Using Smartwatches to Improve Health and Wellness

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Introduction

A smartwatch is a computing device that resembles a wristwatch and is attached to a band worn around your wrist. In the last century, the wristwatch replaced the pocket watch as a more convenient device to get at time information quickly (Darmwal, 2015). Thus, it is no surprise smartwatches are the most popular and useful type of wearable devices, with hundreds of affordable models already available in the marketplace. Smart watches have been used to support health in everyday living by self-monitoring of personal activity, obtaining feedback based on activity measures, identifying patterns of behavior, and supporting bi-directional communication with health care providers and family members. In this paper, I gave an overview of popular smartwatches and selected apps, evaluated the effectiveness of using smartwatches to improve health and wellness, and discussed some of the social, security, and ethical issues involved.

Background

Brief History

The first digital watch was the Hamilton Pulsar P1(Kim, K. J., & Shin, D., 2015). This watch was created by Seiko, a Japanese company, and was the very first digital watch to reach the market. In May 2012, the Pebble, one of the first companies manufacturing smartwatches, had one of the most successful campaigns in the history of crowd funding at the time. They raised more than 10 million dollars in 30 days to fund the development. The Pebble story is evidence of a huge market demand for such technology (Price, 2014).

Hardware Features of Selected Smartwatches

Using wireless communications links (Wi-Fi or Bluetooth), smartwatches connect to a smartphone, host system, or the Internet. Wi-Fi is a short range (typically hundreds of feet) system that typically covers the network operators own property, and is often used by end users

like us to access our own home or school network. Bluetooth is primary used for very short distance (limited to 33 feet) connection such as between a computer and its peripheral devices like keyboard, mouse, phones, and printers. While both being wireless technologies, Bluetooth connects special purpose device over very short distance, such as between a cellphone and its wireless headphones or a paired smartwatch; in contrast, Wi-Fi provides faster data transfer rates thus is used for more general purpose connections between computers and networks (Steinberg, 2015).

In this paper, I compared 4 popular smartwatches that use different operating systems: Apple Watch Series 2, Samsung Gear S3, Huawei Watch, and Pebble 2 (Table 1). I also compared the processor, RAM, storage, battery life, and some other hardware features based on published data (Carte, 2016).

Table 1. Comparing 4 Popular Smartwatches using Different Operating Systems

	Apple Watch Series 2	Samsung Gear S3	Huawei Watch	Pebble 2
Processor	Apple S2	1 GHz dual core	1.2 GHz Qualcomm Snapdragon 400	ARM Cortex M4
Operating System	WatchOS 3.0	Tizen 3.0	Android Wear 1.5	Pebble Firmware 4.2
RAM	1000 MB	768 MB	512 MB	0.256 MB
Storage	8 GB	4 GB	4 GB	0.01 GB
Battery Life	1.5 days	3 days	1.5 days	10 days

Different smartwatches run on different operating systems. Android Wear, which operates the Huawei Watch, is the most common operating system among smartwatches and it's compatible with both iPhone and Android smartphones. Apple Watch uses Apple Watch OS and is only compatible with iPhone. Samsung and Pebble have their own operating systems for their smartwatches: Samsung Gear S3 uses Tizen, and Pebble 2 uses Pebble Firmware.

Not all manufactures disclose the speed of their processors, which reflect the overall performance of the smartwatches. The faster the processors' speed, the faster the watch, and the

more quickly it is able to complete a function the user requested. Most of the smartwatches have a speed slightly over 1 GHz.

RAM, or random access memory, is used by the smartwatches to multitask and handle several operations at once, such as counting steps while playing music. The larger the amount of memory, the better the smartwatch is at handling multiple tasks at once. Most smartwatches have an average of 512 MB of RAM, which is slow compared to smartphones with 3GB of RAM on average. Apple Watch has 1000 MB RAM, while Pebble only has 0.256 MB of RAM. The smaller RAM in smartwatches means that they can only handle simpler operations and run operations more slowly compared to the smartphones.

The average storage capacity for a smartwatch is 4GB. But, for smartwatches, the amount of storage isn't critical because most information is pushed to the smartphone. Apple Watch Series 2 has 8 GB of storage capacity, while Pebble 2 can hold only 0.01 GB of data.

One of the biggest issues with smartwatches is that the batteries within them don't last long before we have to recharge them. The average battery life is about 1 to 2 days at most. For the Apple Watch Series 2 and Huawei Watch the battery life only last for 1.5 days. For the Samsung Gear S3 the battery life last for 3 days. Pebble 2 battery life lasts the longest with 10 days. Pebble 2 has very small RAM and storage space, suggesting that it's not designed to provide many sophisticated functions. As a result, its battery can power it for longer period of time. In contrast, smartwatches provide many sophisticated apps and multimedia functions require faster processor, more RAM and greater storage space, therefore more batter power to operate would have reduced battery life.

Smart watches are an emerging technology. The technical challenges include constraints due to smaller screen size resulting in more restricted input/output, and their smaller room for hardware resulting in weaker computing capability, as well as more limited battery capacity.

Software/Apps Offered to Promote Health and Wellness

While in most cases smartwatches run paired to a smartphone, they still have app stores which enable users to add to the core features of the watch – just like a smartphone. Many health and fitness apps are available on smartwatches. For example, the Runtastic app can track activities and monitor progress. The app can also measure heart rate. Currently, the Runtastic app has an avatar displayed to show the right way of doing each exercise (Buhr, 2015). The WebMD app seems to be a useful tool to promote adherence. The app reminds patients to take their medication and provide instructions how to take the medication. A daily schedule is provided of when to take the medication (Buhr, 2015). The Nike+Running app allows people to connect with its global running community, and log the distance and duration of running (Buhr, 2015). Both Runtastic and WebMD are available for iOS and Android phones, while Nike+Running is only available with iOS.

Smartwatch Uses for Health and Wellness

Reeder and colleagues conducted a systematic review of smartwatch studies that engaged people in their use to improve health and wellness. Seventeen studies published between 2014 and 2016 were included in their review. Most health studies employed the use of consumer-grade smart watches (82%) with Samsung Gear model smartwatches as the most commonly used devices (29%) in studies. Four studies used accelerometers to detect step counts and reported the feasibility of collecting reliable step counts from the device. Three studies used accelerometry to detect seizures or tremors in epilepsy patients. Other studies examined activity

monitoring, heart rate monitoring, speech therapy adherence, diabetes self-management, scratching, eating, and medication-taking behaviors. (Reeder, 2016).

Scientists from Austria developed a smartwatch-based system for elderly for fall detection, inactivity recognition, and medication adherence. The system is also capable of providing a way of manually calling for help. The assistance system consists of a Pebble smartwatch that communicates with an Android smartphone via Bluetooth. In case of emergency situations alerts are sent to configurable emergency contacts via text messages (Deutsch, M., & Burgsteiner, H., 2016).

A group of international scientists developed a diabetes patient self-management tool using smartwatches. The system provided a two-way communication between the applications on the smartwatch and mobile phone for people with type 1 diabetes. The designed smartwatch system using Pebble allows for users to record data on carbohydrates, insulin, and blood glucose, with the option to view previously recorded data. Users were able to record specific physical activities, program reminders, and automatically record and transfer data, including step counts, to the mobile phone version of the diabetes diary. In this study about this tool, users reported usefulness and responded positively toward its functionalities (Årsand, E., Muzny, M., Bradway, M., Muzik, J., & Hartvigsen, G., 2015).

Although studies that employ smart watches for health and wellness applications generally reported encouraging results, they were conducted mainly in studies with small sample sizes, and with no comparison groups. The technical function, acceptability, and effectiveness of smartwatches in supporting of health and wellness have to be confirmed in larger, better studies that include real-world participants.

Some researchers are skeptical about the accuracy of the device in monitoring health and wellness activities, but there has been little evaluation. A study conducted by scientists at the University of Pennsylvania evaluated the accuracy of smartphone applications and wearable devices compared with direct observation of step counts. The scientists found that the relative difference in mean step count ranged from −22.7% to −1.5% for the wearable devices like smartwatches, and −6.7% to 6.2% for smartphone applications, as compared with direct observation. These differences seem acceptable for step counts and the findings helped reinforce individuals' trust in using smartphone applications and wearable devices to track health behaviors (Case MA, Burwick HA, Volpp KG, & Patel MS., 2015).

Security and Privacy

Smartwatches use Wi-Fi or Bluetooth to communicate with smartphones, while Wi-Fi and Bluetooth provide a signal to any computer within the range to receive it. Such open signals can present a security risk because of intercepted data, security breach, or unauthorized use. For these reasons, encrypting wireless signals is needed. Encryption involves disguising the data being transmitted so an intruder is unable to read the data and to understand their contents (Steinberg, 2015).

Smartwatches are vulnerable to cyberattack due to insufficient authentication, and lack of encryption, which also raise privacy concerns. According to a Smart Watch Security Study, some popular watches such as Apple, Samsung, and Sony are easily hacked [Smart Watches: Latest Tech Trend Carries Security Implications] (2016, February17). Retrieved from http://search.proquest.com/pqrl/docview/1765476843/fulltext/C035A89C59F8463EPQ/1?accountid=14541. Smartwatches are equipped with sensors and record personal data. It can also measure a person's physical health such as heart beat and blood pressure. Privacy is a major

concern as companies find ways to collect and use personal health, location and purchasing habits found on the wearable devices of their customers (Lindqvist, 2017).

Some companies have tried to improve security on mobile devices and wearables by equipping them with biometric recognition such as fingerprint readers and iris scanners. For example, Apple's Touch ID on Apple Watch uses fingerprint scanner to perform user authentication. Samsung is also developing their systems specifically relates to a smartwatch performing user authentication using unique bio signals. There are also wearables that authenticate users on the basis of their heartbeat pattern. In the future, other internal signals from the body, such as DNA or the internal microbial community, may be paired with smartwatches so that the devices would unlock only when in close proximity to the owner. With these kinds of improved security, and many upgrades in communications networks, users in the future would stand a better chance in security (Austen, 2015).

Ethical/Legal

Wearables, like smartwatches, can hold considerable amounts of data and their increased market presence has raised various controversial and data privacy concerns, including identity theft, profiling, discrimination, and stalking. However, wearable users are apparently willing to provide their personal data in exchange for the benefits of having a round-the-clock analysis of their health. But is the data held in smartwatches considered as 'personal data' within the legal definition? According to the International Conference of Data Protection and Privacy Commissioners, stated in a declaration in October 2014, big data derived from the IoT should be regarded and treated as personal data [Mauritius Declaration on the Internet of Things]. (2014, October 14). Retrieved from https://icdppc.org/wp-content/uploads/2015/02/Mauritius-Declaration.pdf. Therefore, encryption should be put in place to ensure the data passing over a

network between devices is not subject to tampering. Another challenge is "what's illegal in one country may not be illegal in another." As data move cross servers, clouds, and devices, attempting to understand where data reside and who has claims over data is an impossible task (Greengard, 2015).

Social Implications

The IoT has created webs of connections that transform the way people and things interact with each other. Having a smartwatch is not only for fitness or health monitoring, but communication has been extended to other smart uses. For example, using the Nike+Running app, you are connected with other runners and users to share activity data and motivate each other to run more and better.

The "digital divide" is an issue of economic and social inequality. People who can afford the smartwatches and smartphones could benefit from the technologies to further improve health. However, those who cannot afford the devices won't benefit. Those who lack digital tools are likely to further lack opportunities in education, health, and other aspects of life. The technology magnifies these differences (Greengard, 2015).

Future Use

According to market research, health and fitness will remain a dominant portion of the smartwatch market, providing healthcare workers and hospitals with savings opportunities. As technology and app development advances, the benefits of smartwatches within these segments will become even stronger (Beaver, 2016).

Conclusion

Our technology has improved from what we had in the past of wearing traditional wrist watch to tell time into a piece of technology we can wear on our wrist that can do many more

things. We can now use many functions of our smartphones without needing to get them out of our pockets or purses, including tracking and communicating our health with other people. Indeed, smartwatches have been demonstrated to be feasible and helpful in promoting wellness, disease management, and monitoring biomedical conditions and behaviors, all are important benefits in today's society where maintaining good health and cutting down healthcare related costs are in everyone's mind. Although privacy and security remain important challenges to be resolved, benefits and efficiency from the device still outweigh the concerns, as long as we use this smart technology wisely.

References

Arsand, E., Muzny, M., Bradway, M., Muzik, J., & Hartvigsen, G. (2015). Performance of the first combined smartwatch and smartphone diabetes diary application study. *J Diabetes Sci Technol, 9*(3), 556-563. doi: 10.1177/1932296814567708

This medical study explored the use of smartwatch and smartphone as a diabetes patient self-management tool. The system, including a two-way communication between the applications on the smartwatch and mobile phone, was tested with 6 people with type 1 diabetes. The designed smartwatch system displays the time, day, date, and remaining battery time. It also allows for the entry of carbohydrates, insulin, and blood glucose, with the option to view previously recorded data. Users reported usefulness, responded positively toward its functionalities, and also provided specific suggestions for further development.

Austen, K. (2015). The Trouble With Wearables. *Nature, 525*(7567), 22-24. Retrieved from https://search.proquest.com/docview/1710029842?accountid=14541

This article talks about the security concerns of wearable technology. Wearing wearable technologies depend on a huge amount of data that they access and generate. This article tells us that there are two major problems that researchers and technology developers are struggling with. The first problem is, finding ways to transmit data to and from wearables. The second problem is making sure everyone's information is kept safe. Some companies have tried to improve security on mobile devices and wearables by equipping them with biometric devices such as fingerprint readers and iris scanners.

Beaver, L. (2016, September 27). The Smartwatch Report: Forecasts, adoption trends, and why the market isn't living up to the hype. Retrieved from

http://www.businessinsider.com/smartwatch-and-wearables-research-forecasts-trends-market-use-cases-2016-9

This article examined smartwatch market, including a five-year forecast, key growth trends, market leaders, consumer demand, and more. The articles predicted several trends for the next few years. Demand for smartwatches has cooled as consumers wait for better functionality, but the market could take off when functionality improves. Apple will continue to drive a large portion of the overall market, however, Android Wear devices will quickly catch up as emerging markets begin to adopt the technology. Health and fitness remain a dominant segment of the smartwatch market, providing healthcare workers and hospitals with savings opportunities. As technology and app development advances, the benefits of smartwatches within these segments will become even more robust.

Buhr, S. (2015, April 24). The 22 Best Apple Watch Health And Fitness Apps. Retrieved from https://techcrunch.com/2015/04/24/the-22-best-apple-watch-health-and-fitness-apps/

Many health technology companies have developed apps to promote health and wellness. This article reviewed selected fitness apps available for Apple and Android smartwatches.

Carte, B. (2016, December 06). The Best Smartwatches of 2017 | Top Ten Reviews. Retrieved from http://www.toptenreviews.com/mobile/smartwatches/best-smartwatches/

This article compared and rated 10 popular smartwatches available in 2017. Three top smartwatches – the Apple Series 2, the Apple Watch Series 1, and the Samsung Gear S3, stood out in comparison to other smartwatches, mostly due to their design, battery life and wide range of features.

Case, M. A., Burwick, H. A., Volpp, K. G., & Patel, M. S. (2015). Accuracy of smartphone applications and wearable devices for tracking physical activity data. *JAMA, 313*(6), 625-626. doi: 10.1001/jama.2014.17841

This article talks about a study that is being done on the accuracy of smartphone and wearable devices for tracking physical data.

Darmwal, R. (2015). Wrist wars: Smart watches vs traditional watches. Telecom Business Review, 8(1), 69-79. Retrieved from https://search-proquest-com.mutex.gmu.edu/docview/1845226067?accountid=14541

This interesting article talks about the difference between smartwatches and the traditional watches. The traditional watches are mechanical usage and smartwatches are computerized usage. This article lists various features of smartwatches. The authors also analyzed factors for someone buying a smartwatch. Finally, the article predicts smartwatches will impact the healthcare industry the most driven by the demand of continuous monitoring.

Deutsch, M., & Burgsteiner, H. (2016). A Smartwatch-Based Assistance System for the Elderly Performing Fall Detection, Unusual Inactivity Recognition and Medication Reminding. Stud Health Technol Inform, 223, 259-266.

This article talks about how we should have a smart-watch based assistance system for the elderly. The resulting system is capable of performing fall detection, inactivity recognition, issuing medication reminders and alerting relatives upon manual activation.

Greengard, S. (2015). The internet of things. Cambridge, MA: MIT Press.

Samuel Greengard explains that the Internet of Things is still in its early stages. Smartphones, cloud computing, radio frequency identification, technology, and sensors are converging to make new generation of imbedded technology.

Kim, K. J., & Shin, D. (2015). An acceptance model for smart watches. *Internet Research*, *25*(4), 527-541. Retrieved from https://search-proquest-com.mutex.gmu.edu/docview/1696687790?accountid=14541

This article starts off talking about the first smartwatch which was called Hamilton Pulsar P1. It describes how the technology has improved over years. The digital watches started to become modern smartwatches with a number of smart features and high-computing power. Throughout the rest of the article, it goes into details about if smartwatches are an acceptable wearable technology. The researchers conducted an online survey assessed the proposed psychological determinants of smart watch adoption. The results indicated that the devices' subcultural appeal and cost were notable antecedents of user attitude and intention to use, respectively.

Lindqvist, U., & Neumann, P. G. (2017). The Future of the Internet of Things. Communications Of The ACM, 60(2), 26-30. doi:10.1145/3029589

This article talks about the future of the internet of things and their potential risks. The authors mentioned a few examples of application areas where the use of IoT devices brings inherent risks. Hospitals and healthcare establishments tend to use devices that are already remotely controlled or accessible Things: patient monitors, body scanners, pacemakers, defibrillators, infusion pumps, main and auxiliary power, lighting, air conditioning, and much more. The article also mentions critical infrastructure sectors such as electric power, oil, natural gas, manufacturing, and transportation use IoT devices as sensors and actuators for automation and remote monitoring and control. The controllers themselves may be Internet accessible.

Price, M. (2014, September 11). Here's How the Pebble Smartwatch Became the Most Funded Project in Kickstarter History. Retrieved from

http://www.huffingtonpost.com/michaelprice/heres-how-the-pebble smar_b_5798406.html

This article describes how Pebble started their smartwatch development and business. The reported interviewed Eric Migicovsky, an entrepreneur, about using crowd fund to support starters.

Reeder, B., & David, A. (2016). Health at hand: A systematic review of smart watch uses for health and wellness. *J Biomed Inform, 63*, 269-276. doi: 10.1016/j.jbi.2016.09.001

This article is a review of smartwatches that are used for health and wellness. Smart watches have the potential to support health in everyday living by: enabling self-monitoring of personal activity; obtaining feedback based on activity measures; allowing for in-situ surveys to identify patterns of behavior; and supporting bi-directional communication with health care providers and family members.

Steinberg, G. (2015). Introduction to computer information systems. Kendall Hunt.

This book is an introductory college level course in computing. It is suitable supporting an introductory survey course or as a first course in an Information Systems Program.

Mauritius Declaration on the Internet of Things [PDF]. (2014, October 14). Retrieved from https://icdppc.org/wp-content/uploads/2015/02/Mauritius-Declaration.pdf.

The Mauritius Declaration on the Internet of Things of 14 October 2014 emphasizes the IoT's benefits related to healthcare, transportation and energy by also referring to the device's potential to simultaneously disclose large amounts of intimate details without the data subject's content.

Smart Watches: Latest Tech Trend Carries Security Implications. (2016, Feb 17). US Fed News Service, Including US State News. Retrieved from https://search.proquest.com/docview/1765476843?accountid=14541

This article discusses the security implication of smartwatches such as how having a smartwatch is a gateway of people that can steal your personal information.