to maintain continuous skin contact while minimizing motion artifacts. Each electronic module was housed in a protective fabric container to improve durability.

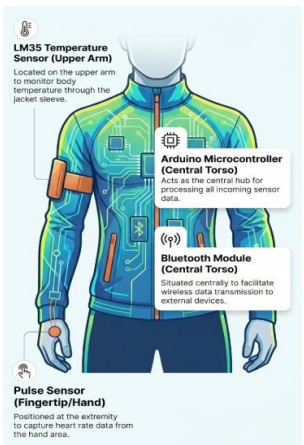


Figure 5. Component placement and wearable implementation of the IoT Fitness Jacket

As illustrated, the pulse sensors extends to the fingertip to provide reliable heart rate detection [18], while the LM35 temperature sensor is positioned on the upper arm of body temperature measurement. The Arduino Uno microcontroller and the HC-05 Bluetooth module, which perform the primary processing and wireless communication functions, are centrally located in the torso section of the jacket. This practical arrangement enables accurate physiological data acquisition from the sensing locations while ensuring convenient integration of the processing and communication modules within the wearable garment.

B. Heart Rate Measurement

The pulse sensor operates based on photoplethysmography (PPG) principles, where variations in blood volume produce corresponding changes in the reflected light intensity detected by the sensor. The detected pulse intervals were processed internally by the Arduino microcontroller to calculate the heart rate in beats per minute (BPM)[19]. The BPM calculation used in the proposed system is expressed in Equation (1).

$$BPM = \frac{60}{T_{pulse}} \quad (1)$$

where T_{pulse} is time interval, in seconds, between two consecutive heartbeat pulses detected by the pulse sensor.

The calculated BPM values were displayed on the LCD module and transmitted wirelessly to the smartphone application through the HC-05 Bluetooth module.

C. Body Temperature Measurement

The LM35 temperature sensor was used to measure the user's body temperature. The sensor produces an analog voltage output proportional to the measured temperature. The Arduino analog-to-digital converter (ADC) processed the analog signal and converted it into temperature values using Equation (2)[20].

$$Temperature\ (°C) = \frac{V_{out} \times 100}{1023} \quad (2)$$

where V_{out} is the analog voltage value obtained from the LM35 sensor through the Arduino ADC

The measured temperature values were displayed in real time on both the LCD module and smartphone application.

D. Experimental Validation

Experimental validation was conducted using eight healthy participants under resting conditions. The measured heart rate and temperature values obtained from the proposed system were compared with readings recorded from certified commercial medical devices. The percentage error was calculated using Equation (3).

$$Percentage\ error\ (\%) = \frac{|Measured - Reference|}{Reference} \times 100 \quad (3)$$

where
Measured is the value obtained from the proposed IoT Fitness Jacket
Reference is the value recorded from the certified medical device

This analysis was performed to evaluate the accuracy and reliability of the developed wearable monitoring system.

E. Mean Measurement Analysis

Repeated measurements were conducted for each participant to improve data reliability. The average measurement value was calculated using Equation (4).

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \quad (4)$$

where
x = measured value
n = the total number of measurements performed during the experimental validation process

IV. RESULTS AND DISCUSSION

The developed prototype of the Internet of Things (IoT) Fitness Jacket was successfully integrated and experimentally evaluated under controlled indoor conditions. The hardware solution comprises an Arduino UNO microcontroller, a pulse sensor, an LM35 temperature sensor, and LCD module, an HC-05 Bluetooth module and a keypad interface embedded within the wearable jacket platform. Physiological data was successfully captured in real-time, and the measured data was wirelessly sent to a smartphone application via Bluetooth communication.

The completed prototype of the IoT Fitness Jacket with the integrated monitoring interface is shown in Figure 6. During operation, the pulse sensor detected photoplethysmography (PPG) signals from the user's fingertip, while the LM35 sensor continuously measured body temperature. The measured data were simultaneously displayed on the LCD module and the smartphone application, demonstrating stable system integration and real-time monitoring capability.



Figure 6. Prototype of IoT Fitness Jacket

To evaluate the performance of the heart rate monitoring subsystem, experiments were conducted using eight healthy participants under resting conditions. The BPM values presented in Table 1 were calculated using Equation (1), in which the pulse intervals detected by the PPG sensor was

converted into beats per minute (BPM). Only the final BPM values are presented for performance evaluation.

Table 1
Heart Rate Measurements

Test Subject	Reference Device (BPM)	IoT Fitness Jacket (BPM)	Absolute Error (BPM)	Percentage Error (%)
Subject 1	75	78	3	4.00
Subject 2	72	76	4	5.56
Subject 3	80	83	3	3.75
Subject 4	82	86	4	4.88
Subject 5	77	80	3	3.90
Subject 6	74	78	4	5.41
Subject 7	70	73	3	4.29
Subject 8	68	71	3	4.41
Average	74.75	78.13	3.38	4.53

The percentage error values shown in Table 1 were calculated using Equation (3) to evaluate the accuracy of the proposed system compared with a certified commercial pulse oximeter. The proposed system demonstrated consistent heart rate measurements with percentage errors ranging from approximately 3.75% to 5.56%. The average percentage error was 4.53%, indicating acceptable accuracy for non-clinical wearable health monitoring applications.

Figure 7 illustrates the real-time heart rate monitoring performance of the proposed system compared with the certified reference device. The BPM values measured by the IoT Fitness Jacket closely followed the trend of the reference measurements for all participants. Minor deviations were observed due to motion artifacts and signal fluctuations; however, the overall measurement trend remained consistent, indicating stable signal acquisition and reliable heart rate monitoring performance.

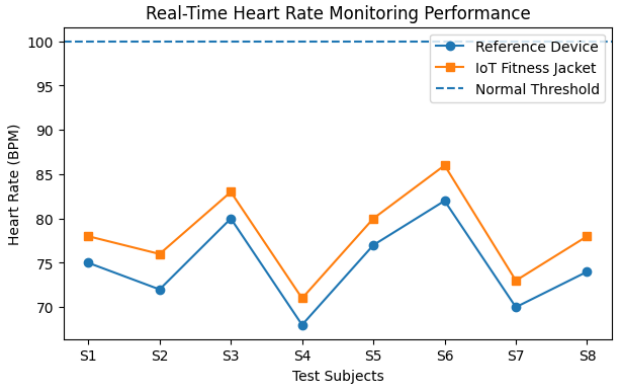


Figure 7. Real-time heart rate monitoring comparison between the proposed IoT Fitness Jacket and the reference device

The temperature monitoring subsystem was evaluated by comparing the measured body temperature values with readings obtained from a certified digital thermometer. The body temperature readings shown in Table 2 were calculated using Equation (2), where the analog output voltage from the LM35 sensor was converted into temperature values in degrees Celsius.

The percentage error values in Table 2 were calculated using Equation (3) to evaluate the accuracy of the proposed temperature monitoring subsystem. The LM35 sensor demonstrated stable and linear measurement characteristics throughout the experimental validation process. The average percentage error for temperature measurement was approximately 0.65%, indicating high measurement consistency and reliable sensing performance.

Table 2
Comparison of Temperature Measurements

Test Subject	Reference Device (°C)	IOT Fitness Jacket (°C)	Absolute Error (°C)	Percentage Error (%)
Subject 1	36.5	36.8	0.3	0.82
Subject 2	36.7	36.9	0.2	0.54
Subject 3	36.1	36.5	0.4	1.10
Subject 4	36.6	36.9	0.3	0.83
Subject 5	36.8	37.2	0.4	1.10
Subject 6	36.7	36.9	0.2	0.54
Subject 7	36.3	36.6	0.3	0.83
Subject 8	36.8	37.0	0.2	0.54
Average	36.55	36.79	0.24	0.65

Figure 8 demonstrates the consistency of the temperature measurements obtained from the developed system. The recorded temperature values remained within the normal physiological range and closely matched the reference thermometer readings, confirming the stability and reliability of the LM35 sensing subsystem.

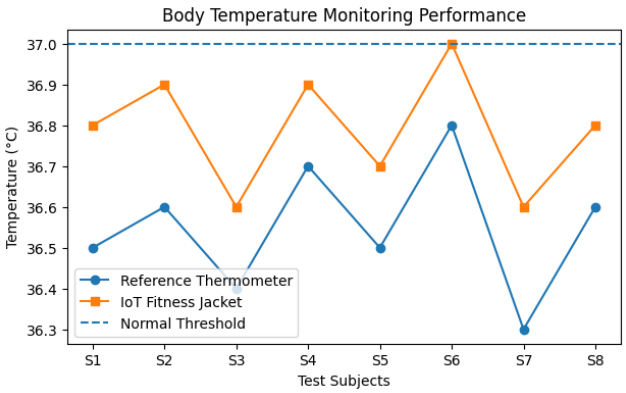


Figure 8. Body temperature monitoring performance of the proposed IoT Fitness Jacket

The Bluetooth communication subsystem was evaluated to determine the transmission stability and responsiveness between the IoT Fitness Jacket and the smartphone application. Experimental testing showed that the HC-05 Bluetooth module maintained stable connectivity within an indoor operating range of approximately 5–8m.

No packet loss or communication interruption were observed during continuous monitoring. The average transmission delay was approximately 1-2s, which is suitable for real-time wearable health monitoring applications.

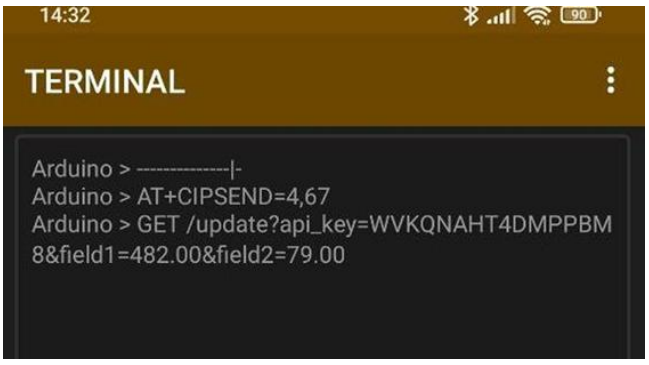


Figure 9. Smartphone interface

The recorded physiological data were successfully displayed on the smartphone interface without significant delay, confirming the reliability of the wireless communication architecture utilized in the proposed system. Figure 9 shows the real-time physiological data shown correctly on the smartphone interface without communication failures.

Overall, the developed IoT Fitness Jacket demonstrated reliable performance for real-time physiological monitoring. The mathematical formulations presented in Equations (1)–(4) were successfully implemented in the Arduino-based processing system to calculate physiological parameters and evaluate measurement accuracy. The experimental results validate the effectiveness of the proposed mathematical models for real-time wearable health monitoring applications.

Figure 10 illustrates the percentage error values for the heart rate measurement obtained from all participants. The percentage errors remained within an acceptable range for wearable health monitoring applications. The relatively uniform error distribution shows the stable performance of the proposed system and its good agreement with the reference medical device.

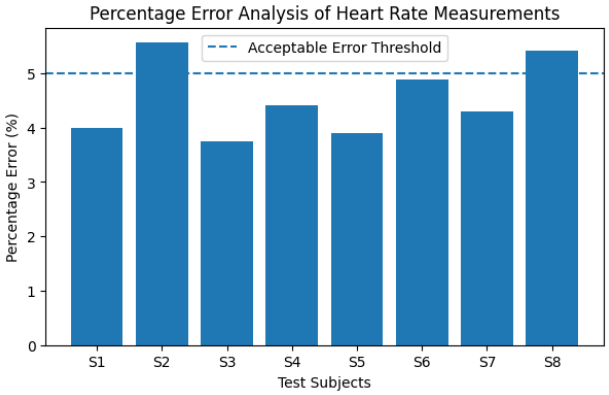


Figure 10. Percentage error analysis of heart rate measurements

Under controlled experimental conditions, the proposed system showed satisfactory agreement with certified commercial medical devices, confirming its appropriateness for non-clinical personal healthcare and fitness monitoring applications. Moreover, its low-cost implementation and portable wearable design make it a practical solution for continuous daily health and fitness monitoring.

Although the proposed system demonstrated satisfactory performance, several limitations were identified during experimental testing. Motion artifacts and inconsistent sensor placement may affect signal stability during dynamic movements. Future work will focus on implementing advanced signal filtering techniques, miniaturizing the hardware platform, integrating cloud-based data storage, and incorporating additional physiological sensors to further improve system performance, monitoring accuracy and user convenience.

V. CONCLUSION

In this research, IoT-based Fitness Jacket for real-time heart rate and body temperature monitoring was successfully designed, developed, and validated using Arduino technology. The developed system demonstrated stable performance, acceptable measurement accuracy compared with a commercial digital pulse oximeter and digital temperature, and reliable Bluetooth communication for real-time data transmission. The integration of sensing, processing, and wireless communication within a wearable platform shows the possibility of developing low-cost smart garments for personal health and fitness monitoring applications.

To future enhance system performance, future work should focus on improving motion artifact filtering to increase heart rate measurement accuracy during physical activity. Additional improvements may include miniaturizing the hardware to enhance user comfort, integrating cloud-based data storage to support remote monitoring, and incorporating additional physiological sensors, such as blood oxygen sensor(SpO_2) and physical activity sensors. These enhancements would improve system's scalability, usability, and overall performance in real-world health and fitness monitoring applications.

ACKNOWLEDGMENT

The authors wish to acknowledge Universiti Teknologi Mara (UiTM) Johor Branch, Pasir Gudang campus for providing the research platforms and facilities.

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest regarding the publication of the paper.

AUTHOR CONTRIBUTION

All authors contributed equally to the conception and design of the study, data collection and testing, analysis, and manuscript preparation.

REFERENCES

[1] S. Abdulmalek et al., "IoT-Based Healthcare-Monitoring System towards Improving Quality of Life: A Review," Healthc., vol. 10, no. 10, 2022, doi: 10.3390/healthcare10101993.

[2] M. K. Bin Nor, N. Bin Hassim, and I. Bin Hindustan, "Low-Cost Multi-Parameter Vital Sign Monitoring Using Arduino and IoT Alerts," Int. J. Res. Innov. Soc. Sci., vol. IX, no. XII, pp. 2787–2794, 2026, doi: 10.47772/ijriss.2025.91200210.

[3] S. D. Mamdiwar, R. Akshith, Z. Shakruwala, U. Chadha, K. Srinivasan, and C. Y. Chang, "Recent advances on iot-assisted wearable sensor systems for healthcare monitoring," Biosensors, vol. 11, no. 10, pp. 1–37, 2021, doi: 10.3390/bios11100372.

[4] N. Singh, A. Prince, S. Chattopadhyay, R. Patra, and B. Mukherjee, "Design of a Real-Time Heart Rate Monitoring System Using Photoplethysmography and Smartphone," 2018 15th IEEE India Counc. Int. Conf., pp. 1–4, 2018, doi: 10.1109/INDICON45594.2018.8987163.

[5] T. Khatib, A. Mohamed, and K. Sopian, "A software tool for optimal sizing of PV systems in Malaysia," Model. Simul. Eng., vol. 2012, 2012, doi: 10.1155/2012/969248.

[6] F. A. Jhuma et al., "A Hybrid Photoplethysmography (PPG) Sensor System Design for Heart Rate Monitoring," pp. 1–14, 2024.

[7] J. S. Meena, S. Bin Choi, S. B. Jung, and J. W. Kim, "Electronic textiles: New age of wearable technology for healthcare and fitness solutions," Materials Today Bio, vol. 19. 2023. doi: 10.1016/j.mtbio.2023.100565.

[8] J. Wan et al., "Wearable IoT enabled real-time health monitoring system," Eurasip J. Wirel. Commun. Netw., vol. 2018, no. 1, 2018, doi: 10.1186/s13638-018-1308-x.

[9] A. Angelucci et al., "Smart textiles and sensorized garments for physiological monitoring: A review of available solutions and techniques," Sensors (Switzerland), vol. 21, no. 3. 2021. doi: 10.3390/s21030814.

[10] K. Kwon et al., "Full Body-Worn Textile-Integrated Nanomaterials and Soft Electronics for Real-Time Continuous Motion Recognition Using Cloud Computing," ACS Appl. Mater. Interfaces, vol. 17, no. 5, 2025, doi: 10.1021/acsami.4c17369.

[11] A. Ahmed, M. M. Khan, P. Singh, R. S. Batth, and M. Masud, "IoT-based real-time patients vital physiological parameters monitoring system using smart wearable sensors," Neural Comput. Appl., vol. 35, no. 7, 2022.

[12] A. Saw, "IOT Based Health Monitoring System Using Arduino and Generic ESP8266," Int. J. Sci. Res. Eng. Manag., vol. 09, no. 04, 2025, doi: 10.55041/ijsrem45019.

[13] A. Servati, L. Zou, Z. Jane Wang, F. Ko, and P. Servati, "Novel flexible wearable sensor materials and signal processing for vital sign and human activity monitoring," Sensors (Switzerland), vol. 17, no. 7. 2017. doi: 10.3390/s17071622.

[14] F. Khoshmanesh, P. Thurgood, E. Pirogova, S. Nahavandi, and S. Baratchi, "Wearable sensors: At the frontier of personalised health monitoring, smart prosthetics and assistive technologies," Biosensors and Bioelectronics, vol. 176. 2021. doi: 10.1016/j.bios.2020.112946.

[15] H. Lee and K. Baek, "Developing a smart multifunctional outdoor jacket with wearable sensing technology for user health and safety," Multimed. Tools Appl., vol. 80, no. 21–23, 2021, doi: 10.1007/s11042-021-11166-7.

[16] M. H. Bhuyan and M. Hasan, "Design and Simulation of Heartbeat Measurement System Using Arduino Microcontroller in Proteus," vol. 14, no. 10, pp. 350–357, 2020.

[17] V. R. Parihar, A. Y. Tonge, and P. D. Ganorkar, "Heartbeat and Temperature Monitoring System for Remote Patients using Arduino," vol. 6495, no. 5, pp. 55–58, 2017.

[18] S. Sarkar, S. Roy, S. Roy, and S. Chakrabarty, "Portable Heart Rate Monitor Using Arduino and," no. January, 2025.

[19] S. Srusti, M. P. Trupthi, S. Smitha, and N. R. Meghana, "Heart Rate Monitoring System using Finger Tip through Arduino and Processing Software," vol. 6, no. 13, pp. 1–4, 2018.

[20] M. M. Khan, T. Tazin, and T. Hossain, "Development of Wireless Monitoring System for Pulse Rate : A New Approach †," 2020, doi: 10.3390/ASEC2020-07524.