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# *Introduction to wearable technology*

**Prof. Ombretta Gaggi**  
Department of Mathematics  
University of Padua



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*What do you have in mind when you  
think about wearable?*

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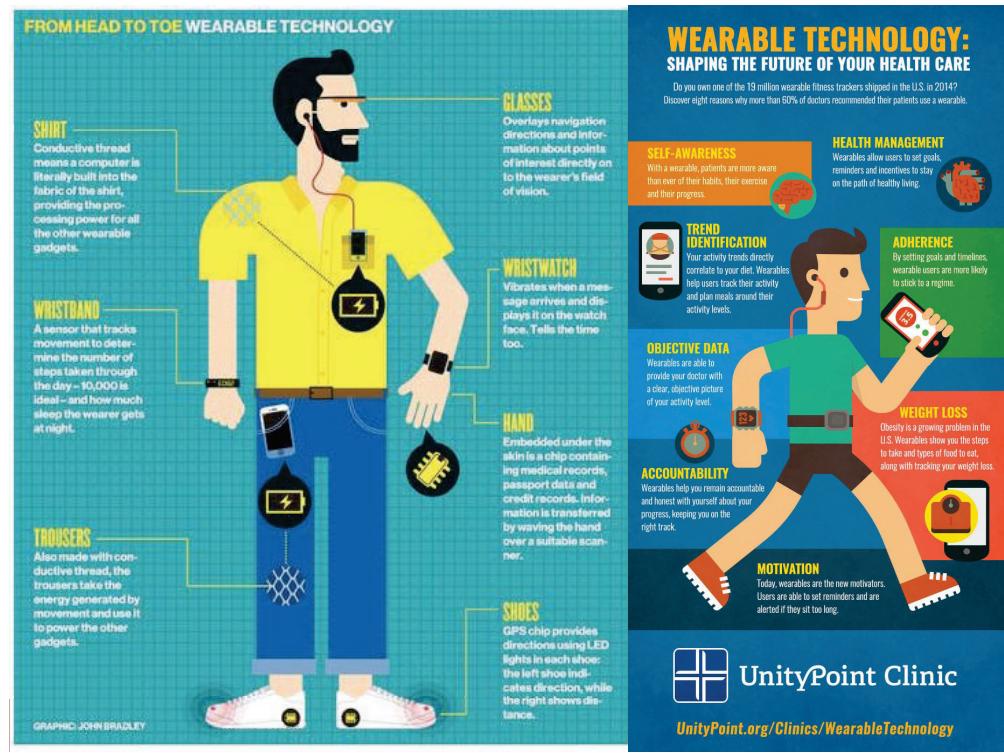
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## WEARABLE TECHNOLOGY: SHAPING THE FUTURE OF YOUR HEALTH CARE

Do you own one of the 13 million wearable fitness trackers shipped in the U.S. in 2014? Discover eight reasons why more than 60% of doctors recommend their patients use a wearable.



**UnityPoint Clinic**

[UnityPoint.org/Clinics/WearableTechnology](http://UnityPoint.org/Clinics/WearableTechnology)





Augment  
Ourselves



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But  
Wearable Tech  
isn't new



1961: First wearable computer to help winning the roulette

## What a wearable is not



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- Wearables are not a replacement of mobile devices
  - Wearables complement mobile devices and can even depend on them
  - Android wear watches cannot connect to the Internet and download apps without being connected to a mobile devices
- Wearables are not suitable for all
  - They are perfect for quick interactions like setting an alarm, but not suitable for more complex action like writing an email
- More accessible than mobile devices in particular situations

## What is a wearable object?



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- Something smart that you can wear
- A set of sensors and actuators that can interact with you or your smartphone
  - wearables as extension of user mobile device
- *"An extension of yourself"*
- A small, but powerful, computer in your pocket or mounted in your bracelet, glasses, etc

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## What can be done with wearables?



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- It depends on several factors:
  - Type of device
  - Sensors
  - Actuators
  - Operating systems and APIs
- Some examples:
  - Monitor vital signs
  - Monitor movements and gestures
  - Notify about important things
  - Overlay information right in front of your eyes
  - Capture data from the environment (light, sound)

# Several application fields!



- Fashion

- U2 use leather jacket with embedded LEDs

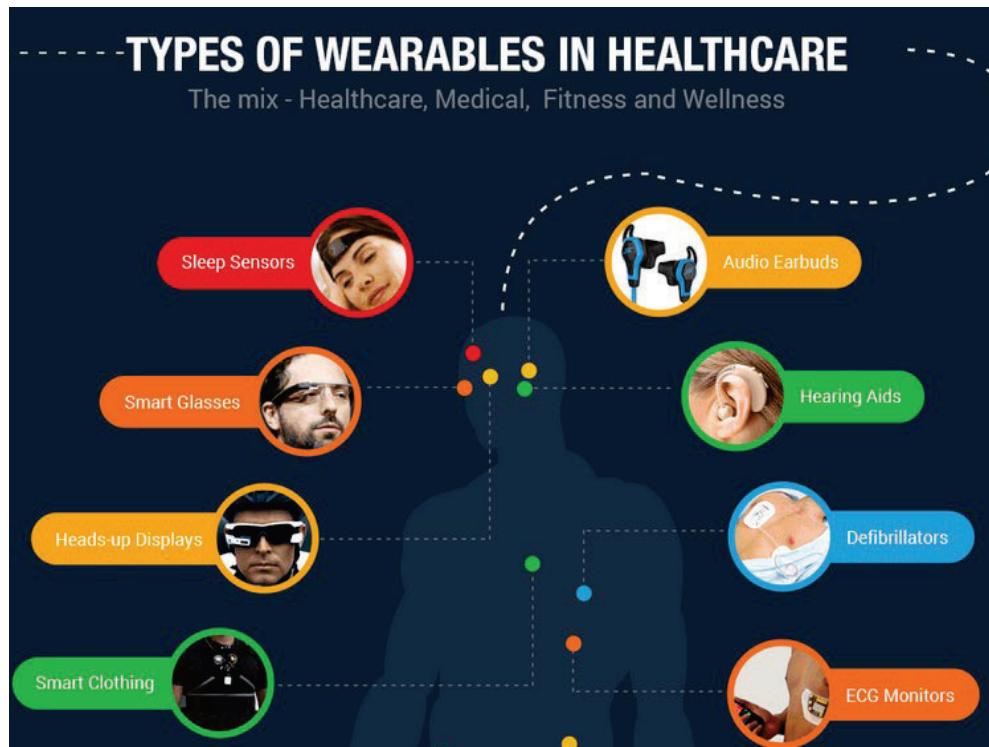


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## TYPES OF WEARABLES IN HEALTHCARE

The mix - Healthcare, Medical, Fitness and Wellness



# Several application fields!



- Fashion

- U2 use leather jacket with embedded LEDs

- Military Field

- Healthcare

- Monitoring and support for patient's autonomy
  - Fitness & Wellness
  - ...

- Workspace

- security

- Infotainment

- Time

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# Wearable Technology Market: Key Industries 2012-2018



Source:Researchmoz.com

AppStudioz

## Android Wear



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- Android Wear is an operating system specific for the wearable realm
- It's like Android but tiny
- The idea: to create an OS for wearable which can easily sync with other Android devices
- An Android Wear device can do (almost) anything that a phone can do. The biggest difference is the form factor.
- Design Considerations Are Important!

## Tools and SDK



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- Many wearables, many SDK!
  - Unfortunately, an open standard does not exist
  - Many wearable comes with its operating system and developers must download its SDK from the manufacturer
- NO cross-platform framework for wearables!
- Android Wear tries to solve the problem

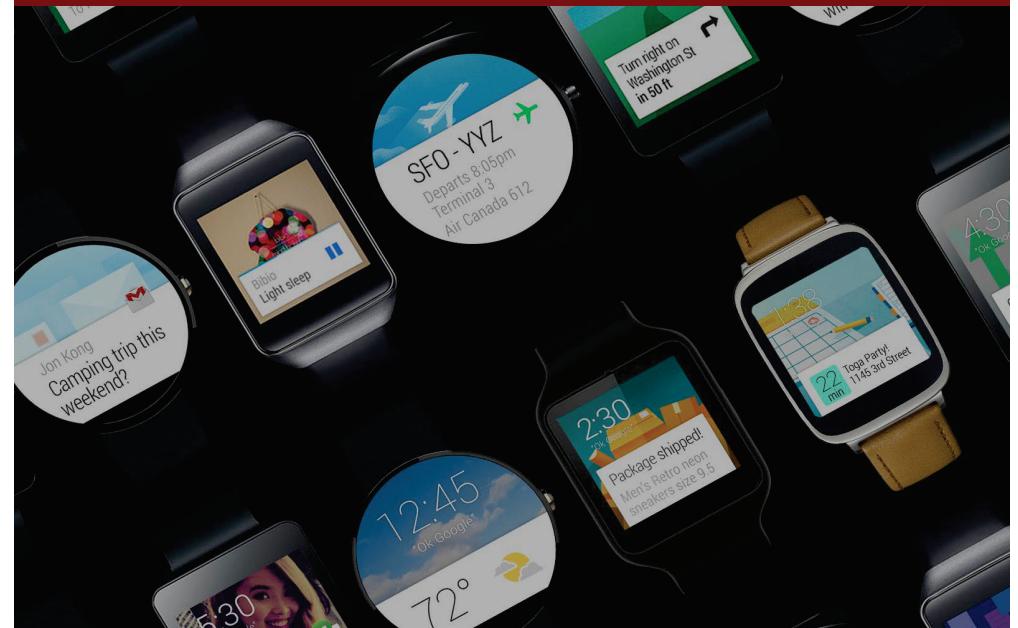
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## Round or squared?



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## Round or squared?



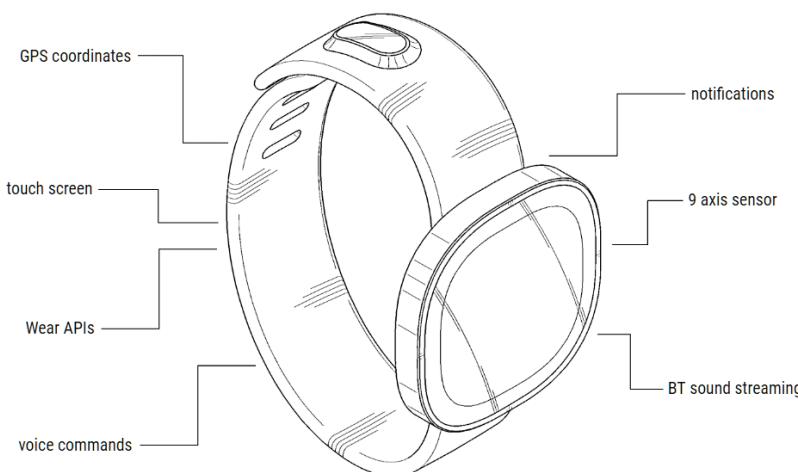
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## Hardware equipment



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## Suitable for ...



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- Quick interaction (accept/decline, swipe, tap, etc)
- Notification
- Display short message
- Collect data (number of steps, gestures, etc)

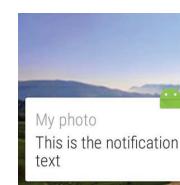
## Platform and technology



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- To develop applications for Android Wear you need:
  - Android Studio
  - Android Wear SDK
  - An Android smartphone and an Android Wear device

*Applications are not usually developed for wearable devices, but they extend functionalities provided by smartphones apps*



## Simple example: a button



The screenshot shows the Android Studio interface with a project named "Hello Square World". The code editor displays Java code for a class `MainActivityWear` that extends `Activity`. The code initializes a `TextView` and a `Button`, and sets an `onClick` listener for the button to change its text to "I'm clicked!!". The project structure shows files for both mobile and wear components, including XML layouts and Java classes.

```
public class MainActivityWear extends Activity {  
    private TextView mTextView;  
    private Button mButton;  
  
    @Override  
    protected void onCreate(Bundle savedInstanceState) {  
        super.onCreate(savedInstanceState);  
        setContentView(R.layout.activity_main_activity_wear);  
        final WatchViewStub stub = (WatchViewStub) findViewById(R.id.watch_view_stub);  
        stub.setOnLayoutInflatedListener((stub) -> {  
            mTextView = (TextView) stub.findViewById(R.id.text);  
  
            // this is the code needed to link your button  
            mButton = (Button) stub.findViewById(R.id.button);  
            mButton.setOnClickListener(buttonListener);  
        });  
  
        private View.OnClickListener buttonListener = new View.OnClickListener() {  
            @Override  
            public void onClick(View v) {  
                // In here we can react  
                mButton.setText("I'm clicked!!");  
            }  
        };  
    }  
}
```

## Watch Faces



## Android Wear



- Android Wear allows to:
  - design our own Watch Faces

## Android Wear



- Android Wear allows to:
  - design our own Watch Faces
  - create special notifications (short messages) from our normal apps
  - create novel interactions (e.g., voice input, gestures)
  - give feedback to users through vibration
  - ... etc...

# Collecting data from sensors



- A small Android wear device can be equipped with even more than 15 sensors

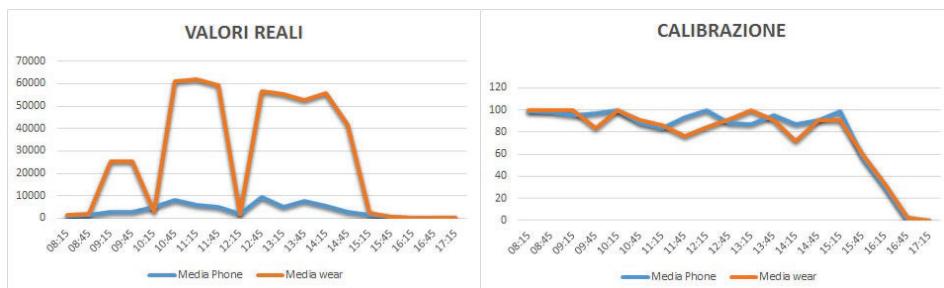
TABLE 10-1: Sensors Available on the LG G Watch

NAME	TYPE	DESCRIPTION
STMicro 3-axis Tilt Sensor	Software	
MPL Gyroscope	Hardware	
MPL Raw Gyroscope	Hardware	
MPL Accelerometer	Hardware	An accelerometer sensor that includes the gravity force.
MPL Magnetic Field	Hardware	
MPL Raw Magnetic Field	Hardware	
MPL Orientation	Software	An older-style sensor that has been deprecated and is on its way out of the Android system. You should use the Rotation Vector instead.
MPL Rotation Vector	Software	Gives a rotational unit vector based on the East-North-Up coordinates.
MPL Game Rotation Vector	Software	Similar to the Rotation Vector, except that it uses different underlying hardware. This also means that the sensors report different values.
MPL Linear Acceleration	Software	An accelerometer that has the gravity already excluded.
MPL Gravity	Software	Reports the gravity vector in the device's coordinate system. Should be identical to the raw accelerometer values when the device is resting.
MPL Signification Motion	Software	A composite sensor that allows the device to fall asleep while the sensor is still working, which is very different from other sensors. This sensor is often used to listen for when the user starts to walk, run, bike, or something else.
MPL Step Detector	Hardware/software	Fires a single event for every detected step the user takes while the sensor is active. Chapter 9 covered this sensor.
MPL Step Counter	Hardware/software	Keeps track of the total number of steps the user has taken since the device was started. It resets the number of steps when the device is turned off or rebooted.
MPL Geomagnetic Rotation Vector	Software	Also called a magnetometer and is very similar to the rotation vector sensor. However, where the rotation vector uses a gyroscope, this uses the magnetometer. It reports the same set of values as the rotation vector.

## Calibration



- Every sensor has different
  - Sensibility
  - Scale limit (max value)
- Need for a calibration phase



# Problem



- During an experiment, a set of devices are used to collect data about the environment (light and sound)
  - Two Samsung Galaxy Nexus
  - A Samsung Galaxy S5
  - A Motorola Moto 360
  - A Sony Smartwatch 3
- Collected data are reported on a graph and ...  
*everything goes wrong!*

Why?

## An important note



- Everything can be hacked!
- Wearables are "*embedded computer*", therefore security is a very important issue



Jack Barnaby  
22 November 1977 – 25 July 2013

Last but no Least!

# Energy Consumption

Bluetooth  
communication between  
smartphone and  
smartwatch can soon  
drain the battery of both  
devices



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Ombretta Gaggi

Dipartimento di Matematica  
Università di Padova  
gaggi@math.unipd.it

## References

- Books:
  - David Cuartielles Ruiz, Andreas Coranssson. "Professional Android Wearables". Wiley, 2015
  - A. Calvo. "Beginning Android Wearables". Apress, 2015
- Some examples
  - <https://github.com/pro-android-wearables/courseware>
- Documentation
  - <https://developer.android.com/training/building-wearables.html>
- Misc
  - The invention of the first wearable computer
    - <https://www.cs.virginia.edu/~evans/thorp.pdf>
  - Jack Barnaby
    - [https://en.wikipedia.org/wiki/Barnaby\\_Jack](https://en.wikipedia.org/wiki/Barnaby_Jack)

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