

WEARABLE TECHNOLOGIES AND ITS FUTURE APPLICATIONS

MESUT ÇİÇEK

Yalova University, Turkey
E-mail: mcicek@yalova.edu.tr

Abstract- The popularity of wearable technologies have increased day by day. In the near future, wearable technologies are expected to become an indispensable part of our daily life. The aim of this study is twofold. The first one is the classification of wearable technologies based on the specifications and applications as; wearable health technologies, wearable textile technologies, and wearable consumer electronics. The second aim of the study is to point out how wearable technologies will be a milestone both for daily life of people and the way of doing businesses of the companies in the future. The potential applications indicate that the future will be safer, easier, healthier, quicker, and more entertaining with the wearable technologies.

Keywords- Wearable Technologies, Future Application, Aim, Textile Technology etc.

I. INTRODUCTION

Since the mankind has started to move on the path of civilization technology has developed gradually. However, recently, some revolutionary changes such as the invention of electronic chips, GPS systems, Wi-Fi systems, the internet, computers, sensors, and advancements in nanotechnology have transformed the entire world at an unprecedented rate. Wearable technologies are one of the most important fields which have evolved from these continuous technological advancements (Tao, 2005). Although there is no clear and agreed definition in the extant literature, in the simplest form wearable technologies can be defined as “the technological devices that are worn on a user’s body” (Nugroho, 2013, p. 6). Wearable technological devices have been existing for decades, even centuries, but it is only lately that they have become popular, fashionable (Kurwa, Mohammed, & Liu, 2008) and functional. Since the wearable technologies have been popular newly, the designs and functionalities of the wearable technologies are still relatively unexplored (Dunne, 2004). Therefore, technology companies and university research laboratories together have devoted a large amount of effort to enhance and improve the wearable technologies (Tao, 2005).

The scope of wearable technologies is very broad and amorphous, and determining the characteristics and specifications of wearable technologies is very thorny. Therefore, to understand the classification of wearable technologies based on the basic characteristics will be very beneficial. According to the literature, the wearable technologies may be divided into three main categories. These categories can be called as wearable health technologies, wearable textile technologies and wearable consumer electronics.

The wearable technologies may be worn in the form of an eyeglasses, wristwatch, wristband, a ring, a badge, jewelry, shoes or clothing (Tao, 2005).

However, in order to enhance the usage and adoption of wearable technological devices, the companies and institutions are working hard to design more comfortable, reliable, useful, integrated, lighter, smaller, aesthetic and vogue products (Fortmann et al., 2013; Kurwa et al., 2008; McCann & Bryson, 2009). Hereby, the sales volume of the wearable devices will increase and people will integrate these devices in their daily activities. ABI Research Company estimates that the wearable technology sector will reach 170 million devices by 2017 and Juniper Research Company forecasts the revenue from wearable technological devices will reach 19 billion \$ by 2018 (Kurwa et al., 2008). These forecasts indicate the importance of wearable technologies. After the proliferation of wearable technologies, probably there will be a breakthrough change for people, companies and the interactions between the different entities.

In this context, the aim of this study is to indicate how wearable technologies will lead a breakthrough change in the future both for society and the way of doing businesses through exemplifications.

II. DEFINITION AND CHARACTERISTICS OF WEARABLE TECHNOLOGIES

In the literature, there is no clear definition pertaining to wearable technologies. However, there are some relative terms which have very close meanings, even synonyms of wearable technologies. These terms are “wearable devices”, “wearable computers”, “and wearable electronics”. Although the terms are different, it can be derived from the definitions that they have the same meaning and can be used interchangeably except wearable computers. Although the difference between wearable technology and wearable computer is vague, “wearable computers are part of the larger classification of wearable technology”(Dunne, 2004, p. 6) and support and perform complex computations (Profita, 2011). One of the most comprehensive

definitions of wearable technology is “an application-enabled computing device which accepts and processes inputs. This device is generally a fashion accessory usually worn or attached to the body. The device could work independently or be tethered to a smartphone allowing some kind of meaningful interaction with the user. The wearable product could be on the body (like a smart patch), around the body (like a wristwatch or a headband) or in the body (like an identification sensor embedded under the skin or a sensor attached to the heart monitoring cardiac aberrations)” (Kurwa et al., 2008, p. 2).

Wearable technologies have some distinctive characteristics which differentiate them from other technological devices. In order to understand the applications and future effects of the wearable devices, firstly the characteristics and features are needed to be examined. The main characteristic of the wearable technologies is hands-free function (Watier, 2003). From this point of view, even mobile phones cannot be considered as a wearable device (Sanganee, 2013). Hands-free function enables people and employees to access the data while performing their daily routine activities and job tasks. In addition, in the literature several authors stated some characteristics that wearable technologies must bear. Some of these characteristics are as follows;

Wearable technologies must be integrated, seamless, transparent, comfortable, portable, multi-functional, useful, reliable and practical (Kurwa et al., 2008) Hands-free operation, mobility, augmented reality, sensors and perception (Kortuem, Segall, & Bauer, 1998) Accessible, wearable, stable, convey information in an effective manner, and be socially acceptable (Profita, 2011).

Nugroho (2013) stated that there are several key attributes which play significant role in the design of wearable technologies. These attributes are size and dimension of the devices, device position, power source, heat, weight, durability, washability, enveloping, functionality, usability, sensation, the connectivity of the designs. The companies who invest in wearable technologies should take these key attributes into consideration while designing the wearable devices.

On the other hand, wearable technologies consist of at least five main functions. These functions are the interface, communication, data management, energy management and integrated circuits. The interface is a medium for transferring data between the wearer and the device. Data can be gathered via sensors, antennae, global positioning-systems receivers, cameras. Communication is the transfer of the information via radio frequencies, wireless systems, infrared, Bluetooth technology and personal area network. Data management refers to storing and

processing of data. Energy management is another important function (Tao, 2005). However, companies have not accomplished to solve power supply issue for the wearable technologies even for today. For example, the latest Google Glass's (which is considered the most successful wearable technology so far) battery life is just 6 hours (Ackerman, 2013). Although the history of wearable devices started more than 500 years ago with the invention of wristwatch, the popularity and the evolution of them have accelerated in the 21st century. These wearable technologies have been designed and used for several purposes and several industries. For each purpose and industry the wearable devices have their own features, characteristics and applications. Consequently, grouping the wearable technologies based on their own applications and features plays an important role to analyze the wearable technologies meticulously.

III. TYPES OF WEARABLE TECHNOLOGIES

It can be revealed from the literature that there are three main wearable technology categories. These categories are health related wearable technologies, textile based wearable technologies and wearable consumer electronics.

3.1. Wearable Health Technologies

Nowadays, probably the most extensive use of wearable technologies has been carried out in the health sector. Moreover, in the literature, most of the studies related to wearable technologies are about the health applications. The developments in wearable technologies are expected to lead a paradigm shift in the health sector (Rutherford, 2010). In this context, the academics and industry professionals have exerted a great effort to design and develop wearable systems for health related issues (Chan et al., 2012). The most important contribution of wearable technologies in the health sector is enabling continuous monitoring of a patient's health status and gathering real-world information about the patient (Binkley, 2003; Bonato, 2010; Chan et al., 2012). Thus, the doctors may monitor the heart rate, blood pressure, fever, and other health indicators ubiquitously and time independently while the patients performing their daily routine activities (Bonato, 2005). Wearable technologies can be used for diagnoses and treatments of several diseases (Brady et al., 2006). Chan et al. claimed that wearable technologies can be used for “‘telehealth’, ‘telehealthcare’, ‘telemedicine’, ‘telecare’, ‘telehomecare’, ‘e-health’, ‘p-health’, ‘mhealth’, ‘assistive technology’, or ‘gerontechnology’”. In addition, Bonato (2010) stated that for the treatment of “congestive heart failure, prevention of chronic conditions such as diabetes, improved clinical management of neurodegenerative conditions such as Parkinson's disease, and the ability to promptly

respond to emergency situations such as seizures in patients with epilepsy and cardiac arrest in subjects undergoing cardiovascular monitoring” wearable technologies can be used. Other applications of wearable technologies in the health sector are Cardiovascular Disease, Rehabilitation, Applications in Parkinson’s Disease, Functional Assessment After Stroke (Binkley, 2003). However, today the wearable technologies in the health sector are mostly focused on data gathering, monitoring and diagnosis of health problems.

3.2. Wearable Textile Technologies

Integrating the technologies into textile products is a recent concept, which enables the development of wearable electro textiles for sensing / monitoring body functions, delivering communication facilities, data transfer, control of the environment, and many other applications (Tao, 2005). Especially, the emergence of nano-fibres and nano-coatings provide an unusual characteristics and lead breakthrough changes in the textile industry (Hurford, 2010). One of the most significant applications of wearable technologies in the textile industry is the clothes which can change their colors on demand or based on the biological indicators of the wearer. For instance, The researchers at Philips Company created Bubelle Dress which changes its color according to the wearer’s emotions (Philips.com, 2014). In order to enhance the popularity and social acceptance of the wearable textile technologies, the designers should take some key attributes into considerations. These attributes are “thermal management, moisture management, mobility, durability, flexibility, and sizing and fit, as well as the psychological areas of cognitive load and attention” (Dunne, 2004, p. 10). In addition, fashion (Profita, 2011) and aesthetic (Fortmann et al., 2013) are the key important issues that the designers should focus on while designing wearable textile technologies.

3.3. Wearable Consumer Electronics

In the literature, there are hardly ever studies related to the wearable consumer electronics. “Consumer electronics include electronic equipment intended for everyday use. Consumer electronics are most often used in entertainment, communications and office productivity” (Okwu & Onyeje, 2013, p. 614). Major consumer electronics products are TV’s, mobile phones, cameras, camcorders, music and video players (Hartmann, Trew, & Bosch, 2012). In this context, wearable consumer electronics can be defined as the electronic devices that are worn on a user’s body to catalyze the daily activities. Today, the big electronic companies such as Google, Apple, Samsung, Nike, Qualcomm and Microsoft makes strategic investments in wearable consumer electronics (Kurwa et al., 2008). Although there are several types of wearable consumer electronics such as wristband, headbands, rings etc., the most

promising products are smart glasses and watches. Juniper Research estimates that the retail revenue from wearable consumer electronics such as smart watches and glasses will be \$19 billion in 2018 (Kurwa et al., 2008). As of now, one of the most sophisticated smart watch is the Samsung’s Galaxy Gear 2. This smart watch enables users to make and receive calls, read SMS’s, receive instant notifications, take pictures, monitor exercises and heart rate, listen to music (Samsung.com, 2014).

Besides all other wearable devices, when they complete their evolution, smart glasses are expected to lead a paradigm shift in users’ everyday life. Today, the most respectable smart glasses is the Google Glass. It is a device that is worn like conventional glasses, and composed of computerized central processing unit, integrated display screen, high-definition camera, microphone, bone conduction sound transducer, and wireless connectivity (Muensterer, 2014). The leader of Project Glass, Babak Parviz, claimed that Google Glass will provide information so instant that you think that you have already known it (Ackerman, 2013). As stated previously, Smart Glasses have long way to go. Designers should solve several issues such as the battery, heating, comfort, aesthetic and fashion etc. In the near future, smart glasses will continue to evolve and there will be a breakthrough change in the way of living, consuming and performing daily routine activities.

IV. THE FUTURE WITH WEARABLE TECHNOLOGIES

Nowadays, most of the influential electronic companies have focused on wearable technologies, some of them have launched the initial versions of their wearable products, while others are in the prototype development stages. In this context, Wearable technology is at an 'early adopter' stage both for public and commercial use (Taylorwessing.com, 2014). In the future, probably the most powerful and commonly held wearable product will be the integration of smart glass and augmented reality. When these products are developed and their prices are decreased, these products will reach the maturity stage and social acceptance of these devices will accelerate.

The increasing popularity of wearable technologies creates two major debates. The first debate is that “Is the emergence of wearable technologies a breakthrough innovation or is it just a fad?” There are always some counter-view especially related to the technology. In the history, there are several bad predictions such as “I think there is a world market for maybe five computers” (Watson, 1943) and “There is no reason anyone would want a computer in their home.” (Olson, 1977) (Rinkworks.com, 2014).

This paper proposes that wearable technologies are not a fad; it will be socially accepted and will change the life of the wearers in the future. The investment and future plans of the key influential companies such as Google, Apple, Samsung, Microsoft also can be considered as an indicator of this idea.

Another substantial debate pertaining to wearable technologies is that “will the wearable devices be beneficial or hazardous and detrimental for the society?” In the literature, several authors stated the hazards of wearable devices especially in the context of privacy. Popat and Sharma (2013) claimed that if the wearable technologies are left unattended and / or unsecured, private information about the individuals and companies can be stolen. Concordantly, Ackerman (2013) stated that wearable technologies could lead to an unprecedented loss of control over the individual’s personal information. Another privacy issue that people can confront is secretly videotaping or capturing the people, private properties, places, products. However, the most of the privacy issues can be solved via laws and legislations, firewall, anti-virus, anti-spyware and anti-malware software exclusively designed for wearable technologies. In this context, the benefits of the wearable technologies will outweigh the hazards.

In the near future, there will be numerous benefits and applications of wearable technologies. The usage and applications of wearable technologies can be categorized based on the area of utilization.

4.1.The Public and Personal Safety: In contrast with the position that wearable technology will give harm to security, the wearable devices will provide the safety of the society. For example, in the near future Bio-sensors will be integrated into the wearable devices, and these sensors will monitor the brain activities (Livescience.com, 2014). These devices may be compulsory for the current and/or potential criminals. When they intend to commit a crime these sensors will directly warn the authorities. Thus, the crime rate in the society will be decreased. In addition, smart glasses with the exclusive applications will be used in driving.

The camera of the smart glasses, can navigate the direction, monitor the traffic, and warn the driver if his /her eyes are closing. This system can also be compulsory for coach and truck drivers. In this way, company officials may monitor driving behaviors of the drivers instantaneous via smart glasses’ camera. On the other hand, Smart Glasses will also be very useful for firemen. Smart Glasses provide a GPS based indoor navigation to the firemen, and provide instant access to vital information while they are in action, and also record the scene of accidents (Hos, 2014). Moreover, Policemen will use a smart glasses integrated with face recognition. In the streets, Police

cannot ask everyone to show their ID’s. However, via wearable technology, they can scan and query most of the people without disturbing them and detect the suspects.

4.2.Business:The wearable technologies are expected to innovate the companies’ strategies and the way of doing business. In the near future, there will be no need to go to meetings physically. Instead of W/C meetings, the managers may meet in a virtual meeting room formed by augmented reality and all the decisions will be recorded (Sanganee, 2013). In addition, secretarial services will disappear. Because, wearable devices will be the workers’ virtual assistant, the virtual assistants will warn the wearer whenever, wherever they are in need, set the meetings, remind the necessary information. The virtual assistants will also know the wearer cumulatively and never forget any type of information. The wearable technologies can be used for the different functions of business such as research, production, sales, and services.

4.3.Research:Wearable technologies provides several opportunities for companies in the context of market research. Researchers use some eye-tracking techniques in the laboratory experiments. In the future, they can gather real-life data via eye-tracking software built in a smart glasses. Even they can use crowdsourcing to gather data that some volunteers or paid people can install the necessary application on their smart glasses. While they are walking in the streets, or in a store researchers may observe which locations are attractive, which locations are blind spots. In addition, the researchers also gather information via GPS based wearable devices. The researchers get very valuable data via wearable technologies. They can use this data in shelf allocation, outdoor ads allocation, store area selection, shopping mall area selection and so on.

4.4.Production:In production and in the logistics workers should work very efficiently and find and bring the necessary parts. However, sometimes they can be confused about the location of the necessary parts or products. With Smart glasses, when the factory needs some parts, the list may be automatically uploaded to the glasses. It can put them in the order and may navigate the optimum route for the workers, and this lead to time and cost efficiency.

4.5.Sales:Retailers can use a system that customers upload shopping list to the Smart Glasses, and the glasses will make the customers finish their shopping as fast as possible via indoor navigation. In addition, there may be no need to try on clothes in the near future. When we choose a dress the smart glasses may show the dress on the wearer virtually and it will be like looking at a mirror. Thus, customers can try on more clothes virtually in a short time with a little effort. On the other hand, in the near future, the

consumption rate may be decreased with the emergence of smart clothes, handbags, shoes and other accessories. Because, these smart products may change its colors, pattern, and shapes according to the wearer's preferences.

4.6.Service: The integration of smart glass, face recognition and data management may lead to an augmented service for the customers. For example, when a customer sign up for the internet site of the airline company, they can be asked several questions related to their preferences. During the flight, when the hostess looks at a passenger, all his/her information will appear on the screen of the Smart Glasses. Thus, the passengers will be behaved as they wish and this will increase the customer satisfaction and loyalty. On the other hand, Smart Glasses can be used for repair issues. When a mechanic is faced with a problem while repairing something. He can instantly access to the user's manuals while in action, if he could not find the solution, the specialist can connect to the mechanic's Smart Glasses and help the mechanics to solve the problem. In addition, the users can get instant online help for uncomplicated breakdown issues.

4.7.Tourism: Augmented reality integrated wearable technologies enable people to visit cities, tourist attractions virtually without going there. They also use virtual city sightseeing tours. New virtual tourism companies may emerge in the near future. In other respects, tourism agencies may show the hotels to the customers in virtually 3D format. Hereby, the customers will make the right choices.

4.8.People with impairments: One of the biggest impact of wearable technologies will be for the people with impairments. Smart Glasses can navigate for the blind people both indoor and outdoor. In addition, with the face recognition function they can know whom they meet. The classes can also read the signs for the wearer and warn them if they are faced with a dangerous situation. A new sector may emerge that will become the eye of the people with visual impairment. A paid person or a volunteer can connect to the blind person's smart glass and help the wearer when he / she must stop, navigate the road, and keep him / her safe. For people with hearing impairment, a smart glasses may sense the voice and transform the speech into text format and show the text to the people with hearing impairment instantaneous. Namely, wearable devices can be acting as the eyes of the blind people and the ear of the deaf people.

4.9.Health: Wearable technologies will probably be used very often for the health related issues. Wearable devices may continuously monitor the health indicators of the people. If something goes wrong, the device can automatically send a signal to the emergency service and share current situation of

the patients and share the exact location of the patient with the emergency service. In the future, some special wearable technologies can be integrated into the patient's body and in case of emergency these devices that may administer treatment to the patient. For example, when the insulin level decrease, the wearable device will inject insulin according to the amount that the body needs.

4.10.Entertainment: With the emergence of wearable technologies, there will also be a paradigm shift in the gaming industry. Oculus Rift, which is a virtual reality head-mounted display, can be considered as the preliminary version of this shift. When a user wears this head-mounted display he/she can view the virtual environment almost as real. In addition, with the new motion sensing input devices users no more need a keyboard, or joystick. The games sense the real motions of the gamers. Therefore, with just a head mounted display, users can play games like they are in real life. Moreover, by using this virtual reality head mounted displays of virtual amusement parks can be constructed.

CONCLUSION

In conclusion, wearable technologies have evolved gradually in parallel with technological advancements such as electronic chips, GPS systems, Wi-Fi systems, the internet, computers, and sensors. The major applications of the wearable technologies are in the health industry, textile industry and the consumer electronics industry. Today, the diffusion of the wearable technologies is just at the early adopter stage both for the society and companies. However, in the near future the evolution of wearable technologies, especially smart glasses and smart watches, will almost be completed their evolutions and these technological devices will be adopted by the societies and companies. The objective of the study is to point out how wearable technologies will be a milestone both for daily life of people and the way of doing businesses of the companies in the future. In this paper, it is proposed that wearable technologies will ease the life for the people with impairments; enable companies to interact with the other business people easier, to conduct market research more effectively, to apply sales and service strategies more efficiently; enable policemen, firemen, military members to provide public and personal safety; enhance the virtual reality in games, and enable the doctors to monitor the health indicators of the people continuously. To sum up, the future will be safer, easier, healthier, quicker, and more entertaining with the wearable technologies...

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