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Responder Technology Alert (June 2015)

July 2015

JF Upton
SL Stein



Prepared for the U.S. Department of Homeland Security
Science and Technology Directorate
under Contract HSHQPM-14-X-00058

U.S. DEPARTMENT OF
ENERGY

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Pacific Northwest National Laboratory
Richland, Washington 99352

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1.0 Introduction

The Pacific Northwest National Laboratory (PNNL) is supporting the Department of Homeland Security (DHS) to advance technologies to enhance responder health and address complex and changing threat environments. The DHS Science and Technologies First Responders Group established the Responder Technology Alliance (RTA) to accelerate the development of solutions to first responder needs and requirements by identifying, analyzing, and recommending solutions that improve responder safety, enhance their ability to save lives, and minimize property loss. The end goal is for RTA to develop and implement strategies that will make effective solutions available to first responders.

As part of technology foraging for the RTA, this report summarizes technologies that are relevant in the area of “wearables,” with the potential for use by first responders. The content was collected over the previous month(s) and reproduced from a general Internet search using the term wearables. Additional information is available at the websites provided. The content is organized by technology function including:

- Sensors – Devices that detect physiological, particle, and chemical activity
- Displays – Heads-up and body-worn visual displays
- Power – Wearable power systems including chargers, batteries, self-powering or harvesting technologies, and power supplies
- Communications – Voice and data communications systems utilizing Bluetooth, wireless, hands-free, ergonomically optimized systems, noise-filtering digital speakers or microphones, etc.
- Location tracking – Track users indoors or outside
- Cameras – Body-worn photo and video cameras
- Breathing Apparatus – Wearable air supply and monitoring devices
- Exoskeletons – Whole or partial body suit that enhances mobility and physical performance
- Wearable Computers – Body-worn data processing devices
- Other – Miscellaneous technologies as well as emerging trends or recent advances in the field of wearables.

This report is not meant to be an exhaustive list nor an endorsement of any technology described herein. Rather, it is meant to provide useful information about current developments in the area of wearable technology.

These reports are available online at <http://nwrta.pnnl.gov>. A spreadsheet summarizing these technologies is available in Appendix A. For an electronic copy, contact Jaki Upton at jaki.upton@pnnl.gov

2.0 Sensors

2.1 Physiological

2.1.1 ADI: ADUCM350

Technology name: ADUCM350 microprocessor

Description: ADI's ADUCM350 is a high-performance microprocessor that can be combined with optical and sensors and software algorithms to create an optical system ideal for wearables and heart-rate monitoring. Compared to traditional electrocardiogram (ECG), photoplethysmogram measures oxygen saturation in the blood via a light sent to the surface of the skin using photo sensors. The device is described by ADI as a "complete, coin cell powered, high precision, meter-on-chip for portable device applications such as point-of-care diagnostics and body-worn devices for monitoring vital signs. The ADuCM350 is designed for high precision potentiostat, current, voltage, and impedance measurement capabilities." The technology can address interference by ambient light, hairs, motion, or sweat.

Product link: <http://www.analog.com/en/products/processors-dsp/analog-microcontrollers/arm-cortex-m3-processor/aducm350.html>

Source: ADI considers wearable technology in the healthcare sector <http://www.cieonline.co.uk/adi-considers-wearable-technology-in-the-healthcare-sector.aspx>

2.1.2 Apple

Technology name: Multi-modal physiological sensing system

Description: Apple has reportedly filed a patent for the Apple Watch with a physiological sensing system. The device is described as including a pulse oximeter that uses a light emitter and light sensors to measure a user's heart rate while compensating or filtering for "noise" in the reading, such as that resulting from a user's motion. The device may include multiple sensing modes including optics, force/pressure, temperature, motion, proximity, impedance, and more.

Source: New Apple Watch Patent Covers Wearable Multi-Modal Physiological Sensing System <http://www.patentlyapple.com/patently-apple/2015/06/new-apple-watch-patent-covers-wearable-multi-modal-physiological-sensing-system.html>

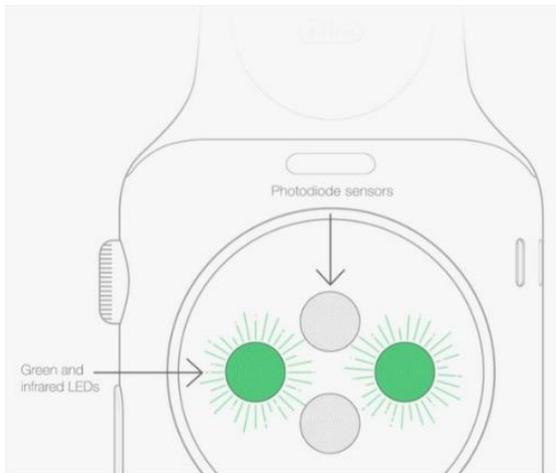


Photo source: <http://www.patentlyapple.com/patently-apple/2015/06/new-apple-watch-patent-covers-wearable-multi-modal-physiological-sensing-system.html>

2.1.3 Elbit: Canary

Technology name: Canary head-worn physiological monitor

Description: Canary is a physiological monitoring device was developed with support from the Defense Ministry for air force pilots. The device features LifeBEAM sensors and reportedly “enables the jet’s on-board computer to switch to autopilot if the human pilot suffers hypoxia (lack of oxygen) or loss of consciousness.” Canary monitors a pilot’s vital signs and provides alerts on a helmet-mounted or computer display, without interference to the pilot.

Product link: https://www.elbitsystems.com/elbitpr/files/launching_pilot_health_monitoring%20.pdf

Source: New Israeli device enables jet to take over if pilot passes out <http://www.jpost.com/Israel-News/New-device-enables-jet-to-take-over-if-pilot-passes-out-406069>



Photo source: Elbit Systems

2.1.4 Google

Technology name: Health wristband

Description: Google X research division is developing a health wearable that can measure pulse, heartbeat rhythm, skin temperature, light exposure, and noise levels, and more. It is Google’s first wearable hardware and is designed for use in clinical trials. The device will help clinical trial doctors

collect data on participants at the lab and at home. Google has also developed the Google Fit platform that collects biometric data from compatible devices.

Source: Google unveils sensor-laden health wearable for monitoring patients in clinical trials
<http://venturebeat.com/2015/06/23/google-unveils-sensor-laden-health-wearable-for-monitoring-patients-in-clinical-trials/>



Photo source: <http://venturebeat.com/2015/06/23/google-unveils-sensor-laden-health-wearable-for-monitoring-patients-in-clinical-trials/>

2.1.5 Imec, Holst

Technology name: Smart t-shirt

Description: Conductive silver traces link electrocardiogram systems to a small, cheap, low-powered chip. The chip features ECG, EEG, and galvanic skin response sensors; Arm Cortex M0 processor; button-cell battery; and Bluetooth LE to stream data to a smart device or the cloud. The shirt can accommodate more wearable technologies such as sensors to track other biometric data, LED indicators or haptics.

Source: Smart T-shirt with removable electronics is next step in wearable health
<http://www.healthtechevent.com/sensor/smart-t-shirt-with-removable-electronics-is-next-step-in-wearable-health/>



Photo source: <http://www.healthtechevent.com/sensor/smart-t-shirt-with-removable-electronics-is-next-step-in-wearable-health/>

2.1.6 Jaguar

Technology name: Biometric “emotion sensing” band with heart rate monitor and GPS

Description: Jaguar is employing a biometric band with a heart rate monitor and GPS to measure a wearer's excitement level (biometric, atmospheric, and sociometric) at Wimbledon 2015. Results will be compared to sensors measuring noise, crowd movements, and social media. The goal is to provide insight into entertainment levels or fans' response to key moments.

Product link: http://jaguar.wimbledon.com/en_GB/wrapper/jlr/index.html

Source: Jaguar testing emotion sensing wearable at Wimbledon 2015
<https://www.wearable.com/wearable-tech/jaguar-testing-emotion-sensing-wearable-at-wimbledon-2015-1312>

2.1.7 Pratik Saraogi (Individual): Oxstren

Technology name: Oxstren smart gloves

Description: The Oxstren smart gloves track physiological metrics (steps, calories, etc.) and can identify exercises using accelerometer and gyroscope sensors. The leather gloves feature sweat-resistant layers, latex, and Oxstren's patented smart fabric. They can track and provide alerts regarding heartbeat, breathing patterns, and hydration. Oxstren's algorithms help evaluate a user's form, provide feedback (via vibrations), and calculate exerted force.

Product link: <http://oxstren.com/>

Source: Oxstren – how world's first smart gym glove is taking workouts to a different level
<http://yourstory.com/2015/06/oxstren/>



Photo source: <http://yourstory.com/2015/06/oxstren/>

2.1.8 PureTech

Technology name: Wearable sensors

Description: This article explores new and upcoming wearable physiological sensors and the many data points and capabilities they present.

Research link: <http://www.nature.com/nbt/journal/v33/n5/full/nbt.3222.html>

Source: Nature Biotechnology: Wearable sensors <http://wirelessrighttoknow.com/nature-biotechnology-wearable-sensors/>

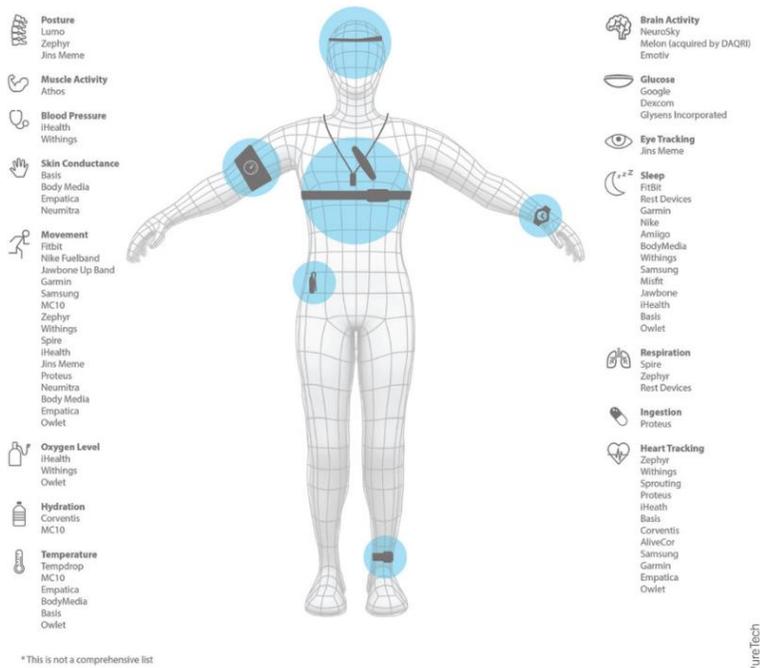


Photo source: http://www.nature.com/nbt/journal/v33/n5/fig_tab/nbt.3222_F1.html

2.1.9 Sano Intelligence

Technology name: Health-sensing wearable

Description: Sano is developing a wearable biometric sensor that can monitor a range of data including noninvasively tracking blood glucose, primarily for wellness (not medical) purposes.

Company link: <http://www.sano.co/>

Source: Sano raises \$10M for wellness-focused, noninvasive blood glucose tracking wearable
<http://mobihealthnews.com/44590/sano-raises-10m-for-wellness-focused-noninvasive-blood-glucose-tracking-wearable/>

2.1.10 Sensoria, Renault Sport

Technology name: Sensoria heart-rate monitor and smart garment, Renault Sport Monitor mobile app

Description: Designed for sports car drivers, the technology combines Sensoria's smart garment with heart-rate tracking technology with Renault Sport's Monitor mobile app. The user's heart rate is transmitted via Bluetooth to the app through Sensoria's heart-rate monitor. The app can also record videos of each lap while also recording physiological data and acceleration forces.

Product link: http://www.sensoriafitness.com/renaultsport_EN

Source: Monitor App Integrated With Wearable Bluetooth Smart Heart Rate Sensing T-Shirt
<http://www.sensormag.com/sensors-products/external/news/monitor-app-integrated-wearable-bluetooth-smart-heart-rate-18358>

2.1.11 University of Tokyo

Technology name: Elastic conductive ink

Description: This conductive ink has applications in wearable clothing, such as sportswear, to incorporate biometric sensors (heart rate, muscle contraction, etc.). This use of cloth material would reportedly “enable a new generation of wearable devices that fit themselves to the human body.” This material is printable on textiles in a single step. The material maintains its high conductivity when stretched to more than three times its original length. Researchers have already used the material to develop wrist-band muscle-activity sensors.

Research link: <https://dx.doi.org/10.1038/ncomms8461>

Source: New stretchy `conductive ink` for wearable tech developed
<http://www.dnaindia.com/scitech/report-new-stretchy-conductive-ink-for-wearable-tech-developed-2099012>

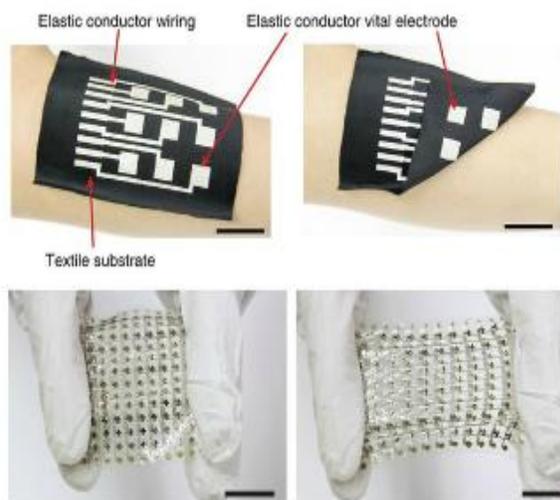


Photo source: Someya Laboratory

2.2 Chemical/Particulate

2.2.1 Spec-Sensors

Technology name: Electrochemical sensors

Description: Spec-Sensors is adapting its electrochemical sensors for use in wearables. The sensors can display real-time levels of various gases/particulates. The goal is to reduce the sensor size from 15 mm x 15 mm to 5 mm x 5 mm.

Company link: <http://www.spec-sensors.com/>

Source: This wearable startup wants to help runners in China's most polluted cities avoid the smog
<http://www.businessinsider.com/this-wearable-startup-wants-to-help-runners-in-chinas-most-polluted-cities-avoid-the-smog-2015-6>



Photo source: <http://www.spec-sensors.com/product-category/current-products/>

2.3 Other

2.3.1 dorsaVi: ViMove

Technology name: ViMove posture tracker

Description: ViMove can track and analyze a user's movement and posture. ViMove's assessment modules assess range of movement, postural angles, and muscle activity. ViMove sensors connect wirelessly with a smart device to interpret and display data regarding performance. The software performs analyzes strain data to assess how the work is impacting muscles/joints.

Product link: <http://us.dorsavi.com/vimove/>

Source: Clinical-grade wearable for posture, movement tracking gets second FDA clearance
<http://mobihealthnews.com/44000/clinical-grade-wearable-for-posture-movement-tracking-gets-second-fda-clearance/>



Photo source: <http://dorsavi.com/vimove/>

2.3.2 Moodmetric: Galvanic skin response

Technology name: Galvanic Skin Response sensor

Description: The GSR sensor measures conductivity of a user's skin and sweat to determine arousal as a reflection of mood or stress level. The sensor is being used in wristbands (Jawbone's UP3 and Microsoft's Band), rings (Moodmetric), and even clothing (Sensoree's GER mood sweater). The garment indicates a user's emotion as a color, such that green is tranquil, purple is aroused, red is nervous, yellow is ecstatic, etc.

Source: Wearables Get Moody With the GSR Sensor

http://www.designnews.com/author.asp?section_id=1386&doc_id=277976&itc=dn_analysis_element&dfpPParams=ind_184,industry_consumer,kw_49,aid_277976&dfpLayout=blog



Photo source:

http://www.designnews.com/author.asp?section_id=1386&doc_id=277976&itc=dn_analysis_element&dfpPParams=ind_184,industry_consumer,kw_49,aid_277976&dfpLayout=blog

2.3.3 RMIT University

Technology name: Ultraviolet light sensor

Description: Researchers are exploring the use of wearable ultraviolet light sensors in the form of an ultra-thin, stretchable, transparent skin patch. The patch can detect toxic gases (hydrogen, nitrogen dioxide, etc.) The patch is reported to be “100 times thinner than sheet of paper” as well as “unbreakable and cheap to make.”

Research link: <http://doi.org/10.1002/sml.201500729>

Source: Wearable UV sensors to help prevent cancer <http://www.cio.com.au/article/577091/wearable-uv-sensors-help-prevent-cancer/>



Photo source:

<http://www.cio.com.au/article/577091/wearable-uv-sensors-help-prevent-cancer/>

2.3.4 **Vigo Technologies, Inc., Wichita State University**

Technology name: Bluetooth headset for monitoring alertness

Description: Researchers are developing a Bluetooth headset equipped with an infrared sensor that monitors head movements and detects blinks—a common indicator for operator drowsiness. The data is transmitted to a smartphone. The headset vibrates, flashes, and beeps if drowsiness is detected. The user can control the device and track their performance via a mobile app.

Source: Device created at Wichita State could detect driver drowsiness, make roads safer
<http://www.wichita.edu/thisis/stories/story.asp?si=2884>



Photo source:
<http://www.wichita.edu/thisis/stories/story.asp?si=2884>

3.0 Displays

3.1 Heads-up (on face or head)

3.1.1 Amazon

Technology name: Pointer tracking for eye-level scanner and displays

Description: Amazon has a recently published patent for wearable displays anticipated to benefit warehouse operations with hands-free operations and the ability to recognize objects associated with a specific task. The technology is anticipated to have the ability to display textual information to a wearer when it recognizes a target object. The technology is described as “A wearable computer device [that] may include multiple imaging devices or other sensors working in concert to recognize conditions, objects or areas of an environment in which the wearable computer device is situated. The device may include an imaging device and a sensor, which may but need not be a imaging device (sic), for sensing and capturing information regarding the environment.”

Patent link: [Patent No. US20150168727](http://www.uspto.gov/patent/publications/details/pat20150168727/pat20150168727.pdf)

Source: Why Amazon is Building a Google Glass Clone <http://www.cheatsheet.com/gear-style/why-amazon-is-building-a-google-glass-clone.html/?a=viewall>

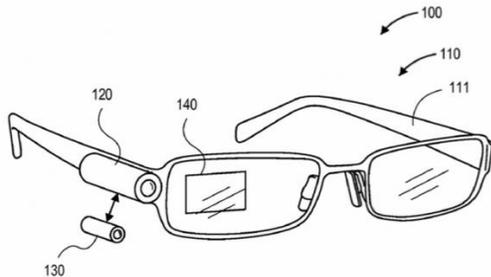


Photo source: US Patent Office

3.1.2 APX Labs, Nuance Communications

Technology name: Skylight Voice smart glasses with voice recognition

Description: APX Labs and Nuance Communications are partnering to combine Nuance’s voice recognition capabilities with APX Labs’ Skylight R5 smart glasses software platform to allow users to access information and communicate with colleagues in an easy way. The embedded voice technology will allow for hands-free operation with on-screen contact. The device will be able to function with or without network connectivity and in 25 languages.

Product link: [Skylight](http://www.apxlabs.com/skylight), [Nuance Communications](http://www.nuance.com)

Source: Nuance Communications (NUAN), APX Labs Partner on Voice Recognition Capabilities for Skylight R5

[http://www.streetinsider.com/Corporate+News/Nuance+Communications+\(NUAN\).+APX+Labs+Partner+on+Voice+Recognition+Capabilities+for+Skylight+R5/10650822.html](http://www.streetinsider.com/Corporate+News/Nuance+Communications+(NUAN).+APX+Labs+Partner+on+Voice+Recognition+Capabilities+for+Skylight+R5/10650822.html)

3.1.3 Beijing Palo Alto Tech Co. Ltd.

Technology name: Cool Glass One

Description: This smart glass features a touchpad and photo and 1080p HD video capability, and users can control the device using a swiping motion on the interface. It can currently only be used with Android operating systems. The device is expected to come with an affordable price tag approximately one-third of the price of leading smart glasses.

Source: China's Answer To Google Glass: 'Cool Glass One' Wearable For A Fraction The Price
<http://www.ibtimes.com/chinas-answer-google-glass-cool-glass-one-wearable-fraction-price-1948954>



Photo source:
<http://shanghaiist.com/2015/06/02/chinese-company-google-glass.php>

3.1.4 Intel, Recon Instruments

Technology name: Head-mounted display

Description: Intel acquired Recon Instruments, which specializes in wearable sports displays, to help advance Intel's efforts in head-mounted displays.

Source: Intel acquires wearable display company Recon Instruments
<http://www.theverge.com/2015/6/17/8796781/intel-wearables-recon-instruments-acquisition>

3.1.5 Leti, III-V Lab

Technology name: High-density micro-LED

Description: LED microdisplays are anticipated to benefit heads-up and head-mounted displays because they offer a small footprint, low-power consumption, high-contrast ratio, and high brightness. The technology is reported to offer "100- to 1,000-times improvement compared to existing self-emissive

microdisplays, with very good power efficiency. The technology also will allow fabrication of very compact products that significantly reduce system-integration constraints.”

Product link: <http://www.leti.fr/>

Source: Path to Fabricating Micro-LEDs for Wearables and Nomadic http://www.novuslight.com/path-to-fabricating-micro-leds-for-wearables-and-nomadic-systems_N4210.html

3.1.6 Method50: Vuzion

Technology name: Vuzion heads-up display

Description: Vuzion is a heads-up display viewable through a wearable and fully and “truly” overlaid into the user’s view, by manipulating the light wave length entering the glass. Developers project that the use of motion optics and combiner glass will eliminate the need for microscreens. The technology is intended to allow a user to project a range of information (profiles, locations, speeds, altitudes, alarms, etc.). Proposed applications include using the device to give a military jumper improved situational awareness of the landing zone thanks to GPS technologies.

Source: Vuzion: An Actual Overlaid Heads Up Display Wearable <https://www.kickstarter.com/projects/305765519/vuzion-an-actual-overlaid-heads-up-display-wearabl?ref=discovery>

3.1.7 Vufine

Technology name: Vufine wearable display

Description: Vufine is a high-definition, clip-on wearable display that can connect, via a thin HDMI cable, to devices capable of outputting a 720p HDMI signal. It features a magnetic docking station that can easily attach to a variety of glasses. Users plug Vufine into their device and clip Vufine onto their glasses, turning them into a wearable display.

Product link: <http://www.vufine.com/>

Source: Vufine: a Handsfree Wearable Display <https://www.kickstarter.com/projects/1991375881/vufine-a-handsfree-wearable-display>

-  Plug Vufine into smartphones, tablets and laptops to either act as a second monitor or to display information like GPS directions, emails and text messages. Vufine is the perfect way to watch Netflix or Hulu while you're on your daily subway or train commute.
-  Use Vufine as a wearable viewfinder for any sort of camera.
-  Use Vufine as a viewfinder for GoPro to make sure that you're capturing the exact scene that you want to.
-  Use Vufine as a rearview camera for bicycle or motorcycle riding.
-  Use Vufine in drone flight to see exactly what the drone is seeing without taking your eyes off of it.
-  Vufine is useful as a second display to many different types of professionals. For example, it's a quick and easy way for doctors to check their patients' vitals.

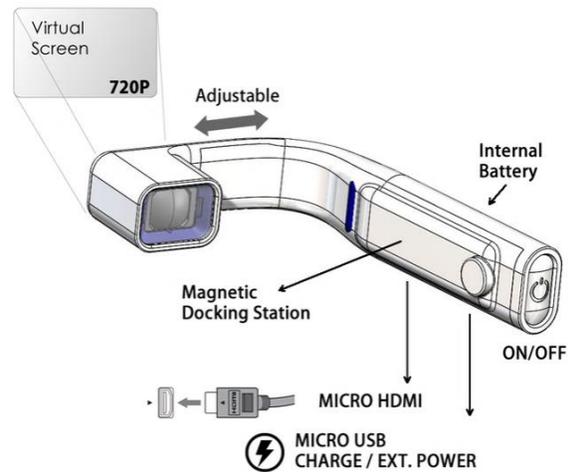


Photo source: <https://www.kickstarter.com/projects/1991375881/vufine-a-handsfree-wearable-display>

3.2 Body-worn (wrist, arm or chest)

3.2.1 Air Force Research Laboratory

Technology name: Various wearable technologies

Description: As part of the Battlefield Air Targeting Man-Aided kNowledge, or Batman, demonstration program, the U.S. Air Force is testing wearable technologies including a wrist mount that can hold a smart device, gloves with red and fiber-optic lights, and a signal gun for air traffic controllers. The wrist mount can hold the Samsung Galaxy Note 3 and S6, which are capable of running military apps also developed by the program.

Source: Air Force tests new wearables in Batman program <http://defensetech.org/2015/06/04/air-forces-batman-drops-in-at-pentagon-lab-day/>



Photo source: <http://defensetech.org/2015/06/04/air-forces-batman-drops-in-at-pentagon-lab-day/>

3.2.2 Institute for Basic Science, Seoul National University

Technology name: Ultra-thin wearable quantum dot light emitting diodes (QLEDs)

Description: Researchers propose QLEDs as a candidate for next-generation displays due to their thinness, ability to tune colors, stability, and printability. The ultra-thin material can be applied like a sticker.

Research link: <http://dx.doi.org/doi:10.1038/ncomms8149>

Source: Quantum dot LEDs meet wearable devices <http://www.nanowerk.com/nanotechnology-news/newsid=40282.php>

3.2.3 University of Central Florida

Technology name: Ultra-thin flexible display

Description: Researchers are developing a wearable electronic screen that is an ultra-thin flexible display that is described as being thinner than human hair. The material has a liquid crystal core that changes colors when voltage is applied.

Research link:

http://www.nanoscience.ucf.edu/chanda/files/Cover_Article_Nature_Communications_Plasmonic_Reflective_Displays.pdf

Source: Scientists Create Wearable Electronic Screen So Thin It Can Be Worn As A Dress

http://www.huffingtonpost.co.uk/2015/06/25/electronic-video-dress-camouflages_n_7663296.html?utm_hp_ref=uk-tech&ir=UK+Tech



Photo source: http://www.nanoscience.ucf.edu/chanda/files/Cover_Article_Nature_Communications_Plasmonic_Reflective_Displays.pdf

4.0 Power

4.1 Self-powering (Harvesters)

4.1.1 Massachusetts Institute of Technology

Technology name: Ultra low-power circuit

Description: Researchers developed a low-power chip reportedly capable of transferring up to 80% of solar energy into electricity for use to charge devices. The chip charges and powers a device, allowing for operations in low-light surroundings.

Source: Solar Energy Microchip Could Enable Internet of Things Wearables

<http://circulatenews.org/2015/06/solar-energy-microchip-could-enable-internet-of-things-wearables/>

4.1.2 Nanning University

Technology name: Power shirt

Description: Researchers are exploring how to harvest human body energy to power wearables smart garments, developing a “power shirt” that harvests ambient mechanical energy from the user’s movement and converts it into electric power.

Research link: <http://pubs.acs.org/doi/pdf/10.1021/acsami.5b03680>

Source: Cloth-Based Power Shirt for Wearable Energy Harvesting and Clothes Ornament

<http://pubs.acs.org/doi/pdf/10.1021/acsami.5b03680>

4.1.3 StretchSense

Technology name: Energy-harvesting elastic fabric

Description: StretchSense, which previously created stretchable sensors, is developing elastic fabrics that can power wearable sensors by harvesting energy from a user’s movement.

Source: New Fabrics Harvest Motion to Power Wearables <http://www.i4u.com/2015/06/92090/new-fabrics-harvest-motion-power-wearables>

4.1.4 University of Virginia

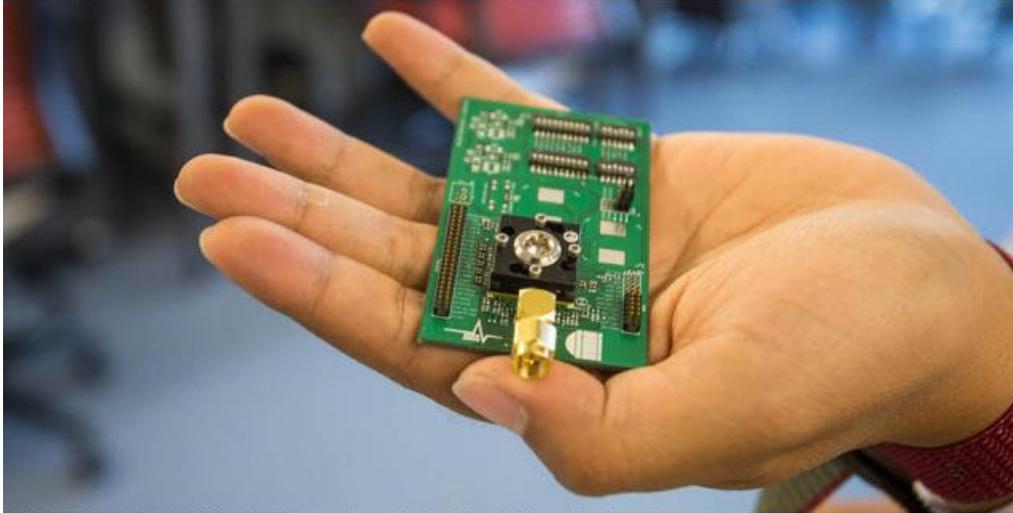
Technology name: Low-power microchip

Description: Researchers are developing a low-power microchip that harvests energy from sources such as body heat, motion, and sunlight, to provide power for body metric sensors. The chip will also serve as a receiver, collecting data from the attached sensors and transmitting it wirelessly to a smart device. The goal is for “a high-functioning, ultra-low-power microchip [that] will allow the Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST)

team to keep their sensory devices small without the hindrances of larger batteries or communication devices.”

Source: New Microchip Improves Future of Self-Powered Wearable Technology

<https://news.virginia.edu/content/new-microchip-improves-future-self-powered-wearable-technology>



U.Va.'s self-powering ASSIST microchip and the small circuit board where it is housed.

Photo source: <https://news.virginia.edu/content/new-microchip-improves-future-self-powered-wearable-technology>

4.2 Power supplies

4.2.1 Arizona State University

Technology name: Flexible lithium-ion battery

Description: Researchers are developing a stretchable battery designed after the Japanese art of kirigami, which combines specific folding and cutting patterns. The technology is reported to have the capacity to extend over 150% of its original size and maintain functionality. Researchers successfully integrated the material into an elastic band that powered a smartwatch while being stretched.

Company link: <http://stretchsense.com/>

Source: Flexible battery based on kirigami <https://uk.news.yahoo.com/flexible-battery-based-kirigami-130127807.html#NXbs4zc>

4.2.2 University of Washington

Technology name: Wi-fi power charging

Description: Scientists are developing a “power over Wi-fi system” that can provide far-field wireless power to support smart devices and wearables. They demonstrated the technology to wirelessly recharge a battery more than 20 feet away. Researchers propose that this could allow a user to deliver power through their Wi-fi routers.

Research link: <http://arxiv.org/abs/1505.06815>

Source: Scientists transmit electricity to wearables via Wi-Fi <http://thenextdigit.com/22267/scientists-transmit-electricity-wearables/>



Photo source: <http://arxiv.org/pdf/1505.06815v1.pdf>

5.0 Communications

5.1 Integrated voice/data/video

5.1.1 Bloom

Technology name: Bloom information sharing platform

Description: Bloom is designing an easy-to-use photo and video sharing platform. Initially designed for elderly users and focused on ease of use, bloom comprises the bloomband wearable, a wristband that transmits photos, videos, calls, and activity to the bloomview display or app. The bloomview display is a leather-wrapped 10” display with a 3MP camera and wireless charger. The bloomband wearable also features activity tracking and emergency support.

Product link: <https://bloomcloser.com/>

Source: A New Boston Tech Startup Wants to Keep Families Connected Across Generations
<http://bostinno.streetwise.co/2015/06/16/bloom-unveils-wearable-technology-video-photo-sharing-app/>

5.1.2 Lynx

Technology name: Lynx Wearable Router

Description: The Lynx Wearable Router is a light-weight, rugged unit that supports a series of sensors (biometric, environmental, GPS); 3G/4G/LTE, Wi-Fi, Bluetooth, WWAN handheld radio, cellular connectivity; cameras, and more. The device is described as enabling wireless mobility, increased situational awareness, tracking, and analytics at the edge, with potential benefits to a range of industries including public safety, mining, utilities, energy and transportation.

Product link:

http://www.telecomsys.com/Libraries/Collateral_Documents/Lynx_Wearable_Router.sflb.ashx

Source: Advanced Networking Powered by Cisco Technology

<http://www.telecomsys.com/products/deployable-coms/baseband/lynx-wearable-router.aspx>



Photo source: <http://www.telecomsys.com/products/deployable-coms/baseband/lynx-wearable-router.aspx>

5.1.3 MYLE Electronics Corp.: Think, Act, Perform

Technology name: Think, Act, Perform (TAP) wearable thought-capturing device

Description: The user taps the TAP device to record up to 30-second audio notes that are transmitted to the cloud for transcription into text that can then be pushed to a user's mobile or web app. TAP is a lightweight, button-sized, clip-on device with built-in memory for 2,000 messages. Messages sync to a user's smartphone via Bluetooth. TAP has a 7-day battery life, is water-resistant, can operate in more than 40 languages, and features a customizable software development kit platform.

Product link: <http://getmyle.com/>

Source: MYLE TAP: The First, Smart Wearable Thought-Capturing <http://globenewswire.com/news-release/2015/06/18/745581/10138981/en/MYLE-TAP-The-First-Smart-Wearable-Thought-Capturing-Device.html>

5.2 Short-range low-power Bluetooth

5.2.1 STMicroelectronics: BlueVoice

Technology name: BlueVoice

Description: BlueVoice provides developers the drivers and libraries necessary to transmit voice over a Bluetooth low-energy connection. The technology comprises ST's STM32 microcontrollers, BlueNRG ultra-low-power network processors, and digital MEMS microphones. The platform is anticipated to benefit voice and gesture controls with an intuitive and natural user-interfaced.

Product link: www.st.com/bluevoicelink-nb

Source: STMicroelectronics Launches Voice-Over-Bluetooth Low Energy for Wearable and Remote-Control <http://globenewswire.com/news-release/2015/06/10/743580/10138017/en/STMicroelectronics-Launches-Voice-Over-Bluetooth-Low-Energy-for-Wearable-and-Remote-Control-Applications.html>

6.0 Location Tracking

6.1.1 Apple

Technology name: Indoor remote-triggered location scanning

Description: Apple's recent patent application addresses location sharing between devices in indoor environments. It is proposed to allow a user to quickly determine the location of another user inside a building. Users can request that other users share their location and then map a travel path. The technology is described in the patent application as: "In some implementations, wireless transceivers ("nodes") can be located throughout a building. In some implementations, an originating mobile device can request the current location of a target mobile device. In some implementation, if a direct connection cannot be established between the originating mobile device and the target mobile device, the originating mobile device can send the location request to one or more nodes in the building. The nodes can relay the location request to the target mobile device. The target mobile device can determine the target mobile device's current location and send the current location of the target mobile device back to the originating mobile device through the nodes."

Patent link: [Patent No. 20150181548](http://www.patentlyapple.com/patently-apple/2015/06/apple-invents-a-method-for-the-iphone-to-locate-friends-family-andor-colleagues-within-buildings-like-a-mall.html)

Source: Apple Invents a Method for the iPhone to Locate Friends, Family and/or Colleagues within Buildings like a Mall <http://www.patentlyapple.com/patently-apple/2015/06/apple-invents-a-method-for-the-iphone-to-locate-friends-family-andor-colleagues-within-buildings-like-a-mall.html>

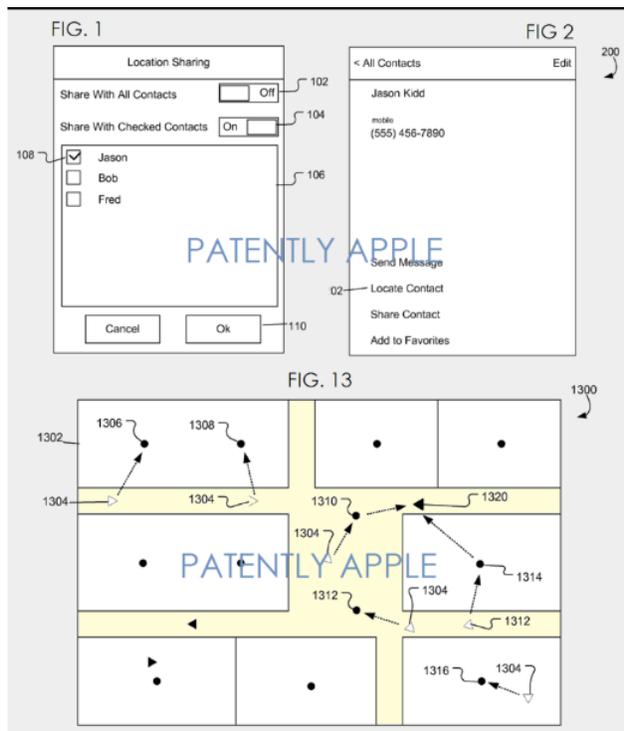


Photo source: <http://www.patentlyapple.com/patently-apple/2015/06/apple-invents-a-method-for-the-iphone-to-locate-friends-family-andor-colleagues-within-buildings-like-a-mall.html>

6.1.2 CyberTimez

Technology name: Location tracking

Description: CyberTimez is focusing on at location tracing and mapping for on-scene situational awareness, using sensors to track a user's location, rather than build an external map. CyberTimez is specifically exploring first-responder applications.

Product link: <http://cybertimez.com/>

Source: The Pitch: CyberTimez expanding wearable tech for the disabled to first responders
<http://www.bizjournals.com/dallas/blog/techflash/2015/06/the-pitch-cybertimez-expanding-wearable-tech-for.html>

6.1.3 Leica Geosystems: Pegasus:Backpack

Technology name: Pegasus:Backpack wearable reality-capturing sensor platform

Description: Pegasus:Backpack is a wearable mobile mapping device comprising 4MB cameras and lightweight LiDAR profilers, Velodyne pucks, and four batteries, for a combined total of approximately 28 pounds. It offers a three-hour scanning life with its standard batteries. The backpack is intended for scanning projects on foot and both indoor and outdoor mapping situations, using both GPS and SLAM (simultaneous location and measurement) positioning with an accuracy of 50cm to 50cm after 10 minutes' walking. The cameras are placed to capture full 360-degree view.

Product link: http://www.leica-geosystems.us/en/Leica-PegasusBackpack_106730.htm

Source: Pegasus:Backpack, Leica's Wearable Scanner <http://www.sparpointgroup.com/news/vol13no22-pegasus-backpack-leicas-wearable-scanner>



Photo source: http://www.leica-geosystems.us/en/Leica-PegasusBackpack_106730.htm

6.1.4 University of Kent, CPI

Technology name: 3D-printable wristband with printed antenna

Description: Researchers are developing a 3D-printable wristband with printed antenna technology and tracking capabilities. The technology is expected to benefit developers' ability to embed technology and functionality into their wearable designs with more versatility and functionality.

Source: CPI and the University of Kent 3D Print a Wearable Tracking Bracelet <http://www.uk-cpi.com/case-studies/cpi-and-the-university-of-kent-3d-print-a-wearable-tracking-bracelet/>

7.0 Cameras

7.1.1 360Fly

Technology name: Wearable panoramic video camera

Description: 360Fly's panoramic camera offers 360-degree views in a small, lightweight (5 oz.) form with a touch screen. It is easily mounted to skateboards, kayaks, etc., and controlled via a mobile device, where the content can be edited and shared. The content does not have to be loaded onto a computer.

Source: 360Fly's wearable panoramic video recorder captures scene from all angles
<http://triblive.com/business/headlines/8408458-74/360-camera-company#axzz3fRNS2vRv>



Photo source: <http://triblive.com/business/headlines/8408458-74/360-camera-company#axzz3fRNS2vRv>

7.1.2 Genetec

Technology name: Security Center (5.3 SR1)

Description: Genetec's Security Center (5.3 SR1) now supports import/archiving of video content from wearable cameras (B-CAM, GoPro, Viewue, Zepcam), allowing users such as law enforcement, to complement their surveillance with wearable footage via a single video management platform. Users can easily import/export, review, and index standard video footage via Security Center. The platform also allows for streaming video over a cellular or wireless network.

Product link: <http://www.genetec.com/solutions/all-products/security-center/security-center-53>

Source: Genetec Expands Support for Body Wearable Cameras in Latest Release of Security Center
<http://www.prweb.com/releases/2015/06/prweb12783077.htm>

7.1.3 Google

Technology name: Jump virtual reality technology platform

Description: Jump's virtual reality platform features a GoPro 360-degree camera array mounted to a hat or cap, with the ability to connect wirelessly to a smart device to transmit the video, as well as to connect

to social networking or another interactive platform. The patent also outlines how the technology will be beneficial in emergency situations, with a routing system from the user's viewpoint and GPS location through emergency handling systems to elicit emergency response.

Product link: <http://www.google.com/get/cardboard/jump/>

Source: Google Reveals a Newly Invented Wearable Device

<http://www.patentlymobile.com/2015/06/google-reveals-a-newly-invented-wearable-device.html>

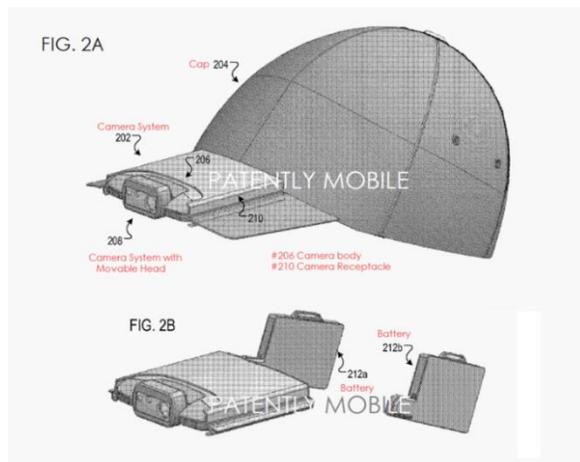


Photo source: <http://www.patentlymobile.com/2015/06/google-reveals-a-newly-invented-wearable-device.html>

7.1.4 Panasonic: HX-A1

Technology name: HX-A1 wearable video camera

Description: Panasonic released a video camera weighing only 45 grams that is shockproof, water proof, and capable of 3.54MP camera resolution. It also offers Wi-Fi connectivity, live-streaming, and a night-mode and noise-reduction function. An external infrared light is also available that achieve 3.54MP resolution even in no light.

Status: Evolving

Funding:

Product link: <http://www.panasonic.com/uk/consumer/cameras-camcorders/camcorders/active-hd-camcorders/hx-a1me.html>

Source: Panasonic releases new mirror-less camera, wearable camcorder

http://www.koreatimes.co.kr/www/news/tech/2015/06/133_180983.html

8.0 Exoskeletons

8.1.1 Active Bionics Inc.

Technology name: Exoskeleton

Description: This exoskeleton attaches to the user's legs and the battery is carried in a backpack by the user. The exoskeleton leads the user's legs where they want to go. If the user waivers, the exoskeleton locks, holding them in place.

Company link: <http://www.active-bionics.com/>

Source: Trio creates exoskeleton to help paraplegics walk again
<http://www.ottawasun.com/2015/06/27/trio-creates-exoskeleton-to-help-paraplegics-walk-again>

8.1.2 Alex Czech (individual)

Technology name: 3D-printed exoskeleton

Description: This previously reported 3D-printed exoskeleton continues to expand from a hand to an entire arm. The arm consists of 13 unique parts. The design is downloadable and entirely 3D printable, except for the screws and metal washers required for assembly.

Product link: <http://3dprint.com/75997/3d-printed-exoskeleton-arms/>

Source: Alex Czech's 3D Printable Exoskeleton Hands are Now Extended to Full Arms
<http://3dprint.com/75997/3d-printed-exoskeleton-arms/>



Photo source: <http://3dprintit.com.au/gallery.html>

8.1.3 Robo-Mate

Technology name: Exoskeleton

Description: Robo-Mate is developing an exoskeleton capable of making a load up to 10 times lighter. In demonstrations, a user lifted a 15kg seat easily. The device features motors and sensors that work together to reduce the user has to bear and it reduces postural damage. The device comprises modules for the arms, the trunk of the body and the legs. The arms use motors to reduce the load on the user. The trunk module stabilizes and protects the user's back and spinal column, while keeping their torso straight while lifting or bending. The leg module stabilizes the inner thighs during movements such as squatting.

Product link: <http://www.robo-mate.eu/>

Source: First Exoskeleton for Industry Unveiled <http://www.pddnet.com/news/2015/06/first-exoskeleton-industry-unveiled>



Photo source: <http://www.pddnet.com/news/2015/06/first-exoskeleton->

8.1.4 U.S. Army: Mobile Arm Exoskeleton for Firearm Aim Stabilization

Technology name: Mobile Arm Exoskeleton for Firearm Aim Stabilization (MAXFAS)

Description: MAXFAS is a lightweight (10 oz.), carbon fiber device that fits over a user's arm to assist in shooting accuracy via a system of cables, gyroscopes, accelerometers, and sensors.

Source: These Army Exoskeletons Make Soldiers Shoot Straighter
<http://www.popularmechanics.com/military/research/a15851/army-exoskeletons-make-soldiers-shoot-straighter/>



Photo source: <http://www.popsci.com/army-has-exoskeleton-makes-soldiers-better-shots>

8.1.5 US Bionics

Technology name: Low-cost exoskeleton

Description: Developers are working on a low-cost, lightweight exoskeleton. The device features buttons on crutches that communicate with sensors in and control the different parts of the exoskeleton. Its battery life will support 4 hours of continuous walking. The modular device can be strapped whole or in parts to the wearer.

Source: 'Bionic men' may proliferate in 2016 if US firm scores funding from Asia

<http://www.scmp.com/tech/start-ups/article/1825938/bionic-men-may-proliferate-2016-if-us-firm-scores-funding-asia>



Photo source: <http://www.scmp.com/tech/start-ups/article/1825938/bionic-men-may-proliferate-2016-if-us-firm-scores-funding-asia>

8.1.6 Victor Morales (individual)

Technology name: Scout Exoskeleton Robot, Independence Exoskeleton Robot

Description: The Scout Exoskeleton Robot is designed for the chest and legs for people with walking problems or paraplegia of the lower limbs. The Independence Exoskeleton Robot expands on Scout with

arms and robotic hands, intended for quadriplegia. The exoskeletons can be controlled via smart phone or GoogleGlass and via voice or eye control.

Product link: <https://www.indiegogo.com/projects/exoskeleton-robots#/story>

Source: Crowd Funders to Transform People's Lives with Exoskeleton Robots
<http://www.digitaljournal.com/pr/2574996>

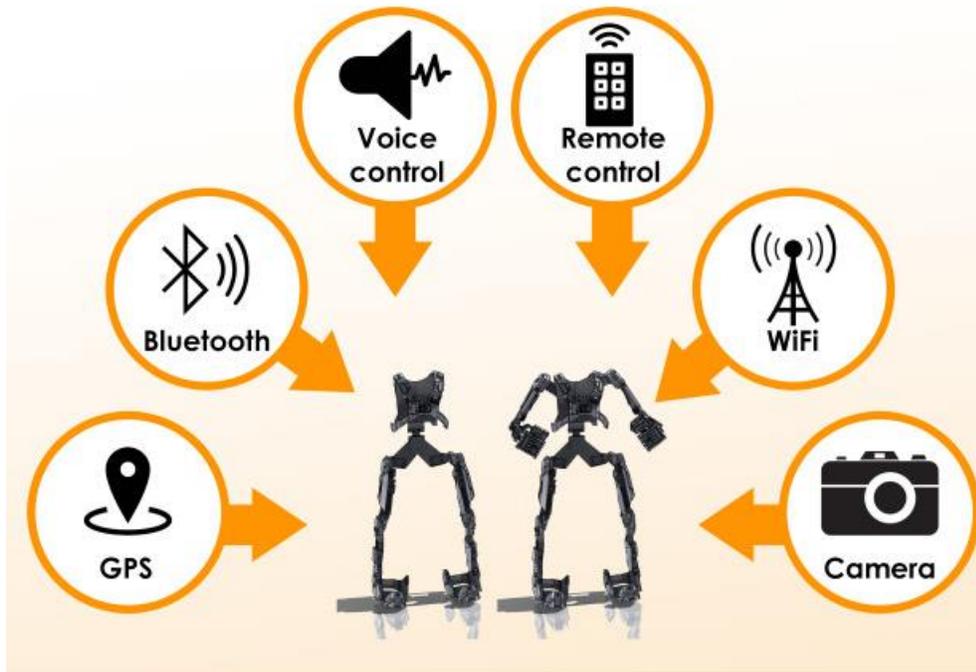


Photo source: <https://www.indiegogo.com/projects/exoskeleton-robots#/story>

9.0 Wearable Computers

9.1.1 Optivent

Technology name: ORA-X smart glass

Description: The ORA-X smart glasses feature high-end wireless headphones, quality audio, and disruptive see-through display as well as a microphone, 9-axis motion sensor, wireless connectivity (Bluetooth, Wi-Fi, GPS), a trackpad, high-capacity lithium-ion rechargeable battery, and a power microprocessor and graphics processing unit. It allows for hands-free mobile computing.

Source: Optinvent Unveils a Disruptive New Wearable Device Category at the AWE 2105
<http://augmentedworldexpo.com/optinvent-unveils-a-disruptive-new-wearable-device-category-at-the-awe-2105/>

9.1.2 Osterhout Design Group

Technology name: R7 augmented reality glasses

Description: The R7 augmented reality glasses feature a 720p display, built-in battery, Wi-Fi and Bluetooth LTE connectivity, GPS radio, altimeter, compass, and high-speed 1080p video camera.

Product link: <http://osterhoutgroup.com/products-r7-glasses>

Source: Osterhout Shows New Self-Contained AR Glasses
<http://wearablesinsider.com/2015/06/09/osterhout-shows-new-self-contained-ar-glasses/>

9.1.3 VA-ST: SmartSpecs

Technology name: SmartSpecs

Description: SmartSpecs are augmented reality glasses and head-worn computer to assist visually impaired users. The device comprises a processor, three camera sensors, and display to produce easily viewable frames with simple, high-contrast images and to detect the distance to an object. The glasses operate on Android with microprojectors to display images on transparent lenses and feature zoom/pause functions.

Product link: <http://www.va-st.com/smart-specs/#>

Source: These Wearable Glasses Lets Legally Blind People See Again
<https://www.hackread.com/smartspecs-wearable-glasses-legally-blind/>



Photo source: <http://www.va-st.com/smart-specs/#>

10.0 Other

10.1.1 Amyko

Technology name: Near-field communication (NFC)-based bracelet modules

Description: These NFC bracelet modules communicate with smart devices to share medical information in emergencies. A user uploads their medical information to the Amyko cloud, wears the bracelets, and in the case of an emergency anyone can use a smartphone to view the information.

Product link: <https://amyko.it/en>

Source: Amyko: your Medical and First Aid Device <https://www.indiegogo.com/projects/amyko-your-medical-and-first-aid-device#/story>

Amyko is a bracelet suitable for any type of wrist and is fully customizable



Photo source: <https://www.indiegogo.com/projects/amyko-your-medical-and-first-aid-device#/story>

10.1.2 Apple

Technology name: Gesture-controlled data sharing

Description: Recent patent applications suggest the next-generation Apple devices may offer wireless data exchanges with wearables and smart phones via hand gestures like a high five. Gestures bring the devices into proximity and the device incorporates the acceleration/movement. The device would be programmable to identify different gestures to trigger different sharing of information.

Source: Apple Watch 2 could pack hand-shaking info exchange tech <https://www.wareable.com/apple-watch/apple-watch-2-could-pack-hand-shaking-info-exchange-tech-1315>

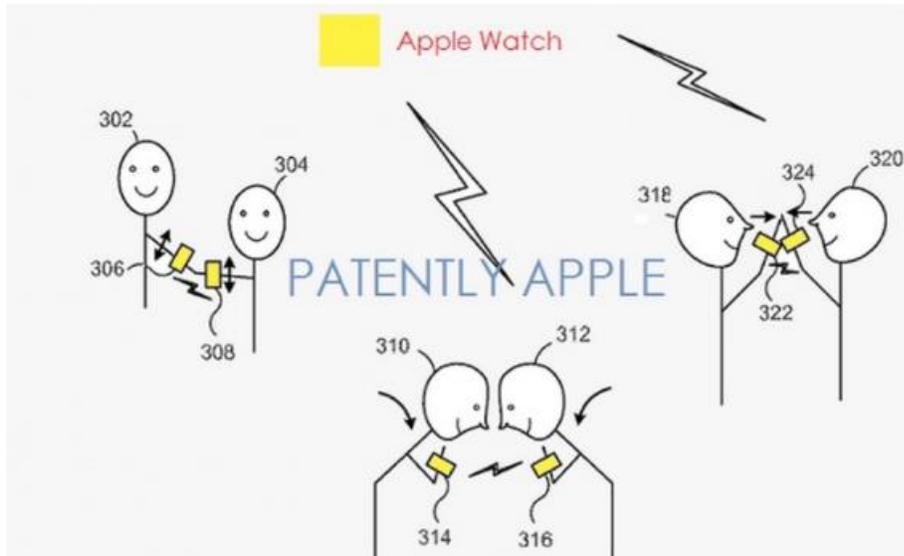


Photo source: <http://www.patentlyapple.com/patently-apple/2015/06/apple-reveals-fun-new-ways-to-share-information-between-two-apple-watch-users-and-other-all-new-features-in-the-works.html>

10.1.3 Battelle, Feinstein Institute for Medical Research

Technology name: Neural tourniquet

Description: Researchers are exploring the use of neurostimulation to control blood loss. The “neural tourniquet” as a wearable that could clip onto a patient’s ear, stimulate the vagus nerve, and enable stimulation of the spleen to stimulate blood clotting. The device is proposed to apply to emergency situations, such that responders could have the device on hand to help control a victim’s blood loss.

Source: Wearable Device on Your Ear Controls Blood Loss

<http://www.mdtmag.com/blogs/2015/06/wearable-device-your-ear-controls-blood-loss>

10.1.4 CommandScope

Technology name: CommandScope pre-planning program

Description: CommandScope is a digital, pre-plan program that provides responders with information about buildings and its occupants as well as en route access to site plans, floor plans, hazardous material details, utility shut-off locations, geographical maps, fire hydrants locations, residents with special needs, and other critical building data.

Product link: <http://www.realviewllc.com/>

Source: CommandScope First Responder Tech Blankets Chicago's North Suburbs

<http://www.fireengineering.com/articles/2015/06/commandscope-first-responder-tech-blankets-chicago-s-north-suburbs.html>

10.1.5 Doppel

Technology name: Doppel wrist-worn psychophysiology wearable

Description: Doppel uses customized haptic feedback to influence a user's mood, similar to mood music. Different tempos pulse on the wrist. The Doppel app allows a user to set the device to their resting heart rate. The theory is that a user's bio-rhythms can affect well-being. Developers are testing the device's effect on alertness and focus.

Product link: <https://www.kickstarter.com/projects/1799505246/doppel-a-new-breed-of-wearable-technology-to-set-y/description>

Source: Doppel Is A Wearable That Puts A Pulse On Your Pulse
<http://techcrunch.com/2015/06/16/doppel/>



Photo source: <https://www.kickstarter.com/projects/1799505246/doppel-a-new-breed-of-wearable-technology-to-set-y/description>

10.1.6 EasyM2M: iWristPhone

Technology name: iWristPhone

Description: EasyM2M is pursuing technology to provide underground wifi to Eastern Coal Field mines as well as wrist phones to miners with real-time tracking and two-way communication. Developers created low-cost wireless mesh networks to provide internet for the iWristPhone, which features a gravity sensor that can detect miners falling or being trapped, it can monitor and record miners' GPS coordinates, it has a 3MP camera for video calls, and it has sensors for heart rate and blood pressure. The wireless mesh networks eliminate the need for traditional wired networks and cost approximately one-third of the price.

Product link: <http://www.easym2m.in/>

Source: EasyM2M to launch wearable device iWristPhone for miners; has real-time tracking, WiFi
<http://economictimes.indiatimes.com/tech/hardware/easym2m-to-launch-wearable-device-iwristphone-for-miners-has-real-time-tracking-wifi/articleshow/47686186.cms>



Photo source: <http://economictimes.indiatimes.com/tech/hardware/easym2m-to-launch-wearable-device-iwristphone-for-miners-has-real-time-tracking-wifi/articleshow/47686186.cms>

10.1.7 Gunilla Alsio and Senseboard Inc.

Technology name: Virtual keyboard technology

Description: The wearable virtual keyboard attaches to a user's hand with transducer sensors on the fingers that sense gestures that then move the cursor or interact with a keyboard on the screen.

Source: Wearable Virtual Keyboard Patents Available from ICAP Patent Brokerage
<http://www.prweb.com/releases/icap-patent-brokerage/wearable-keyboard/prweb12776983.htm>

10.1.8 Instamic

Technology name: Instamic wearable audio recorder

Description: Instamic is a small (1-inch), waterproof, clip-on wearable recorder capable of capturing high-quality sound using remote technology. Its different models can record in dual-mono quality and stereo-quality. It features 2GB internal memory, wireless control via Bluetooth within 30 feet, and can capture 4 hours of audio on a single charge. Up to seven Instamic devices can connect at one time for simultaneous recording.

Product link: <https://www.indiegogo.com/projects/instamic-the-smart-small-gopro-of-microphones>

Source: Meet the Smallest and Smartest Wearable Mic <http://www.psfk.com/2015/06/meet-the-smallest-smartest-wearable-mic.html>



Photo source: <https://www.indiegogo.com/projects/instamic-the-smart-small-gopro-of-microphones>

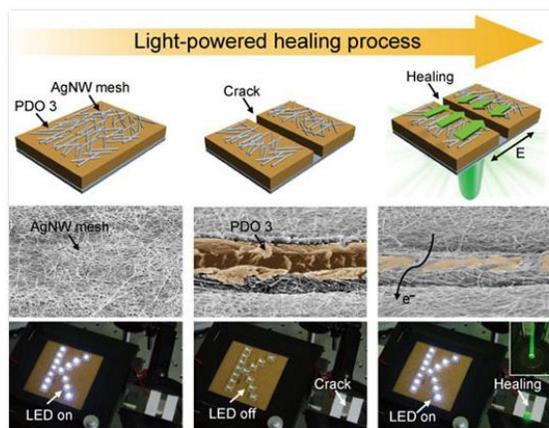
10.1.9 Korea Advanced Institute of Science and Technology

Technology name: Light-powered healable electrical conductor

Description: Whereas bending, folding, twisting, etc. can typically lead to conductive failures, researchers propose healable electric conductors. Researchers are exploring light-powered healing via the use of a photochromic soft material directionally moved along the light polarization. This is anticipated to enable “an efficient healing process, regardless of crack propagation directions, light incident angles, and the number of cracks.” The outcome “provides rapid, noninvasive, and on-demand healing for a flexible electronic conductor, making light-powered healing more amenable to dynamically deformable wearable devices beyond existing systems.”

Research link: <http://dx.doi.org/doi:10.1002/adfm.201401666>

Source: Light-powered healing of a wearable electrical conductor
<http://www.nanowerk.com/nanotechnology-news/newsid=40260.php>



Light-powered healing of electrical conductor: (left to right) pristine, cracked, and optically-healed electrical conductor. (Image: KAIST)

Photo source: <http://dx.doi.org/doi:10.1002/adfm.201401666>

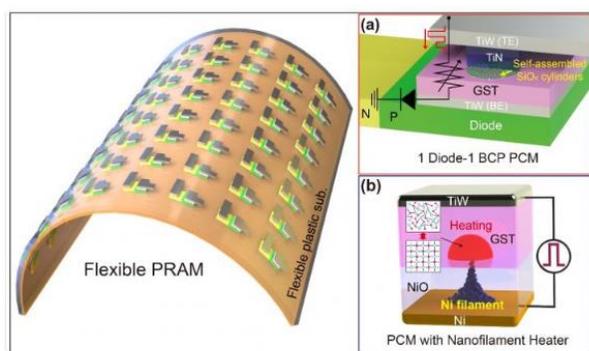
10.1.10 Korean Advanced Institute of Science and Technology

Technology name: Phase change random access memory (PRAM)

Description: Researchers are exploring the use of PRAM as a candidate for nonvolatile memory in flexible and wearable devices. PRAM features block copolymer silica nanostructures with an ultra-low current operation on plastic substrates, which offers a smaller contact area and significant power reduction.

Research link: <http://onlinelibrary.wiley.com/doi/10.1002/adma.201501592/full>

Source: A KAIST research team develops the first flexible phase-change random access memory <http://electroiq.com/blog/2015/06/a-kaist-research-team-develops-the-first-flexible-phase-change-random-access-memory/>



Low-power nonvolatile PRAM for flexible and wearable memories enabled by (a) self-assembled BCP silica nanostructures and (b) self-structured conductive filament nanoheater.

CREDIT: KAIST

10.1.11 Martin Jetpack

Technology name: P12 Martin Jetpack

Description: In development for more than 35 years, the Martin Jetpack is a personal jetpack. The technology is proposed to have applications in helping responders with situational awareness. The P12 version features a V4 200 horsepower petrol engine driving two ducted fans, allowing it fly for more than 30 minutes at up to 74 kilometers per hour and 1,000 meters high, while carrying up to 120kg. It also includes a ballistic parachute system. The device is reported to feature Vertical Take-off and Landing technology, allowing it to land on rooftops, fly in confined areas, and become a practical alternative to helicopters.

Product link: <http://www.martinjetpack.com/>

Source: Finally! World's first consumer jetpack will go on sale next year (but be warned - it will set you back \$150,000) <http://www.dailymail.co.uk/sciencetech/article-3139277/Finally-World-s-consumer-jetpack-sale-year-warned-set-150-000.html>



Photo source: <http://www.martinietrack.com/>

10.1.12 Mindstream Inc.: ThumbTrack

Technology name: ThumbTrack wearable mouse

Description: ThumbTrack is a wearable mouse worn on the forefinger. It features 9-foot range, USB dongle, 15-hour battery life, two touch-sensitive buttons, and scrolling capability.

Product link: <http://mindstreaminc.com/>

Source: MindStream Inc.: ThumbTrack – The world’s smallest wearable mouse
<http://icrowdnewswire.com/2015/06/01/mindstream-inc-thumbtrack-the-worlds-smallest-wearable-mouse/>



ThumbTrack – The world’s smallest wearable mouse.

Let your thumb do the moving.



Photo source: <https://www.indiegogo.com/projects/thumbtrack-wearable-mouse-better-than-ever#/story>

10.1.13 MyMDband

Technology name: Wearable medical information wristband

Description: MyMDband is a wristband with an engraved, scannable QR code that provides access to a user's medical profile and alerts to a user's network with the user's location. The device is waterproof, multilingual, maintenance-free, silicon band with a laser-engraved QR code on a stainless steel buckle. The user's profile includes prior medical conditions, medications, allergies, vaccinations, and more. The device has a subscription feature to support ongoing updates to the multilingual display, which is updated as more medications come to market.

Product link: <https://www.mymdband.com/LandingPage.aspx>

Source: Medics create smart wearable bands with complete medical profiles
<http://www.israel21c.org/headlines/medics-create-smart-wearable-bands-with-complete-medical-profiles/>



Photo source: <https://www.mymdband.com/LandingPage.aspx>

10.1.14 Nod Labs

Technology name: Nod gesture ring

Description: The Nod gesture ring features high-resolution movement sensors that track a user's gestures. The lightweight, waterproof device features 80 components, touch sensors and buttons, and syncing with a smart device via Bluetooth. It allows a user to control devices (from smart phones to headsets to thermostats and lights) and operate a virtual keyboard. The ring can uniquely sync with multiple devices

Product link: <http://store.nod.com/products/nod-gesture-ring>

Source: Wearable smart ring <http://www.thehindu.com/features/metroplus/wearable-smart-ring-nod-is-lightweight-gadget/article7370792.ece>

10.1.15 North Carolina State University

Technology name: Stretchable, transparent conductors

Description: Researchers are developing stretchable, transparent conductors that employ a nano-accordion design fit for use in flexible electronics, stretchable displays, and wearable sensors.

Research link: <http://pubs.rsc.org/en/content/articlelanding/2015/MH/C5MH00070J#!divAbstract>

Source: Nano-Accordion Structures Used for Wearable Sensors, Flexible Electronics
<http://www.cemag.us/news/2015/06/nano-accordion-structures-used-wearable-sensors-flexible-electronics>

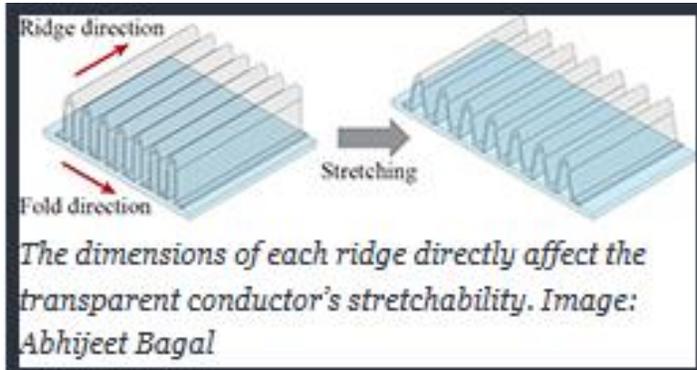


Photo source: <http://pubs.rsc.org/en/content/articlelanding/2015/MH/C5MH00070J#!divAbstract>

10.1.16 PogoTec, Inc.

Technology name: On-Track, Look & Shoot, and Pogo-Power

Description: Formerly Photo-Eyewear, PogoTec is expanding its electronic wearable products to include On-Track, Look & Shoot, and Pogo-Power. On-Track is an eyewear mounting system for attaching wearables (cameras, sensors, hearing aids) to glasses frames. Look & Shoot is developing small, proprietary camera to attach to eyewear via On-Track. Pogo-Power is developing a wireless transfer system to wirelessly power wearables.

Product link: <http://www.pogotec.com/>

Source: New Company, PogoTec, to Develop Proprietary Eyewear Wearables
<http://www.visionmonday.com/latest-news/article/new-company-pogotec-to-develop-proprietary-eyewear-wearables-1/>

10.1.17 Qualcomm, Google: Project Tango

Technology name: Project Tango

Description: The next generation of Google's Project Tango smartphones may include Qualcomm's Snapdragon 810 processor. The phones are expected to feature a camera, gyroscope, accelerometer, including tracking six degrees of free motion and 3D motion tracking and mapping. The device is anticipated to have applications in indoor navigation and virtual/augmented reality experiences. Snapdragon 810 will deliver optimized computing capability for the devices' video, imaging, and graphics, particularly in respect to the 3D mapping. According to Qualcomm's press materials, the technology offers "fast graphics and compute performance while reducing power consumption. It offers support for camera image and video post-processing, hardware tessellation, geometry shaders and programmable blending, as well as advanced GPU security for secure composition and management of premium video and other multimedia."

Product link: <https://www.qualcomm.com/news/releases/2015/05/29>

Source: Qualcomm Working With Google On Project Tango
<http://www.wearabletechworld.com/topics/wearable-tech/articles/404481-qualcomm-working-with-google-project-tango.htm>

10.1.18 Rithmio

Technology name: Gesture recognition platform

Description: Rithmio, which specializes in gesture recognition, is creating technology to provide users accurate interpretation of a user's movements. By integrating with wearable training devices, Rithmio's software analyzes a range of movements and translates that into usable data.

Product link: <http://rithmio.com/>

Source: Rithmio Raises \$3M For Its Technology That Makes Wearables Smarter
<http://chicago.inno.streetwise.co/2015/06/30/rithmio-raises-3m-for-its-technology-that-makes-wearables-smarter/>

10.1.19 Stanford University

Technology name: Wearable heater

Description: This wearable heater traps a user's body heat and provides a cost-effective method to control comfort without adjusting the thermostat. The fabric reflects a user's infrared radiation back to the body, trapping an estimated 80% of the body's heat while allowing moisture to pass freely. The material can also increase warmth when exposed to small amounts of electricity such as that from a computer. Reportedly 0.9 volts of electricity can warm the material to 100 degrees Fahrenheit.

Source: Hi-Tech Fabric Provides Wearable Heater <https://www.fishersci.com/us/en/education-products/publications/headline-discoveries/2015/issue-2/hi-tech-fabric-provides-wearable-heater.html>

10.1.20 University of California

Technology name: Adaptive Textiles Technology with Active Cooling and Heating (ATTACH) Smart fabric with temperature control

Description: The ATTACH smart fabric, a "wearable air conditioner," is designed to maintain temperature comfort, aimed at reducing the need for air conditioning (or HVAC) systems and environmental impacts. The smart textile responds to change in ambient temperature, with polymers that become thicker or thinner as the temperature changes. The device will be self-powered with a rechargeable battery and biofuel cells that use human sweat to generate energy.

Research link: <http://pubs.acs.org/doi/abs/10.1021/nn507221f>

Source: ATTACH: A smart fabric that doubles as a personal, wearable air conditioner!
<http://www.hexapolis.com/2015/06/25/attach-a-fabric-that-doubles-as-wearable-air-conditioner/>



Photo source: <http://www.hexapolis.com/2015/06/25/attach-a-fabric-that-doubles-as-wearable-air-conditioner/>

10.1.21 University of Pittsburg Swanson School of Engineering

Technology name: Responsive hybrid material

Description: Researchers are developing “materials that compute”: flexible, responsive hybrid materials that perform computations based on environmental/movement changes, and possibly a user’s vital signs. It may be able to be integrated into clothing or a shoe, for example. The material performs computations without external inputs (energy, amplification, computer mediation).

Research link: <http://www.nature.com/srep/2015/150624/srep11577/full/srep11577.html>

Source: Toward wearable computers <https://machineslikeus.com/news/toward-wearable-computers>

10.1.22 Vital Connect, Inc.: VitalCore™

Technology name: VitalCore™ system-on-chip processor

Description: VitalCore™ is a custom, integrated circuit for wireless biosensors aimed at decreasing power requirements for detecting and processing capabilities while enabling continuous biometric monitoring and longer battery life. The chip comprises a powerful processor and analog circuit fit for low-power measuring vital signs in clinical settings.

Source: Vital Connect Develops Groundbreaking System-on-Chip for Wearable <http://www.vitalconnect.com/news/vital-connect-develops-groundbreaking-system-on-chip-for-wearable-biosensors>

10.1.23 Wearsafe Labs

Technology name: Wearsafe Tag personal safety wearable

Description: The Wearsafe Tag is a wearable safety device with low-energy Bluetooth connectivity that can connect to and send alerts to a user’s smartphone up to 165 feet away. The device is approximately the size of a quarter and waterproof. The device uses a smartphone’s GPS function to identify the user’s location and also sends a 60-seconds of surrounding audio to the user’s contacts.

Source: Hartford startup pitches wearable safety device app
<http://www.hartfordbusiness.com/article/20150615/PRINTEDITION/306129958/hartford-startup-pitches-wearable-safety-device-app>

10.1.24 Yonsei University

Technology name: Stretchable, conductive fiber

Description: Researchers are using silver nanowires and nanoparticles to create stretchable conductive fiber that can be embedded into gloves to recognize human motions.

Research link: <http://onlinelibrary.wiley.com/doi/10.1002/adfm.201570139/abstract>

Source: Stretchable Electronics: Ag Nanowire Reinforced Highly Stretchable Conductive Fibers for Wearable Electronics <http://onlinelibrary.wiley.com/doi/10.1002/adfm.201570139/abstract>

Appendix A

Technology Summary

Appendix A Technology Summary

The table below provides a summary of the technologies compiled in this report. For an electronic copy, please contact Jaki Upton at jaki.upton@pnnl.gov. This information is not meant to be an exhaustive list nor an endorsement of any technology described herein.

Company	Technology	Description
Sensor		
Physiological		
ADI	ADUCM350 microprocessor	High-performance microprocessor that can be combined with optical and sensors and software algorithms to create an optical system ideal for wearables
Apple	Multi-modal physiological sensing system	Multi-modal physiological sensing including a pulse oximeter that uses a light emitter and light sensors to measure a user's heart rate while compensating or filtering for "noise" in the reading.
Elbit	Canary head-worn physiological monitor	Head-worn device that monitors a pilot's vital signs and provides alerts on a helmet-mounted or computer display, without interference to the pilot.
Google	Health wristband	Health wearable that can measure pulse, heartbeat rhythm, skin temperature, light exposure, and noise levels, and more.
Imec, Holst	Smart t-shirt	Chip integrated into clothing, featuring ECG, EEG, and galvanic skin response sensors; Arm Cortex M0 processor; button-cell battery; and Bluetooth LE to stream data to a smart device or the cloud.
Jaguar	Biometric "emotion sensing" band	Biometric band with a heart rate monitor and GPS to measure a wearer's excitement level (biometric, atmospheric, and sociometric)
Pratik Saraogi (Individual)	Oxstren smart gloves	Smart gloves track physiological metrics (steps, calories, etc.) and can identify exercises using accelerometer and gyroscope sensors
PureTech	Wearable sensors	Research exploring new and upcoming wearable physiological sensors and the many data points and capabilities they present.
Sano Intelligence	Health-sensing wearable	Wearable biometric sensor that can monitor a range of data including noninvasively tracking blood glucose, primarily for wellness (not medical) purposes.
Sensoria, Renault Sport	Sensoria heart-rate monitoring smart garment, Renault Sport Monitor app	Combines Sensoria's smart garment with heart-rate tracking technology with Renault Sport's Monitor mobile app. The user's heart rate is transmitted via Bluetooth to the app through Sensoria's heart-rate monitor. The app can also record videos of each lap while also recording physiological data and acceleration forces.
University of Tokyo	Elastic conductive ink	Material maintains its high conductivity when stretched to more than three times its original length and is printable on textiles in a single step.
Chemical/Particulate		
Spec-Sensors	Electrochemical sensors	Electrochemical sensors for use in wearables. The sensors can display real-time levels of various gases/particulates. The goal is to reduce the sensor size from 15 mm x15 mm to 5 mm x 5 mm.
Other		
Moodmetric	Galvanic Skin Response (GSR) sensor	Measures conductivity of a user's skin and sweat to determine arousal as a reflection of mood or stress level.
RMIT University	Ultraviolet light sensor	Ultraviolet light sensors in the form of an ultra-thin, stretchable, transparent skin patch. The patch can detect toxic gases (hydrogen, nitrogen dioxide, etc.)
Virginia Technologies, Inc.; Wichita State University	Bluetooth headset for monitoring alertness	Bluetooth headset equipped with an infrared sensor that monitors head movements and detects blinks. Data is transmitted to a smartphone. The headset vibrates, flashes, and beeps if drowsiness is detected.

Displays		
Heads-up		
Amazon	Pointer tracking for eye-level scanner and displays	Wearable displays offering hands-free operations and the ability to recognize mailing addresses, bar codes, QR codes, etc.
APX Labs, Nuance Communications	Skylight Voice smart glasses with voice recognition	Embedded voice technology allows for hands-free operation with on-screen contact.
Beijing Palo Alto Tech Co. Ltd.	Cool Glass One	Smart glass featuring a touchpad and photo and 1080p HD video capability.
Intel, Recon Instruments	Head-mounted display	Intel acquired Recon Instruments, which specializes in wearable sports displays, to help advance Intel's efforts in head-mounted displays.
Leti, III-V Lab	High-density micro-LED	LED microdisplays are anticipated to benefit heads-up and head-mounted displays because they offer a small footprint, low-power consumption, high-contrast ratio, and high brightness.
Method50	Vuzion heads-up display	Heads-up display viewable through a wearable and fully and overlaid into the user's view, by manipulating the light wave length entering the glass.
Vufine	Vufine wearable display	High-definition, clip-on wearable display that can connect, via a thin HDMI cable, to devices capable of outputting a 720p HDMI signal. It features a magnetic docking station that can easily attach to a variety of glasses.
Body-Worn		
Air Force Research Library	Various wearable technologies	As part of the Battlefield Air Targeting Man-Aided kNowledge, or Batman, demonstration program, the U.S. Air Force is testing wearable technologies including a wrist mount that can hold a smart device, gloves with red and fiber-optic lights, and a signal gun for air traffic controllers.
Institute for Basic Science, Seoul National University	Ultra-thin wearable quantum dot light emitting diodes (QLEDs)	QLEDs bring to displays thinness, ability to tune colors, stability, and printability. The ultra-thin material can be applied like a sticker.
University of Central Florida	Ultra-thin flexible display	Wearable electronic screen that is an ultra-thin flexible display that is described as being thinner than human hair. The material has a liquid crystal core that changes colors when voltage is applied.
Power		
Self-powering/Harvesting		
Massachusetts Institute of Technology	Ultra low-power circuit	Low-power chip reportedly capable of transferring up to 80% of solar energy into electricity for use to charge devices.
Nanning University	Power shirt	Harvests ambient mechanical energy from the user's movement and converts it into electric power.
StretchSense	Energy-harvesting elastic fabric	Elastic fabrics that can power wearable sensors by harvesting energy from a user's movement
University of Virginia	Low-power microchip	Low-power microchip that harvests energy from sources such as body heat, motion, and sunlight, to provide power for body metric sensors. The chip will also serve as a receiver, collecting data from the attached sensors and transmitting it wirelessly to a smart device.
Power Supplies		
Arizona State University	Flexible lithium-ion battery	Stretchable battery designed after the Japanese art of kirigami, which combines specific folding and cutting patterns. The technology is reported to have the capacity to extend over 150% of its original size and maintain functionality
University of Washington	Wi-fi power charging	Wi-fi antenna to transmit electricity via Wi-fi to smart devices and wearables.
Communications		
Integrated Voice/Data/Video		

Bloom	Bloom information sharing platform	easy-to-use photo and video sharing platform
Lynx	Lynx wearable router	Light-weight, rugged unit that supports a series of sensors (biometric, environmental, GPS); 3G/4G/LTE, wi-fi, Bluetooth, WWAN handheld radio, cellular connectivity; cameras, and more.
MYLE Electronics Corp.	Think, Act, Perform (TAP)	The user taps the TAP device to record up to 30-second audio notes that are transmitted to the cloud for transcription into text that can then be pushed to a user's mobile or web app. TAP is a lightweight, button-sized, clip-on device with built-in memory for 2,000 messages.
Short-range low-power Bluetooth		
STMicroelectronics	BlueVoice	Drivers and libraries necessary to transmit voice over a Bluetooth low-energy connection.
Location Tracking		
Apple	Indoor remote-triggered location scanning	Location sharing between devices in indoor environments. Users can quickly determine the location of another user inside a building. Users can request that other users share their location and then map a travel path.
CyberTimez	Cyber Eyez, Cyber Earz, Cyber Armz	Cyber Eyez uses Google Glass to read items to a user in real time; Cyber Earz runs an app that listens for specific sounds, like smoke alarms, and sends and alert to the user; Cyber Armz uses a smart watch, voice commands, and linear 3D-printed actuators to close doors and windows.
Leica Geosystems	Pegasus: Backpack	Wearable mobile mapping device comprising 4MB cameras and lightweight LIDAR profilers, Velodyne pucks, and four batteries, for a combined total of approximately 28 pounds.
University Kent, CPI	3D-printable wristband with printed antenna	3D-printable wristband with printed antenna technology and tracking capabilities.
Cameras		
360Fly	360Fly panoramic video camera	Camera with 360-degree views in a small, lightweight (5 oz.) form with a touch screen and controlled via mobile.
Genetec	Security Center	Supports import/archiving of video content from wearable cameras (B-CAM, GoPro, Vievue, Zepcam), allowing users such as law enforcement, to complement their surveillance with wearable footage via a single video management platform.
Google	Jump virtual reality technology platform	Features a GoPro 360-degree camera array mounted to a hat or cap, with the ability to connect wirelessly to a smart device to transmit the video, as well as to connect to social networking or another interactive platform.
Panasonic	HX-A1 wearable video camera	Video camera weighing only 45 grams that is shockproof, water proof, and capable of 3.54MP camera resolution. It also offers wi-fi connectivity, live-streaming, and a night-mode and noise-reduction function.
Exoskeletons		
Active Bionics Inc.	Exoskeleton	Attaches to the user's legs and is carried in a backpack by the user. The exoskeleton leads the user's legs where they want to go. If the user waivers, the exoskeleton locks, holding them in place.
Alex Czech (individual)	3D-printed exoskeleton	3D-printed exoskeleton from a hand to an entire arm. The arm consists of 13 unique parts. The design is downloadable and entirely 3D printable, except for the screws and metal washers required for assembly.
Robo-Mate	Exoskeleton	Exoskeleton capable of making a load up to 10 times lighter. The device features motors and sensors that work together to reduce the user has to bear and it reduces postural damage. The device comprises modules for the arms, the trunk of the body and the legs.
U.S. Army	Mobile Arm Exoskeleton for Firearm Aim Stabilization (MAXFAS)	A lightweight (10 oz.), carbon fiber device that fits over a user's arm to assist in shooting accuracy via a system of cables, gyroscopes, accelerometers, and sensors.

US Bionice	Low-cost exoskeleton	The device features buttons on crutches that control the different parts of the exoskeleton. Its battery life will support 4 hours of continuous walking.
Victor Morales (individual)	Scout Exoskeleton Robot, Independence Exoskeleton Robot	The Scout Exoskeleton Robot is designed for the chest and legs for people with walking problems or paraplegia of the lower limbs. The Independence Exoskeleton Robot expands on Scout with arms and robotic hands, intended for quadriplegia. The exoskeletons can be controlled via smart phone or GoogleGlass and via voice or eye control.
Wearable Computers		
Optivent	ORA-X smart glass	Smart glasses with high-end wireless headphones, quality audio, and disruptive see-through display as well as a microphone, 9-axis motion sensor, wireless connectivity (Bluetooth, wi-fi, GPS), a trackpad, high-capacity lithium-ion rechargeable battery, and a power microprocessor and graphics processing unit. It allows for hands-free mobile computing.
Osterhout Design Group	R7 augmented reality glasses	Augmented reality glasses with a 720p display, built-in battery, wi-fi and Bluetooth LTE connectivity, GPS radio, altimeter, compass, and high-speed 1080p video camera.
VA-ST	SmartSpecs	Augmented reality glasses and head-worn computer to assist visually impaired users. The device comprises a processor, three camera sensors, and display to produce easily viewable frames with simple, high-contrast images and to detect the distance to an object.
Other		
Amyko	Near-field communication (NFC)-based bracelet modules	NFC bracelet modules communicate with smart devices to share medical information in emergencies.
Apple	Gesture-controlled data sharing	Wireless data exchanges with wearables and smart phones via hand gestures like a high five.
Battelle, Feinstein Institute for Medical Research	Neural tourniquet	Uses neurostimulation to control blood loss. The “neural tourniquet” as a wearable that could clip onto a patient’s ear, stimulate the vagus nerve, and enable stimulation of the spleen to stimulate blood clotting.
CommandScope	CommandScope pre-planning program	digital, pre-plan program that provides responders with information about buildings and its occupants as well as en route access to site plans, floor plans, hazardous material details, utility shut-off locations, geographical maps, fire hydrants locations, residents with special needs, and other critical building data.
Doppel	Doppel wrist-worn psychophysiology wearable	Uses customized haptic feedback to influence a user’s mood, similar to mood music.
EasyM2M	iWristPhone	Wireless mesh networks to provide underground wifi to connect to iWristPhone, which features a gravity sensor that can detect miners falling or being trapped, it can monitor and record miners’ GPS coordinates, it has a 3MP camera for video calls, and it has sensors for heart rate and blood pressure.
Gunilla Alsio and Senseboard Inc.	Virtual keyboard technology	The wearable virtual keyboard attaches to a user’s hand with transducer sensors on the fingers that sense gestures that then move the cursor or interactive with a keyboard on the screen.
Instamic	Instamic wearable audio recorder	Small (1-inch), waterproof, clip-on wearable recorder capable of capturing high-quality sound using remote technology. Its different models can record in dual-mono quality and stereo-quality. It features 2GB internal memory, wireless control via Bluetooth within 30 feet, and can capture 4 hours of audio on a single charge.
Korean Advanced Institute of Science and Technology	Light-powered healable electrical conductor	Light-powered healing via the use of a photochromic soft material directionally moved along the light polarization.
Korean Advanced Institute of Science	Phase change random access	PRAM as a candidate for nonvolatile memory in flexible and wearable devices. PRAM features block copolymer silica nanostructures with

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and Technology	memory (PRAM)	an ultra-low current operation on plastic substrates, which offers a smaller contact area and significant power reduction.
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MyMDband	Wearable medical information wristband	Wristband with an engraved, scannable QR code that provides access to a user's medical profile and alerts to a user's network with the user's location.
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North Carolina State University	Stretchable, transparent conductors	Stretchable, transparent conductors that employ a nano-accordion design fit for use in flexible electronics, stretchable displays, and wearable sensors.
PogoTec, Inc.	On-Track, Look & Shoot, and Pogo-Power	On-Track is an eyewear mounting system for attaching wearables (cameras, sensors, hearing aids) to glasses frames. Look & Shoot is developing small, proprietary camera to attach to eyewear via On-Track. Pogo-Power is developing a wireless transfer system to wirelessly power wearables.
Qualcomm, Google	Project Tango	Snapdrago 810 will deliver to the next generation Project Tango smartphones optimized computing capability for the devices' video, imaging, and graphics, particularly in respect to the 3D mapping.
Rithmio	Gesture recognition platform	Technology to provide users accurate interpretation of a user's movements. By integrating with wearable training devices, Rithmio's software analyzes a range of movements and translates that into usable data.
Stanford University	Wearable heater	Traps a user's body heat and provides a cost-effective method to control comfort without adjusting the thermostat. The fabric reflects a user's infrared radiation back to the body, trapping an estimated 80% of the body's heat while allowing moisture to pass freely.
University of California	Smart fabric with temperature control	Wearable air condition designed to maintain temperature comfort, aimed at reducing the need for air conditioning (or HVAC) systems and environmental impacts. The smart textile responds to change in ambient temperature, with polymers that become thicker or thinner as the temperature changes.
University of Pittsburg Swanson School of Engineering	Responsive hybrid material	Flexible, responsive hybrid materials that perform computations based on environmental/movement changes, and possibly a user's vital signs.
Vital Connect, Inc.	VitalCore™ system-on-chip processor	Custom, integrated circuit for wireless biosensors aimed at decreasing power requirements for detecting and processing capabilities while enabling continuous biometric monitoring and longer battery life. The chip comprises a powerful processor and analog circuit fit for low-power measuring vital signs in clinical settings.
Wearsafe Labs	Wearsafe Tag personal safety wearable	Wearable safety device with low-energy Bluetooth connectivity that can connect to and send alerts to a user's smartphone up to 165 feet away.
Yonsei University	Stretchable, conductive fiber	Uses silver nanowires and nanoparticles to create stretchable conductive fiber that can be embedded into gloves to recognize human motions.



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