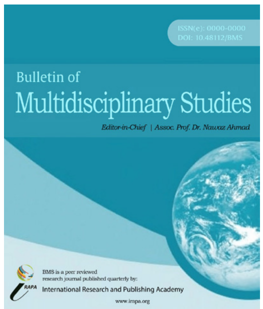
05-39-BMS-6407-1169

Bulletin of
Multidisciplinary Studies
Vol. 2 No. 4 | October – December, 2025 | 379-385
ISSN(e): 3007-0619 | ISSN(p): 3007-0600
DOI: https://doi.org/10.5281/zenodo.18253603



Original Article

Comparison between Fitbit's Charge HR and Microlife's Wrist Watch for Healthcare

Article history:
Received: October 11, 2025
Revised: December 07, 2025
Accepted: December 15, 2025
Published: December 31, 2025

Hina Ali[*1] (*Corresponding Author*)
Department of Software Engineering
Mehran University of Engineering and Technology, Hyderabad, Pakistan
https://orcid.org/0009-0008-8550-078X
hinaabdullah04@gmail.com

Din Muhammad Sangrasi (Ph.D)[2]
Department of Software Engineering
Mehran University of Engineering and Technology, Hyderabad, Pakistan
din.muhammad@faculty.muet.edu.pk

Authors' Biography

1 She is a Lecturer at the Department of Software Engineering, Mehran University of Engineering and Technology, Hyderabad, Pakistan. She is currently a PhD Scholar (Information Technology) at the University of Sindh, Hyderabad, Pakistan.

2 He is an Assistant Professor at the Department of Software Engineering, Mehran University of Engineering and Technology, Hyderabad, Pakistan. He obtained his Doctorate Degree in AI from the University of Wollongong, Wollongong, Australia.

JEL Classification: **I11**

How to Cite:

Ali, H., & Sangrasi, D. M. (2025). Comparison between Fitbit's Charge HR and Microlife's Wrist Watch for Healthcare. *Bulletin of Multidisciplinary Studies, 2*(4), 379–385. https://doi.org/10.5281/zenodo.18253603

ABSTRACT

In this study, two commercially available pulse rate monitoring wrist watches, the Fitbit's Charge HR and the Microlife's wrist watch, are compared for testing under a number of controlled situations, including resting and post-physical activity. This study is driven by known variability in wearable heart-rate sensing caused by motion artifacts, sensor location, and physiological variances, as described in previous validation studies, rather than assuming measurement errors. Therefore, the absence of context-specific comparative assessments of consumer-grade pulse monitoring devices among local populations and real-world usage situations is the research gap that this study attempts to fill. This study attempts to quantify accuracy discrepancies, uncover scenario-dependent performance variances, and give empirical evidence to support these findings by methodically comparing Fitbi's Charge HR and Microlife's wrist watch readings against standardized reference values. Accuracy is measured by testing strategies, testing strategies which are used in this research work are Black-box testing. Black-box testing methods include both hardware testing and software testing.

Keywords: *Black box testing, Fitbit's Charge HR, Healthcare devices, Microlife's wrist watch, Pulse rate, Sensor testing*

INTRODUCTION

Wearable technology is the advanced scheme which is simple attached to human body and that device works as data acquisition agent. Wearables include various devices like wrist watch, glasses, ring, shoes etc. Applications of wearable's can be viewed in entertainment, healthcare, tracking etc. (Mutz et al., 2003). Initially, wearable devices were analogue then they were modified to digital then to single functioned wearable device than to the devices were made connected but some time connected wearable devices with cellular devices. Now the devices are in market which provide full time connection with cellular system (Bonato, 2005). There are lots of wearable devices with different functionalities and with different operating systems like android, iOS, Tizen etc. Now a day's android and iOS are becoming more popular because of their user known and user-friendly environment and their connectivity with other electronic devices like mobile and laptops.

Wide variety of wearable devices is available in market. Healthcare wearable's reserve highest rate of manufacturing and shipment according to survey. Fitness and medical devices are two main groups in healthcare gadgets. These gadgets offer services like health intense care and cure (Rossi et al., 2003). Researchers in medical discipline are working to advance the precision level and consistency. In this regard handy devices can be helpful to increase the correctness of the facts by applying intelligent algorithms and clinical trials (Jafri & Ali, 2014). At present healthcare industry has adopted wearables for asthma monitoring, back therapy, blood pressure nursing, pulse rate monitoring etc.

As it is mentioned earlier that wearable devices are being for lots of purposes but according different survey reports healthcare wearable devices reserve highest rate of manufacturing and shipment (Mendis et al., 2011). Fitness and medical devices are two main groups in healthcare wearable devices. Now days various researchers are focusing on wearable devices and its medical application (Sarkar & Das, 2025; Lam et al., 2021). Researchers in medical discipline are working to advance the precision level and consistency. In this regard handy devices can be helpful to increase the correctness of the facts by applying intelligent algorithms and clinical trials (Hu et al., 2024; Lam et al., 2021). At present healthcare industry has adopted smart wearable devices for asthma monitoring, back therapy, blood pressure nursing, pulse rate monitoring, glucose level monitoring, sleep calculation etc. (McGill Jr, et al., 2008).

When it comes to the yearly sales of wearable devices, smart watches top the list. There are numerous smart wearable devices existing in the marketplace; these devices demonstrate exclusive features like health measurement, entertainment, exchange of data, storage, biofeedback indicating emotions etc. Smart watch models may rely on smart sensors, chips, storage media, short-range wireless devices such as Bluetooth or local Wi-Fi setups. Smart watches are heavily being used in healthcare industry and several manufacturing corporations like Samsung, Apple, Fitbit, Microlife etc produce very good quality smart watches (Hu et al., 2024; Sarkar & Das, 2025).

Smart watches use different hard ware and software techniques to predict, measure, and monitor health parameters (Jafri & Ali, 2014; Capela et al., 2016). In Hardware techniques of smart watches medical sensors play a critical role, as they collect health-related information that can be used to elaborate diagnostics in real-time of human health conditions and that information is stored in smart watch memory in form of health care data. Software techniques include response time testing, accuracy testing and error rate testing etc. (Park & Jayaraman, 2003). Cardiovascular diseases have the highest mortality rate in the world according to sources like World Health Organization (WHO), Pakistan Medical organization (PMO), Agha khan hospital etc. Cardiac diseases are diagnosed by monitoring pulse rate. For pulse rate measurement different conventional methods, electronic devices and wearable devices are utilized (Sarkar & Das, 2025; Wahbah et al., 2014). The pulse is an essential metric that is commonly employed in determining an individual's health, particularly overall cardiovascular (CV) health (Hu et al., 2024).

Our research is mainly focusing on wearable s used for measuring pulse rate. We have considered two devices Fitbit Charge HR and Microlife's wrist watch for testing. Fitbit's Charge HR is selected because it has highest rate of shipment globally (Hu et al., 2024) and Microlife wrist watch has large market in Pakistan (Lam et al., 2021) and these both devices are budget friendly. We have conducted Black-box testing on both devices and compared average readings with manual readings of pulse rate at different time intervals to check the accuracy level and error rate of the products. Readings are obtained through one-on-one interview and questioner from user. After that all hardware and software testing methods were applied. The article highlights uniqueness via local population testing and controlled scenario comparison, placing results in the context of global validation investigations.

LITERATURE REVIEW

Several tests have been conducted in earlier research works focusing on health care wearable devices (Rossi et al., 2003). Park and Jayaraman, (2003) have discussed the key challenges faced in medical industry. Then, they have described the implementation of wearable motherboard (Smart Shirt) an advanced technique to monitor the health parameters directly or distantly aiming at improving the excellence of human life (Hass, 2014). Deshmukh and Shilaskar (2015) have emphasized the developments in biomedical field. Because wearable sensors continuously perform intensive care of sensitive health variables related to cardiac diseases (Mutz et al., 2003). Jayanth et al. (2017) have proposed a scheme that will generate alerts for the patient to take medicine it also monitors the heart rate of the patient. The minute device will encounter irregularity in the pulse rate device will generate warnings for medicine intake (Cem Kaner, 2006).

METHODOLOGY

Comparative testing analysis has been performed to evaluate the correctness of the wearable. We have performed Black-box testing which involves software and hardware testing. Software testing involves performance testing, accuracy testing and usability testing. On the other side hardware testing consists of sensor comparison, wrist belt comparison and screen comparison. For conducting performance testing pulse rate readings were obtained using manual system, Fitbit hr and Microlife charge wrist watch. Average readings were acquired by merging all the results of users which were collected at different time intervals.

The timings were 10:00 am; 1:00 pm, 5:00 pm, and 9:00 pm. Pulse rate readings were gathered considering the following details pulse rate after meal, after walk/exercise. Readings were obtained from 20 users, 6 readings per day were gained so total 1800 reading were recorded for 15 days. Testing data was gathered from users whose age was between 20 and 70, heart and non-heart patient, masculine and feminine. Subsequently average readings were obtained from both devices for comparison with manual readings of pulse rate. Readings from users were obtained through one-on-one interview and questioner.

Black-Box Testing

To evaluate both wearable devices, Black box testing is done that include both software and hardware testing; black-box testing is external and functional testing of both devices. Low chance of false positives.

Software Testing

We have analyzed the performance based on response time, accuracy test and usability.

Response Time

Figure 1 displays the total time taken by the device to respond the action performed, illustrating the response time of Fitbit hr and Microlife Wrist Watch. Elapsed time of microlife device is about 30 seconds and 3 seconds for that of Fitbits charge and 60 seconds for manual pulse rate check.

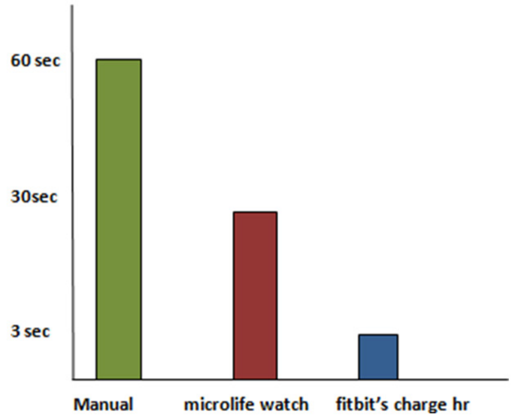


Fig. 1. Response Time

Accuracy Testing

The procedure of finding the correctness of the device by calculating error rate and standard deviation.

Average Error Percentage

Error rate was the difference between the actual result ant the desired result (Rodriguez et al., 2014). Error rate is calculated as:

$$Error\ rate = \frac{(MEASURED - ACTUAL)}{ACTUAL}$$

Error rate of Microlife Wrist watch is 18.5% and 4.3% is the rate for Fitbit Charge HR (Figure 2).

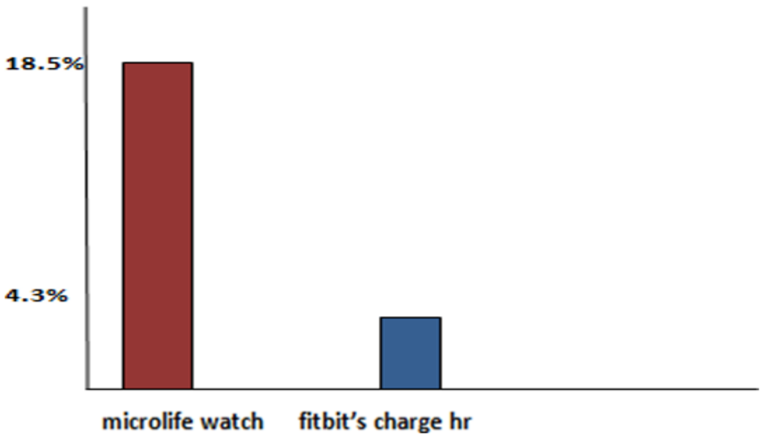


Fig. 2. Error Rate

Findings after Exercise and Meal

Figure 3 shows that error rate of Microlife wrist watch is much higher than that of Fitbit HR in both modes.

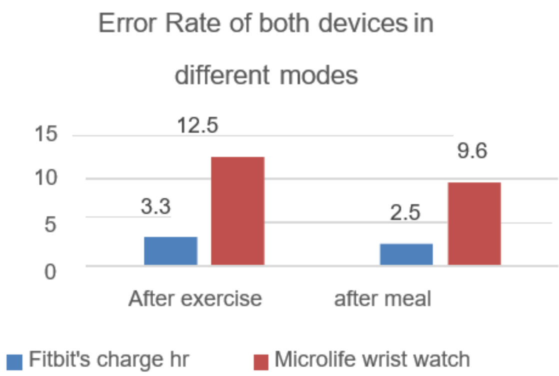


Fig. 3. Error Rate at Different Modes

Findings for Heart Patients and Non-Heart Patients

Figure 4 shows that error rate of Microlife's wrist watch is much higher than that of Fitbit's HR in both modes.

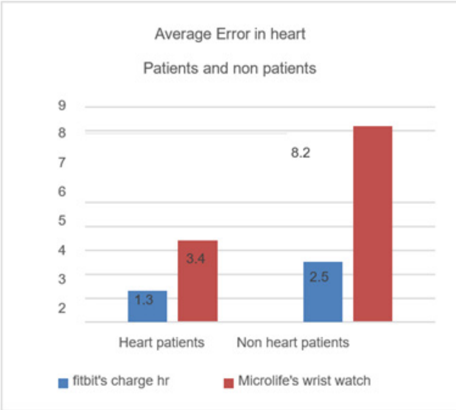


Fig. 4. Error Rate for Heart Patients and Non- Heart Patients

Findings for different Age Groups

Figure 5 shows that error rate of Microlife wrist watch is significantly higher in ages between 15 and 50 than that of Fitbit HR in all age groups. Error rate decreases in pulse rate of people whose age is between 50 and 70.

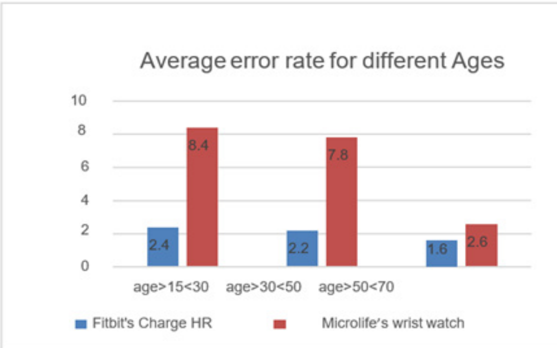


Fig. 5. Error Rate for Different Age Groups

Standard Deviation

Standard deviation is a method to find out the difference between the actual value and the value obtained.

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(x_{i-\mu}\right)^2}$$

$$\mu = \frac{1}{N}\sum_{i=1}^{N}(x_i)$$

In Figure 6, we can clearly see that Microlife's device result stray by 10.47% and Fitbit's result deviates by 4.8% from the desired results.

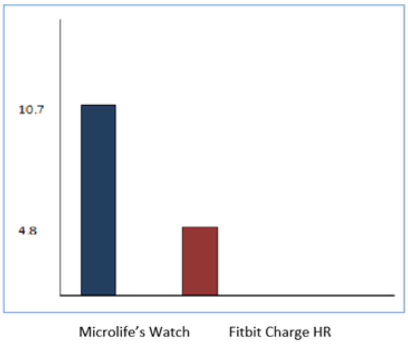


Fig. 6. Standard Deviation

Usability Testing

Usability testing refers to the device that how friendly people can operate the device. Table 1 demonstrates the brief response of the consumers.

Table 1
Users Feedback

Fitbit's Charge HR	Microlife's Wrist Watch
Display screen is small	Display screen is large
Fonts are small	Fonts are large
User interface is unfriendly	User Interface is user-friendly

Hardware Testing

Hardware testing is a technique used in Blackbox testing to evaluate the hardware specifications of the product. Various tests are performed to check the core details of the devices like sensor condition, usability, manufacturing etc. Hardware testing includes sensor, wrist belt and screen display comparison.

Sensors Comparison

In this comparison we have compared the sensors of both devices to check the category and functional details of sensors. Fitbit's Charge HR uses optical heart rate sensor to measure heart rate by optical light sensor that monitors variation in the blood flow in the vessels on the wrist. This sensor proves to be the more reliable sensor in comparison with ECG monitor because it works on light sensor and blood without problem absorbs light. On the other side Microlife's wrist watch uses Pulse Arrhythmia Detection (PAD) sensor to sense the blood pressure and heart rate. It basically uses an algorithm which calculates the heart rate on the basis on rhythm.

Wrist Belt Comparison

Elastomeric material is used in Fitbit's wrist belt is which is mostly used in sports watches. It repels environment agents like dust and water these properties make it reliable. Wrist belt is comfortable to wear because of high quality satin less steel. On other hand simple parachute material is used in Microlife's wrist watch belt. It is not resistant to environment variables.

Screen Comparison

Fitbit Charge HR offers small OLED display so becomes hard for the users to read the resultant values. In contrast Microlife's wrist watch provides large LCD display and user- friendly environment to its users.

CONCLUSION

After conducting Black-box testing we can conclude that Fitbit Charge HR is supplementary stable in all circumstances, whereas Microlife's wrist watch appears unstable in diverse scenarios. Hardware testing shows that Fitbit's Charge HR is more comfortable for user and durable whereas the environment provided by Microlife's wrist watch is more user-friendly. That's why despite all accuracy levels and durability feature Microlife's wrist watch is widely used in Pakistan. According to hardware testing Fitbit's charge is accurate in terms of results generation due to its sensors.

Competing Interest

The author had no competing interests.

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