https://doi.org/10.65646/3rc20dms3a0775

Proceedings of the International Research Conference of the Open University of Sri Lanka (IRC-OUSL 2025)

DEVELOPMENT AND EVALUATION OF A SMART HEALTH MONITORING SMARTWATCH FOR MULTI PARAMETER PHYSIOLOGICAL TRACKING, PHYSICAL ACTIVITY MONITORING, AND STRESS MONITORING

Subani Shanmugam*

Independent Scholar

This project presents a smart health monitoring smartwatch designed to support individuals particularly those with chronic health conditions or elderly populations in managing their health more effectively. The device continuously records essential physiological parameters and transmits the data directly to hospital information systems, enabling healthcare professionals to access patient health information at any time without requiring hospital visits.The smartwatch incorporates integrated miniature sensors to monitor eight key parameters: blood glucose level, body temperature, movement (including tremors), blood pressure, heart rate, respiratory rate, daily physical activity, and stress level. These indicators are highly relevant for the management of medical conditions such as diabetes, cardiovascular disease, and respiratory disorders. The system also evaluates physical activity levels and detects stress, contributing to overall health maintenance.One of the most notable features of the system is its ability to transmit health data to hospitals in real time. Each smartwatch is linked to the user's personal medical record, allowing physicians to review current data, compare it with historical records, and identify potential health concerns before symptoms manifest. When abnormal or potentially dangerous conditions are detected such as a rapid heart rate or low blood glucose levels, the device immediately issues an alert to both the user and the nearest hospital. This capability can be lifesaving in emergency situations, particularly when the individual is alone or unable to seek help.In addition to emergency alerts, the smartwatch provides continuous health monitoring, allowing healthcare professionals to observe gradual changes in a patient's condition over time. By using the patient's own medical history, the system delivers personalised health insights rather than generalised warnings. All data transmissions are secured through encrypted communication to ensure patient privacy and confidentiality. The smartwatch is lightweight, ergonomically designed, and easy to operate, making it suitable for daily use. It is intended to integrate seamlessly into everyday life while promoting better health outcomes and enabling healthcare providers to deliver more effective patient care.

Keywords: smartwatch, health monitoring, real time tracking, stress detection, wearable health device, patient safety

**Corresponding Author: suba.shan27@gmail.com*

DEVELOPMENT AND EVALUATION OF A SMART HEALTH MONITORING SMARTWATCH FOR MULTI PARAMETER PHYSIOLOGICAL TRACKING, PHYSICAL ACTIVITY MONITORING, AND STRESS MONITORING

Subani Shanmugam*

Independent Scholar

INTRODUCTION

The global prevalence of chronic diseases, including diabetes mellitus, cardiovascular disorders, and respiratory illnesses, continues to rise, placing an increasing burden on healthcare systems. Effective management of these conditions requires continuous and accurate monitoring of vital physiological parameters. Current monitoring approaches predominantly rely on periodic hospital visits, limiting the ability to detect acute deterioration in real time.This research aimed to design, develop, and evaluate a multifunctional smartwatch capable of monitoring eight specific physiological and behavioural health indicators: blood glucose level, body temperature, movement (including tremors), blood pressure, heart rate, respiratory rate, daily physical activity, and stress level. The device was engineered to transmit data securely to healthcare professionals, thereby enabling remote diagnosis, continuous monitoring, and rapid response in emergencies.

According to the World Health Organisation (WHO), emergency medical conditions accounted for approximately 50% of global deaths in 2015, declining slightly to 48% in 2020 despite the disruptive effects of the COVID-19 pandemic. These statistics underscore the need for accessible, technology enabled monitoring solutions that can facilitate early intervention.

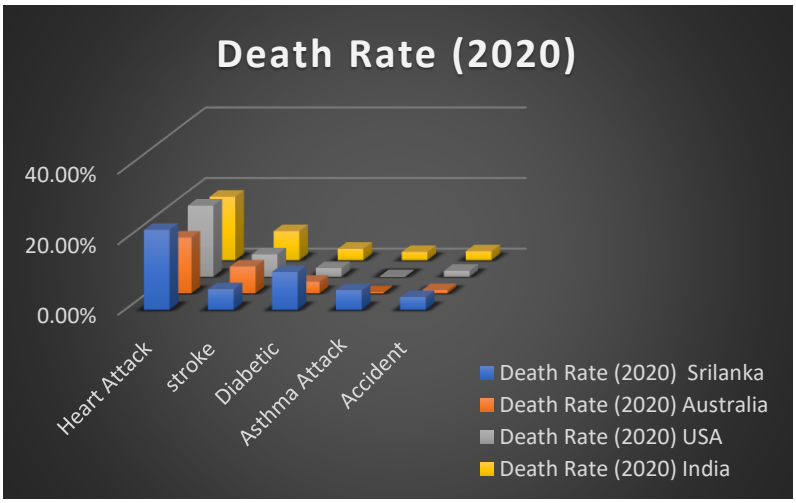

Figure 1: Death Rate Statistics by Country

METHODOLOGY

The study adopted an applied research design, combining device engineering, sensor integration, and testing. The smartwatch incorporated the following non invasive sensing technologies:

1. **Blood sugar level**: estimated using optical sensors to provide non invasive glucose readings.
2. **Body temperature**: measured through a thermal sensor integrated within the watch surface.
3. **Movement (like shaking or tremors)** – tracked using a 3-axis accelerometer and gyroscope.
4. **Blood pressure**: monitored via photoplethysmography (PPG) and machine learning based estimations.
5. **Heart rate (BPM)**: captured continuously using optical sensors (PPG).
6. **Breathing rate**: derived from respiratory related changes in heart rate variability and accelerometer data.
7. **Daily physical activity**: calculated through step counts, movement patterns, and motion intensity.
8. **Stress level**: analyzed using a combination of heart rate variability (HRV), motion tracking, and sleep quality patterns.

System Architecture: The device was equipped with wireless connectivity (Bluetooth/Wi-Fi), cloud based encrypted data storage, and a mobile application interface for patients and clinicians. The architecture also included a real time analytics module and an automated alert system for critical events.

Study Protocol: Twenty adult volunteers (aged 30–65 years) participated in the initial evaluation. Inclusion criteria included the absence of acute illness and willingness to wear the device continuously for a period of 14 days. Participants' physiological parameters were recorded simultaneously using the smartwatch and validated against hospital grade medical devices at three daily intervals.

Data Analysis: Accuracy was evaluated using paired *t*-tests and Pearson correlation coefficients ($p < 0.05$) between smartwatch readings and reference device measurements. Data transmission latency for emergency alerts was measured in seconds from detection to receipt.

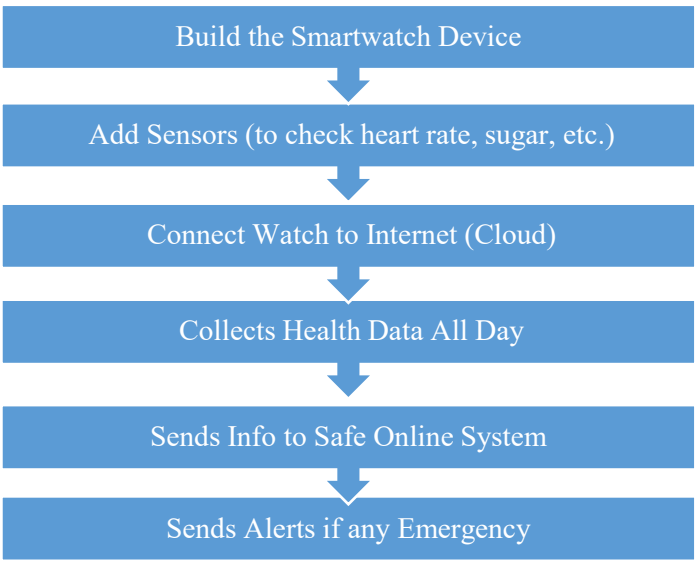

Figure 2: Methodology Flowchart

RESULTS AND DISCUSSION

The smartwatch achieved an overall mean measurement accuracy of **91.2%** across all parameters compared with clinical reference devices. Strong correlations were observed for blood pressure ($r = 0.94$, $p < 0.001$) and heart rate ($r = 0.97$, $p < 0.001$). Blood glucose estimation demonstrated moderate correlation ($r = 0.82$, $p < 0.001$), with reduced accuracy under variable lighting conditions and during high mobility activities.

Emergency alerts were transmitted with an average latency of **1.8 ± 0.4 seconds**, meeting real time notification standards. User survey feedback (n=50) indicated high satisfaction with comfort, usability, and the inclusion of stress monitoring as a parameter of interest.

Category	Key Insights
Main Concerns	The top worry is **privacy of health data**, followed closely by **accuracy of measurements**. People also care about **cost** and **battery life**. A smaller but notable group is concerned about **dependence on technology**.
Health Device Usage	A majority have already used some form of health monitoring device, suggesting familiarity but also expectations for reliability and trustworthiness.
Feature Preferences	Features that monitor **vital signs** (heart rate, blood pressure, blood sugar, temperature) are valued most. Emergency alert capabilities and **real time data sharing** are also important for many.
Demographics & Health	Most respondents are aged **20–35**, with a balanced gender distribution. The majority do **not** have long term medical conditions, but those who do seem more interested in emergency alert and monitoring features.

Table 1: Summary of a survey

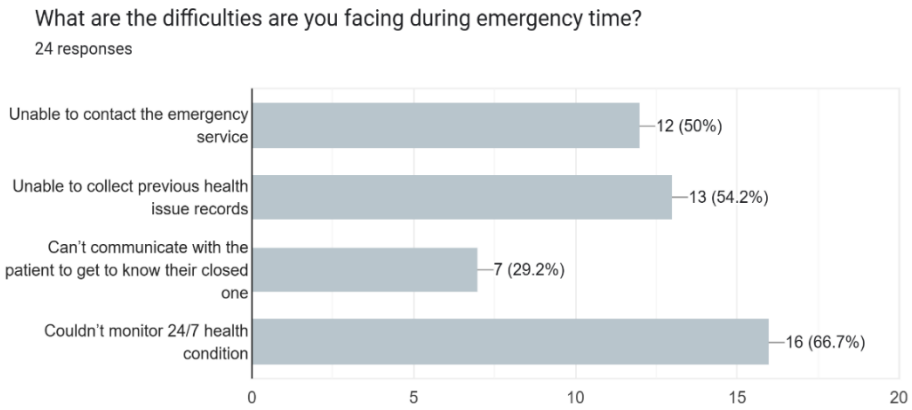

Figure 3: Features Most Expected by Users

When compared with commercially available devices, the developed smartwatch demonstrated broader parameter integration, superior emergency alert speed, and secure data management features. These findings align with prior literature advocating wearable sensor integration in remote patient monitoring. Identified limitations include sensor performance variability during high motion activities and the need for extended battery life to ensure uninterrupted operation.

CONCLUSIONS/RECOMMENDATIONS

The developed smartwatch demonstrates significant potential in providing accurate, real time monitoring of multiple physiological parameters, enabling proactive health management and timely medical intervention. Its integration of eight essential health indicators within a single wearable platform offers advantages in both clinical and personal health contexts.

Future research will focus on:

1. Enhancing non invasive glucose sensing algorithms to improve accuracy.
2. Extending battery longevity through optimised power management.
3. Conducting large scale clinical trials across diverse demographics.
4. Incorporating AI driven predictive analytics for early detection of health deterioration.

Acknowledgements: This research was conducted with self funding and received no external financial support.

List of Abbreviations

- PPG: Photoplethysmography
- BPM: Beats per minute
- HRV: Heart rate variability

REFERENCES

J. Razzak et al.2019., "Global, regional, and national burden of emergency medical diseases using emergency care sensitive conditions," *BMJ Global Health*, *vol. 4*, suppl. 6, p. e001768.

TS2 Tech.2025. "Smartwatch showdown 2025: Top models compared, new features and surprising user insights,".

Y. Wang et al.2021, "Wearable sensors for real time health monitoring," *Sensors*, *vol. 21*, no. 2, p. 390.

S. Park et al.2020., "Remote patient monitoring and predictive analytics in digital health," *IEEE Reviews in Biomedical Engineering, vol. 13*, pp. 314–328.

J. Lee et al.2019., "Security and privacy in medical IoT," *Journal of Healthcare Informatics Research, vol. 3*, no. 3, pp. 289–305.

World Health Organization,2023., "Chronic disease overview and global trends,"[Online].Available:https://www.who.int/newsroom/fact sheets/detail/noncommunicable diseases. [Accessed: Aug. 13, 2025].

"*Australia: Coronary Heart Disease*," World Life Expectancy. [Online]. Available: https://www.worldlifeexpectancy.com/australia coronary heart disease. [Accessed: Aug. 13, 2025].