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Wearable Electronics

WEARABLE ELECTRONICS

Until recently, wearable accessories had one primary purpose-- to be fashionable. Sure, watches are useful for keeping time and staying punctual, but that's about as far as things went for functionality. Today, we have a rising selection of wearable electronics, many of which can be directly credited with a rise in health and lifestyle improvements. They track distance and time on your runs, help assess whether you're getting the right amount of restful sleep, and even keep you connected to your loved ones, hands-free. As a still-emergent technology, there is plenty of room for growth and development, but wearables have already made an undeniable impact on modern society.

Join us as we explore topics related to wearable electronics, including:

- Wearable Electronics Inspire Positive Attitudes Towards Fitness by Quantifying Goals
- Wearable Technology in the Future Will Be Seamless and Convenient
- Fashionable and Functional Wearable Technology for Senior Citizens
- Wearable Devices: Functional and Fashionable Technology
- Facial Recognition and Its Applications in the Internet of Things and Wearables

WEARABLE ELECTRONICS INSPIRE POSITIVE ATTITUDES TOWARDS FITNESS BY QUANTIFYING GOALS

Image source: Flickr User C_osett (CC BY 2.0)

For years, I would just pick a direction and start running. When I lived out in the country, my friends and coworkers would ask me how far I had gone and I'd say, "Man, I don't know. Looped out to the third cattle guard and back. Probably at least a half-marathon, if not three-quarters." The only way I could get an idea was by driving that same route afterwards and watching my odometer (it was about a quarter marathon). I was driving a '93 GMC then, though, so even for an odometer it wasn't very accurate. The same was true when I moved to Brooklyn; I'd pick a direction, run for awhile, take a couple lefts, take a couple rights, and somehow find my way back. The best I could do to tell my distance was look at my watch. If I ran for about an hour, it was a safe guess I'd done around ten miles (okay, maybe somewhere between six and seven.) I had no way to know for sure. That's not the case anymore. With smart, wearable electronics, now when I go out for a run to the lake and back, I know for certain that I ran 5.25 miles, in 37 minutes and 22

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seconds.

Even better, now I can compare my time for the same route on Thursday to my time on Wednesday, and know exactly how much time I added or shaved off. Now that I've been wearing my new watch for over a year when I run, I can visualize my fitness trends, with objective, numerical accuracy, in a way that was never possible for me before. I got faster in the spring, a little slower in the summer, much faster around October, and crawled to a stop when the snow hit. Now I can't wait for spring to come; I know exactly how fast I ran last year, and this year I want to run faster. Wearable technology radically changed my relationship to fitness.

Image source: Flickr User POLISEA (CC BY 2.0)

WEARABLE TECHNOLOGY APPLICATIONS ARE BEING CONTINUOUSLY DEVELOPED

Motivational speakers will tell you the way to achieve a large, nebulous goal is to break it down into a series of small, achievable, measureable steps. Being fit is a large, nebulous goal. What does it even mean to be fit? Without having a clear idea of what your desired destination is, it's impossible to know the right way to get there. You're just picking a direction and running. Maybe you'll get somewhere cool; maybe you won't. Without knowing really where you're going, or how to get there, the task begins to seem futile, sisyphean. Without knowing what good it was doing them, many people weren't feeling good about their fitness. As a result, most people—80%—aren't meeting the fitness standards assessed by the President's Council on Fitness, Sports & Nutrition.

With wearable technology tracking progress however, fitness suddenly became measurable. Future performance could be compared graphically with past performance, and small, achievable goals could be continuously set and met. This gave people the ability to see

exactly what they were hoping to accomplish. Instead of reaching forever for some far-off notion of fitness, people could clearly see the next goal to reach. That inspired people to reach it. Once they had it in hand, they reached for the next goal. How wearable technology really helped people was by giving them hope.

Smart, wearable fitness technology is still new to the marketplace, and so it had not yet been possible to conduct comprehensive, long-term studies on its effectiveness. While short-term studies have not noticed a significant gain in overall fitness from wearable electronics users, it remains to be seen what impact their integration into people's daily routines will have over the course of decades, especially with new technologies and methods being continuously developed. What has been demonstrated, however, is the change in attitudes towards fitness that these technologies have brought about. According to a study conducted by CNN, 91% of the 200 women who participated altered their daily routes to increase their step count and exercise amounts. More importantly, reaching daily targets brought feelings of happiness, self-satisfaction, pride, and motivation to more than 98% of participants. So whether or not people are actually getting healthier thanks to this technology, they're definitely feeling better about themselves, and their fitness regimens, when they use it. That's a big difference.

Image source: Flickr User Robert Scoble (CC BY 2.0)

ADVANCES IN PRINTED CIRCUIT BOARD DESIGN MAKE WEARABLE ELECTRONICS POSSIBLE

While wearable technology has changed the way Americans feel about their fitness regimens, wearable electronics were originally made possible by advances in printed circuit board design. These improvements allow designers to create dense, flexible, and modular wireless devices. In an expanding and competitive wearable technology ecosystem, not only does the success of a product

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depend on an innovative idea or use case, it also depends on that company's ability to make that idea a reality. Efficient printed circuit board layout and cost-effective component sourcing can make the difference between success and failure.

Printed circuit board design is an iterative process; your prototype design will undergo multiple revisions from start to completion and it's annoying and time-consuming to keep track of each change that is made. The right software can keep track of this so that you don't have to. In the same way that professional musicians need top quality audio engineering software—Kanye West isn't using Garageband—professional circuit designers need the best PCB layout software. To learn how Altium can help you make your wearable technology dream a reality, contact us or take a free trial today.

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WEARABLE TECHNOLOGY IN THE FUTURE WILL BE SEAMLESS AND CONVENIENT

When I was younger I was a bit of a nerd, and I guess I still am. The most visible sign of my nerdiness was my fashion sense or lack of it. Tall socks, cargo shorts, and a brown Pacman hoodie that I wore in every season, except summer, made up my daily wardrobe. I was simply more interested in gizmos and gadgets than I was in looking good. I'm still more interested in electronic devices than clothes, but the line between the two is beginning to fade. Current wearable technologies can sometimes be clunky and unfashionable. That's why in the future, they'll be seamlessly integrated into the things we already wear. However, looks aren't the only concern. Convenience is also a major factor in the wearables space, and next gen devices will need to operate with less hassle than current products.

SEAMLESS

Do you remember those Heely shoes? I never had a pair, but the kids that did were the coolest around. One of the most impressive things about Heelys was how seamlessly they integrated a wheel into a shoe. They didn't seem different from any other shoe until the person wearing them started rolling off into the sunset. Electronics will be assimilated into clothing in the same way. There are already several devices out there that are trying to combine cloth and circuits, but they're not all doing a great job. Things like flexible circuits can help companies make the jump from clunky to chic.

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They say that there is nothing new under the sun, and apparently wearable technology is no exception. While we think of wearables as recent technology, there's one example from the early days of computing reminds us what not to do; the Nintendo power glove. This glove was everything wearables should not be, large, clunky, difficult to use, and unfashionable. That being said, if I had one I would wear it out at least once. A more modern electronic fashion faux pas would be the "Beauty and the Geek" keyboard pants. They basically wanted to put a keyboard on your crotch. While the technology is integrated into clothing, it's not what I would call seamless.

The power glove, so cool and yet so clunky. Image Credit: Flickr User mmechtley

One company that gives us an example of how to do things both right and wrong is Sensoria. I wrote about their smart sock not long ago, and it's at once both bulky and brilliant. Currently, their smart socks incorporate an anklet and several flexible sensors into a tall sock. The flexible sensors on the pads of the feet are as seamless as you can get. The anklet is a different story. You have to roll the top of the sock down over the anklet to hold it in place, which reminds me of when I rolled down my tall socks as a child because I wanted cool short socks like the other kids. That's something I never want to relive. Sensoria is making headway, though, by developing a new chip that can be embedded into fabric which is much better than an anklet. Now they need to take it one step further and make it flexible.

Flexible electronics have been around for awhile, and are particularly useful in areas like the aerospace industry. NASA is currently postulating about the next step in flexible electronics, fully printable flexible circuits. PCBs like these could actually be seamlessly integrated into fabric. Some companies have already begun experimenting with this concept through things like knitted electronics and dresses with embedded LEDs. These, however, don't go far enough. The future of wearables lies in creating and incorporating flexible components like microprocessors, memory, and sensors.

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CONVENIENCE

Why did I wear cargo shorts all those years ago? One word, convenience. I could stuff anything into those pockets that I'd need for the day. The only inconvenient thing was how out of style they were. One of the most annoying things about today's wearables is having to charge them. New technologies like wireless charging and in situ energy harvesting can help bring convenience to wearables.

I didn't look half this good in my cargo shorts.

Charging is a hassle for connected devices. For wearables, this problem is being addressed in the more lucrative sphere of Internet of Things (IoT) sensor networks. Companies are developing ultra low power components, like memory, so that devices can drastically reduce their power requirements. WIth energy usage at a minimum, wearables could make use of things like wireless charging or onboard energy harvesting. Some companies are even exploring solar power for charging devices. Regardless of the method, wearables need to be charged without using proprietary cables and connectors.

Wearable technology is an exciting new field, but it has some hurdles to overcome. If companies want people to wear their products, they'll have to integrate them seamlessly into the things we already have on. That kind of assimilation will require fully flexible circuits that can be directly embedded into fabrics. Looks aren't the only thing we're watching out for, we also need convenience. The charging mechanisms for current wearables are tiresome in the extreme. That's why next gen technology will need to incorporate some kind of onboard charging scheme.

Designing the next generation of wearables will be difficult, though not as difficult as being "fashionable." CircuitStudio can help make designing cutting edge circuits easy with its great array of advanced features.

Have more questions about fashion? Call an expert at Altium.

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FASHIONABLE AND FUNCTIONAL WEARABLE TECHNOLOGY FOR SENIOR CITIZENS

Have you checked the year on your smartwatch recently? It's the year 2017 and while I see a lot of young people walking around with wearables, I don't see many elderly with them. That represents an opportunity as the US population is aging and many more people will enter the elderly demographic in the next several years. Older people need wearables for different reasons than their younger compatriots. They're looking for devices that can keep them safe and help monitor their health. They do have a few of the same concerns as everyone else, though, namely looks and convenience. There are several devices currently on the market that are great examples of what wearable technology for senior citizens should look like.

TARGETING THE ELDERLY

I think it's a safe assumption that the majority of PCB and product designers are not senior citizens. Since we haven't quite reached that level yet it can be a bit difficult to anticipate their needs and wants. Like most people, seniors are concerned about looks and convenience. They're also interested in using wearables to track their health and stay safe.

My grandmother likes to look nice. Even after she developed Alzheimer's disease, most days she still puts on her nice shirts and jewelry. Senior citizens want their wearables to look nice as well. Things like bulky pendants that hang out of shirts are not

fashionable, nor are they convenient. User-friendly is a great feature for young people, but it's not necessary. We can dive into menus and scroll through lists with ease. For someone with advanced arthritis, clicking little buttons on a tiny touchscreen isn't so easy. When designing a device for senior citizens be sure to think about their physical impairments and make ease of use a high priority. You'll also want to make it look good in order to tap into this huge market.

If only wearables looked this good.

As far as functionality goes seniors aren't just thinking about counting steps. They're interested in devices that can help them keep track of their health issues. More than 90% of seniors suffer from at least one chronic disease, and 77% have at least two. It can be helpful to record things like sleeping habits, pulse, and stress levels in order to manage these illnesses. Along with ailments, falling is a huge concern for senior citizens. A broken hip can be a death sentence for an older person, so recording falls and preventing them, if possible, is a big deal. If you want your device to beat all the others in terms of functionality, you'll have to be creative. Some of the examples show you what kinds of products that creativity results in.

DEVICES DOING IT RIGHT

My grandfather always liked to teach by example, so let's look through a few devices that are heading in the right direction.

- Wise Wear - This company is a little more concerned with aesthetics than they are with functionality, but they do both well. Wise Wear makes wearable tech that pushes the fashion envelope. Another plus is their long battery life which can last up to 6 days, which makes it much more convenient. However, they're just meeting the status quo with features like step counting and burned calories.

- ActiveProtective - This product is highly unfashionable, but deserves a mention for its creativity and contribution to safety. ActiveProtective is a belt that deploys airbags when it detects a fall. I presume it uses an accelerometer to detect falls. This is

something that more smart watch type gadgets should look into. This might not look cool, but it's creative and takes an active role in fall safety.

- **Lively** - Greatcall's Lively is a watch that does just that. It's a fashion statement made for older people to help them keep track of their health. It has fall detection, a step counter, and an emergency button. One con is that is has a replaceable battery. In my experience it's not easy to change a watch battery, especially if you have an illness that affects your hands.

- **Lechal** - This company has taken a bottom up approach to wearables by designing smart insoles. These things track your activities, but that's not what makes them great for the elderly. My grandmother goes on a walk along the same route every day, but has to have someone to guide her or she'd get lost. Lechal insoles use vibrations in the shoe to subtly guide the wearer in the direction they're supposed to go. This could help someone who has a slight memory problem keep some independence. It's creativity like this that will make a gizmo stand out.

So here we have Wise Wear and Lively that have both made more traditional wearables that are also fashionable. Then there's ActiveProtective and Lechal, which may not be super hip, but get the job done in creative ways. What you need to do is combine fashion, function, and creativity to produce devices that can reach the untapped senior market.

Remember the physical difficulties that your users might experience.

Once you've got a great idea for a new wearable form factor you'll need to design a PCB that can fit inside. Altium Designer is a great piece of PCB design software that can help you do just that. It has rigid-flex design integrated from the ground up, making it great for wearables.

Have more questions about wearable tech? Call an expert at Altium.

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WEARABLE DEVICES: FUNCTIONAL AND FASHIONABLE TECHNOLOGY

Do you ever look at old pictures of your parents when they were younger and wonder, "why were they wearing those hideous clothes?" I find the giant glasses to be particularly bad. Fashion is important, and it always has been, even if trends change. When it comes to the Internet of Things (IoT) and wearable electronics aesthetics often seem to be left by the wayside. Designers seem to let functionality determine look and form factor, rather than developing both concurrently. If you want to sell products, you should realize that fashion is important. I'll go over three devices that combine form and function well.

CHIC GEEK

If you look at our movies and TV shows one thing you'll realize is that geeks still aren't very cool. Even as old as he is now, Fonzie is still cooler than Sheldon from Big Bang Theory. When people buy electronic devices they don't want to look like nerds, and that's where a lot of wearables have failed.

Some news has recently come out that the IoT isn't growing as fast as we all predicted. There are multiple reasons behind this, including slow implementation of smart building technology like low power wide area networks (LPWAN). Wearables have grabbed only a small piece of the IoT market, primarily because they are inconvenient and uncool. I've already talked about convenience, and I've even talked about the fashion factor in regards to senior citizens. With the elderly, you might wear an ugly device if it will save your life. The rest of us, though, are not expecting our watch to save our lives. We want it to keep time, give us alerts, count our

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steps, and look good doing it. If it's ugly, why waste my money? I can just buy a fashionable watch for timekeeping and continue using my phone for everything else. Your gadgets need to work well and look good doing it.

Look at this, no one thinks this looks chick.

POSITIVE EXAMPLES

Brains won't get you everything, sometimes you need looks too. Let's review a few products that are doing it right.

- **Bellabeat Leaf** - Bellabeat is doing a number of things well. Firstly it has a great form factor and even material. It can be made with natural wood, which gives it a different look from many other IoT gizmos out there. Few people want to wear something that screams "tiny supercomputer." They want a product that's unassuming but still does what it's supposed to. The Leaf can get the job done in a variety of forms, such as a clip, a bracelet, and a necklace. Its functions include the traditional step counting, sleep tracking, etc. However, it also has a more interesting function for women that lets them track their monthly cycles. Wearables need to include these other kinds of tracking if they want to separate themselves from the field of gadgets all doing the same old things. The Leaf's design, wood option, and it's meditation goals make it a trendy choice for women who want technology to help them keep track of their lives without shouting it to the world.

- **Omate's Ungaro Ring** - This ring screams chic because it was designed by a French fashion label. It not only looks great, it also has a very interesting function. This ring vibrates to send you a notification, but only from a VIP list that you set on your app. One of the most annoying things about wearables is the constant notifications. I don't want a ping every time my mom uploads and old picture of her and her friends from high school. I want something that buzzes when she or my wife or best friend are calling me. Add in a five-day battery life and this ring starts to meet my convenience requirements as well. This device is elegant in its simplicity, something I think the IoT has lost, or possibly never had found. Your products don't have to

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do everything. Minimalism is currently fashionable, and it will help you save money and battery life on extra sensors.

- **Pebble Time Round** - I had to review a watch because half of wearables are watches. Someone, please design some new devices. The Pebble Time Round is coming to stores near you soon. The Time Round's defining characteristic seems to be that it looks and feels like a watch. Apparently, when it comes to smartwatches size does matter, and smaller is better. Pebble's product is small and light and gives you all the tech of a smartwatch without any of the giant form factors or braggadocious flash. Again, we don't want a tiny supercomputer on our wrist. We want a normal watch that humbly does the same kind of work as my cell phone.

No matter the shape or size, make sure your smartwatch looks good.

These three products all have some things in common. They were all designed to look good. Each device also has minimalist elements. The Leaf is small and unassuming, the ring only does one thing, and the Time Round is small enough to look like a normal watch. Take note of these devices and their "less is more" approach. If you design your products with fashion and function both in mind, you could more effectively tap into the IoT market.

Whether your device is fashionable or not it should be powered by an elegant board. Using some great PCB design software will help you design one. CircuitStudio has a wide range of advanced features that will help you design the next product to put on this list.

Have more questions about fashion? Call an expert at Altium.

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FACIAL RECOGNITION AND ITS APPLICATIONS IN THE INTERNET OF THINGS AND WEARABLES

One of the coolest tech things I saw in movies and couldn't wait to see in the real world was retina scanning. I want to feel like James Bond or some other spy when I unlock my house or go into my office at work. I never thought biometrics could get any cooler than that, but Apple expanded my horizons the other day. They announced that the new iPhone X will be equipped with state of the art 3D facial recognition technology. Using a variety of sensors they're now able to create a "faceprint" instead of a thumbprint or retinal pattern. They're currently using this in the same way that several other companies have, primarily as a security measure. However, Apple has also developed some preliminary apps that showcase the potential of facial mapping. I believe the boundaries of this technology lie only in our imaginations. The Internet of Things (IoT) and wearables markets have been groaning for this technology, and now it's up to designers like you to bring it to fruition.

HOW DOES APPLE DO IT?

Facial recognition has been around for the last 50 years but is just now garnering mainstream attention. This is mainly because previous recognition systems could not match the accuracy of Apple's new technology. Other companies like Samsung have dabbled in facial recognition but did not truly move into 3D facial mapping. Apple has succeeded where others have failed with an impressive new sensor array that can map faces with great accuracy.

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So, how did they do it? The iPhone X uses a variety of sensors to make a 3D map of your face. This multiple sensor fusion is being used in the IoT, and even the automotive industry, in an effort to interpret data more accurately. In this case, Apple is using a proximity sensor, ambient light sensor, normal camera, an infrared dot projector, a flood illuminator, and an infrared camera to capture our features. The most important components are the dot projector, which illuminates our face with 30,000 dots, and the infrared camera, which captures their positions. The result is a 30,000 point map of our face that is so accurate they say the chances of someone else unlocking it are one in a million. Of course, security is always a concern, so apparently Apple even worked with Hollywood mask makers to test hacking attempts. It's unknown if they worked or not, but an average everyday thief wouldn't have access to those kinds of resources, so the majority of us are safe. If we want full security, they might have to add an iris scanner.

If you're not a fan of Apple, you've probably already pointed out that companies like Samsung implemented this technology first. While that is somewhat true, there are some distinct differences in tech. Samsung's system was powered by Google's face recognition software, that identifies faces in 2D photos. It was fairly easy to breach that security, you just had to use a 2D photo. To make up for the poor facial recognition security, they also implemented an iris scanner. However cool retinal scanning is, it's not very practical. A thin range and fairly low resolution made that iris scanner good enough for its time, but not for the future. Apple's system creates a full model of our faces and uses artificial intelligence to identify us even if we get a haircut or are wearing glasses.

*Retinal scanning is now old news.*

APPLE'S USES

Enough about how the tech works. How does Apple plan to use this mapping? Its primary use seems to be security, though they have shown some more fun applications as well.

Another major announcement for the iPhone X was the lack of a home button that previously allowed users to unlock their phones with a thumbprint. That turned out to not be very secure, which is presumably why Apple created this system. The facial recognition

system builds a model of your face, which it stores in the phone and compares to how you look when you try to unlock the phone. Apparently, unlocks will work on a sliding scale. This means Apple could let a face unlock your phone with a 50% comparison match, but require a 90% match for purchases.

Beyond security, they showed off a fun feature that will let emoticons mimic our faces. While that certainly is fun, I think facial recognition technology has more advanced applications.
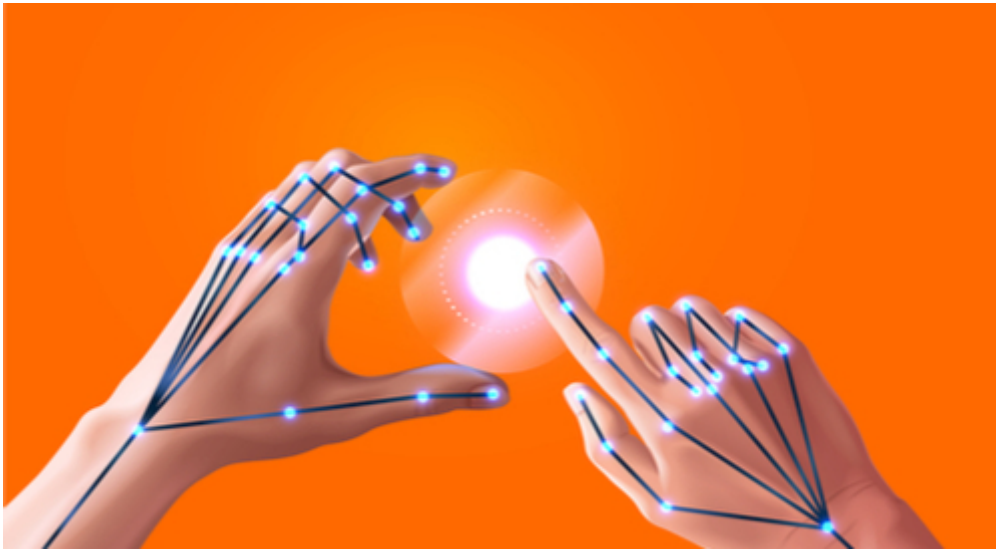
Gesture control is the next step after real-time facial mapping.

IOT AND WEARABLE APPLICATIONS

Facial recognition is not only important because it lets us use our face as a key, but also because systems like Face ID can read our expressions in real time. That means it's time to move into devices that can be controlled by facial gestures.

In the IoT space, this could mean appliances that can be operated with a nod and a wink instead of clunky controls. I recently wrote about IoT tech for senior citizens. What if their TV could read their lips for its commands instead of needing them to remember where the remote is and which buttons to push. People want IoT systems to operate efficiently and easily. They also want their systems to be personal. Imagine if the Google Home or Amazon Echo could recognize a face and bring up user setting without the person having to announce their identity.

Wearables could also greatly benefit from this kind of system. No one wants to input a passcode on their smartwatch or other wearable devices, so user facial recognition would be great. Gesture control would be even more useful here than in the IoT. People want their wearables to be seamless, functional, and fashionable. It's not very kosher to talk to your necklace in public. However, it might be slightly more acceptable to wink at your watch, or even to operate your gadgets with eye tracking. I know I'm getting slightly off topic here, but aside from telecommunication, eye tracking is the end-all-be-all of seamless control. Gesture control is the first step on that road, and you could be one of the few to take the first step.

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The times they are a changing, and we often find Apple in the lead. Their iPhone X will be revolutionary for many reasons, but 3D facial mapping is one of the more important ones. They've put together several sensors that allow our phones to accurately recognize our faces in real time. So far this tech is being used for security and other minor applications. However, this is your chance to take the lead ahead of Apple. The IoT and wearables sectors need gesture control. Real-time 3D facial mapping could be used to do just that and could expand to include things like hand motions.

The future awaits, all you have to do is grab it. In order to do that you'll need a great product and well-designed circuits to make it tick. Circuit designer software, like CircuitStudio, have a great variety of tools to help you build the best board you can.

Have more questions about facial recognition? Call an expert at Altium.

ADDITIONAL RESOURCES

Thank you for reading the guide to Wearable Electronics. To read more Altium resources, visit the Altium resource center here or join the discussion at the bottom of each original blog post:

- Wearable Electronics Inspire Positive Attitudes Towards Fitness by Quantifying Goals
- Wearable Technology in the Future Will Be Seamless and Convenient
- Fashionable and Functional Wearable Technology for Senior Citizens
- Wearable Devices: Functional and Fashionable Technology
- Facial Recognition and Its Applications in the Internet of Things and Wearables

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