PART I
Concepts

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Introduction to Android Wearables

WHAT'S IN THIS CHAPTER?

- Wearable technology defined
- A brief history of user interfaces
- Categories of wearable devices

THE WEARABLE REVOLUTION

Wearable technology is the next big thing in the world of connected devices. It is made of sensors and actuators so close to your skin that they can literally monitor your vital signs, with so much computing power they can make on-the-spot suggestions on health habits, so connected they can notify you about the important things to do today by mining data from your calendars and e-mails, and so ubiquitous they can remind you of tasks from your wrist, or overlaying information right in front of your eyes.

Wearables are small-yet-powerful computers that fit in your pocket or mounted on top of your glasses. They hang from a key ring, and your kids have them in their shoes to indicate the way back home via vibrations.

These concepts aren't science fiction, but are current technologies that allow for this and more. Lighter devices with smaller screens and different use patterns, like the smartwatches, increase battery life. One-touch user interfaces (also known as zero UIs) will help you navigate through complex menus in ways you never imagined.

As you will see later, there are different categories of wearables. Google has launched three different APIs exploring them: Wear for smartwatches, Fit for fitness devices, and Glass for their smart glasses. Not all companies are jumping into these three categories in the same way, and not all of them are willing to commit to open standards.

> *The terms "wearable technology," "wearable devices," and "wearables" all refer to electronic technologies or computers that are incorporated into items of clothing and accessories which can comfortably be worn on the body.*
>
> KIANA TEHRANI AND ANDREW MICHAEL

The latest shift in technology is getting everyone within the tech industry to notice wearables. The preceding definition of what a "wearable" actually is leaves much room for interpretation. It fits everything from iPod controls embedded in the sleeve of your ski jacket to intelligent shoes that tell you which direction to turn when you reach an intersection.

The wearable revolution we are witnessing is the result of an extreme miniaturization of technology, the development of more efficient batteries, and the broadening of the communication infrastructure. Thanks to advancements in technology, we can carry in our pocket as much computing power as a stationary computer had in the late 1990s. And because of communication capabilities, we can take advantage of much more computing power residing in the cloud.

In this post-PC era, many people will never use a computer in the same way we are using it to write this book or to develop applications for the devices described in it. The next generation might access the web from only mobile browsers. A Bloomberg report from 2010 predicted that 36 percent of Indonesia's population would be able to access the Internet in four years, with only 15 percent doing so from a PC. Many of them will start using wearable computers as peripherals to their mobile devices in a much more natural way than we can anticipate.

This chapter gives you an overview of the history of wearable computing and also introduces current trends. Wearables are becoming part of our everyday lives, harvesting data about our whereabouts, health condition, and interests. This chapter introduces the ecosystem of wearables and explains how the different pieces of the puzzle connect.

DISMANTLING THE COMPUTER: THE CYBORG DREAM

Steve Mann, a tenured professor in the Department of Electrical and Computer Engineering at the University of Toronto, is considered the father of wearable computing. Mann, a PhD from MIT, has published more than 200 articles and books on topics ranging from algorithms for the treatment and analysis of digital images to his everyday experiences as a cyborg.

In the early years of wearable computing, Mann used to dismantle computers and make them into wearable devices. He realized that the interaction paradigm for the wearable computer couldn't be the same as that for a PC. Imagine yourself carrying the motherboard and hard drive in different vest pockets, with the heavy battery hanging from your belt, and, as input mechanisms, a camera with added intelligence and a one-button interface. For output, you would wear goggles reproducing an augmented reality (AR) version of audible feedback and what the camera films.

Because he needed to place the technology closer to the body, Mann had to further evolve user interfaces (UIs). Early computers used a command-line interface (CLI); later they used a graphical user interface (GUI). Mann coined the term natural user interface (NUI), which would become the bread and butter of many human-computer interaction (HCI) researchers.

Mann started by taking apart a computer and looking at ways to enhance human cognition by adding layers of AR to what he was seeing. Along with learning how technology could merge with the body without being intrusive, he invented one-button interaction, wearable glasses, and other things that are the essence of contemporary wearable devices.

SOFTWARE EVERYWHERE

Neil Harbisson was the first person allowed to pose for his passport photo as a cyborg. In 2004 he was implanted with a device called an eyeborg, which translates colors into auditory stimuli to make up for his color blindness. The eyeborg lets him perceive ultraviolet and infrared light, which the human eye cannot see. From a purely software point of view, this is very different from the general-purpose computer Mann designed. It is instead a single-purpose machine: It enhances Harbisson's eyesight.

In the same way that a multipurpose machine lets you change the software for a different use, Harbisson believes that what makes him a cyborg is actually the software. He explained in a 2011 interview that it's not the union between the eyeborg and his head that converts him into a cyborg, but the union between the software and his brain.

When it comes to code, most wearable devices follow the model of embedded computing. The weapon of choice is usually nano-power processors with specially written software to command the devices' sensors, actuators, and communication. This is closer to Harbisson's augmentation machine than to Mann's general-purpose machine.

This book is all about software in wearables. We will look at which hooks different devices offer to connect them to Android phones and tablets. Some devices, like the original Sony SmartWatch, have a specific software development kit (SDK) to create applications to be executed in the device and offer an API to allow the watch to talk to an app in a phone. Most of the health bracelets on the market (such as Fitbit, Jawbone, and Nike FuelBand) follow this approach. Sometimes they don't even offer an open API of any kind to allow developers to write their own applications for the device.

Other gadgets, such as Google Glass and the Vuzix glasses (discussed in the section "Glasses"), run their own flavor of Android's OS. In that case, developers are supposed to create applications that can take advantage of the device's specific features.

We can see two main lines of work for developers. Either they write specific apps for devices that run the Android OS, or they write apps on phones and tablets that talk to APIs offered by a certain gadget via Bluetooth or WiFi.

In an attempt to standardize the API between gadgets and the Android OS, Google is launching Android Wear, a version of the Android OS specific to the wearable realm. The idea is to create an operating system for wearables that can easily sync with other Android devices. In that way, Android Wear will offer app developers a simple way to operate rich notifications more than a full-fledged system to create applications.

Some players that came earlier than others to the wearable business—like Sony—seemed uninterested in Android Wear, and were willing to stick with its own SDK to create apps for its SmartWatch ecosystem. But with the arrival of Wear 2.0, the second revision of Android Wear, Sony announced that the 3rd generation of the Sony SmartWatch will also be an Android Wear device.

FASHION IS MORE THAN SKI JACKETS

Wearables offer more than computation power and technical advancement. They are objects we carry with us every day, and they are fashion statements. To succeed as products, wearables have to be desirable. Fashion plays a huge role in this.

The reason for the title of this section is that one of the first applications in the field of wearable technology was an iPod controller embedded in the sleeve of ski jackets. These so-called soft buttons are a version of the tactile switches on many contemporary printed circuit boards (PCBs). They are made of soft materials such as conductive fabrics, foams, and threads.

Fashion, as a creative endeavor, is extremely important in the development of wearable technology as we know it today. Beyond the simplistic approach offered by the ski jacket, we find designers trying to look at conductive materials with different eyes. A good example is the collaboration between Hussein Chalayan and Moritz Waldemeyer in 2007 that resulted in a collection of robotic dresses. These dresses use electromechanical parts to change their shape as the models walk down the runway. Making small, on-the-fly modifications to the surface of one garment in particular causes it to change into the style of a dress from the ’40s, ’50s, or ’60s. These dresses are designed for the runway, not mainstream consumers, but they show how far it is possible to push technology, embedding motors and sensors in minimal space.

A piece closer to the topic of this book is the T-shirt OS project created by design couple CuteCircuit. Their T-shirt with 1,024 pixels arranged in a 32-by-32 grid can display nearly anything. It can show notifications coming from your mobile device, and it also has an accelerometer, camera, microphone, and speakers. You control it using a mobile phone app. Besides shirts, CuteCircuit have embedded LEDs in dresses and the leather jackets musical group U2 wore during one of their tours.

In a sense, the garment is an extension of the phone, almost like a smartwatch. But because of its wearable nature, it makes people behave differently. Suppose your T-shirt displayed your heart rate as you walked down the street. Don’t you think you would try to move in a way that your shirt wouldn’t tell others how out of shape you are?

Another aspect of wearable technology is that, because we wear it all the time, we forget we are carrying it, and then it makes us change our behavior and relationships to others.

Currently, only the garments mentioned here run Android or Android Wear. For the time being, the kinds of gadgets we can focus on are smartwatches, glasses, bracelets, and other activity trackers. But we believe that in a couple of years, more products like CuteCircuit’s T-shirt will make it to the mass market, and we will see people programming their clothes.

FITNESS

Activity bands, or fitness trackers, are devices that help you keep track of your daily physical effort. Typically, these devices communicate with your phone via an app that lets you do basic configuration on them and load data from the specific sensors on the band. Examples of this category of device are Fitbit, SmartBand, Jawbone, Fuel, and Misfit. And new products continue to be created.

Most of these bands work through APIs, a series of callback functions that can be accessed via Bluetooth to get information about the sensors, alarms, and so on. The way software is constructed within these activity bands makes them pretty simple.

A strict definition of wearable computing requires the devices part of this categorization to be reprogrammable; they must be adjustable to different use scenarios. In other words, a wearable computer is a general-purpose machine that people wear close to their bodies. However, the definition has softened over time. New types of devices, such as activity bands, are not truly reprogrammable but offer APIs that let you use them as part of a bigger system.

One of the most direct applications of activity bands is improving health conditions, mostly on the preventive side of the issue. More complex sensors and smart uses of existing sensors such as accelerometers let you gather all sorts of information in an instant: temperature, pulse, blood pressure, galvanic skin resistance, steps walked in the last 24 hours. Even if no commercial band is yet ready to diagnose anything, the potential of the preventive-medicine applications of these wearables is endless.

TIME

Smartphones pushed watches out of our lives. The most basic function of the watch, showing the time, became superfluous when mobile phones included that function. During the last couple of years, technology manufacturers have realized that adding connectivity to the watch, thus making it a smart device, was the added value the watch needed to be hyped again.

We have seen how giants such as Samsung, LG, and Sony have started flooding the market with watches that are nothing but an extension of phones or tablets. Most smartwatches offer an interface to our cloud that doesn't require us to take something out of our pocket all the time.

Android Wear, the new SDK by Google, basically offers an easy way to create software for smartwatches from vendors that are ready to follow some specifications. Watches are powerful computational units, including touch screens, sensors, a microphone, and a camera. The production of software for each of these devices used to require downloading the respective SDK from the manufacturer and writing code for the device under the manufacturer's terms. Android Wear tries to make things easier for app developers, so that they need to deal with only a single way to write applications for watches.

EVERYTHING CAN BE HACKED

As mentioned earlier, smartwatches, activity bands, and other wearable garments correspond pretty well to the embedded computer model. In essence, they are a small computer running a special-state machine that allows them to run some subapplications on top.

Considering that nowadays most development tools for microcontrollers offer open source equivalents, it is possible with a little effort to create alternative-state machines or even SDKs for a wearable device.

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In the summer of 2013, Arduino Verkstad, the Swedish office of the Arduino open source project, was challenged by Sony's design office to hack the Sony SmartWatch version 1.

Thanks to some initial hints about the peripherals contained in the SmartWatch, the Arduino developers put together a version of their software tools to reprogram the SmartWatch. Figure 1-1 shows the SmartWatch running self-made code using the Arduino IDE.

Hacking is not the focus of this book. We want to focus on standard methods of producing code for Android wearables. We want to teach you how to create apps that can later be deployed in many devices at once.

FIGURE 1-1: Sony SmartWatch v1 hacked to be programmed using the Arduino IDE by Arduino Verkstad (image by Asier Arranz)

GLASSES

Visual augmentation is probably the most interesting kind of wearable. It merges fields such as computer vision and augmented reality into something useful for everyday life.

In 1981, Steve Mann created the EyeTap. Worn in front of the eye, it acts as a camera to record what the wearer sees and also superimposes computer-generated imagery on the scene. This artifact is a true ancestor to Google Glass that has been through several iterations. It even comes in waterproof versions.

As a matter of fact, Mann is one of the main critics of the design of Google Glass. As the inventor of one of the most advanced display technologies, he has created his own opportunities by becoming chief scientist of Meta, a company developing a wearable computer with 15 times the display size of Google Glass. He is pushing for a new HCI paradigm called zero user interface (ZUI), in which the user will be able to interact manually with holograms projected by the AR glasses. It looks as though these SpaceGlasses will not run Android but their own 3D operating system.

In a way, this seems to be the paradigm of 3D interaction with interpersonal space. Oblong, another U.S.-based company, has been developing an NUI in which users interact with the space around them and have their actions recorded by an array of infrared cameras. John Underkoffler, chief scientist at Oblong, designed the famous UI for the movie *Minority Report*. Oblong's first series of products are based on *Minority Report*'s UI and use state-of-the-art technology. However, as stated on Oblong's website, its main discovery is not the gestural interface, a type of NUI, but a new type of OS that can support multiple users, devices, and screens and that is strongly networked.

A detailed discussion of the products from Meta and Oblong is outside the scope of this book. Although they are technologically interesting, their realization doesn't involve Android. However, they are worth mentioning because they explore the same kinds of user interfaces we will develop in this book using other devices that connect to the Android OS.

A third company, Vuzix, has created a set of AR glasses that support features that are relevant to us: notifications, cue cards, and voice commands. (These three topics are covered in Part II, and the Vuzix glasses are covered in Chapter 11.) This piece of technology is an Android device in itself. Unlike other smart devices that run their own embedded code and offer Android-friendly APIs to Android phones and tablets, the Vuzix glasses run Android as their OS. It is possible to create applications for them using standard development tools.

Project Glass is Google's approach to this category of wearable devices. It's currently unclear whether Glass will become part of the Android Wear SDK or if it will remain a separate Android device, just as the Vuzix glasses do. Glass and Vuzix are similar, although Vuzix focuses much more on the professional application sector, with its suite of AR applications.

SUMMARY

This chapter has introduced the concept of wearable computing. It included a basic timeline of how the field has evolved over the last 30 years.

Wearable computing is a not-so-new computing paradigm that is about to transform the way we use technology as much as tablets did only a few years ago. Technology is now mature enough to force smart devices out of our pockets and onto our wrists in the form of bracelets and watches, or in front of our eyes as augmented reality glasses.

Technology vendors look at ways to make money out these new trends and offer new chipsets, APIs, innovative battery systems, etc. Google has figured out how to incorporate a lot of the research done in the field over the last decades into a series of software APIs to explore the communication between wearable devices and their surroundings in an easy way. This book will be mostly about getting different devices we carry on us to talk to each other, share information and trigger events.

Chapter 2 will invite you to look into the current paradigm of connected devices: the Internet of Things.

RECOMMENDED READING

Interview with Neil Harbisson at `http://www.ara.cat/premium/societat/No-blancs-negres-tots-taronges_0_411558847.html`

Moritz Waldemeyer online portfolio at `http://www.waldemeyer.com/hussein-chalayan-111-robotic-dresses`

Kiana Tehrani and Andrew Michael. "Wearable Technology and Wearable Devices: Everything You Need to Know." March 2014. *Wearable Devices Magazine*, WearableDevices.com.

The Jakarta Globe website at `http://www.thejakartaglobe.com/archive/internet-users-in-indonesia-to-triple-by-2015-report/`