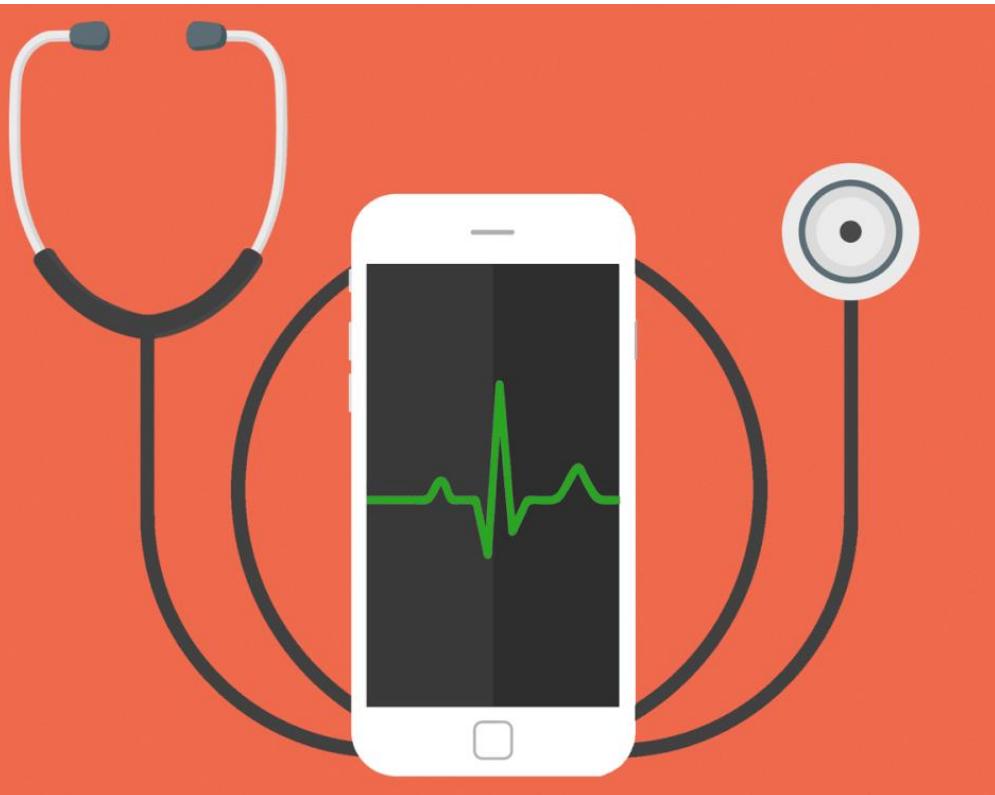


# MOBILE DEVICES, APPS, AND WEARABLES FOR HEALTHCARE



COMPILED BY HOWIE BAUM

# WHAT IS MOBILE HEALTH TECHNOLOGY?

**It is Medical and public health practice supported by mobile devices, such as smartphones, tablets and other mobile devices to deliver health care and preventive health services.**

**According to a recent survey, 83 percent of physicians in the U.S. already use mobile health technology or mHealth to provide patient care.**

**INTERESTING STATISTIC: 35% OF CONSUMERS USE MOBILE APPS ON THEIR SMART PHONES TO SCHEDULE APPOINTMENTS.**



# **WHAT KINDS OF MOBILE WEARABLE DEVICES CAN BE USED TO IMPROVE A PERSON'S HEALTH AND/OR A MEDICAL CONDITION ?**

**There are 2 main types of these devices - those used for health conscious consumers and those for medical reasons.**

1. For health wearables, there are the commercially sold health wearables like FitBit, that track the users every day activities, exercise levels and vital statistics, as well as smart phone apps, and Chatbots, such as Alexa on the Amazon Echo and Dot, Siri, Cortana, etc.



## MEDICAL DEVICES

2) The other types are for those who need medical monitoring or assistance like wearable glucose or heart rate monitors.

**Pulse oximeter** is a noninvasive device used for monitoring a person's **blood oxygen saturation (SO<sub>2</sub>)**.

In its most common application mode, a sensor device is placed on thin part of the patient body, which is usually a fingertip or earlobe in adults and in case of infants it is placed across a foot. The pulse oximeter displays the percentage of blood that is loaded with oxygen.



**Hutchinson Technology Inc.** has received European regulatory approval for the InSpectra StO<sub>2</sub> Spot Check (model 300) device. The company's **tissue oxygen saturation (StO<sub>2</sub>)** technology allows direct measurement of oxygen saturation.

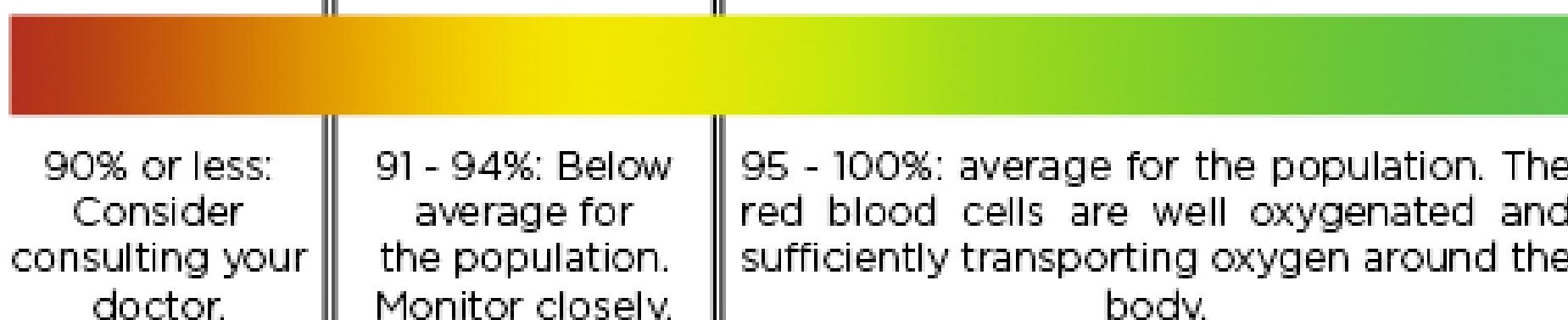


## **Understanding Blood Oxygen Saturation (SpO<sub>2</sub>)**

**≤ 90%**

**91 - 94%**

**95 - 100%**



What's Your Internal Age?  
[www.goithart.com](http://www.goithart.com)



# Types of Wearable Medical Devices

- ❖ The wearable medical devices market includes products that can be broadly segregated in four segments:
  - A. Lifestyle and Fitness:** The wearable lifestyle and fitness devices segment is the most advanced category of the wearable medical devices market. It includes fitness trackers, activity trackers and sports trackers. Personal health monitoring has been a large contributor to this arena of fitness wearable. Although many of the lifestyle and fitness devices are not technically medical devices; the US FDA has defined them as general wellness devices only.

Nike + iPod Sports Kit



Misfit Shine



Moov Now



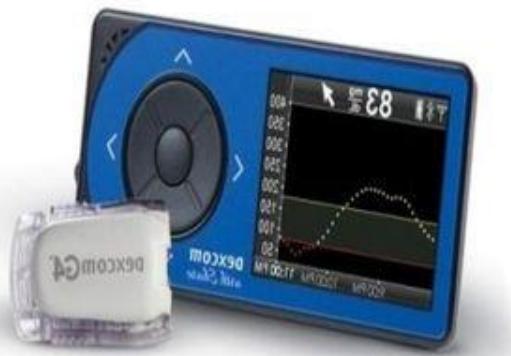
Fitbit Charge 2



# Types of Wearable Medical Devices

**B. Diagnostics and Monitoring:** Wearable diagnostic and monitoring devices are non-invasive devices that provide valuable health information. It includes glucose monitoring, cardiovascular monitoring, event recording, pregnancy, obstetrics, fetal and infant monitoring, neurological monitoring, such as electroencephalogram (EEG) tests and sleep monitoring devices.

Dexcom G4



Quardio core



# Types of Wearable Medical Devices

C. **Therapeutic:** Wearable systems that monitor disease states and track health activity, store data and deliver feedback therapy are the next frontier in personalized medicine and healthcare. This group of devices include respiratory therapy, insulin management, pain management devices, insulin/glucose monitoring devices, rehabilitation devices, and respiratory therapy devices.

**Quell**



**Minimed 530 G Insulin Pump**



# Types of Wearable Medical Devices

**D. Injury prevention and rehabilitation:** Wearable injury prevention and rehabilitation devices are the non-invasive devices that provide valuable health information. They include body motion monitoring devices, wearable sensing garments, fall detection devices.[>>](#)

- ❖ Based on the site of application, the wearable devices market is segmented into handheld, shoe sensors, headband, strap/clip/bracelet, and other areas. Strap/clip/bracelet or wrist-worn devices are expected to hold over 40% of the market share in the domain of wearable medical devices.
- ❖ Wearable Medical Device Market on the basis of application is segmented into remote patient monitoring, sports and fitness, and home healthcare.

Phillips Lifeline



Sproutling Baby Monitor



# Types of Wearable Medical Devices based on site of Application



# Key attributes of wearable tech products

- 3<sup>rd</sup> party apps
- API partners
- Accessories

## Development Platform

### Hands-Free

- Voice / gesture control



### Always-On

- Low power consumption
- Instant wake
- Background working / sensing



### Attention-Getting

- Less distracting when receiving alerts / reminders / messages



### Environment-Aware

- GPS
- Accelerometer
- Compass
- Camera
- Microphone
- Other Sensors

### Connected

- Wi-Fi
- 3G / 4G
- Bluetooth
- NFC

**MOBILE / PORTABLE DEVICES** – This is a general term for any type of smaller portable computer or Smartphone that has a touch screen on it.

Some mobile devices—like tablets, e-readers, and smartphones—are powerful enough to do many of the same things you can do with a desktop or laptop computer.



**TABLET COMPUTERS** usually come in two sizes – 7 or 10 inch, as measured on a diagonal on the screen, as shown:

The most obvious difference is that tablet computers have optional keyboards, but don't have a CD/DVD drive, or touchpads.

Instead, the entire screen is touch-sensitive, allowing you to type on a virtual keyboard and use your finger or a stylus as a mouse pointer.

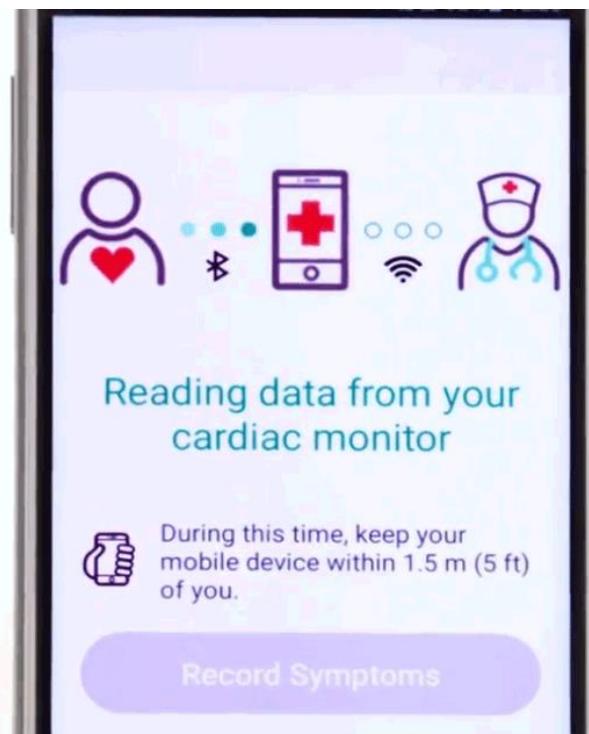


# THE TERM APP STANDS FOR AN APPLICATION

**AN APP IS A COMPUTER SOFTWARE PACKAGE OR PROGRAM THAT PERFORMS A SPECIFIC FUNCTION DIRECTLY FOR AN END USER**

Health and medical apps are application programs that offer health-related services for smartphones, tablet PCs, Wearable watches, etc.

Because they're accessible to patients both at home and on-the-go, health apps are a part of the movement towards **mobile health (mHealth)** programs in health care.



Medical and Health apps for smart phones and/or tablets, can be found mainly on the Apple or Android websites, which are located in the "Cloud".

**APPLE:** For Apple smart phones, tablets, or the Apple Watch, all apps can be found at the Apple iTunes Appstore at

<https://itunes.apple.com/us/genre/mac/id39?mt=12>



**LAST YEAR THERE WERE  
47,526 APPLE HEALTHCARE  
APPS !!**

**THE ANDROID OPERATING SYSTEM IS A PRODUCT OF GOOGLE AND ALL OF THE REGULAR, HEALTH, AND MEDICAL APPS ARE AVAILABLE AT THE GOOGLE PLAY STORE.**

**Last year there was a total of 2.6 million apps on there !!**

**In early 2018, there were 51,533 Android Healthcare apps !!**

To go there on the Internet, the link to go to the Google Playstore for all of their apps is

<https://play.google.com/store/apps>

To just get the Medical & Health info, go to:

<https://play.google.com/store/search?q=medical+and+health+apps>

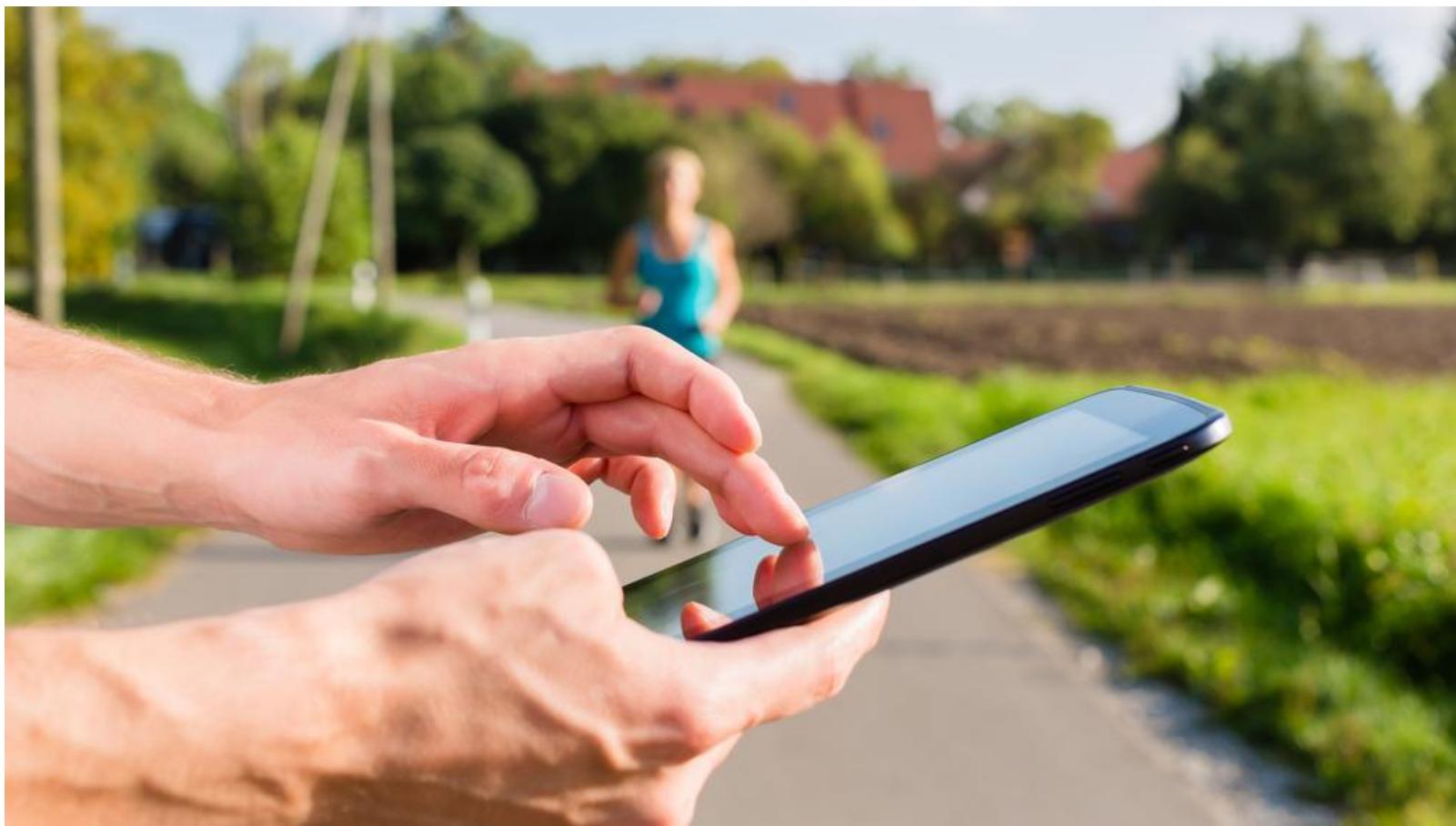


Google play

## **NON-MEDICAL APPS:**

**General Health and Fitness Apps:** These apps constitute almost 75 percent of MMAs (Managed Medical Assistance) found on app stores.

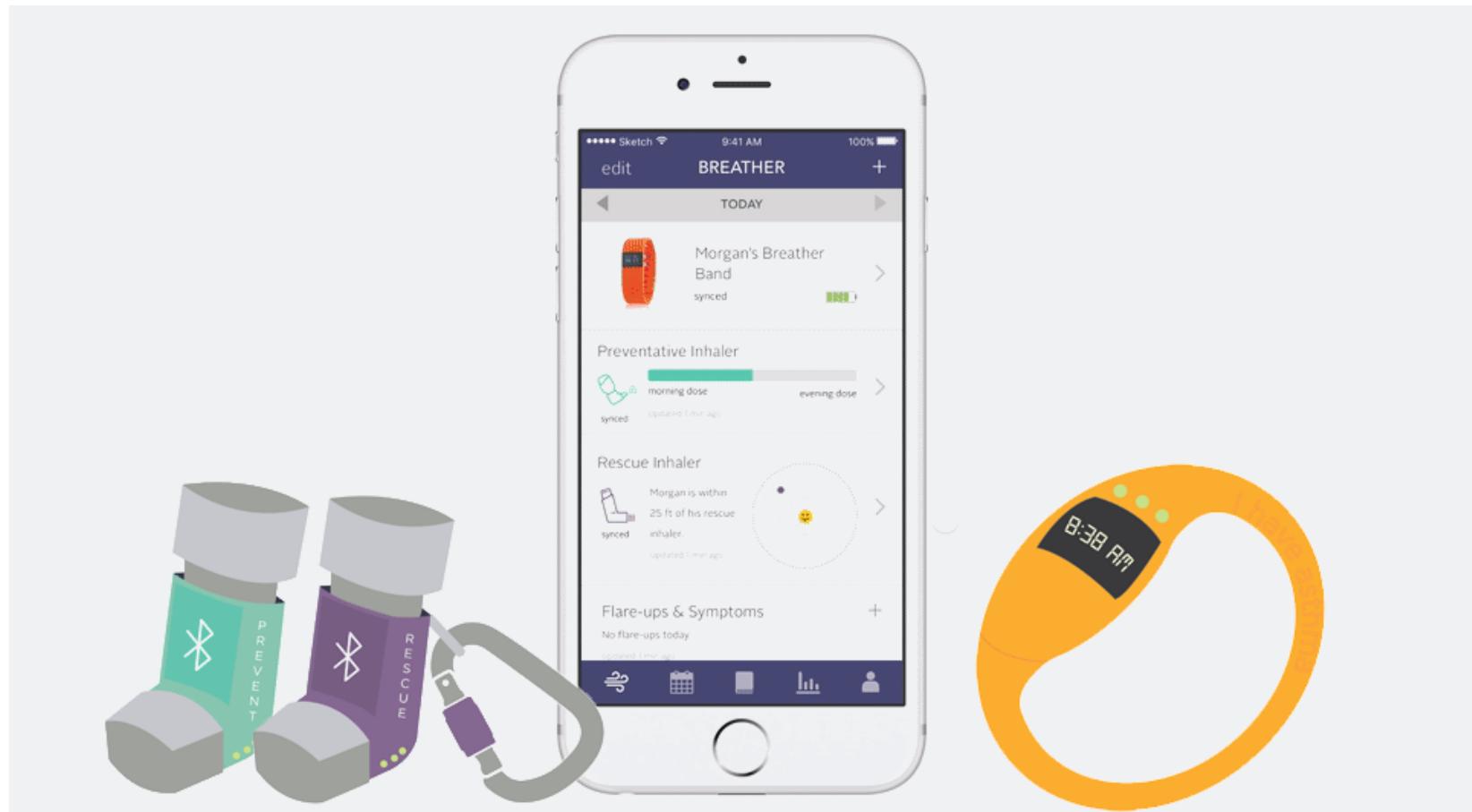
These are related to nutrition, health tracking, fitness, and weight loss, and work with wearable technology devices such as a “FitBit”, Smart Watch, and other types of health monitors.



# MEDICAL APPS

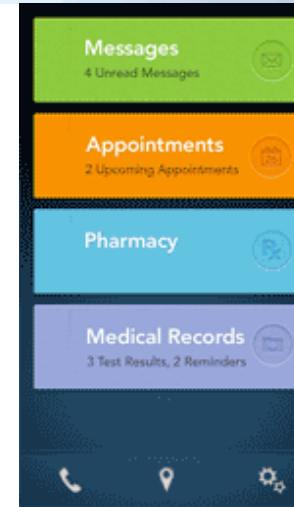
Depending upon how they work, MMAs (Mobile Medical Apps) can be broadly divided into 4 categories:

**1) Chronic Care Management Apps:** These include apps to manage blood pressure, cancer care, diabetes care, breathing issues, mental health, and other illnesses.



## 2) Medication Management

**Apps:** These apps help in keeping track of medicine intake, such as Insulin, to ensure proper dosing at required intervals.



## 3) Personal Health Record

**Apps:** These applications allow patients to make appointments for regular care or consultations, and store their medical conditions data, history, allergies, etc.

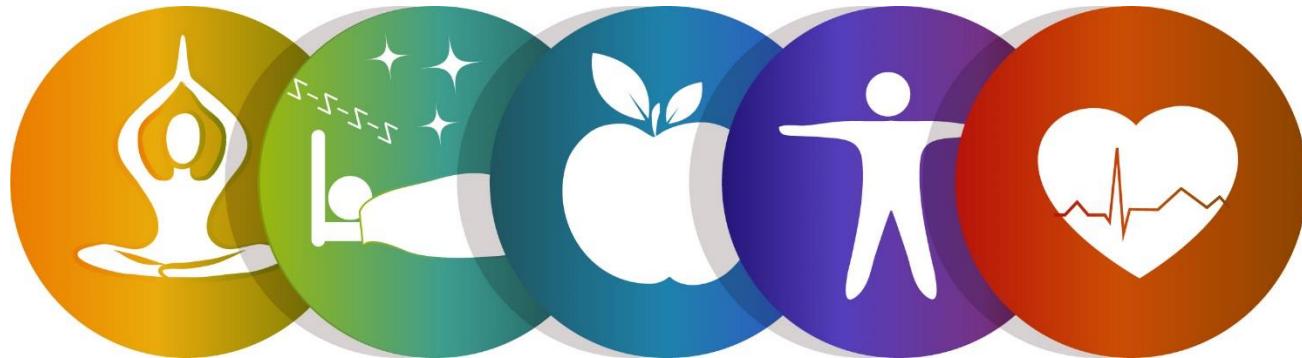


## 4) Women's Health Apps:

This segment includes apps for pregnancy, fertility, breastfeeding, etc.

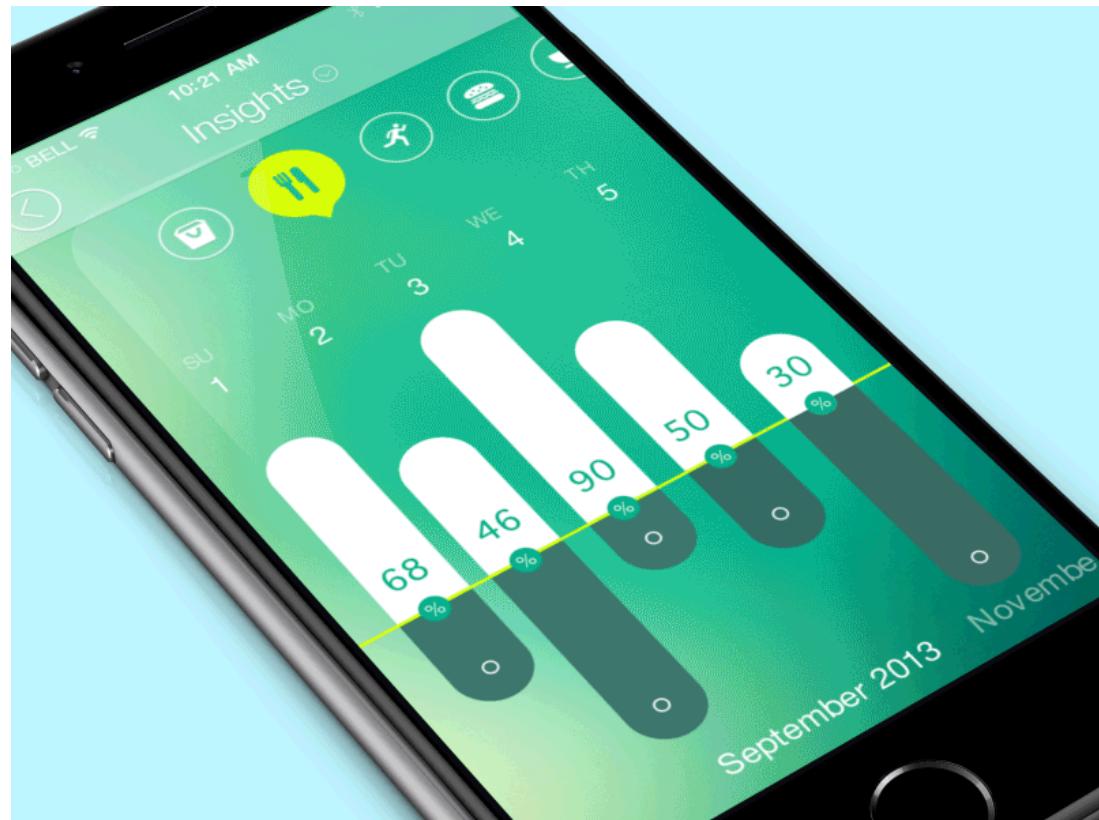
## **The most popular categories of health and wellness apps include:**

- ❖ Sports and fitness activity tracking
- ❖ Diet and nutrition
- ❖ Weight loss coaching
- ❖ Pharmacy
- ❖ Sleep cycle analysis
- ❖ Stress reduction and relaxation
- ❖ Meditation
- ❖ Medical advice and Patient & Caregiver communities
- ❖ Menstrual period tracking
- ❖ Pregnancy
- ❖ Hospital selection and Physician appointment management



# THERE IS A RANGE OF GOOD OPTIONS A DIET APP CAN PROVIDE:

- Healthy Food Suggestions
- Water Consumption
- Food Logger
- Carbs Control/Weight loss
- Diet Planning
- Shopping List Organizers
- Calorie counter based on physical activity & food intake.
- How to hire a Nutritionist or a Dietitian



# **THE TOP CATEGORIES OF MHEALTH APPS AS DEFINED BY DOWNLOADS COMPLETED ARE:**

Weight loss (50 million)

Exercise (26.5 million)

Women's health (10.5 million)

Sleep & meditation (8 million)

Pregnancy (7.5 million)

Tools & instruments (6 million)

Others (18 million)

**According to Research and Markets, the global market for mobile health applications is currently valued at approximately \$28.32 billion and is expected to reach \$102.35 billion by 2023.**

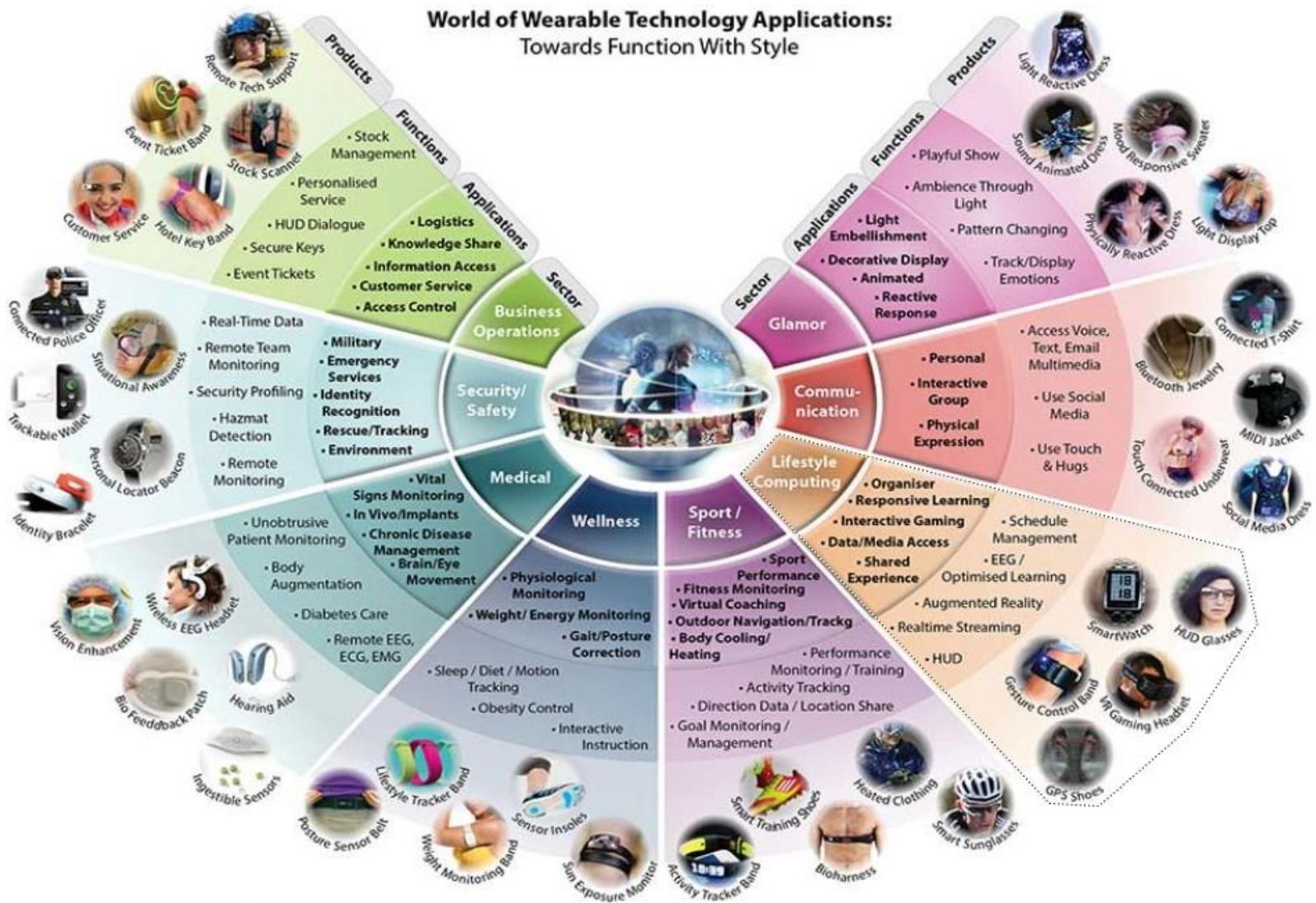


# I. INTRODUCTION

Wearables are small electronic devices, often consisting of one or more sensors and having computational capability. They play an important role in **healthcare** monitoring, analyzing and even healing.



# WEARABLE ELECTRONICS BY SECTOR



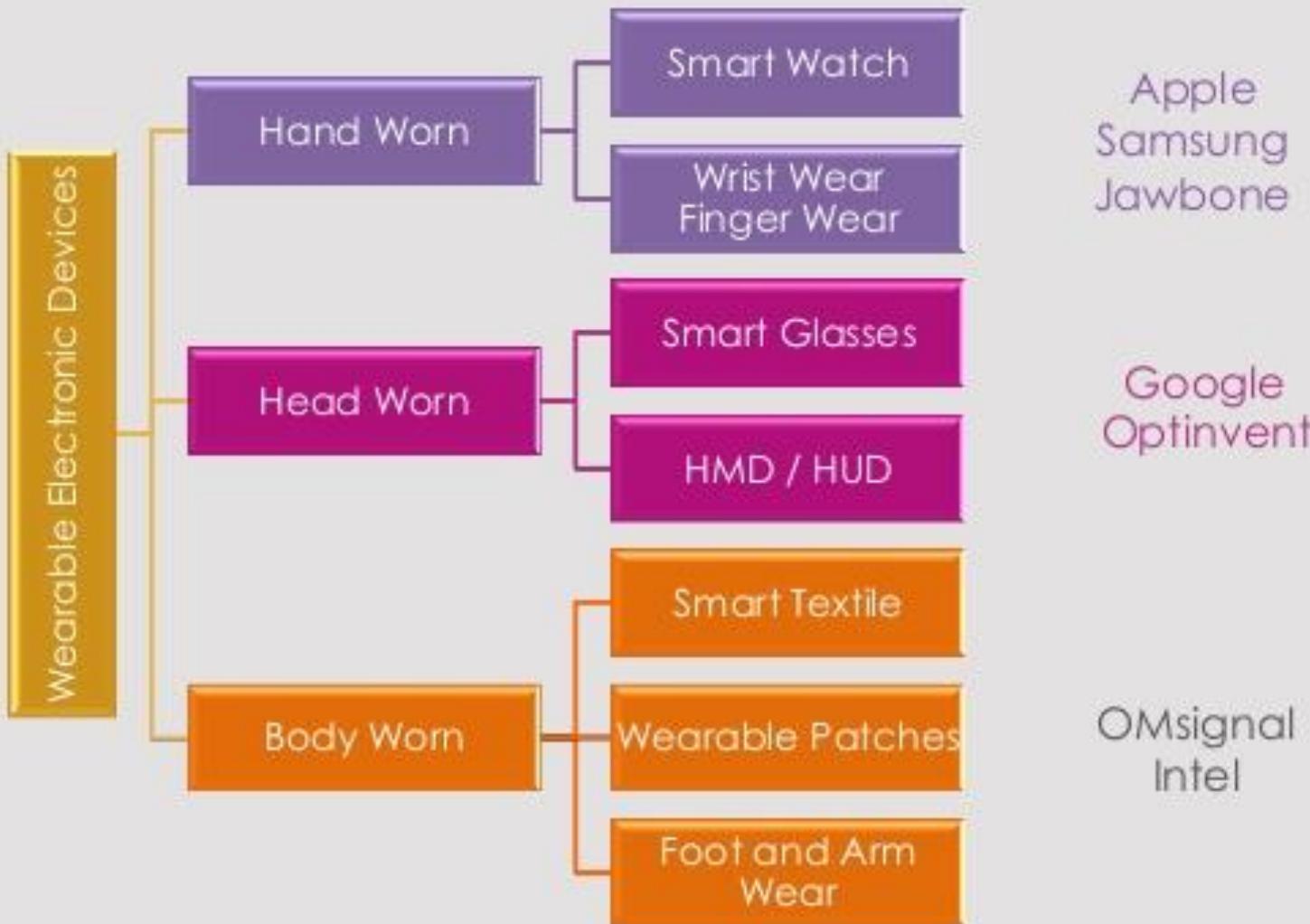
# FOCUSING ON HEALTH CARE



## **APPLICATIONS FOR WEARABLE DEVICES:**

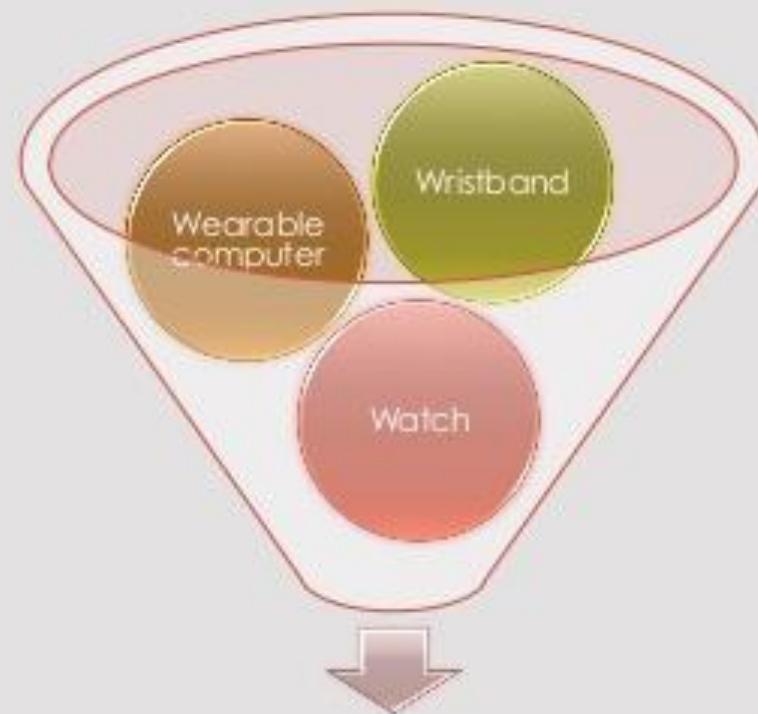
- A headband and software platform for **brain injury detection or sleep evaluations**
- A wristband that monitors **blood oxygen** wirelessly
- Smart patches for **remote monitoring and home diagnosis**
- A tattoo-like plastic **patch that can monitor vital signs**
- **A smart contact lens or skin patch sensor that analyzes sweat, to monitor the user's blood sugar levels.**
- A wearable that will help patients with **Parkinson's disease** by providing deep brain stimulation, a common method of treatment typically requiring heavy physician involvement.

# WEARABLE ELECTRONICS BY USE



# HAND WORN

- Fitness and health tracker
  - IntelligentM Bracelet (how well you wash your hand)
- Wearable computers
  - Amon
- Watch
  - Pebble Smartwatch
  - Martian Notifier Smartwatch
  - Apple watch
  - Samsung gear
- Wristband
  - MIT Wristband
  - The Tactilu Bracelet



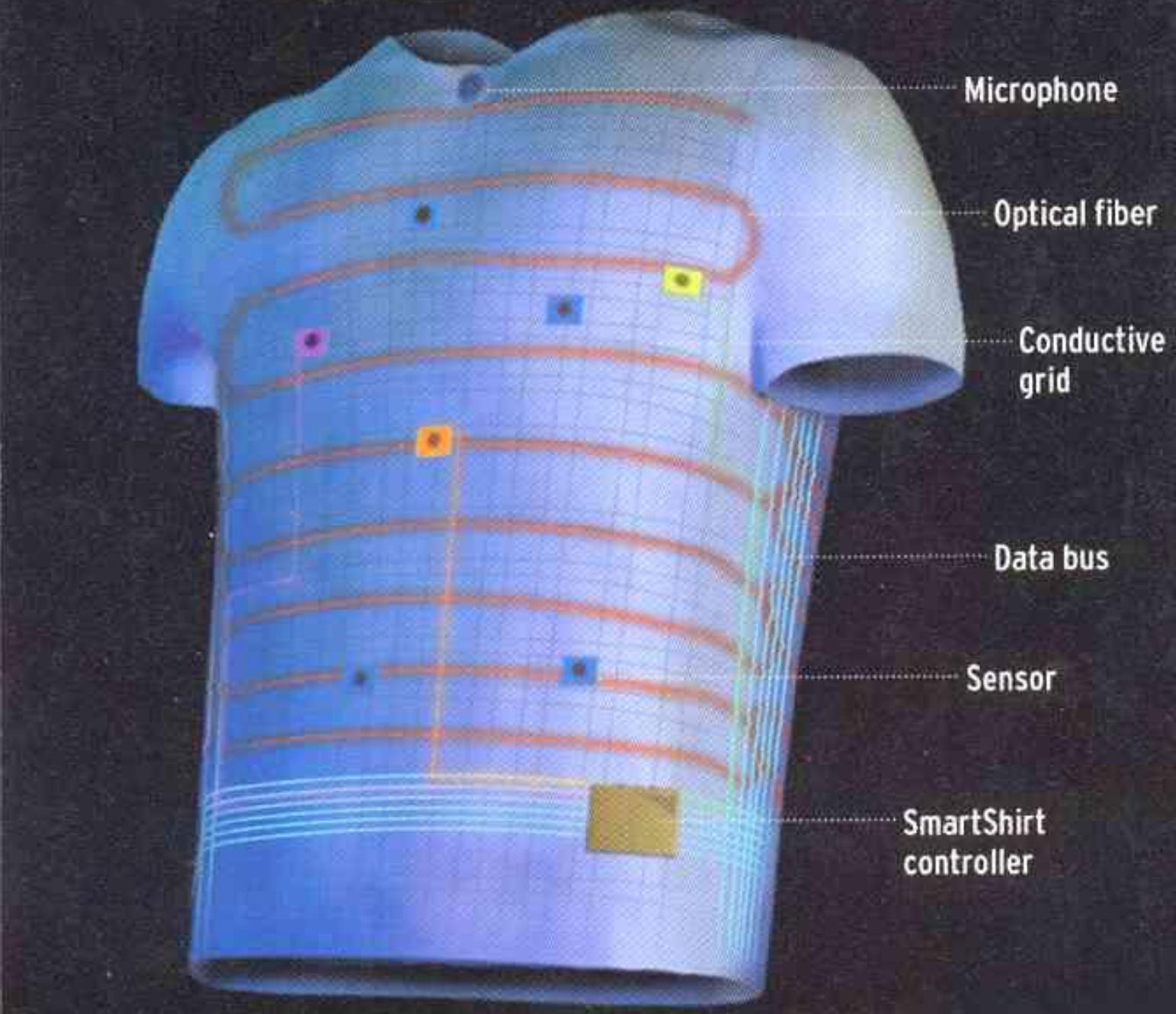
Hand Worn

# HEAD WORN

- Smart glasses
  - Google Glasses
  - Vuzix
  - Optinvent ORA
  - Buhel
- Medical headsets (EEG)
- Breathing masks
- Brain-sensing headband (Muse-InteraXon)
- Communication helmets
  - O.R.B

# BODY WORN

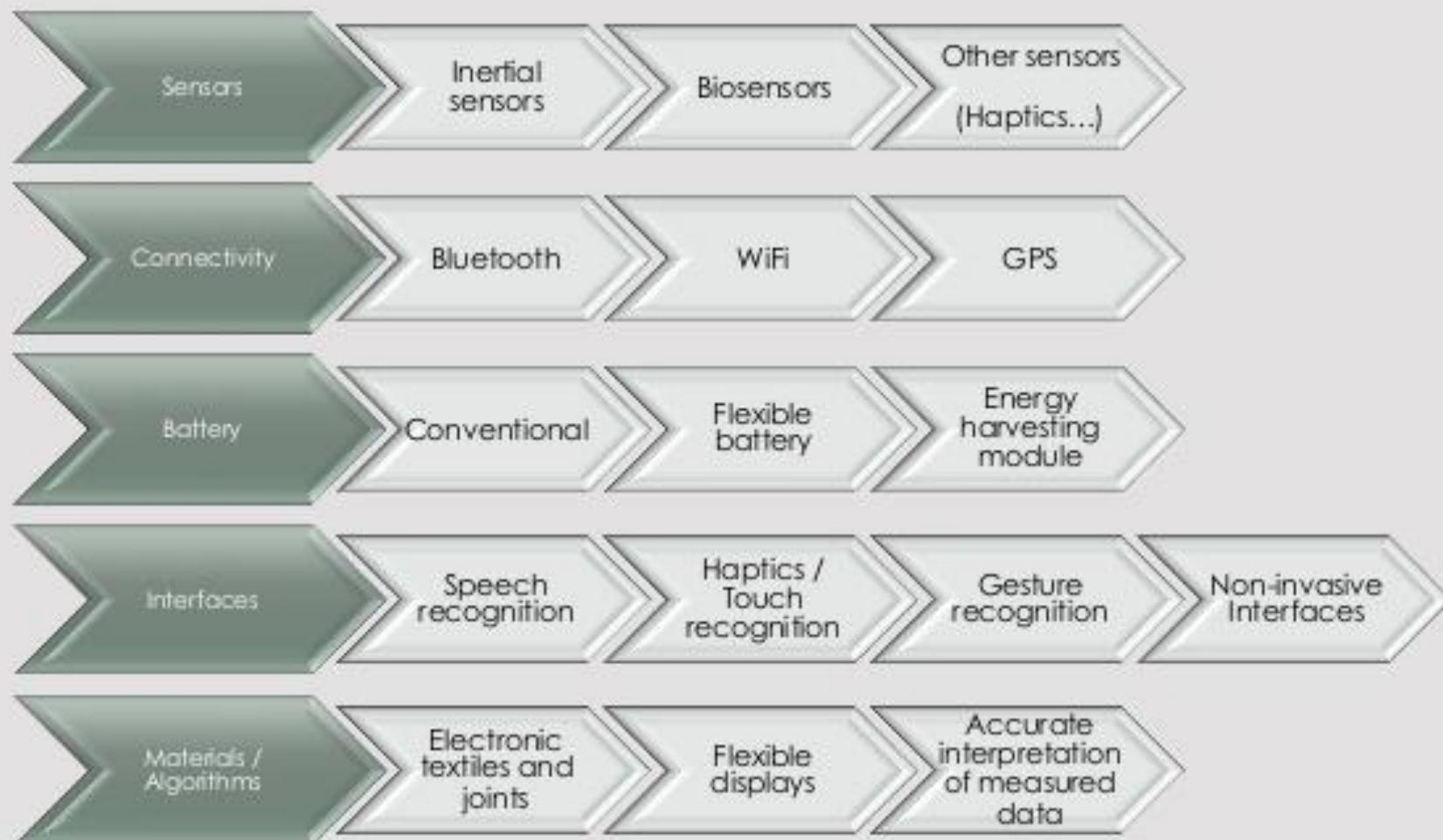
- Smart textile
  - Smart T-Shirt with integrated sensors (fitness trackers)
  - Smart armband (Myo)
  - Safety baby worn blanket (Philips)
- Foot and Arm wear
  - RunScribe
- Wearable Patches
- E-skin



# A SINGLE-CHIP ENCRYPTED WIRELESS 12-LEAD ECG SMART SHIRT FOR CONTINUOUS HEALTH MONITORING



# COMPONENTS OF WEARABLES



# DATA COLLECTING

## Inertial Sensors

- ✓ To monitor body movements

## Bio-Sensors

- ✓ To monitor heart rate
- ✓ Cholesterol Not on a wearable but on a small device) A very small drop of blood is analyzed and data is sent to the device for results.
- ✓ Sweat

**Haptics** Feeling a sense of touch such as a vibration or force as part of interacting with electronic devices.

- ✓ To enhance touch experience

# BIO-SENSORS TO MEASURE CHOLESTEROL

## Electrochemical

- ✓ Electrochemical are considered to be the most important cholesterol biosensor
- ✓ Based on enzymatic catalysis of a reaction
- ✓ **Low response time**
- ✓ High sensitivity
- ✓ **Low cost and low power** required

## Optical

- ✓ Employs an optical fiber as a platform for the biological recognition element
- ✓ Involves diffusion of analytes
- ✓ **Higher response time**
- ✓ Good sensitivity
- ✓ **High cost and high power** required

# A small Eastern Indian Company Is Building A Medical Diagnostic Lab In Your Pocket

The **Inito** clips onto your phone and lets you measure fertility levels.

In the future, its makers say they will test for thyroid, cholesterol and much more.



# INERTIAL SENSORS TO TRACK BODY MOVEMENT

## Accelerometers and gyros

- ✓ Continuous real-time data recording
- ✓ Accurate
- ✓ Body angles
- ✓ Angular acceleration

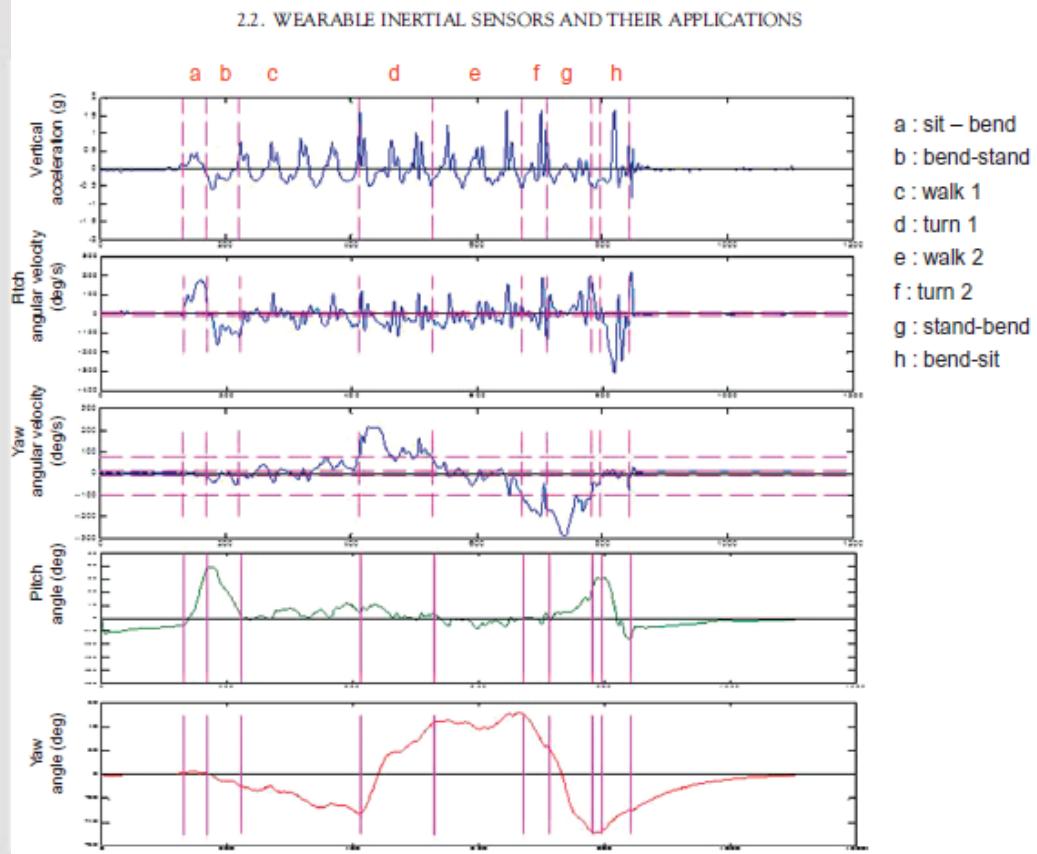


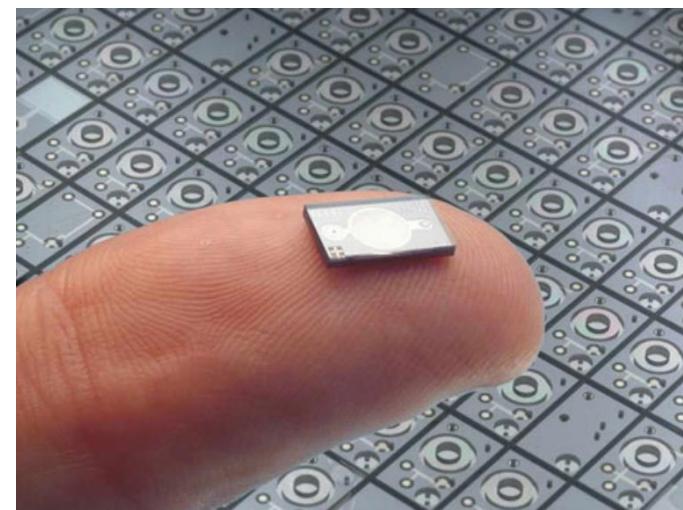
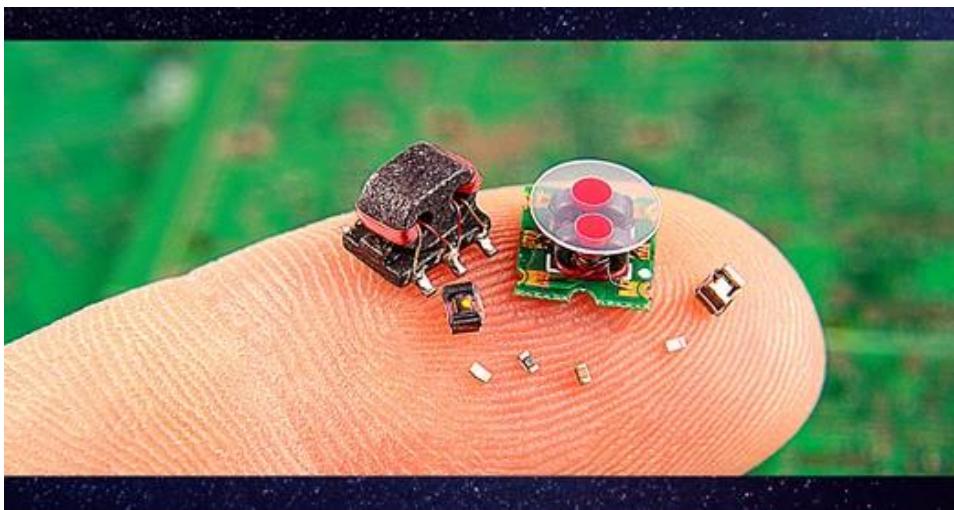
FIGURE 11 An example of TUG test at waist with accelerometer and gyro sensor.

A MEMS (microelectromechanical system) is a miniature machine that has both mechanical and electronic components.

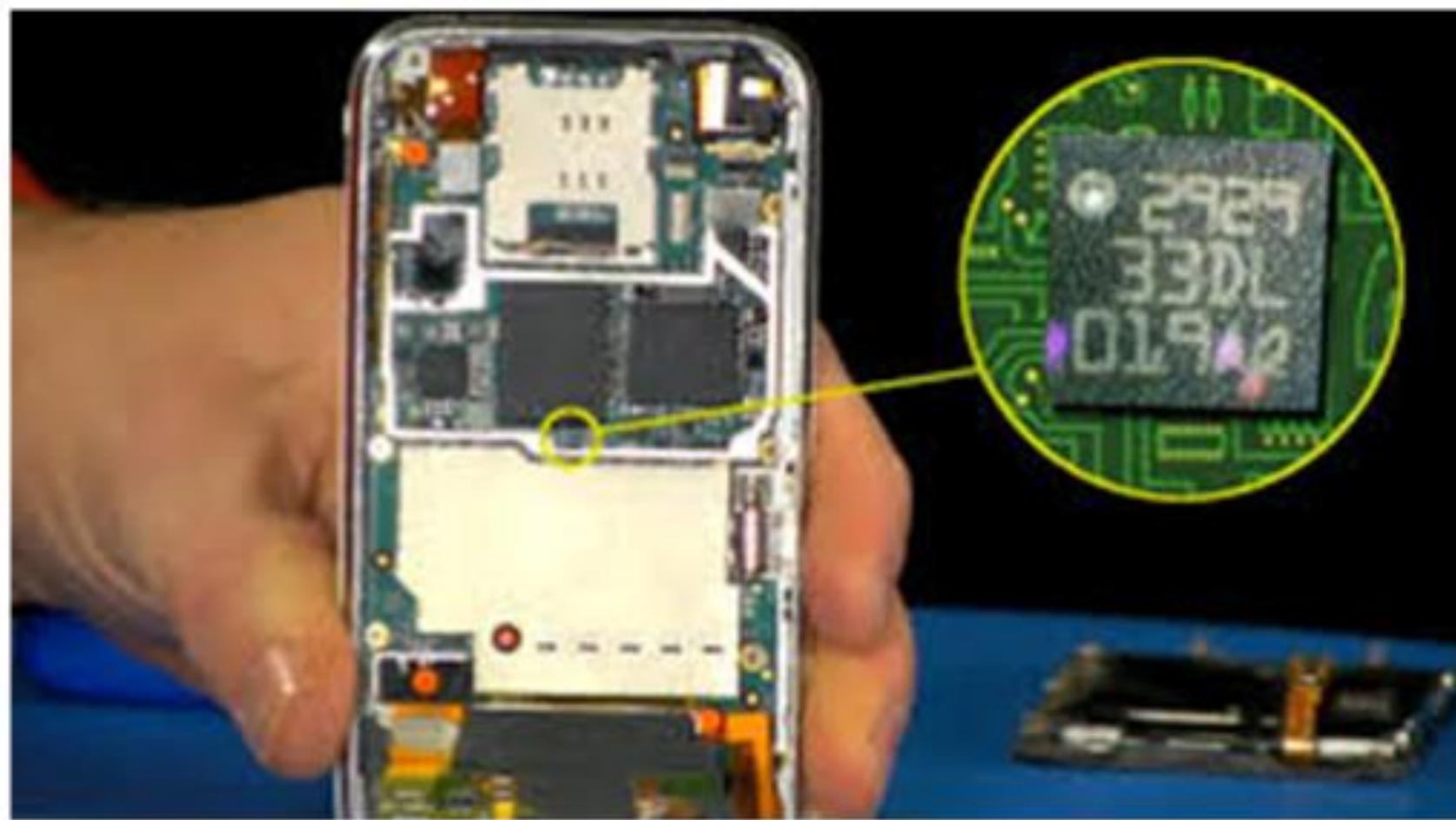
**The physical dimension of a MEMS can range from several millimeters to less than one micrometer, a dimension many times smaller than the width of a human hair.**

**The MEMS shown below, at right, is actually a disposable, wearable insulin pump for managing diabetes.**

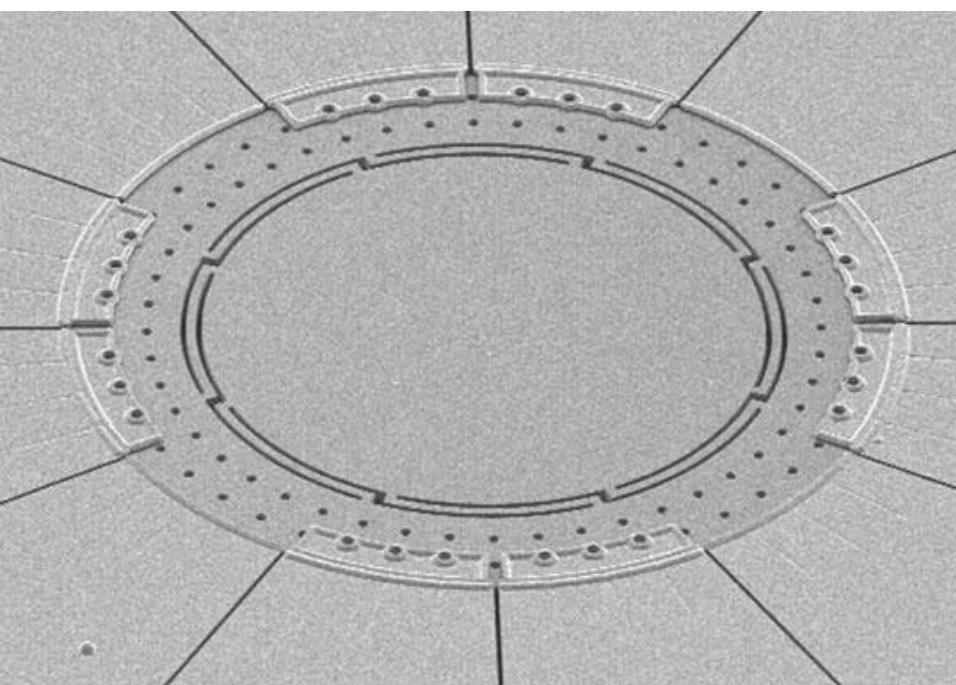
The chip is a stack of 3 layers bonded together: a silicon on insulator (SOI) plate with micro-machined pump structures and two silicon cover plates with through-holes. A piezoelectric actuator on the chip moves the membrane in a reciprocating movement to compress and decompress fluid in the pumping chamber.



THE ACCELEROMETER IN YOUR SMART PHONE LETS YOU TURN THE PHONE 90 DEGREES AND THE PICTURE ROTATES WITH IT. THE DEVICE IS AN EXAMPLE OF AN AMAZING SMALL PART CALLED A MEMS (MICROELECTRICALMECHANICAL SENSOR)

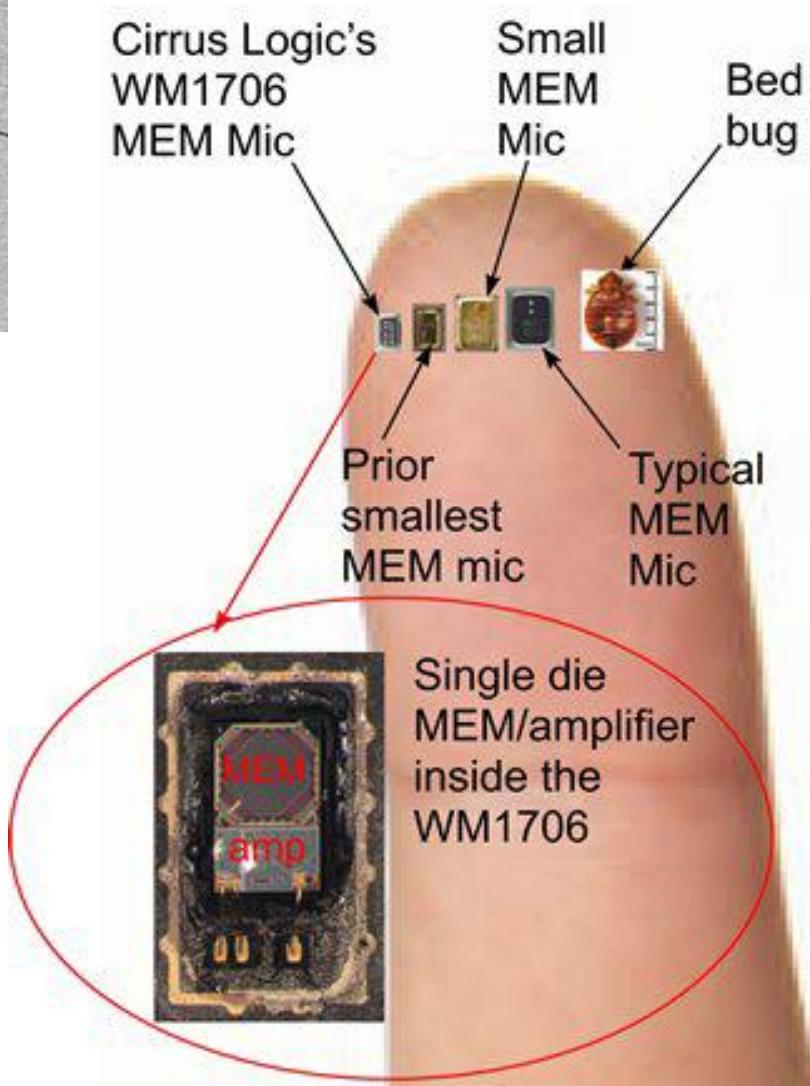


<https://www.youtube.com/watch?v=KZVgKu6v808>



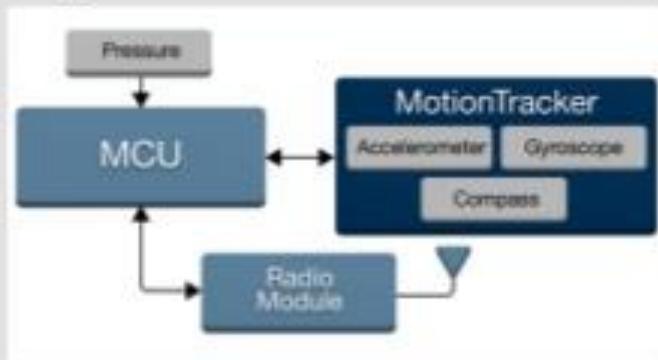
This annulus resonator gyroscope, designed and made in Georgia Tech cleanroom facilities, is a mere 800 microns across yet measures rotation around two in-plane axes — pitch and roll.

A similar design being developed measures rotation around all three axes — yaw, pitch, and roll — using a single tiny device.



# INERTIAL SENSORS TO TRACK BODY MOVEMENT

## Integrated Motion tracking



**Remote patient  
monitoring**

## InvenSense's Motion Tracking device

- ❖ 6 axis
  - (3-axis accelerometer)
  - +
  - (3-axis gyroscope)
- ❖ 9 axis
  - (additional 3-axis ecompass)

Patient's  
motion  
data



Doctors  
and  
Physician

# INERTIAL SENSORS TO TRACK BODY MOVEMENT

Nike FuelBand



FitBits



Basis

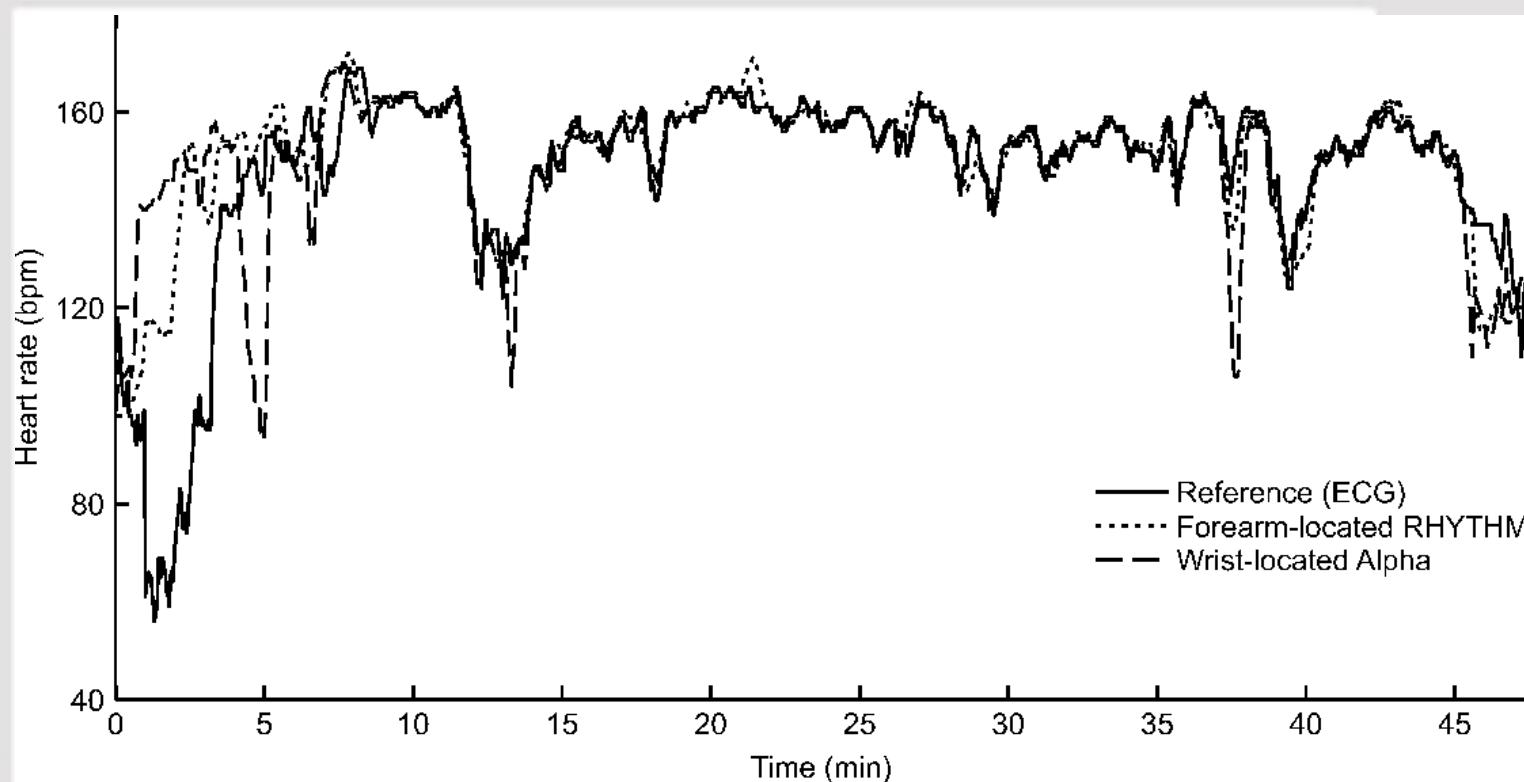


Jawbone

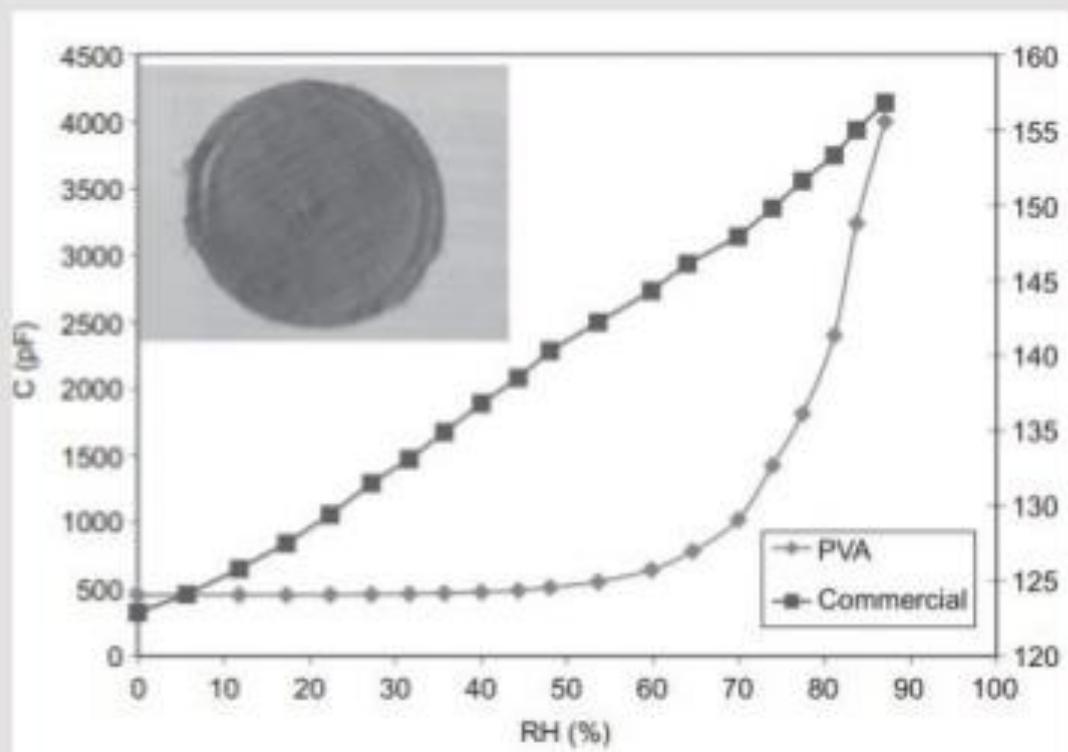


# OPTICAL SENSORS TO MONITOR HEART RATE

- ✓ Acceptable accuracy for over than 15 min use
- ✓ Commonly used in wrist bands



# SWEAT SENSOR

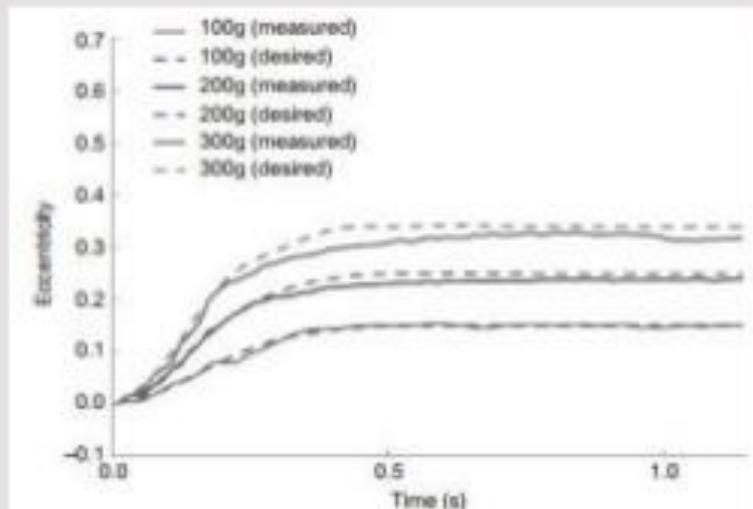
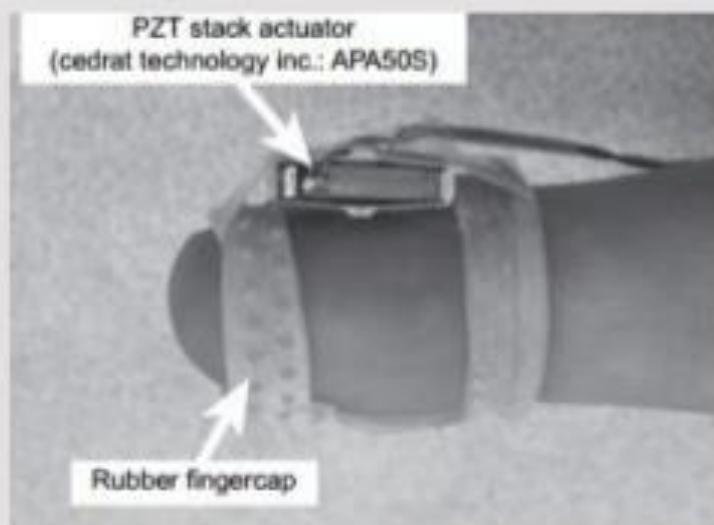


Graph: Textile humidity sensor (upper left) and its calibration curve compared to a commercial humidity sensor

- ✓ Used in **wearable textiles**
- ✓ Considerable improvements required

# HAPTICS TO ENHANCE TOUCH EXPERIENCE

- ✓ Enables **virtual reality**
- ✓ Weight illusions based on fingertip deformation
- ✓ Sensorimotor enhancer improves **tactile sensitivity** in human fingertips

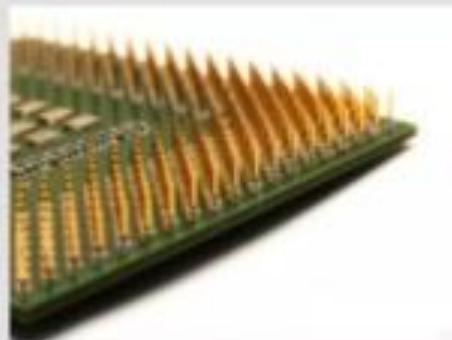


Graph: Desired and measured eccentricity

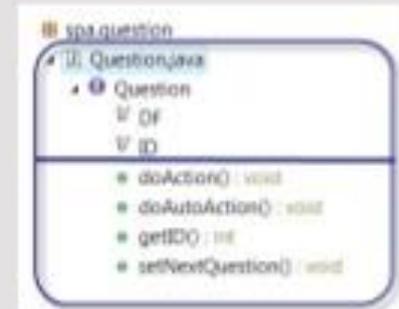
# DATA PROCESSING



## CPUs and Processors



# Data Processing



## Algorithms



# DATA PROCESSING

## Internal Processing

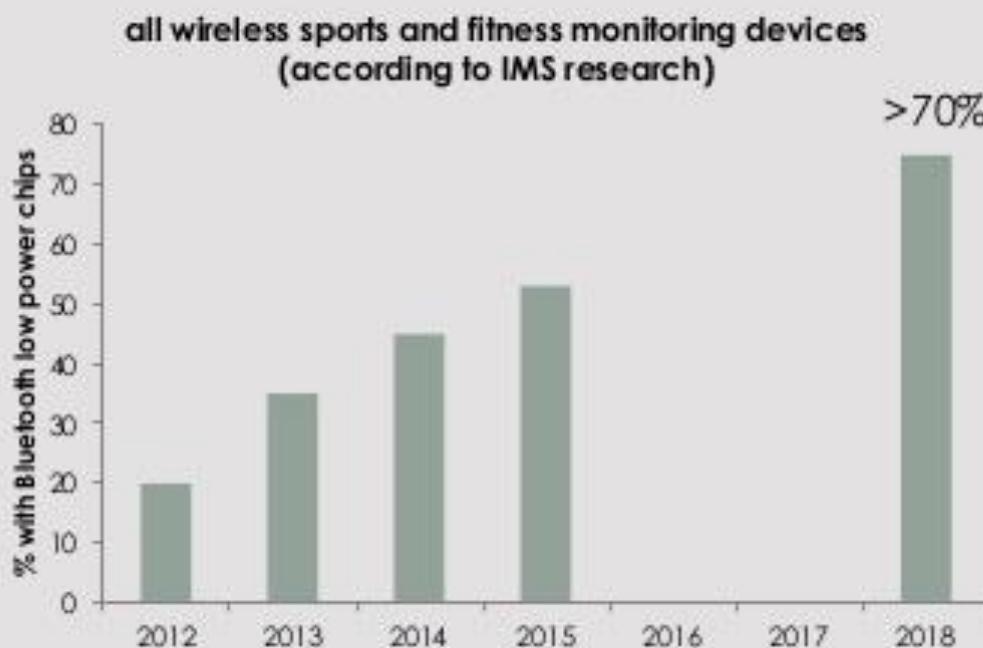
- ✓ Data is processed within the wearable
- ✓ Higher battery consumption
- ✓ Efficient algorithms required

## External Processing

- ✓ Data sent to another device or cloud
- ✓ Data processing on another device
- ✓ Could use higher computational capabilities

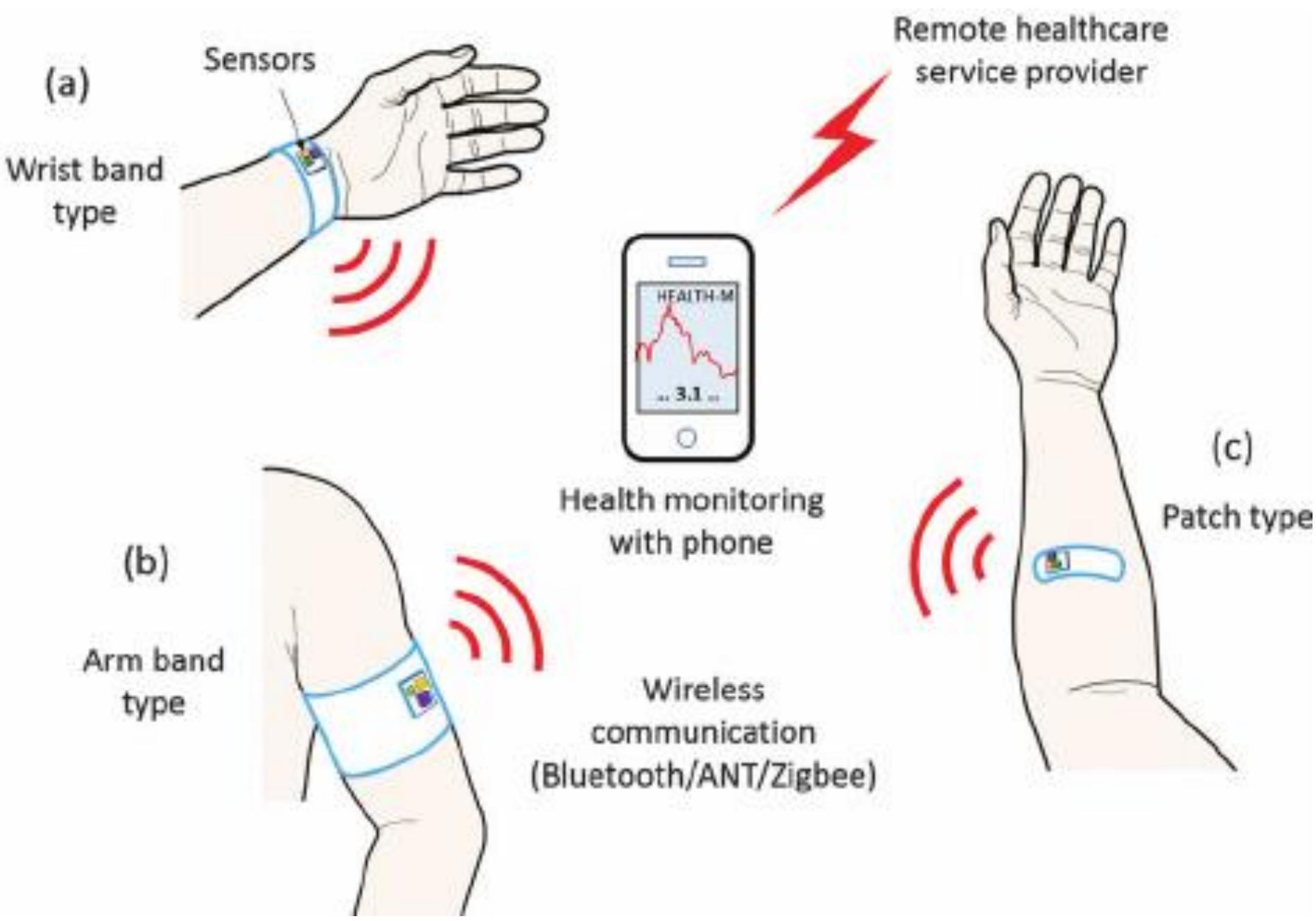
# CONNECTIVITY

Bluetooth v4.0 includes **Bluetooth low energy** marketed as “**Bluetooth smart**”



*Low Energy*

	Bluetooth V2.1	Bluetooth LE
Standardization Body	Bluetooth SIG	Bluetooth SIG
Range	~30 m (class 2)	~50 m
Frequency	2.4-2.5 GHz	2.4-2.5 GHz
Bit Rate	1-3 Mbit/s	>20 Mbit/s
Set-Up Time	>1 s	<0.002 s
VoIP Capable?	Yes	No
Max Output Power	+20 dBm	+10 dBm
Modulation Scheme	GFSK	GFSK
Moderation Index	0.25	0.5
Number of Channels	70	40
Channel Bandwidth	1 MHz	2 MHz



# INTERNAL VS. EXTERNAL PROCESSING

## Internal

- ✓ Devices with low computational requirements
- ✓ High performance to size ratio of processors
- ✓ Connectivity is poor
- ✓ Processing is essential to display results

## External

- ✓ Devices with higher computational requirements
- ✓ Existing processor capabilities are enough
- ✓ Connectivity is not a bottleneck
- ✓ Internal processing is not essential

Ex: Smart Watch

Ex: EEG devices

**HYBRID devices ?**

# DATA DISPLAY

## Internal Display

- ✓ Data displayed in the device or projected somewhere
- ✓ Flexible display and electronics desired
- ✓ Larger wearables



## External Display

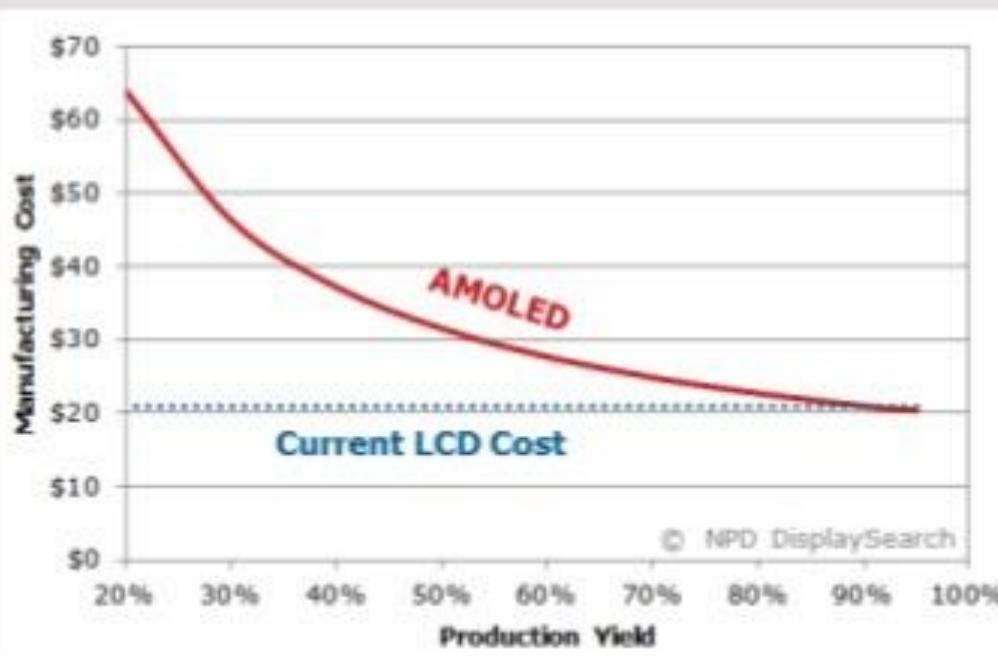
- ✓ Data displayed in another device (E.g. Phones, tabs)
- ✓ Existing display devices are sufficient
- ✓ Smaller wearables



# FLEXIBLE DISPLAYS



- ✓ Better materials need to be discovered
- ✓ Low stiffness, low thickness, better resolution are desired
- ✓ Production costs are falling



# FLEXIBLE ELECTRONICS

- ✓ Flexible electronics would be very important
- ✓ Strain vs. performance of transistor is an indicator

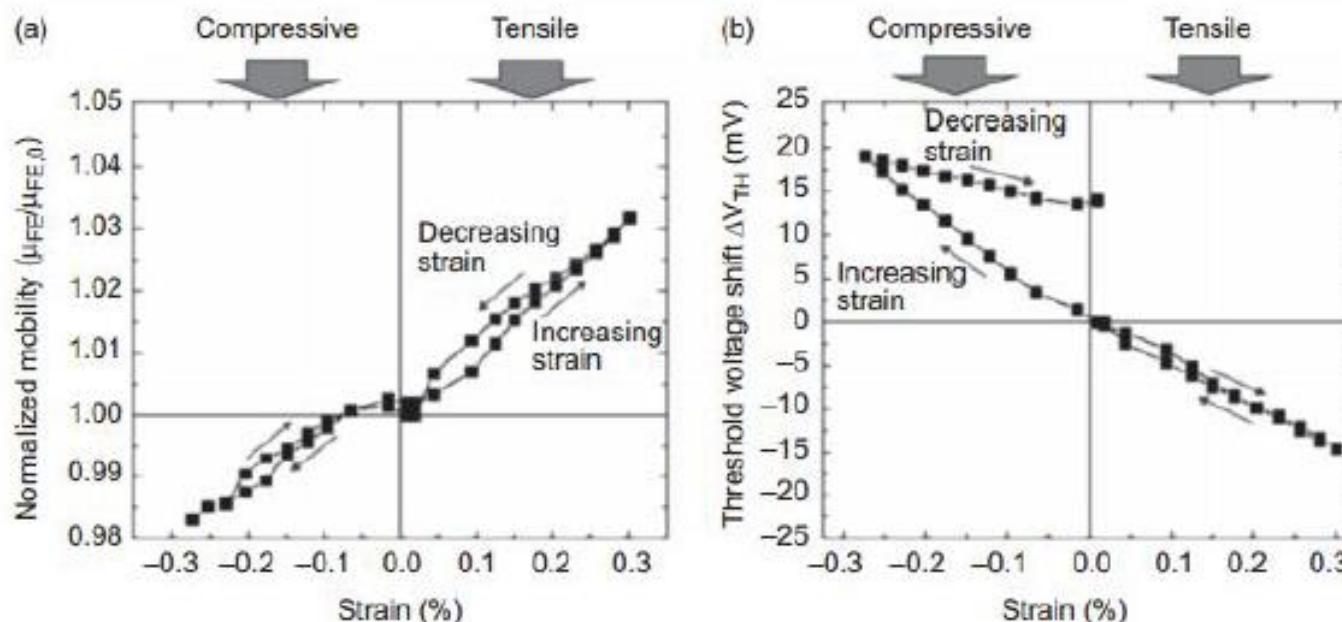


FIGURE 10 (a) Normalized effective mobility and (b) threshold voltage shift for increasing and subsequently decreasing strain. All values are extracted from the same experiment. The time interval between two consecutive measurement points is always 5 minutes.

# FITNESS TRACKING AND IMPROVEMENT

Hand-worn  
and body-  
worn

- Jawbone, Apple watch,  
Polo Tech Shirt



Tracking

- Personal physiological and biological parameters, activity and performance



Data  
collected

- **Heart rate, stress, obesity, sleep, calories, O<sub>2</sub> saturation, blood pressure**



Virtual  
coaching

- Apps



## **HEALTH CARE PROVIDERS USE MOBILE HEALTH TECHNOLOGY TO:**

- Access clinical information (e.g., through mobile health apps and mobile-enabled EHRs)
- Collaborate with care teams (e.g., with secure text messaging)
- Communicate with patients (e.g., through patient portals)
- Offer real-time monitoring of patients, and provide health care remotely, also called telemedicine.

## **PATIENTS USE MOBILE HEALTH TECHNOLOGY TO:**

- Track their own health data through mHealth apps and devices like the Fitbit®
- Access their clinical records through mobile-enabled patient portals
- Communicate with their providers (e.g., through HIPAA compliant e-mail and secure text messaging).

# MANAGEMENT OF HOSPITAL ORGANIZATION

## Collecting



- ✓ **Continuous tracking** of physiological data
- ✓ Hand, head & body-worn
- ✓ Sterility

## Processing

- ✓ Identify priority patients according to their needs
- ✓ Better diagnosis

## Display

basis

- ✓ **Efficient staffing** of nurses and doctors
- ✓ Avoid useless displacement of staff
- ✓ Efficient drug and equipment management
- ✓ Assisting doctors in **operating rooms**

## **•USES FOR MOBILE DEVICES AND APPS BY HEALTH CARE PROFESSIONALS**

### **•Information Management**

- Write notes
- Dictate notes
- Record audio
- Take photographs
- Organize information and images
- Use e-book reader
- Access cloud service

### **•Time Management**

- Schedule appointments
- Schedule meetings
- Record call schedule

### **•Communications and Consulting**

- Voice calling
- Video calling
- Texting
- E-mail
- Multimedia messaging
- Video conferencing
- Social networking

### **•Reference and Information Gathering**

- Medical textbooks
- Medical journals
- Medical literature
- Literature search portals
- Drug reference guides
- Medical news

- Clinical Decision-Making**

- Clinical decision support systems
- Clinical treatment guidelines
- Disease diagnosis aids
- Differential diagnosis aids
- Medical calculators
- Laboratory test ordering
- Laboratory test interpretation
- Medical exams

- Patient Monitoring**

- Monitor patient health
- Monitor patient location
- Monitor patient rehabilitation
- Collect clinical data
- Monitor heart function

- Medical Education and Training**

- Continuing medical education
- Knowledge assessment tests
- Board exam preparation
- Case studies
- E-learning and teaching
- Surgical simulation
- Skill assessment tests

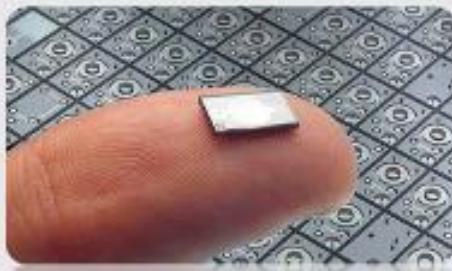
# PERSONAL DRUG DOSAGE TRACKING

## Wearable drug reminding devices

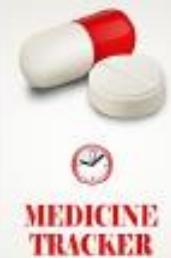
- ✓ Haptic, visual or sound drug reminder
- ✓ **Drug taking devices** for the elderly

## Wearable tracking and healing devices

- ✓ **Insulin monitoring** – direct injection by the wearable
- ✓ Baby care – fever, pain, antibiotics...



Insulin Nano-pump  
with MEMS



Apps to remind you  
when to take your pills



Sproutling wearable  
baby monitor

# INTERCONNECTION OF WEARABLES

Computers, smartphones,  
tablets and the Cloud



Apps

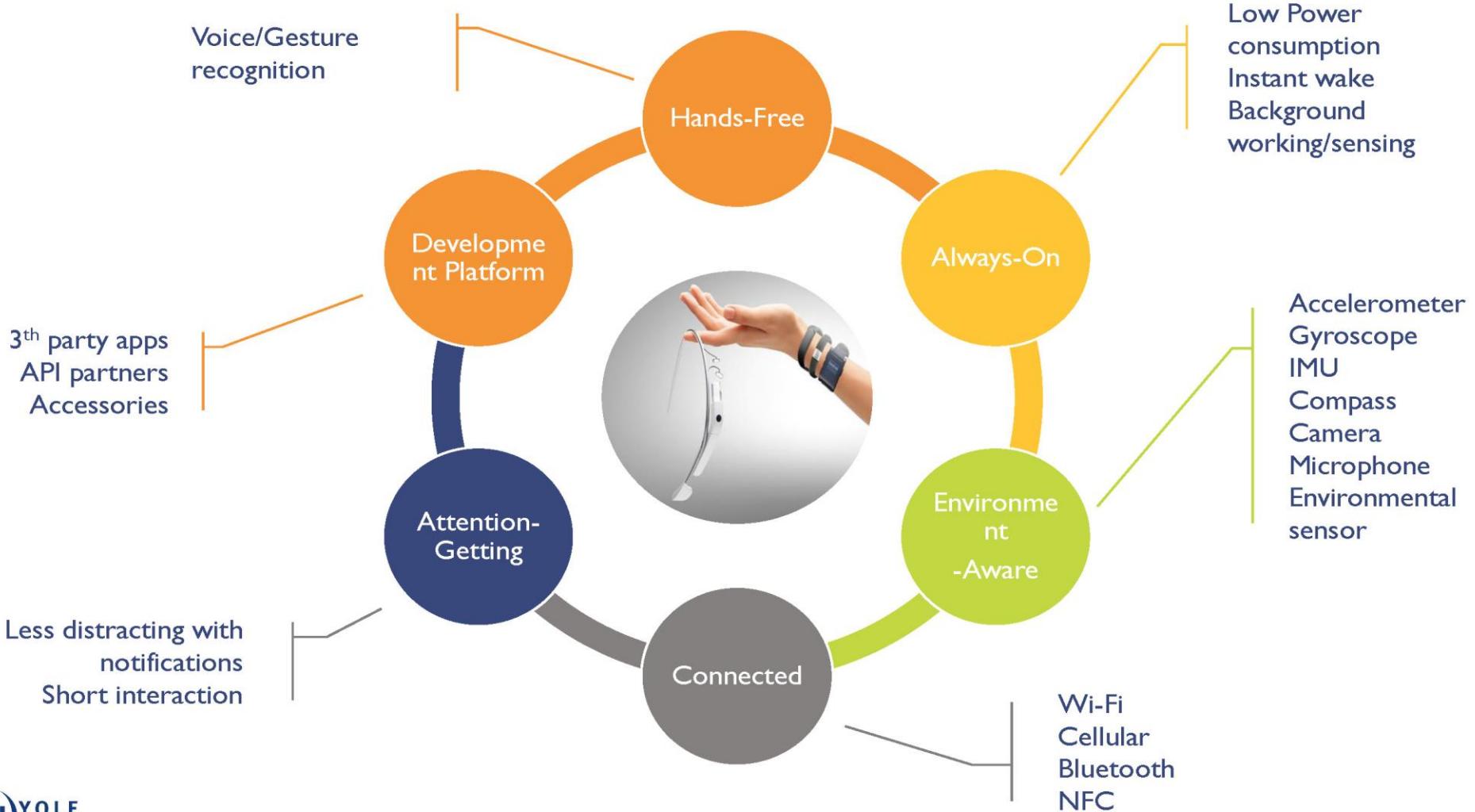


Wearables

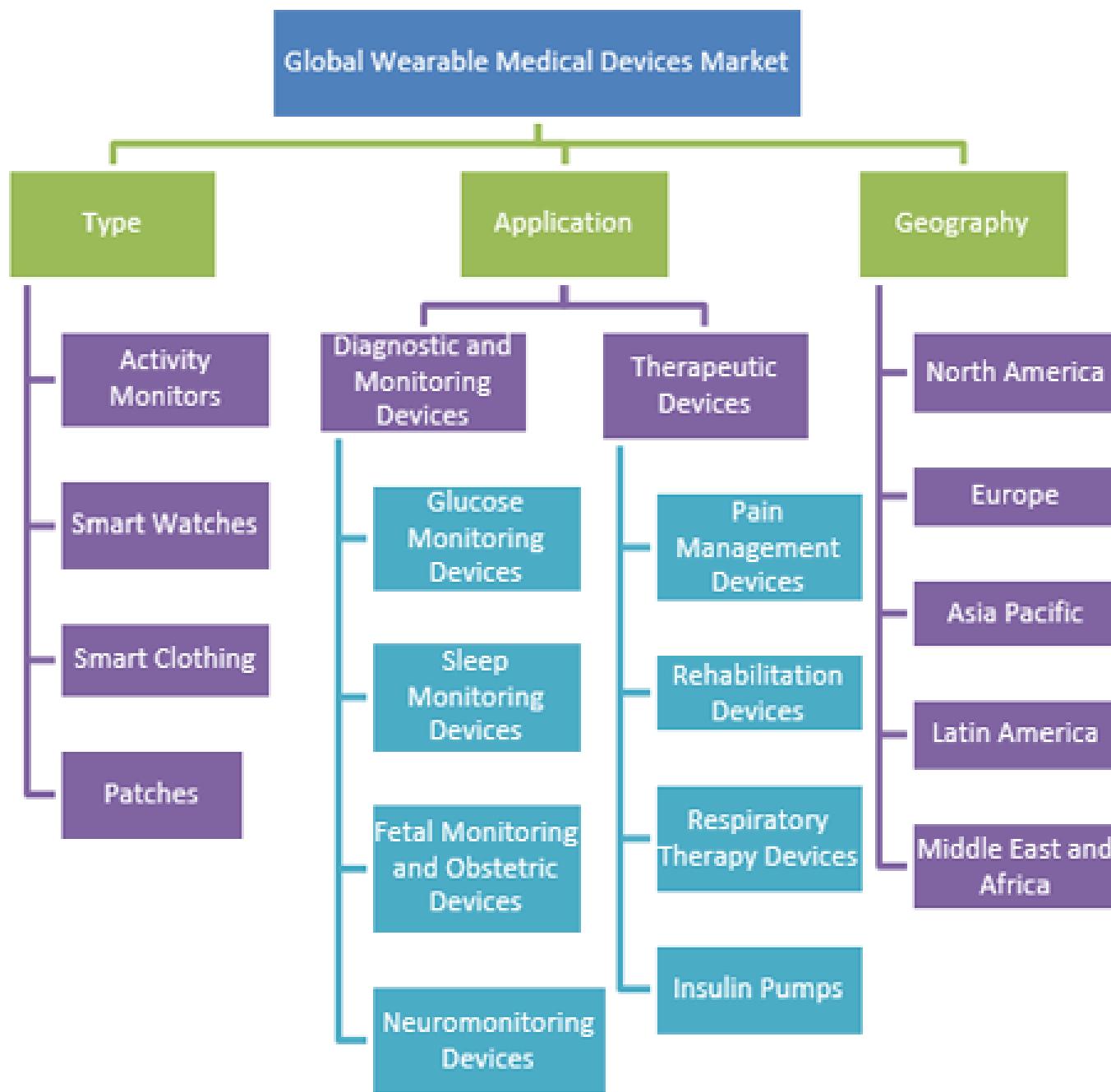


# KEY ATTRIBUTES OF WEARABLE TECH PRODUCTS

(Source: Sensors for Wearable Electronics & Mobile Healthcare report, Jul. 2015, Yole Développement)



# Global Wearable Medical Devices Market Segmentation



# BENEFITS OF WEARABLE TECHNOLOGY

Educate and empower patients to take control of their health

Help physicians & patients monitor & diagnose disease

Assist in medical procedures



Allow patients to control & manage their pain

Make personal fitness more fun

## COMMUNICATION – NEW GENERATION MEDICAL DEVICES

Multi-functional, Adaptable, Portable, Self-documenting,  
Self-managing & Intelligent

Multi-function, Adaptable, Portable, Self-documenting

Devices will communicate information

(to: Physician, Case manager, Benefit manager, etc.)

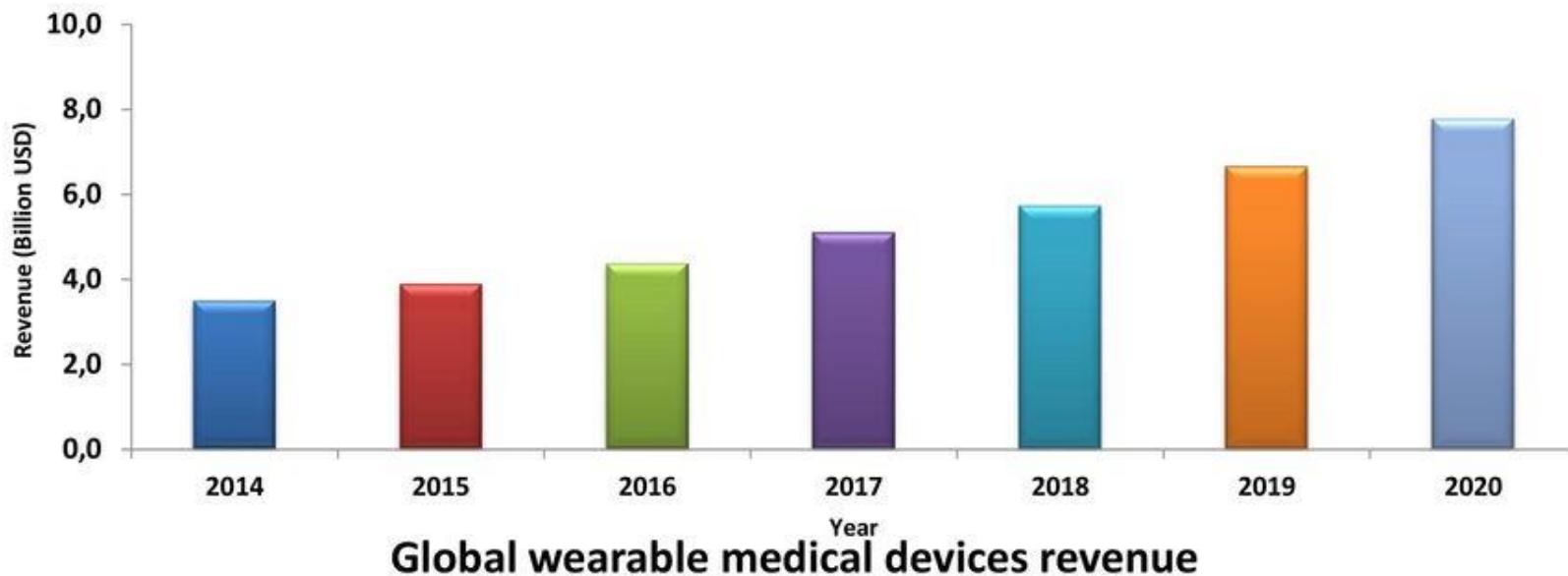
Anytime

Anyone

Anywhere

# Market Overview

- Globally, medical wearable devices market was worth more than USD 3.5 billion in revenue in 2014 and is expected to cross USD 7.8 billion in 2020, growing at a healthy CAGR of over 15%. ➤ (CAGR – COMPOUND ANNUAL GROWTH RATE)

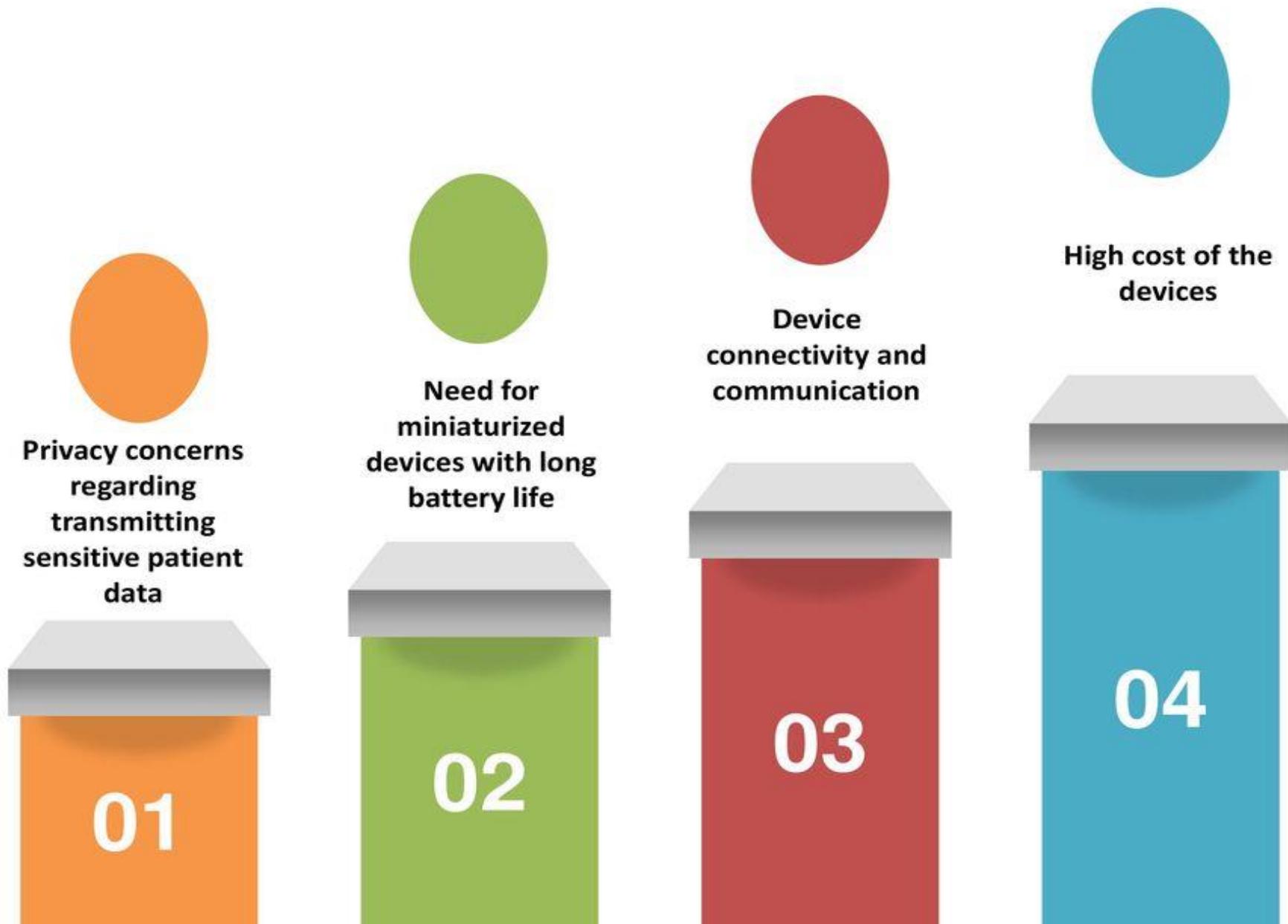


- This growth of the wearable technology market is expected to be driven by consumer preference for sophisticated gadgets, increasing growth prospects of next-generation displays in wearable devices, and growing popularity of Internet of Things (IoT) and connected devices.

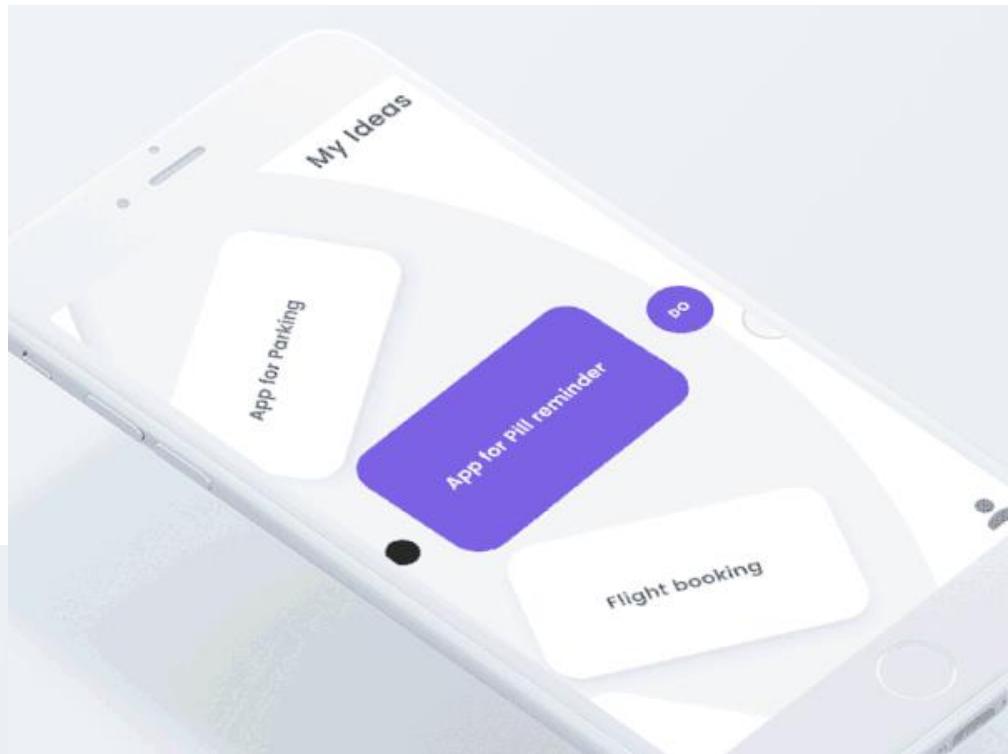
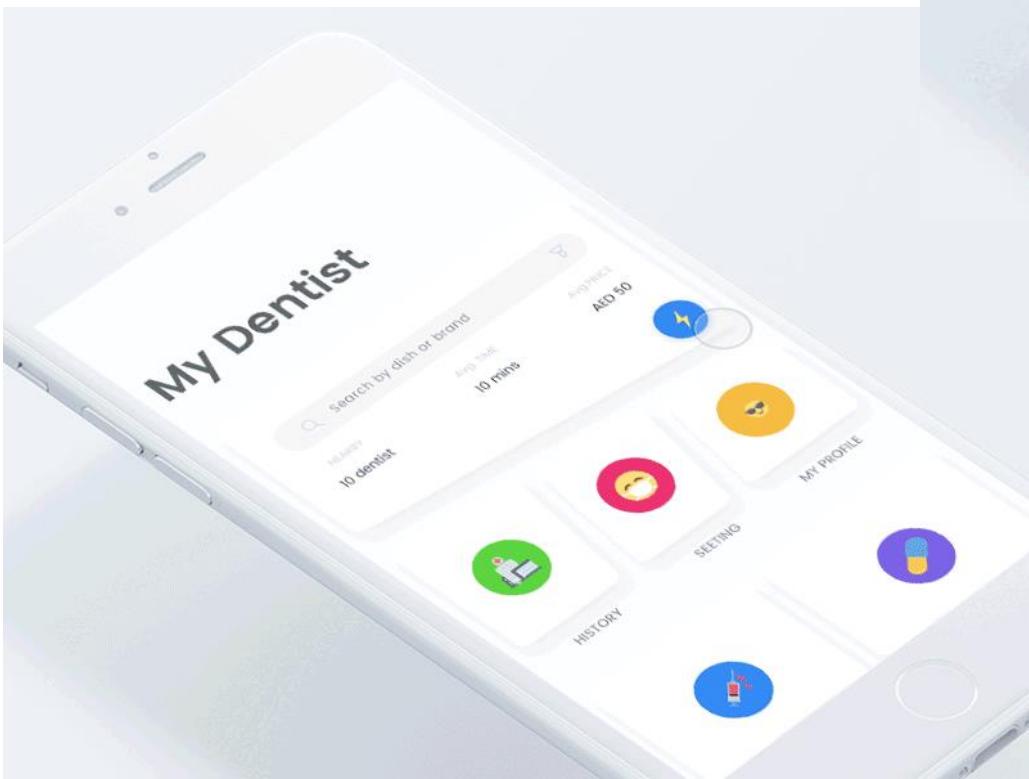
# Major factors driving growth of wearable health monitoring devices market

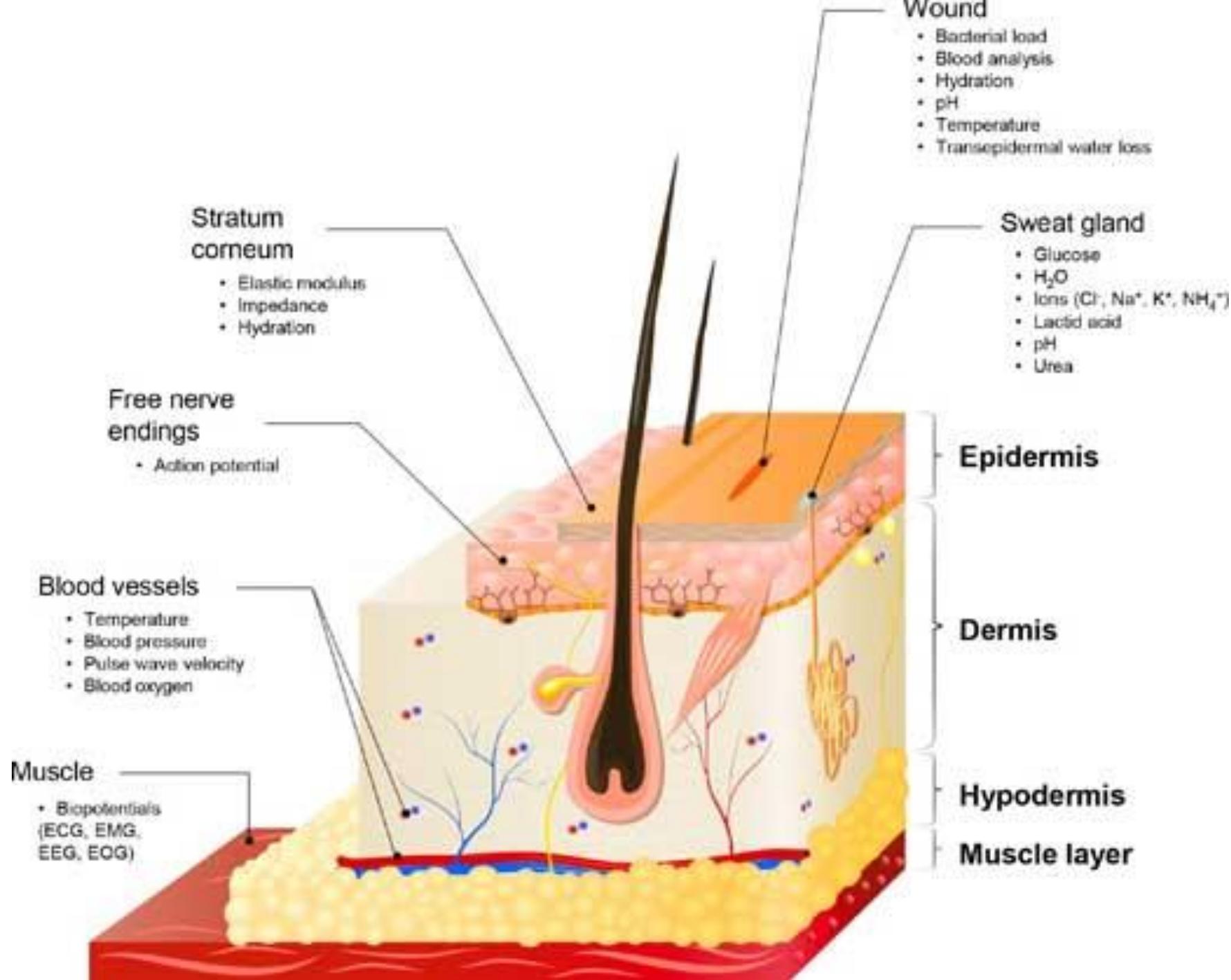


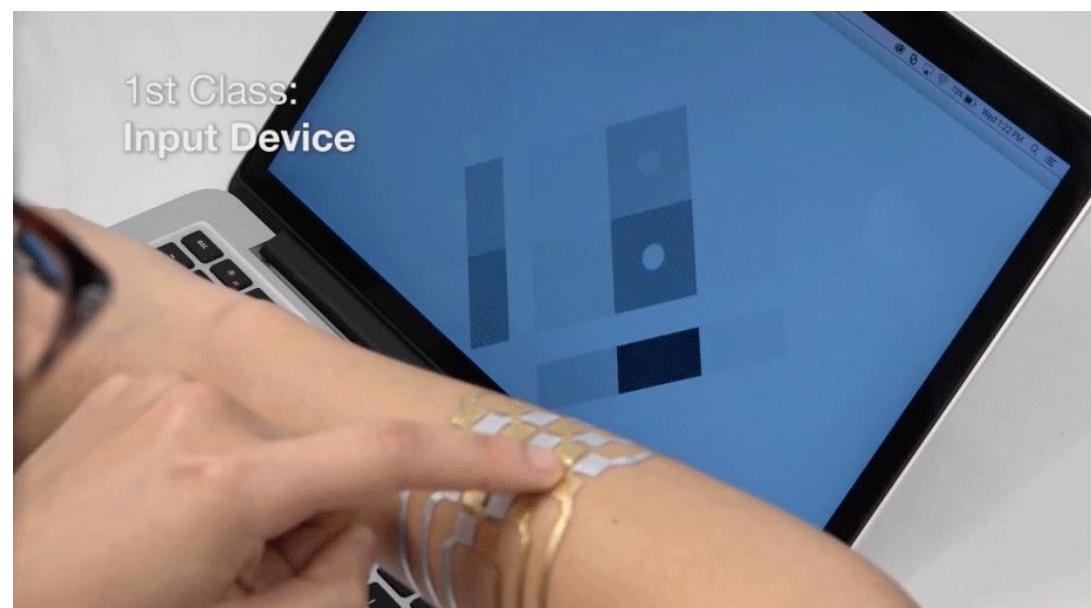
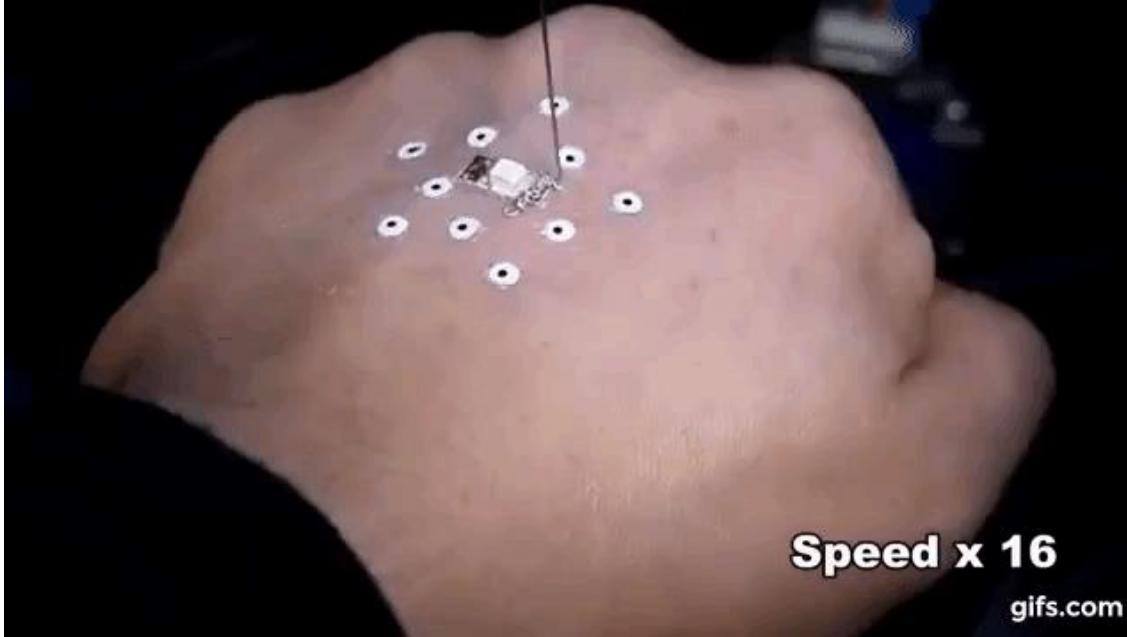
# Challenges in wearable health monitoring device market



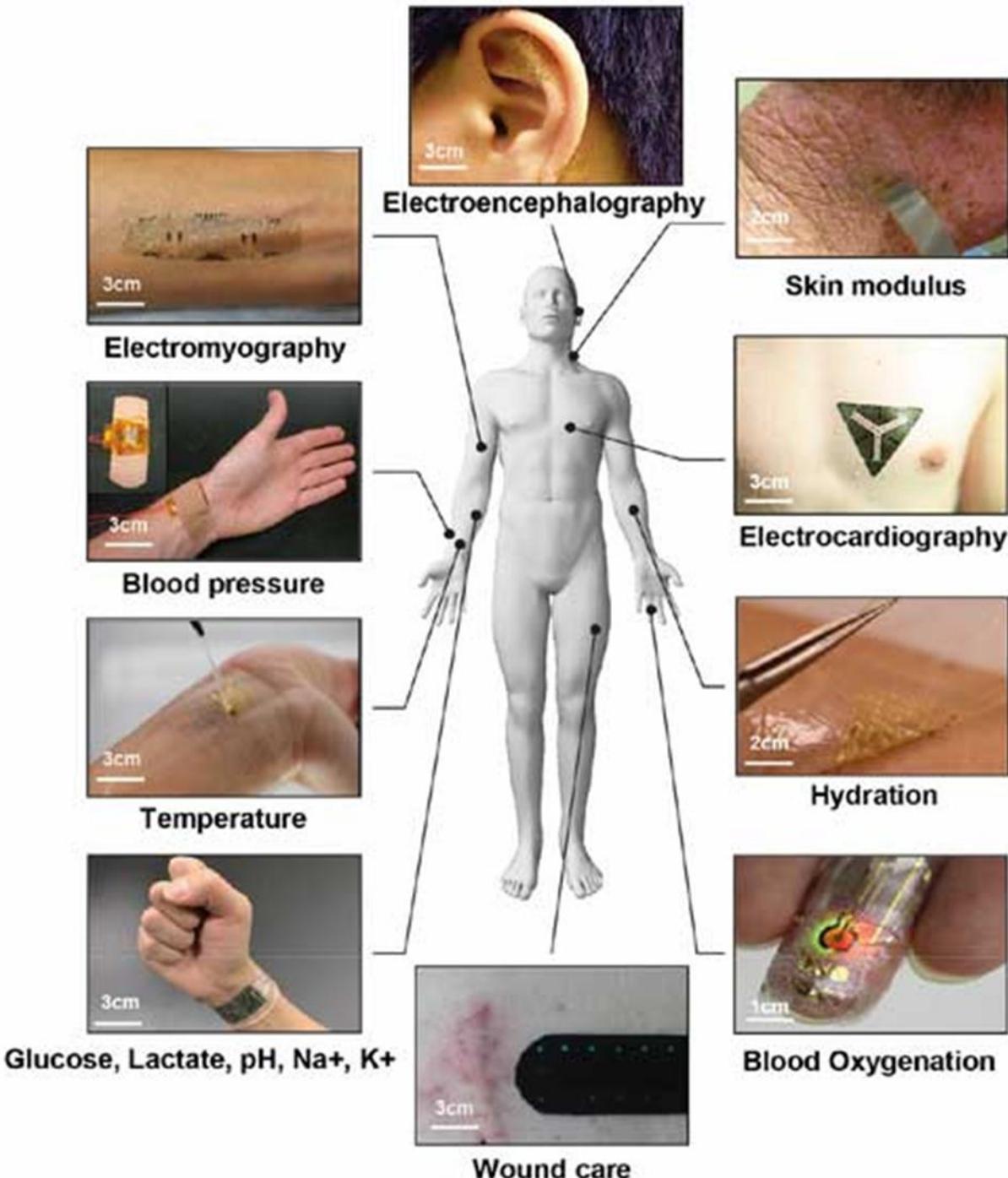
# NEW APPLICATIONS FOR MOBILE HEALTHCARE DEVICES







# NEW KINDS OF ELECTRONIC TATTOOS AND CIRCUITS THAT CAN BE PUT ON THE SKIN WHERE REMOTE MONITORING IS NEEDED





## DEVICES FOR HELPING TO REDUCE BACK PAIN

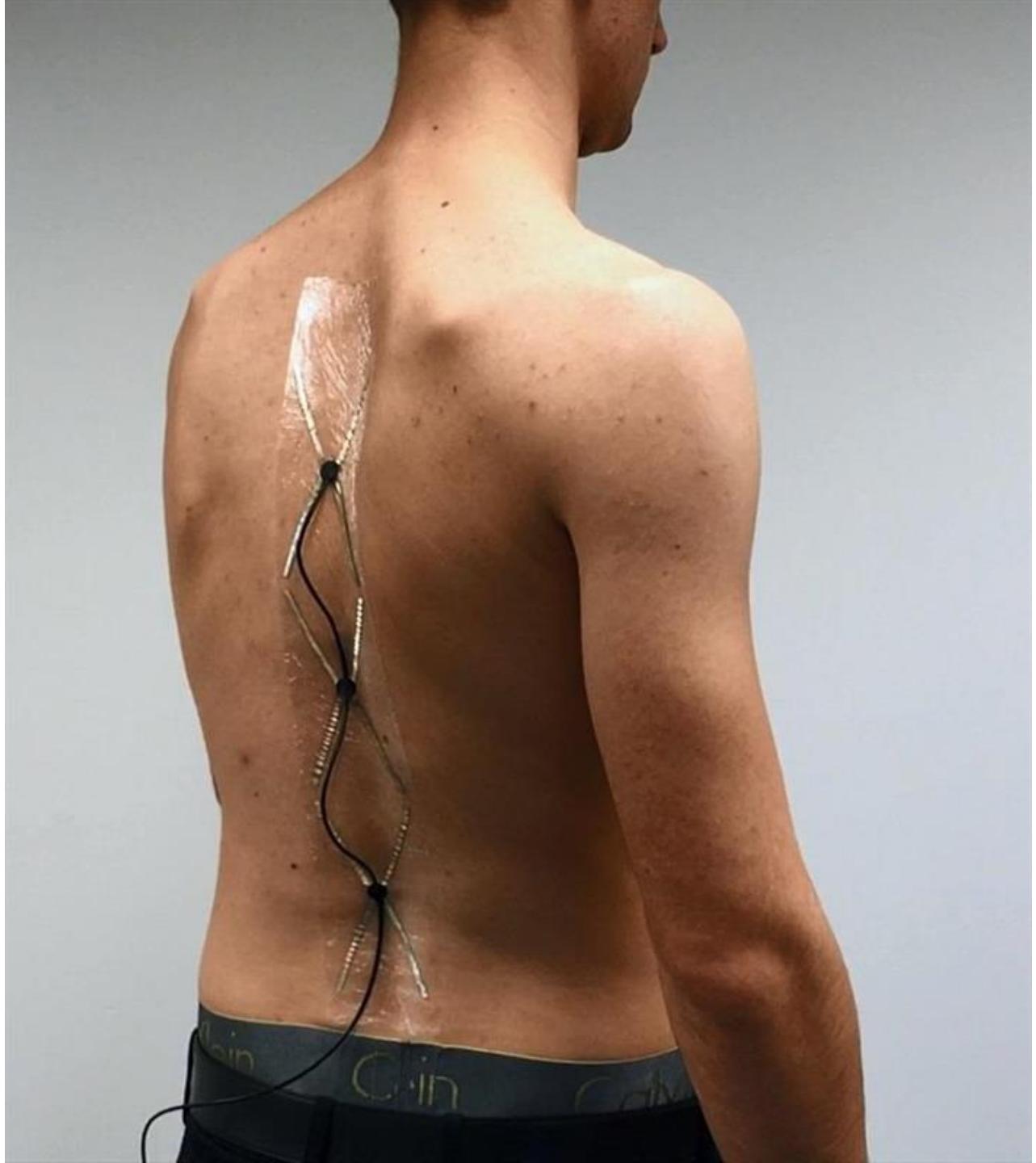
For example, the Valedo wearable is meant for those with lower back pain.

Sensors adhere to the lower back and then transmit data through the app.

The app and interface then gives exercises and instructions to the wearer of how to treat their back pain.



Bainisha's ultra thin skin patches allows back motion to be measured with high accuracy.



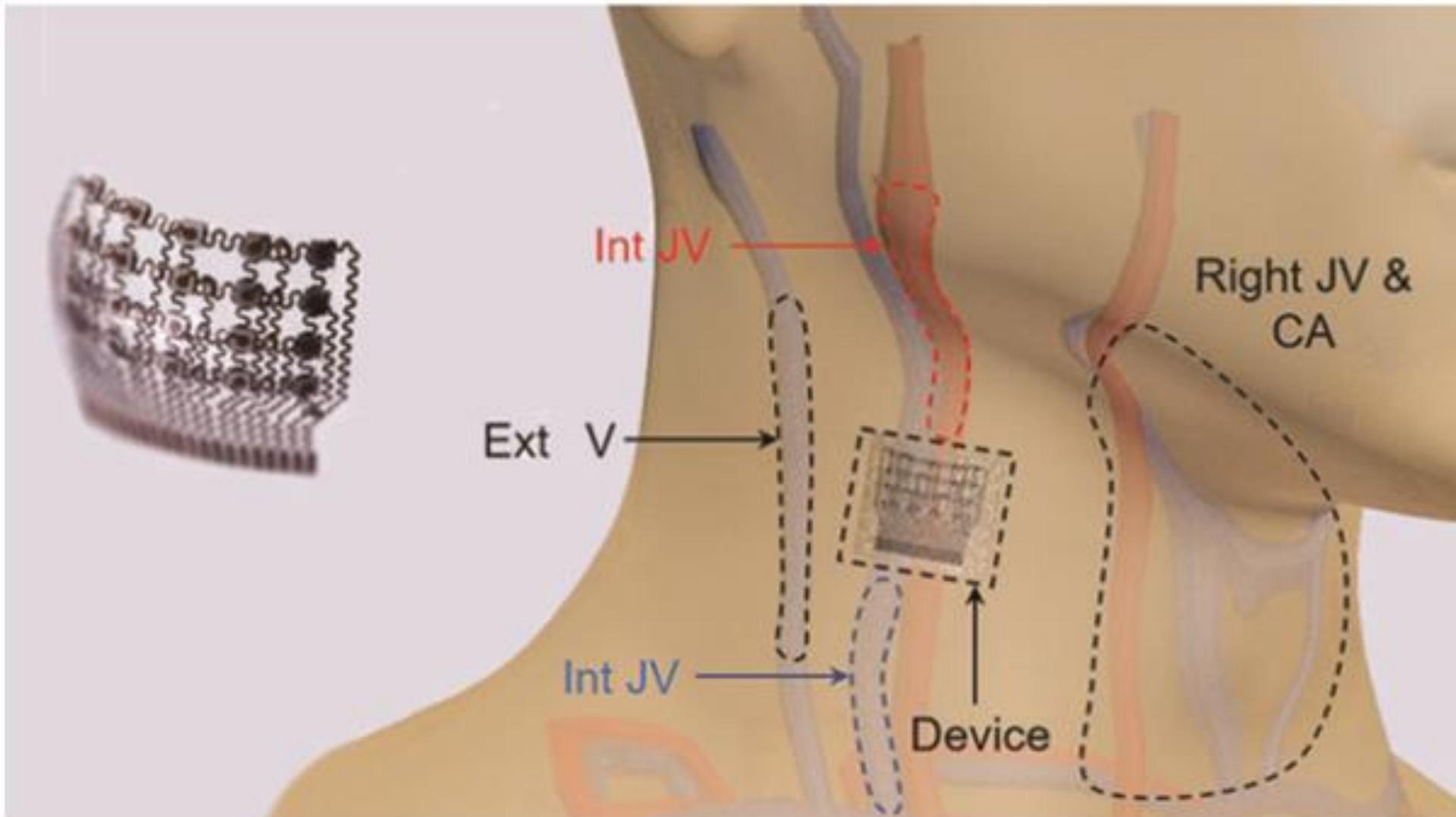
**REDUCING CHRONIC PAIN** – Another orthopedic wearable (**Quell Relief**) comes in the form of a knee brace which offers all the support and functionality of a knee brace while using sensors/electrodes to transmit information and deliver pain medication.

- **Quell** is always worn on the upper calf and stimulates sensory nerves
- It taps into your body's natural pain relief response
- Sensory nerves carry neural pulses to your brain
- Neural pulses trigger a natural response that blocks pain signals, leading to widespread pain relief
- The app works on both iOS (I-phone) and Android devices
- You can control therapy from your smartphone.
- Start and stop therapy sessions as well as adjust the intensity of therapy.
- View detailed therapy and on 8 aspects of your sleep.

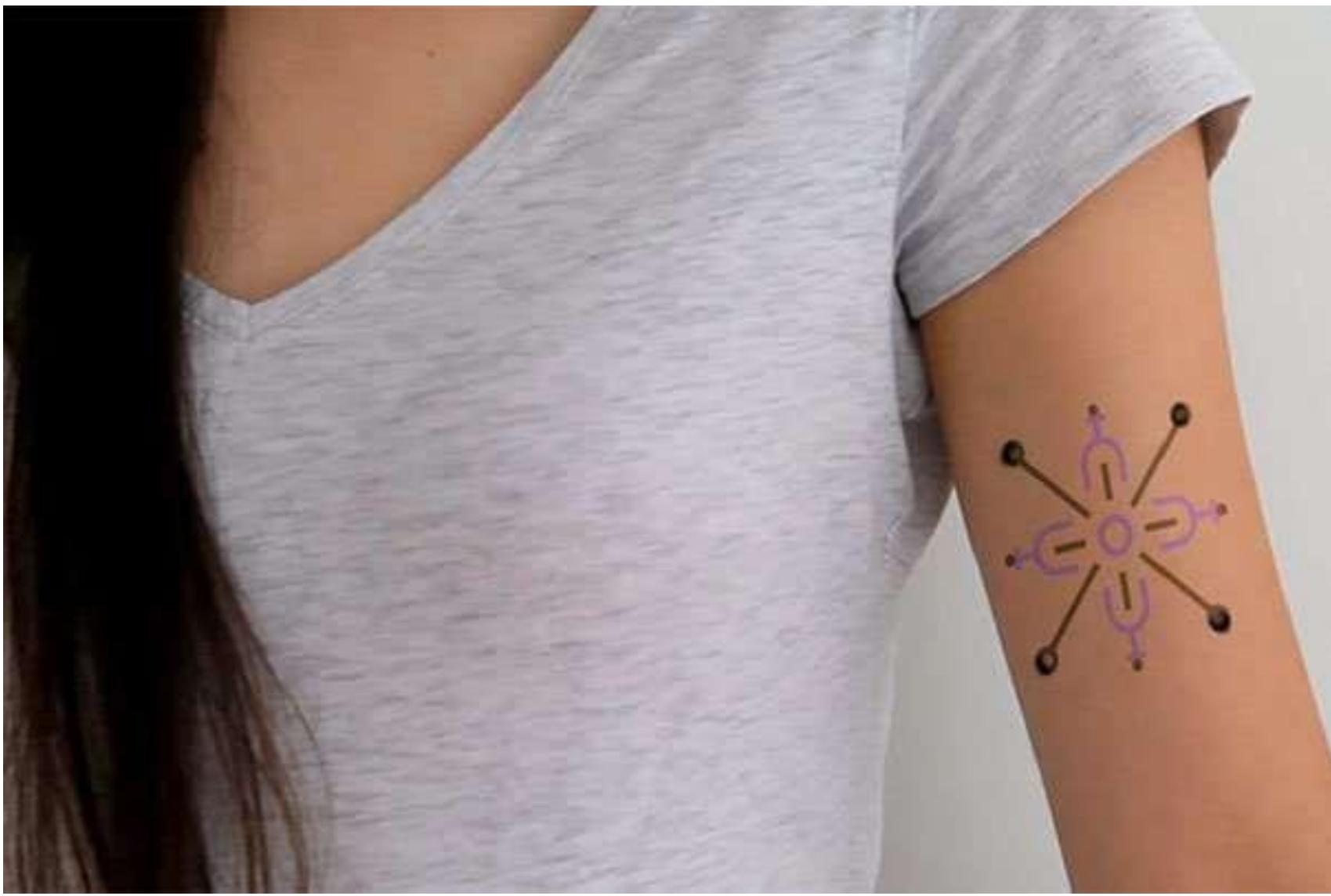


<https://www.youtube.com/watch?v=UGMTLyR74bw>

# WEARABLE ULTRASOUND PATCH MONITORS BLOOD PRESSURE



**Researchers have developed smart bio-sensitive tattoo ink capable of monitoring health by changing color to tell an athlete if she/he is dehydrated or a diabetic if his blood sugar rises.**



# **World's First Non-invasive Continuous Blood Glucose Monitoring Wearable**

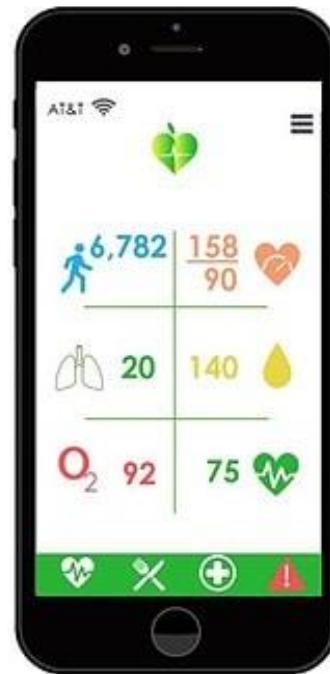
The patent-pending multi-sensor device, called LifeLeaf, non-invasively and continuously monitors:

Heart rate

Blood pressure

Respiration rate

Oxygen saturation.



It monitors and tracks chronic health risks such as:

Diabetes

Cardiac arrhythmia

Congestive heart failure

COPD

Sleep apnoea and hypertension.

# GLUCOSE MONITORS



SYMAX<sup>®</sup>  
DIABETES CARE

sugarwatch<sup>®</sup>

World 1st Wearable Device That Measures  
Glucose With Electrochemistry Technology

Water Proof IPX8 - Unique Power  
Saving Up To 500 Testing Times -  
Specialized Temperature Calibration -  
Handy To-Go Set

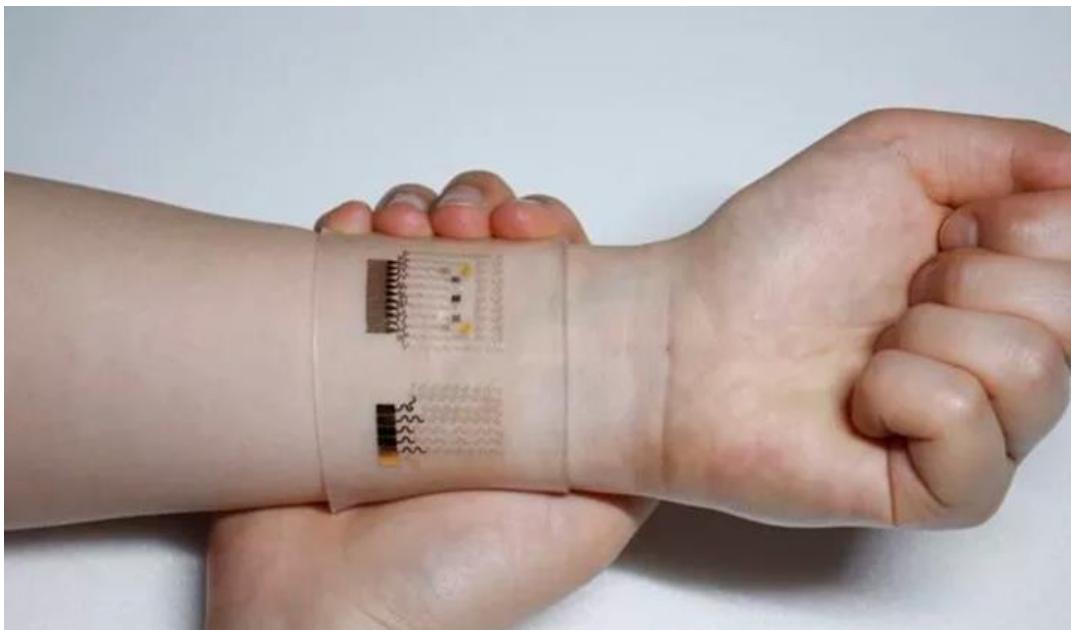
~ Living Healthy With Diabetes ~

EPS  
EO TECHNOLOGY CO.



MEDICA  
Hall 3  
Booth 3250

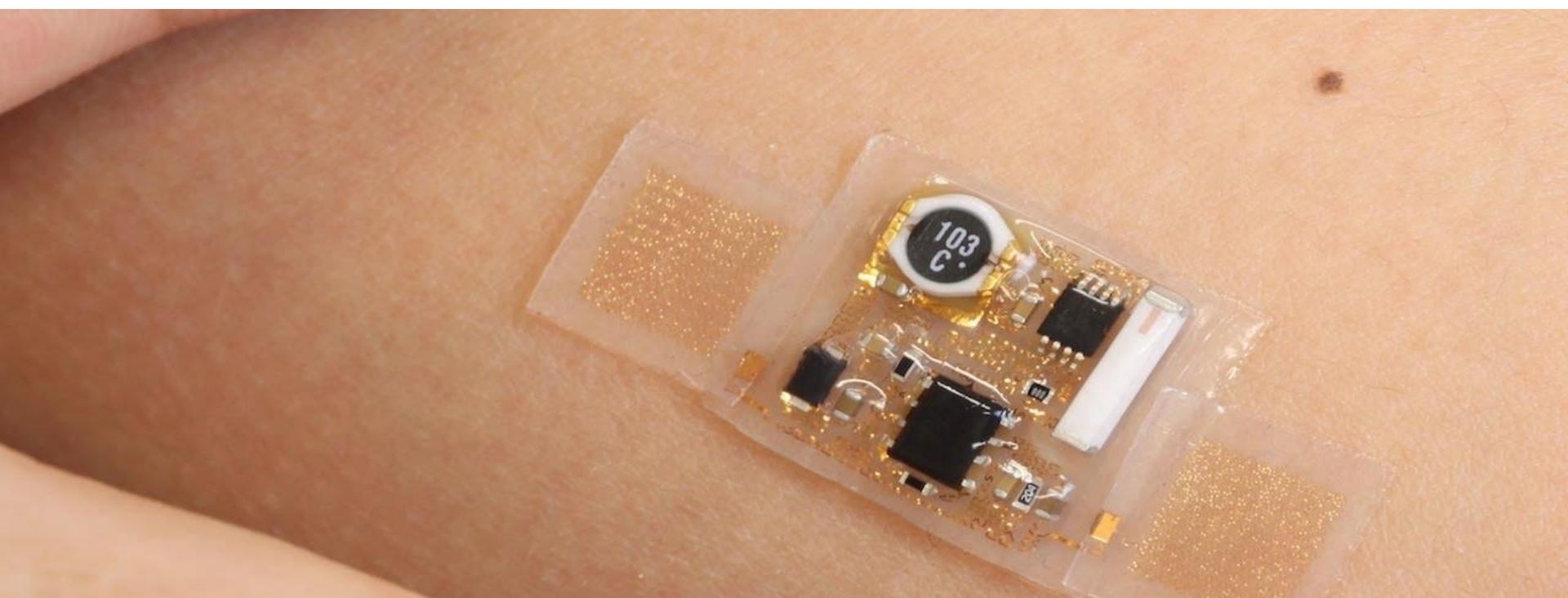
**2 Types of Wearable Patches, Use Sweat To Monitor Blood Glucose Levels and can automatically deliver medication with microneedles**



# EPIDERMAL ELECTRONICS: WEARABLE HEART MONITOR WITH SPEECH RECOGNITION

There have been many developments of skin-mounted electronics that **integrate electrophysiological sensors such as electrocardiogram (ECG) and EMG sensors, temperature sensors, strain sensors, and many others.**

This device **can pick up mechanical waves that spread through tissues and fluids in the human body that reveal acoustical characteristic signatures, which helps diagnose cardiovascular diseases.** For instance, it **can recognize and record the opening and closing of heart valves, vibrations of the vocal cords, the contraction of skeletal muscles, and movement in the gastrointestinal tract.**



# Hidrate Spark 2.0 Smart Water Bottle - Tracks your Water Intake & Glows to Remind You to Stay Hydrated

**Tracks water intakes and syncs with smartphones (iOS and Android) via Bluetooth.**

**Integrates with Fitbit, Apple Watch, and other activity trackers to adjust your daily water goal to your activity level.**





# APPS OR APPLICATIONS FOR HEALTHCARE WEARABLES



## **TYPES OF BODY AND OTHER MEASUREMENTS**

- ❖ **Barometric altimeter**
- ❖ **Blood Oxygen Level**
- ❖ **Blood Pressure**
- ❖ **Brain Activity – Electro-encephalogram – EEG)**
- ❖ **Cholesterol monitoring with an optical bio-sensor**
- ❖ **Eye Tracking**
- ❖ **Glucose Measurement**
- ❖ **Heart Tracking – Electro-cardiogram – ECG)**
- ❖ **Hydration**
- ❖ **Ingestion (Swallowing a test capsule)**
- ❖ **Location – Global Positioning Satellite – GPS)**
- ❖ **Movement - Accelerometer**
- ❖ **Muscle Activity – (Electro-myography - EMG)**
- ❖ **Posture**
- ❖ **Pulse**
- ❖ **Respiration (Breathing)**
- ❖ **Skin Conduction (amount of sweating)**
- ❖ **Sleep quality**
- ❖ **Temperature**

# Different Kind Of Sensors Available On A Smartphone

Barometer



Thermometer



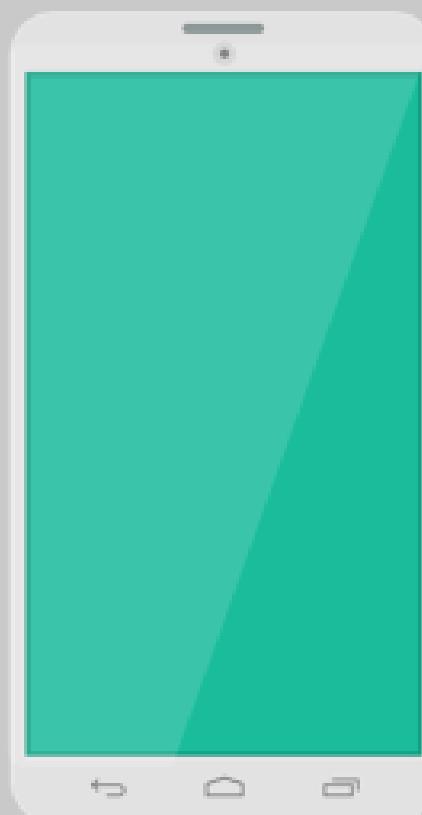
Pedometer



Heart Rate Monitor



Fingerprint Sensor



Accelerometer



Gyroscope



Magnetometer



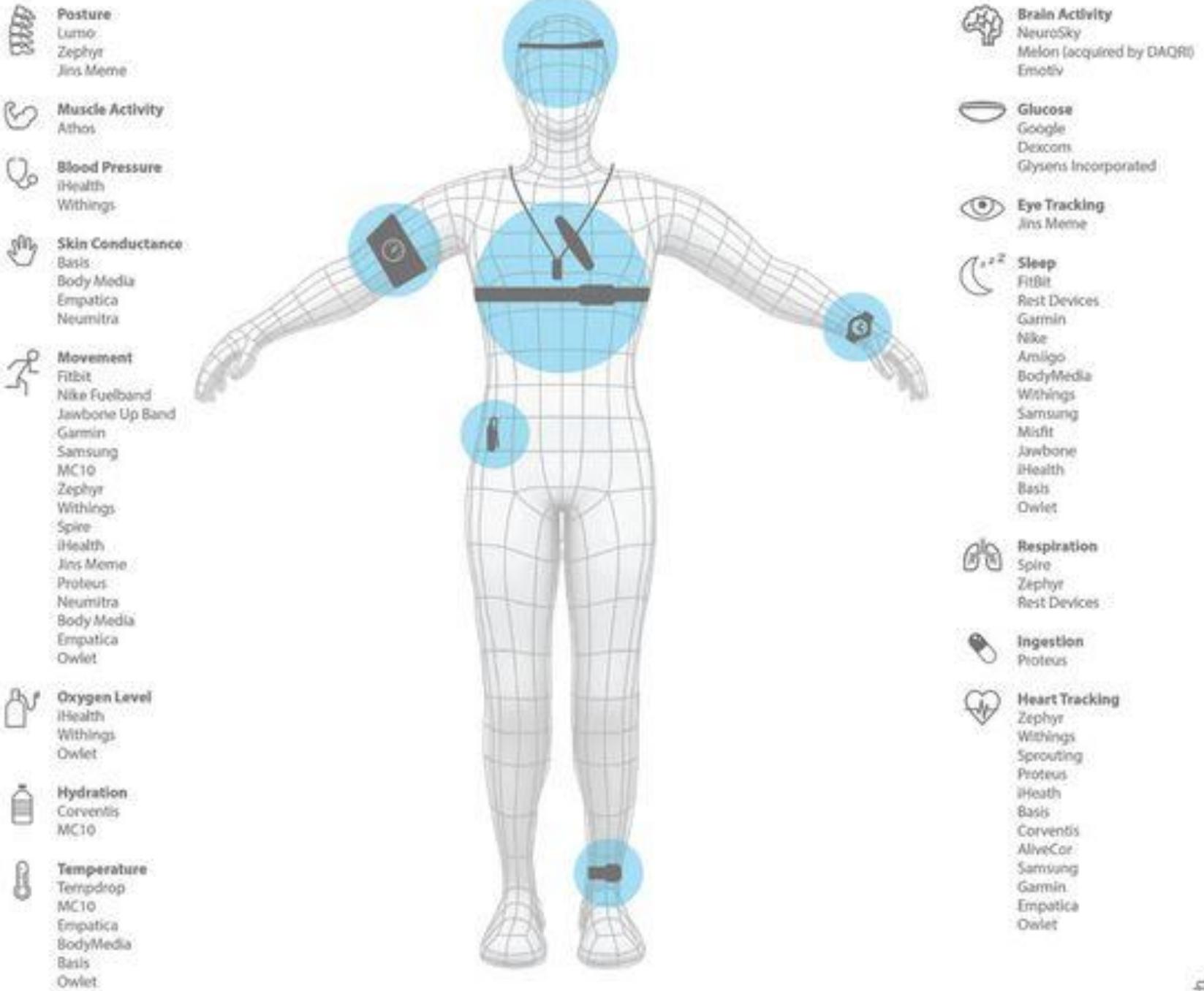
Proximity Sensor

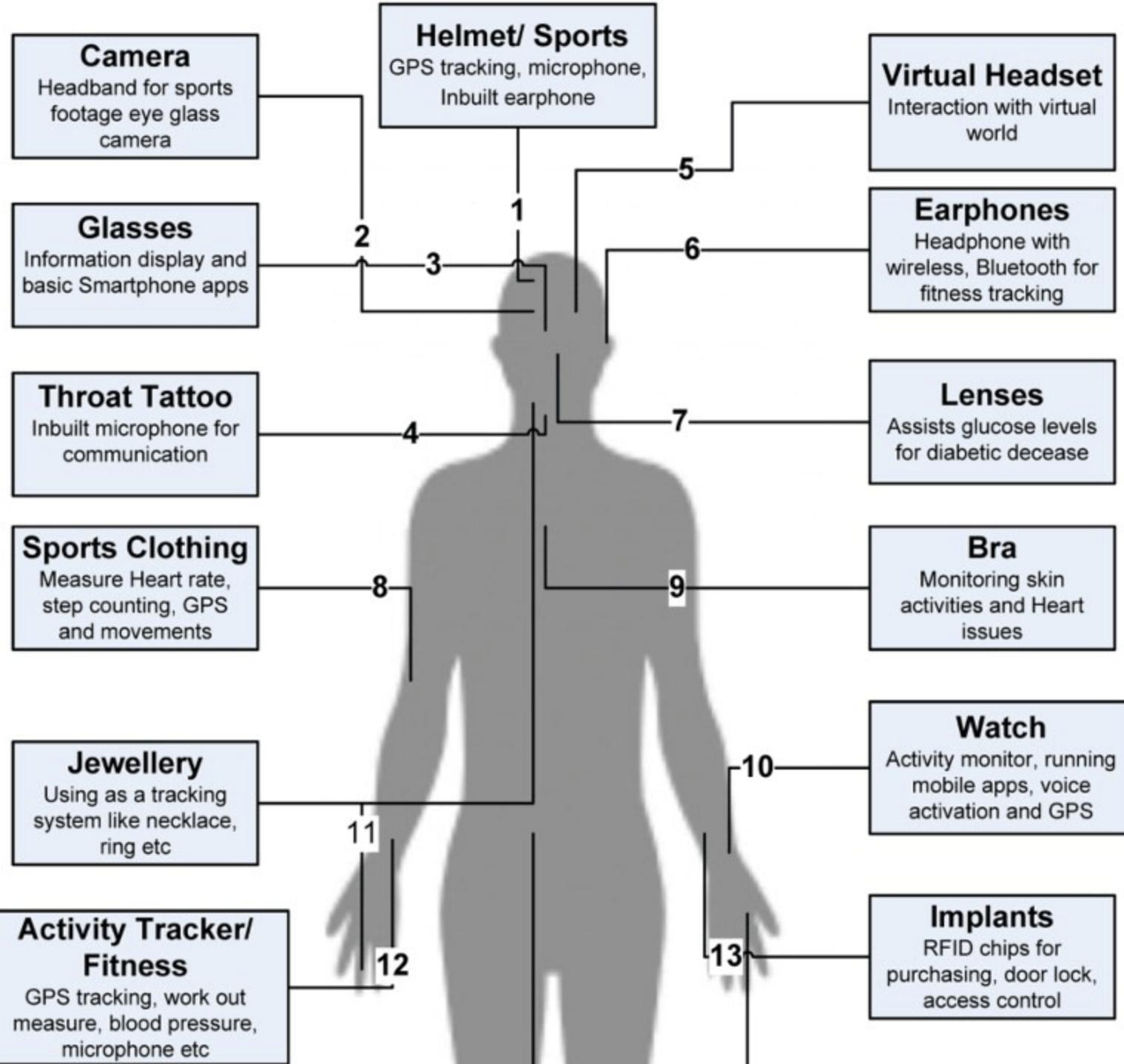


Light Sensor



Microphone





The proliferation of mobile technologies that can measure and gather a variety of data has increased public interest in using consumer electronics to take ownership of their personal health and wellness.

### **Apps, wearables, and sensors can:**

- Efficiently gauge physiological and emotional states
- Collect, quantify, and monitor data regarding a user's day-to-day behaviors
- Provide timely and patient-centered care to those living at a distance with chronic disease
- Send patient information over the Internet, to a Doctor or other Medical Professional
- Used to coordinate care when multiple providers are involved, reducing costs to the health care system.

## **CONCERNS TO BE EVALUATED:**

In all cases, merely tracking data is not enough to maintain health behaviors long-term.

The software must incorporate motivational methods important for the adoption and habituation of health-related behaviors.

Further research is needed to validate their use and long-term impact, such as:

- Physiological harm
- Breaching of privacy and confidentiality with insecure devices
- How to resolve and minimize any risks.
- Have physicians try devices and study the evidence to support the use of the Technology

# EXAMPLES OF WEARABLES

Designed for leading devices



Pebble



Samsung Gear



Google Glass



Moto360



Myo



Nymi



Epson Glass



Jawbone UP



Vuzix m100



Meta



Oculus





# THE APPLE SMART WATCH

The Apple Watch Series 4 (right) completely redesigns the health sensor array on the bottom of the watch to incorporate an ECG (Electro-cardio-gram) (or EKG) electrode and new optical heart rate sensor.

By adding this feature, the Apple Watch has gone from a smart fitness tracker to a potentially life-saving medical device that will be able to warn wearers of abnormal heart rhythms associated with atrial fibrillation (Afib) and other serious medical conditions.

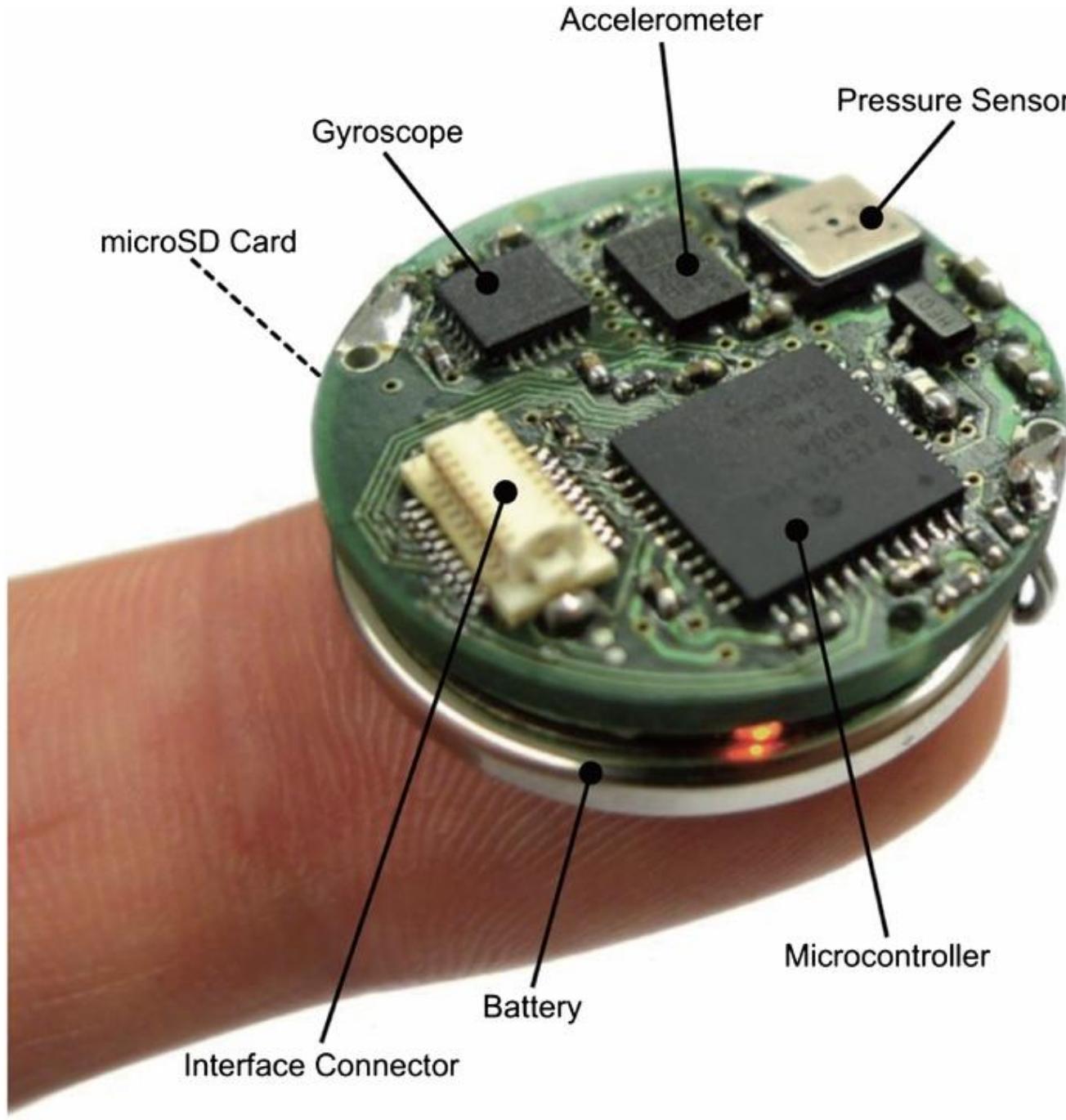


# WHAT ARE THE SENSORS ON BACK OF THE APPLE WATCH?

Its sensor, which rests in the circular back of the watch, is a tag-team effort comprised of **infrared light** blasters and green LEDs.

They work together to employ a tried and true (but difficult to pronounce) technique called photo-plethysmography to give users an accurate **heart rate** reading.





[https://www.youtube.com/watch?v=uCT4laFK\\_jM](https://www.youtube.com/watch?v=uCT4laFK_jM)

## WHAT CAN AN APPLE WATCH DO?

An Apple Watch is a smartwatch that works in conjunction with your iPhone and other Apple devices to perform a variety of functions.

- You can make calls and send text messages.
- **You can use all types of apps including Health and Medical types.**  
Apple Watches support a variety of apps just like an iPhone, including those for photos, music, maps, and a calendar.
- You can consult with Siri.
- An Apple Watch can unlock some newer Mac model computers, so you don't need to enter your password every time you start it up.
- You can listen to music.
- You can track your fitness goals.
- You can utilize Apple Pay.
- You can use it as a remote for an Apple TV and other home theater devices.
- You can monitor your car
- You can control smart home features.



SPO2 IS A  
BLOOD  
OXYGEN  
SATURATION  
SENSOR

## Apps

- Head-worn



- Straps



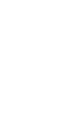
- Shirts



- Wrist-worn



- Clips



- Shoe-worn / Foot pods



# Forces Driving the Growth of Wearable Technology

## Cloud Storage

Internet of things, big data and Software-Defined Network (SDN)

Consumerization of enterprise IT  
Multiple devices ownership,  
Improvement of camera technologies

Cloud storage services – expected to exceed 2 billion by 2014

Reduced IT costs with Cloud Computing

## Location Data

Implicit location information,

Internet traffic information

Device based location service (GPS)

iOS, Android, Blackberry OS, Windows Mobile, Symbian S60

## Faster, smaller, Cheaper hardware

Getting 100 times smaller each decade

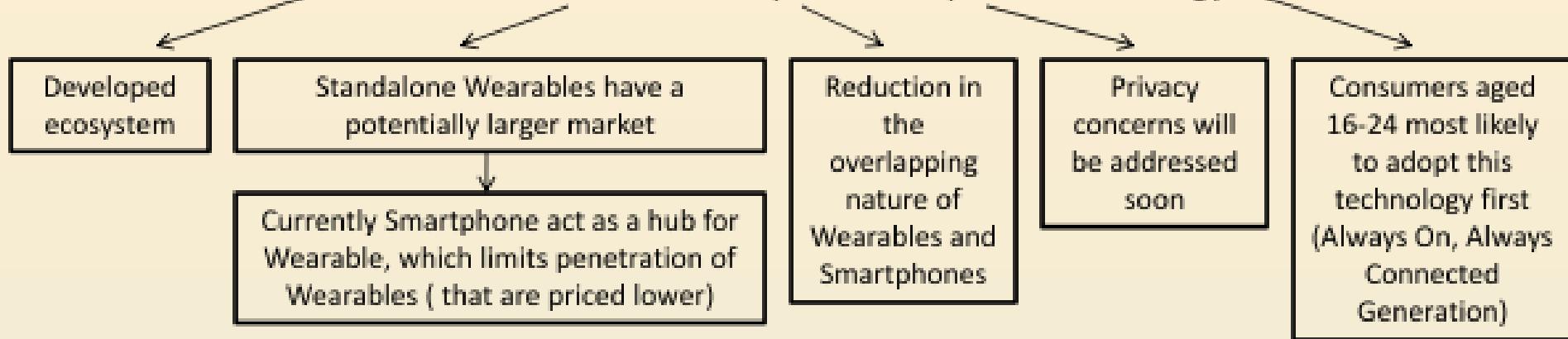
Capabilities and feature convergence

Easy portability

By 2020, batteries are expected to be 2.2x more powerful

# Future Outlook

Wearable Devices should be developed since they enhance the user's lives, and not just due to the easier availability of the required technology.



## Short Term Outlook

Increase in competition and entry of established brands (mainly in proven markets).

Increase in innovation from start-ups. Crowdfunding will continue to be popular.

Emergence of workplace wearables.

## Medium Term Outlook

Explosion of Medical Wearables- To assist doctors with diagnosis

Addition of gamification

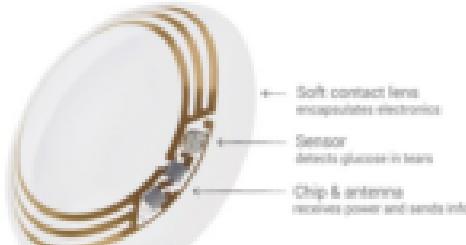
Move from Inertial Measurement Units (inaccurate) to Heart Rate Monitors and Temperature Sensors in the Fitness Devices (Can't place multiple sensors on body)

## Long Term Outlook

Devices will evolve to be a passive entity alongside humans, its presence will become unnoticed.

Implantation will become possible and advantageous.

Life expectancy will increase a lot since we will identify and treat diseases at an early stage.



Google has patented a Smart Contact Lens

\*Source : Tech crunch, Jan 16, 2014

## FATbit: how to cheat your fitness tracker

[https://www.youtube.com/watch?v=tjTLOKjB\\_50](https://www.youtube.com/watch?v=tjTLOKjB_50)



LADIES AND GENTLEMEN,  
I PRESENT TO YOU – FITBARK !!



# LOONEY TUNES

7

# **BIBLIOGRAPHY**

IIPRD Corp. - <https://slideplayer.com/slide/12358033/>

Wearable Devices: BRAVE IN A WORLD OF RISK Barry Dixon, Vice President Underwriting Canadian Reinsurance Conference - April 14, 2015