WEARABLE ELECTRONICS

Abstract

Wearable Electronics are products which implement electronic technology and computing devices within their everyday functionality. Currently, the market for these products is quickly growing, especially within the devices targeted at the common consumer. This is due to the rapid improvements in electronic and computing technology that have been made in the last decade. However, despite these advances there still remains unanswered questions on the future success of these products. As a result both this technology and the potential benefits and drawbacks for everyday wearable electronics will be addressed.

Background/Introduction

Wearable electronics deal with clothing and textiles that incorporate computing devices and other electronic technology into their everyday use and functionality. This term applies not just to articles of clothing, but anything that can be worn on the body. Watches, hats, glasses, and shirts all fall into the very broad category of wearable electronics when paired with some sort of electronic technology.

"Wearable electronics" is a relatively new term which has begun to strongly catch hold within the technology community in the last decade. Due to rapid technological advances, useful wearable electronics are now much more mainstream, tapping into a large array of fields and markets which could benefit from the devices. Medical, academic, and mainstream consumer markets are all areas currently exploring both the popularity and usefulness of this technology.

Perhaps the most interesting of these products deal with everyday consumer applications. Products within this field include devices such as smart watches, fitness bands, and smart glasses. Recent commercialization has led to a production boom, though what the future holds for these products remains unanswered. As a result, this article not only explores the technology within wearable electronics, but also the potential benefits and drawbacks to implementing this technology when it comes to common wearable products.

Market and Applications

Many people are getting excited about wearable electronics because of the extremely wide array and variety of applications that they have. Taking advantage of constant human contact, people find that

wearable electronics force a prolonged and consistent grid connection. This allows for a constant stream of data, and benefits different fields in many ways:

- ♣ Data acquisition
- ♣ Live monitoring and feedback
- ♣ Computing power
- ♣ Grid connection
- ♣ Communication

All of these applications grant tools to consumers, both in the private and public sectors, and are further enhanced by the proximity that their wearable characteristics grant them. Studies prove their usefulness not only in the general market as a whole, but in more specific jobs. This includes medical, academic, military, and many other fields. At the University of Washington, for instance, a study successfully determined that wearable GPS devices could be used to track pesticide levels in children (Holten, 2003). In addition to that, electronic textiles, where the technology and fabric are actually stitched together, are proving extremely handy in a variety of different fields (Service, 2003).

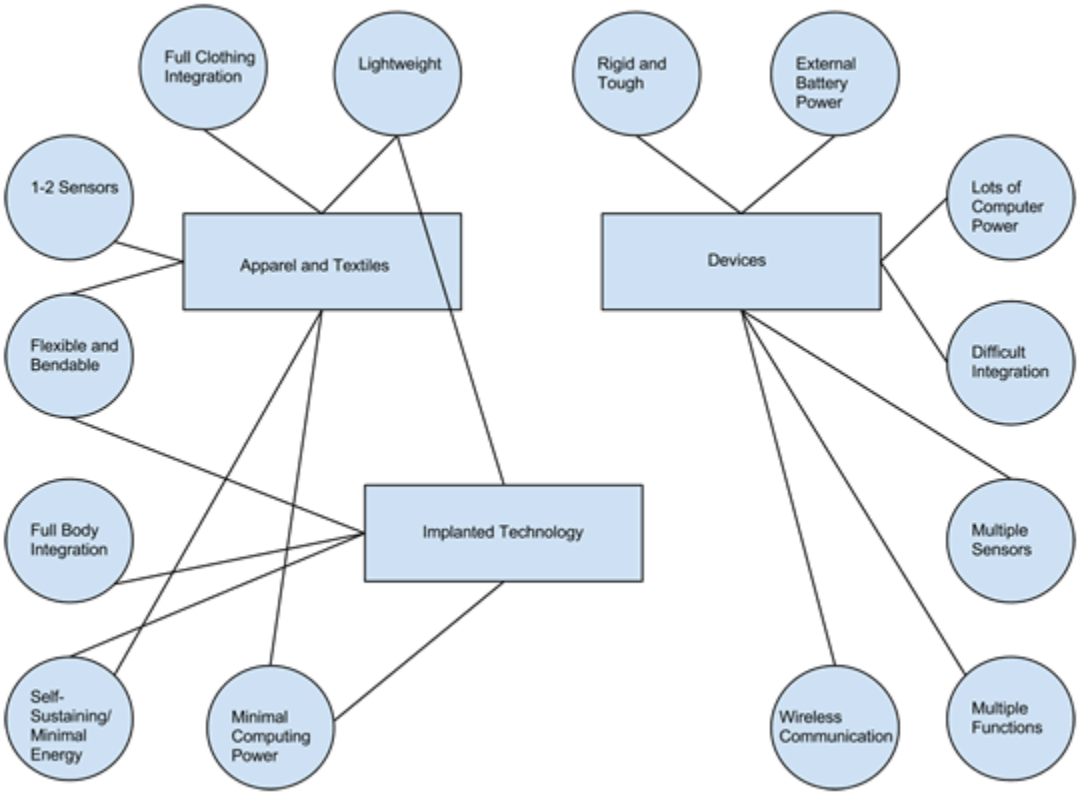

Figure 1

Wearable Electronics Product Types. Source: Andrew Carp derived from 2015.

From Figure 1, it can be seen that the product range for wearable electronics is extremely wide. Varying from rigid computing devices to flexible electronic fabrics, many different types of products have jumped into the market. In fact, the web has grown so large that market size is expected to reach up to 70 billion dollars by 2025 (Harrop, 2014). Various fields spanning this market size include:

- Military
- Healthcare
- Academic
- Agriculture
- Entertainment
- Consumer
- Finance
- Athletics
- Retail

The above list only demonstrates a small portion of the current wearable electronics market. Due to this wide spectrum this article focuses primarily on everyday consumer electronics. These are products which are sold mostly in retail stores directly to the public, and are one of the biggest market sections within wearable electronics today. Common products include the fitbit, a fitness bracelet that tracks your health data during workouts, and pebble, a smartwatch which runs different applications like a smartphone would.

Even though these products are growing fast, the everyday consumer market still has yet to prove itself a reliable industry. Despite the benefits, there still exist risks and drawbacks that have yet to be resolved. These include potential security leaks, issues integrating technology and fashion, and wariness concerning information overload. Because of this, the everyday consumer electronics market will be observed both for the potential benefits it can offer to the public and the drawbacks that they must take into account. Before this can be approached though, the technology within these new products will be explored.

Technology within Wearable Electronics

Much of the market change described in the above section is attributed to the engineering and technology behind these products. Technology's rapid changes over the last half century have led to the creation of many new fields. Social networking, data driven technology, high frequency trading, these are just a few examples demonstrating the effects of recent advances. Wearable electronics will join the ranks of these significant and modern industries thanks to technological advances.

However, out of all of the changes to technology made in the last decade or so, the specific improvements which wearable electronics have relied on remain within the electrical and computer engineering fields. Improvements in size, battery technology, portability, power, memory, and other technologies have sponsored much of the change. As Science News stated back in the late 1990s, just as wearable electronics began to emerge in research: "Shrinkage of computers, displays, and other gear has made 'rigs' worn today by wearable computer pioneers smaller and more comfortable than earlier versions."(Weiss, 1999).

One of the biggest reasons which brought this shrinkage about was the rapid development in transistor technology. Transistors act as the most basic element in computing technology. They help keep track of information, perform calculations, read data, and form the basis for many major computer components today. Back in the 1960s Fairchild Semiconductor was only able to fit about 4 transistors on a board. However, now many companies are able to produce chips that have billions of transistors on them. This vast improvement with transistor density led to much smaller and more efficient computer components, many of which can be seen in Figure 2.

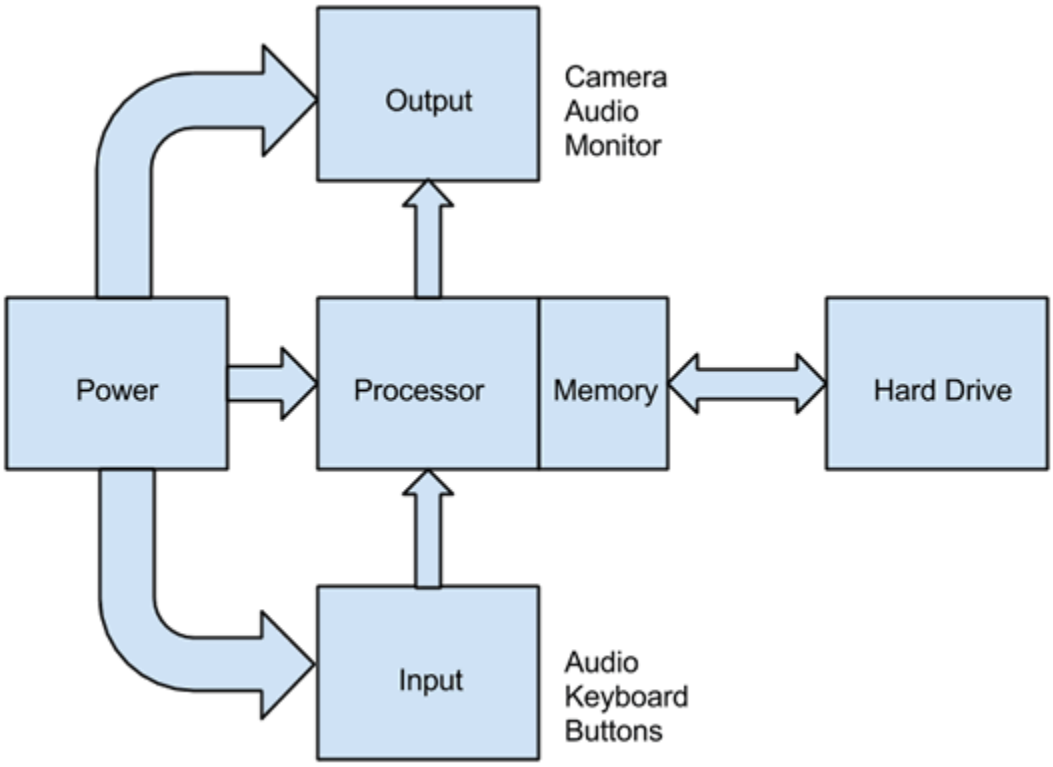

Figure 2

Basic Components of a Computer. Source: Andrew Carp derived from 2015.

Changes to transistor technology weren't the only improvements being made. Lower power devices created products that wouldn't heat up or require too much battery. Smaller hard drives helped to improve computer speed and size. Improvements in battery technology resulted in devices that could be charged and reused for longer periods of time. All of these efforts eventually resulted in the wearable electronic products that the world sees today.

A second technological aspect of wearable electronics are the sensors that they take advantage of. The main job of a sensor is to respond to changes in some environment variable with some sort of appropriate output. These environment variables range from audio: speech and music to visual: light and color to mechanical: buttons and keyboards. Furthermore, output is typically electric and is an input into the computing portion of the device.

Figure 3 details how sensors come into play for detecting different environmental variables. As can be seen, the sensor reacts to some sort of physical input and responds by generating a signal, typically in voltage or current form. This signal is cleaned and smoothed out to make it easier to read, sampled a reasonable rate, then converted into a signal readable by computers. The new signal, called a digital signal, can then be processed by the computing technology shown above in Figure 2.

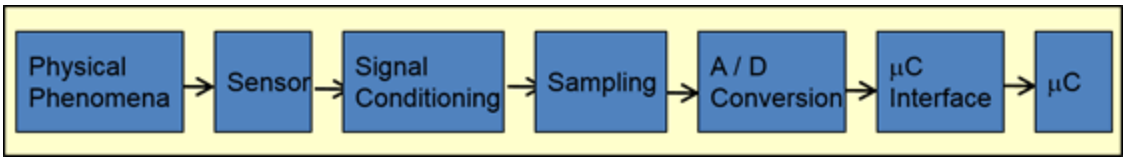

Figure 3

Demonstration of Different Sensor Types. Source: Ron Lasser derived from 2015.

One common sensor example is called an accelerometer, which measures change in speed. The fitbit, a popular wristband sold by Nike, takes advantage of an accelerometer by using it to measure a person's change in speed during workouts. Any arm, leg, or body motion is detected by the accelerometer, and this change is sent to the main processor as an input. From this, the processor can calculate such metrics as calories burned, distance walked, and other useful data.

Table 1

Wearable Electronics and the Technologies They Use . Source: Andrew Carp derived from 2015.

Technology	Application Examples
Hard Drives	Smart Watches

	Smart Glasses Fitness Trackers
Processors	Smart Watches Smart Glasses Fitness Trackers Bluetooth Headset
Batteries	Smart Watches Smart Glasses Fitness Trackers Bluetooth Headsets more examples…
Speakers	Bluetooth Headsets Headphones
Speech Sensors/Microphones	Smart Glasses Bluetooth Headsets
Keyboards/Buttons	Smart Watches Smart Glasses Fitness Trackers
LCD Screens	Smart Watches

When it comes to everyday consumer products though, where exactly does all of this technology come in? Bluetooth headsets, smart watches, and fitness trackers all take advantage of improved computing technology, and none of them would be available if it weren't for these improvements. As can be seen in Table 1 above, many of the technologies that wearable electronics use are very related to electrical and computer engineering research. Because of this, the improvements of the past 50 years in these fields have led to the boom in wearable electronics that we see today.

Wearable Electronics in Everyday Society

Drawbacks

Given the massive outpour of wearable electronics over the last decade, many may assume that this market is destined for success. However, this is not necessarily the case. There are drawbacks to any technological advances and the products still have many issues to be worked out before widespread consumer adoption occurs. The most significant of these issues includes questions dealing with "social wearability", possibilities for security hacks, and concerns with constant grid connection.

To begin, “social wearability” conveys how socially acceptable it is to wear a certain product. Wearing a hat at a baseball game, for instance, is extremely common and a very acceptable thing to wear. Wearing a hat at a funeral or religious ceremony, however, is not common at all and looked down upon in many cases. By that same token, many wearable electronics are not accepted widely within social circles, and while they are not necessarily physically uncomfortable or difficult to use, they can hinder needs for social acceptance. In fact, one study by the Institute for Electrical and Electronics Engineers (IEEE) concluded that success of wearable electronics will not be determined by improvements in electronics, but by how modern fashion styles dictate certain social standards. (Dunne et al, 2014). This is a huge potential issue for wearable electronics, as it is difficult to find a way to integrate them into existing fashion styles and whether or not they will fit the fashion standards of the future still remains a looming question.

Furthermore, wearable electronics pose significant security risks for many entities, both public and private. Given the power of data acquisition that wearable devices grant, having these products constantly around promotes risky security leaks. Video and audio recording, GPS data, Wi-Fi connections, all of these force the user to risk not only their personal data, but also the data of those around them. But how do you stop the risk? Many businesses are stuck with this question, and as SC (Security) Magazine states: “When your watch or glasses can take photos or make phone calls – you can render a whole bunch of DLP controls ineffective.” (Drinkwater, 2014). As technology becomes more and more integrated into our clothes, it becomes extremely difficult to detect these well hidden security leaks. Whether the leaks are intentional or accidental, both personal and private data are at an undeniable risk when it comes to wearable electronics.

Finally, many people are also concerned with wearable electronics overloading society with information. Although some may argue constant connection being a beneficial feature, it isn’t necessarily always good thing and can produce undesirable effects. One study completed by the University of Arkansas found that too much electronic information created “computer anxiety” and even affected the decision making abilities in certain groups of people (Mullins and Sabherwal, 2014). This effect isn’t uncommon, and always having access to the electronic grid may turn many people away from wearable electronics that grant this ability.

Benefits

Despite the drawbacks stated above, there are obviously still many reasons to support the growth of wearable technology in everyday consumer applications. Ability to observe trends over time, health

feedback and self-monitoring capabilities, and well-integrated connection to computing technology are all some of the major reasons people are still pushing for the widespread adoption of wearable electronics.

One study focused on the recent push to use wearable electronics for the purposes of improving exercise. Attaching sensors to different types of runners, they observed how acquiring data over time would help the runners not only in research, but also in improving their running ability over time. "With feedback", the study said, "runners could work on improving their weak areas." (Strohrmann et al, 2012). By using sensors and electronics to gather data over time, people can see what areas of exercise they need to work on and improve them.

However, data analysis also applies to an even wider variety of applications, especially when applied to a live monitoring platform. In clinical applications, many doctors are finding that the wearable devices people already own can be used to monitor and manage their patient's health. Coupling a heart monitor with a smartwatch or other device with internet connection, doctors can receive alerts about patient's cardiovascular health (Binkley, 2003). This allows for constant monitoring, even in the home, and grants an incredibly wide range of real-time data analysis to doctors, stretching to more than just cardiovascular health.

Another application that wearable electronics provides is constant access to both computing technology and information. While some may argue that unbroken and personal connection can lead to certain issues like information overload and computer anxiety, there are also significant benefits. The 21st century has popularly been coined the information age, so bringing information completely to the population's fingertips is, for some, the ultimate goal. In addition to this, many electronic applications such as calculators, weather monitors, and cameras are extremely useful to have around at all times. Wearable electronics could be the future in human assistance, with all the tools people need on them at all times.

Source : https://sites.tufts.edu/eeseniordesignhandbook/2015/wearable-electronics/