International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 01 | Jan 2019 www.irjet.net p-ISSN: 2395-0072

Your Health on your Watch - Causes of Wrong Readings

Tejal Dayal[1], Mansi Joshi[2]

[1,2]*Student, Symbiosis Institute of Computer Studies and Research, Pune, Maharashtra, India*

Abstract - *A Fitness Watch, an activity or fitness tracker, also called a Smartwatch, is a device with an application for monitoring and tracking metrics related to fitness like the distance you walk or run, your calorie consumption, your heartbeat and some watches also check your quality of sleep. The objective of this study is to evaluate the accuracy, precision, and overall performance of wearable fitness device and finding out the causes of their wrong readings. Although these smartwatches are meant for fitness, they might mislead you as some of them are very inaccurate that they give you wrong readings about the calories you've burned or the distance you've travelled or your heart rate monitored. In this study we used an MI Band and decided to walk 100 steps by repeating each set 10 times. Data was recorded after each trial compared with direct observation of step counts. The heart rate was also monitored in comparison to OMRON Blood Pressure Monitor (Model HEM-7111). It was found that the device is prone to overestimate and underestimate activities and your heart rates and also register steps while you're carrying about other tasks.*

Keywords: **fitness, accuracy, monitoring, readings, health watch**

INTRODUCTION

Health or Fitness watches refer to smart wearable devices that examine , monitor and record the fitness activity of a person. It's very common these days among people to use health watches to keep a track of their health and maintain their fitness. These days intelligent and advanced technology has come up which can record activity and monitor vital signs such as calorie consumption, fItness activity, pulse, weight, heart rate, oxygen level, and even sleep patterns. These devices use technology like blood-worn sensors and GPS receivers. Health watches with heart-rate monitors, physical activity tracker are popular these days, but are they even accurate enough for people to rely on?

Various bands and health trackers use various algorithms for monitoring the health. The science which helps monitor heart rate in smart watches is Photoplethysmography (PPG). It uses light source and photo detector on the skin surface for measurement of the artery volume. PPG devices detect the variation in reflected light and use it to estimate heart rate[1].

Steps are measured using a pedometer algorithm. Majority pedometer techniques use 3 axis accelerometer data to identify the steps which sometimes turns out to be inaccurate. The Data for measuring the steps is recorded all the time the watch is worn and during that time it traces the activities of the individual even when he is standing still, walking or running fast[2].

The algorithm used to record the distance is the built-in GPS (Global Positioning System) tracker. It tracks how far you've gone and how fast you are moving, during your run time and even after. The GPS uses the network of total of 29 satellites which orbit the earth. To find out a person's location he/she needs to be in the range of any four satellites[3].

METHODS AND PROCEDURES

This study was conducted using a fitness watch device : MI Band 2, worn on the wrist. There are three parameters of this study, which are the physical activity tracker for steps and distance, and the heart rate monitoring. The objective was to evaluate and analyse the overall performance of the health watch based on accuracy and exactness in comparison with the direct observation of parameters included.

We took an approach where we walked 100 steps with a repetition of 10 times for the device to calculate the counting of true steps and calculating the false positive steps which differ based on the stride length, speed and hand movements.

The heart rate was measured by the fitness watch which supports the heart rate monitoring and compared to the OMRON Blood Pressure Monitor (Model HEM-7111) at the same time on the same hand on which the tracker was worn. Ten readings were recorded for the health tracker simultaneously.

The accuracy along with the precision were calculated in this study for each parameter. In this case, the accuracy is the closeness of measured values on the tracker compared to the counting of steps by the observer and the heart rate measurements observed on the device. The data was recorded after each trial and noted for comparison.

DATA COLLECTION

Table-1: Comparison of fitness watch with the manual readings taken for the calculation of steps walked.

Sr.No	Stride	Watch Readings	Actual Steps
1	Normal	97	100
2	Long	119	100
3	Short	25	100
4	Normal	85	100
5	Long	106	100
6	Short	103	100
7	Normal	95	100
8	Long	164	100
9	Short	69	100
10	Normal	58	100

Table-2: Readings for Monitoring heart rate compared with the OMRON Blood Pressure Monitor (Model HEM-7111) machine.

Sr.No	Cases	Machine	Watch Readings
1	Normal	66	65
2	After physical activity	81	100
3	Before eating	96	76
4	After eating	98	97
5	After physical activity	104	66
6	Before eating	68	71
7	After eating	64	57
8	After sleep	84	110
9	Age 50+ (Female)	75	76
10	Age 50+ (Male)	87	88

Table -3: Readings for distance covered

Sr.No	Walk Style	Actual Kms	Watch Readings
1	Normal	1.5	1.6
2	Brisk	1.5	1.2
3	Running	1.5	1.9
4	Normal	1.5	1.4
5	Brisk	1.5	1.6
6	Running	1.5	1.4
7	Normal	1.5	1.5
8	Brisk	1.5	1.8
9	Running	1.5	2.0
10	Normal	1.5	1.3

ANALYSIS

Interpretation for Table 1:

For the comparison of the fitness watch with the actual calculation of steps walked, we did a study where we walked 100 steps each and repeated each set 10 times. These 10 sets were differentiated by the stride length of the steps in three categories, Normal Strides , Long Strides and Short Strides. It was seen that the normal stride length of steps was not very inaccurate but close to the actual manual readings. Whereas in the long strides, the watch overestimated the steps walked and gave incorrect readings. When short strides were taken

for walking, the watch had difficulty to monitor the steps and underestimated the readings. Many steps in these readings were also calculated with normal hand movements in other activities other than walking.

Interpretation for Table 2:

For the comparison of readings for heart rate monitoring observed by the watch and the Machine. We used the OMRON Blood Pressure Monitor Model HEM-7111. In this study, we took different cases like normal heart rates, heart rates checked before and after eating, heart rates checked after carrying out physical activities and different age group and gender monitoring of heart rates. It was seen that the machine and the watch showed almost similar readings for normal checking of heart rates. Whereas when it was checked after physical activity in some cases the watch overestimated the reading compared to the machine and some cases it underestimated the readings compared to the machine. This shows that the readings are not precise and accurate as they differ depending on various cases.

Interpretation for Table 3:

For the comparison of the distance calculation in the watch with the actual distance we covered a distance of 1.5kms, repeating this set 10 times. These sets were categorised in three different categories which was normal walking, brisk walking and running. It was seen that the watch was somewhat accurate for the normal walk readings in terms of difference. But for the readings of distance for brisk walking the watch underestimated the distance and also overestimated it while running. This shows that the various types of walking also affects the readings along with motion interference of the building around the area.

CAUSES OF WRONG READINGS

The purpose of this study is to sum up the reliability and validity of the wearable fitness activity tracker. To check how precise their ability is to estimate steps, distance, physical activity and heart rate monitoring. The watches give you results but they are often not very accurate. There are various causes of these wrong readings.

One of the causes is the Apps algorithm. The software in the watch can overestimate and underestimate many of the readings giving inaccurate results. [4]

The harder a person exercises, the less accurate and reliable the trackers become. It was seen that there was more variability in the result accuracy as the intensity of the exercise went up or increased.

There are also issues with the motion interface. If there are tall buildings or tunnels on the way or in the surrounding of the person the GPS tracker can be baffled or foxed. The atmosphere also affects the readings of the watch.

For the count of steps walked, the devices treat the hand movements of people differently. If you wave your hands a lot while doing any activity they could be credited in the device for additional steps differently depending on the device[5].

For the calculation of distance, there is difference in the walking when you are indoors and outdoors which causes faulty readings. As people have different walking speeds and different leg lengths, the device has to consider the stride lengths which are calculated differently for different people. A GPS inclusion in the watch does not always give reliability because of various circumstances.

Fitness watches worn on the wrist use PPG (Photoplethysmography) to monitor the heart rate. It measures the artery volume. This makes use of light to measure the pulse. This is done by shining a light into the blood vessels inside the persons wrist, which then detects the changes in the blood volume occurring each and every time your heart beats and pushes blood through your body. Blood in the arteries absorbs light better than the tissues surrounding the body. The intensity of the light reflected rises and falls, when the arteries contract and swell to reciprocate the pulsating blood pressure[6].PPG devices detect this variation in reflected light and use it to estimate heart rate. The wrong readings in this monitoring are seen when people exercise or move up and down or around a lot. There is interference in the measurements because of factors like ambient light and movement of a person's muscles. Sometimes even various skin tones can show difference in the result readings.

CONCLUSION

High intelligent technology has made it easy to track your fitness but these recorded activities of steps , distance and monitoring heart rates are not always reliable. This study focused on the accuracy of the results from a fitness and activity wrist-worn tracker by conducting activities highlighting the causes of the wrong readings. It was found that the physical movements of a person cause different effects on the readings obtained from the watch. Small movements can make a lot of difference in the actual calculations in comparison to the watch readings. Simple hand movements for activities other than walking are assumed as steps by the watch's algorithm which increase the step counts without actually walking[5].The stride lengths of various individuals show different results which would be a wrong basis for tracking the activities. It can also cause difficulty making the weaker pulse signal impossible to detect. There are signal losses caused by a person's movement at the sensor-skin interface which makes it simple to mask the pulse signals by just walking. It is also very difficult when there is a corrupted PPG signal to estimate heart rate in terms of accuracy[7]. The motion interference overlap with the heart signals which combines to give inaccurate readings.

FUTURE SCOPE

There is a need to reduce and eliminate the chances of getting incorrect readings for steps walked along with distance and the heart rate monitoring.To reduce the incorrect readings of the heart rates we can use a strategy which is to stop the recording or not take the readings where there are less or very high levels of motion interference. It is not easy to detect when the signal is corrupted. Inevitably, some bad estimates of heart rate will be recorded in error. There is also a need to eliminate the recordings of the steps when no activities are carried out. The consistency varies depending of the different devices based on the level of activity[8].

ACKNOWLEDGEMENT

We are indebted to our institute Symbiosis Institute of Computer Studies and Research for letting us pursue this research.

This would not have been possible by the support of our faculty Mr. Supratik Ghatak who has actively helped us with all the academic time and help to complete this paper. As our mentor he has taught us more that we can thank him for.

We are grateful for all those with whom we have had pleasure working with during this research paper.

Nobody has been more important to us in the completion of this project than the members of our family. We would like to thank our parents, whose love and guidance are with us in whatever we pursue.

REFERENCES

[1]https://www.independent.co.uk/life-style/health-and-families/health-news/heart-rate-monitor-unreliable-fitbit-garmin-health-science-technology-a8413196.html

[2]https://www.news-medical.net/health/How-do-wearable-fitness-trackers-measure-steps.aspx

[3]https://www.digitaltrends.com/wearables/whats-inside-fitness-tracker-anyway/

[4]ElAmrawy, Fatema & Nounou, Mohamed. (2015). Are Currently Available Wearable Devices for Activity Tracking and Heart Rate Monitoring Accurate, Precise, and Medically Beneficial?. Healthcare Informatics Research. 21. 315. 10.4258/hir.2015.21.4.315.

[5]Evenson, K. R., Goto, M. M., & Furberg, R. D. (2015). Systematic review of the validity and reliability of consumer-wearable activity trackers. International Journal of Behavioral Nutrition and Physical Activity, 12(1), 159.

[6]https://www.wareable.com/fitness-trackers/how-your-fitness-tracker-works-1449

[7]https://www.livescience.com/56459-fitness-tracker-heart-rate-monitors-accuracy.html

[8]https://www.which.co.uk/news/2018/09/why-are-some-fitness-trackers-so-inaccurate/

AUTHORS

[1]**Ms. Tejal Dayal** (BBA in Information technology, pursuing MBA in Information Technology), Symbiosis Institute of Computer Studies and Research

[2]**Ms. Mansi Joshi** (BBA in Information technology, pursuing MBA in Information Technology), Symbiosis Institute of Computer Studies and Research