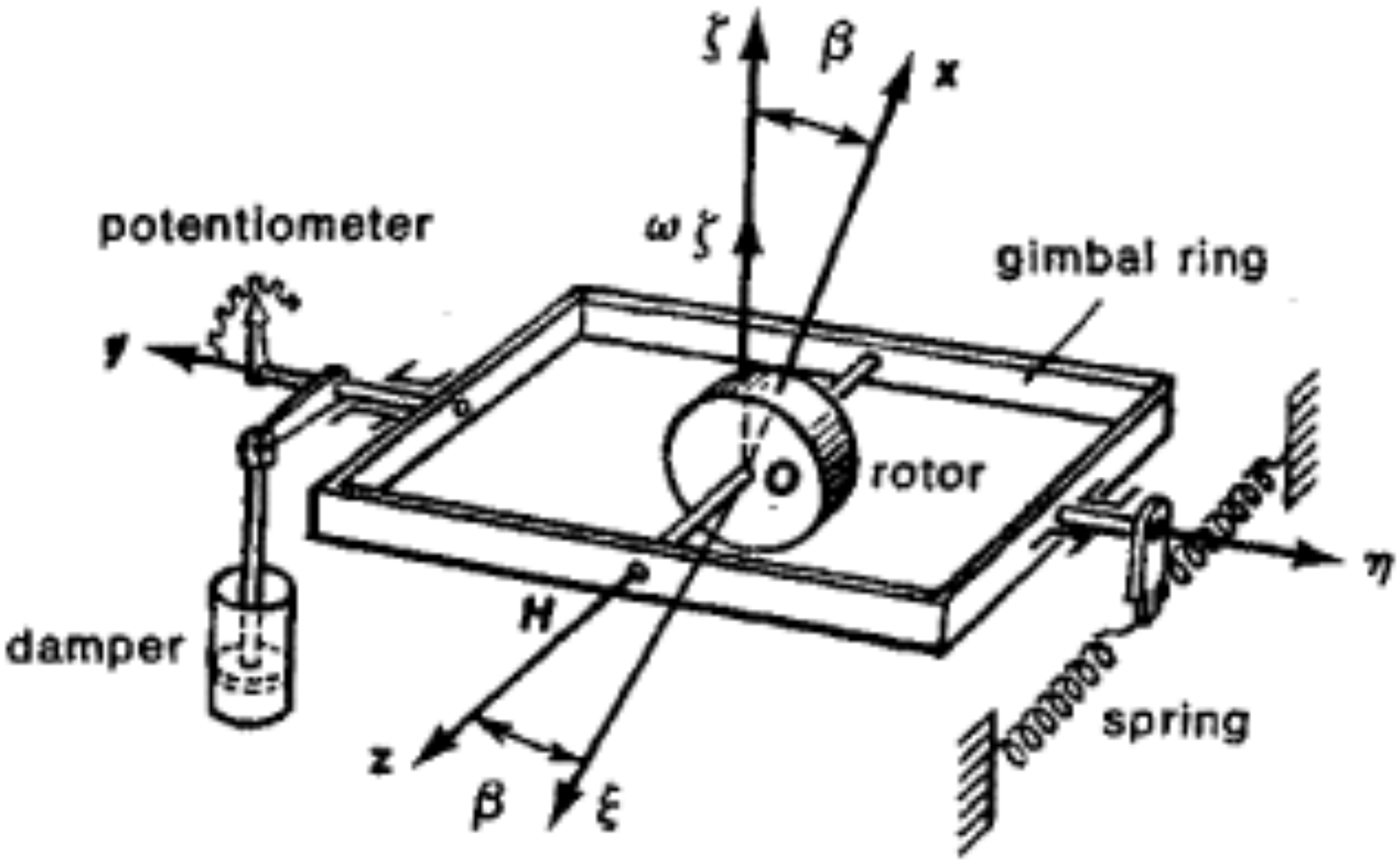


Data Collection: Sensing I

EE382V Activity Sensing and Recognition

UT Austin • Dept. Electrical and Computer Engineering • Fall 2016

Sensing

Environmental vs. On-Body

Specialized vs. Commodity

Mobile and Wearable Sensors

APIs

Papers

Data Collection

Sensing

Environmental vs. On-Body

Specialized vs. Commodity

Mobile and Wearable Sensors

APIs

Papers

Data Collection

Environmental vs. On-Body

Environmental vs. On-Body














Environmental vs. On-Body

Depth Cameras

Environmental vs. On-Body

Lidar

Environmental vs. On-Body

Environmental vs. On-Body

Pros and Cons

Sensing

Environmental vs. On-Body

Specialized vs. Commodity

Mobile and Wearable Sensors

APIs

Papers

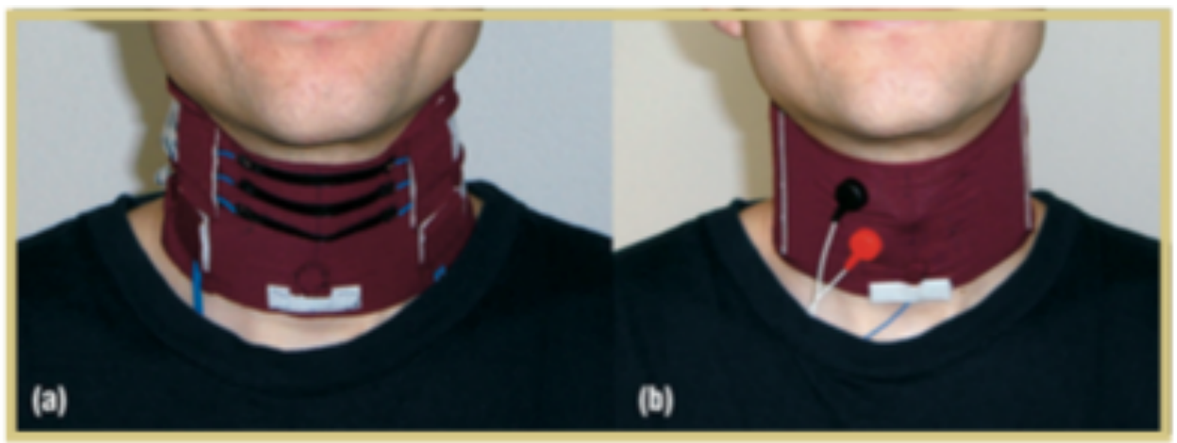
Data Collection

Specialized

Fontana et al, 2014

Kalantarian et al, 2014

Farooq et al, 2014



Amft et al, 2014

Cheng et al, 2013

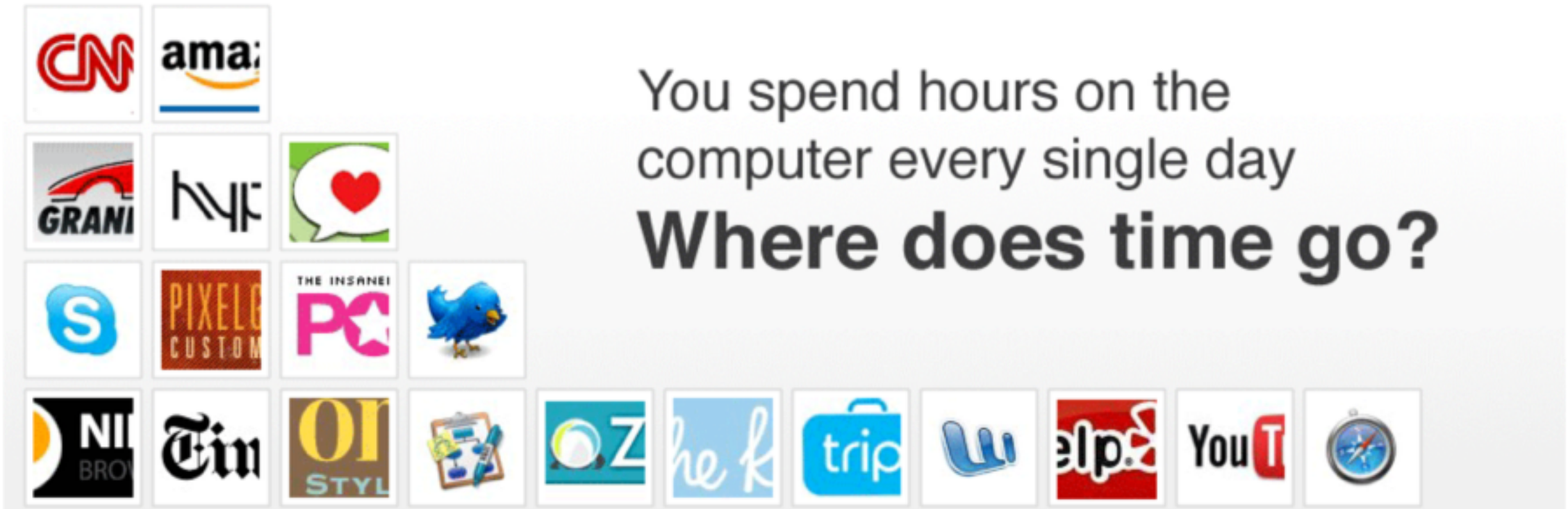
Commodity


ON THE WAY
Lively
Refrigerator
Custom
Pillbox 1
Pillbox 2


nest
65
HEATING
68


zeo
8:32
73

Commodity



Slife makes it impossibly easy to keep track of time and stay productive.

Sign-up

or learn more

Sometimes it seems like the world is on fast-forward. You wake up, get some work done and next thing you know it's 6PM. Where did time go? Slife knows. Slife helps you understand how you spend time in the computer. It automatically observes as you interact with applications, documents and web sites.

Commodity

Specialized vs. Commodity

Pros and Cons

Sensing

Environmental vs. On-Body

Specialized vs. Commodity

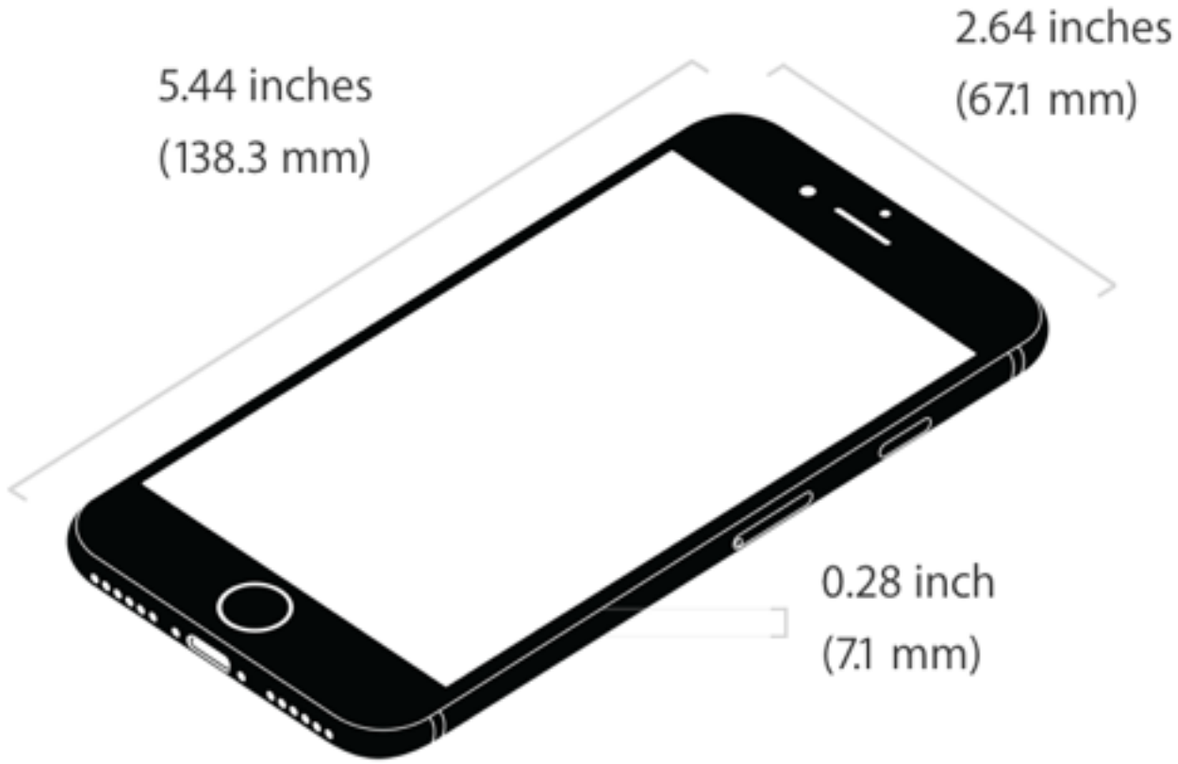
Mobile and Wearable Sensors

APIs

Papers

Data Collection

Mobile Phone



Accelerometer

Magnetometer

Gyroscope

Barometer

Proximity

Ambient Light

Microphone

Camera

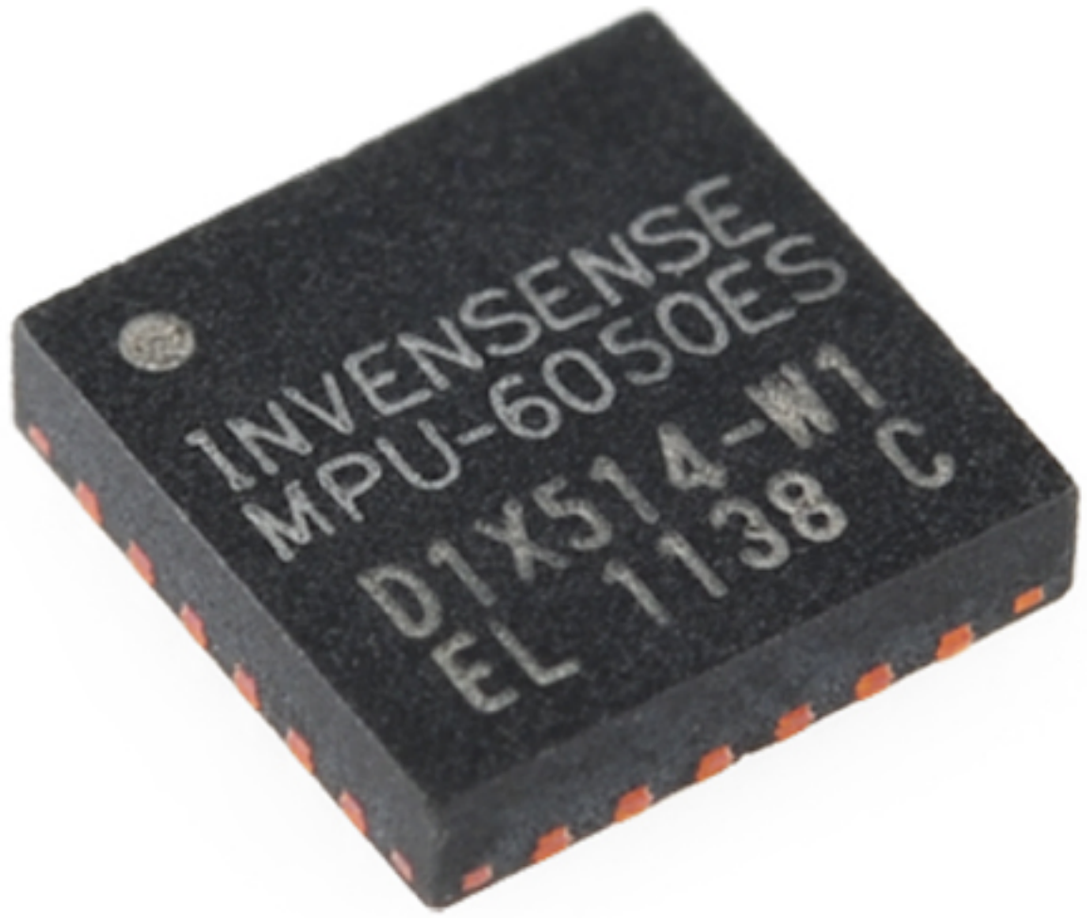
Digital Compass

Assisted GPS and GLONASS

TouchID

Wifi/Bluetooth

Accelerometer



What does an accelerometer measure?

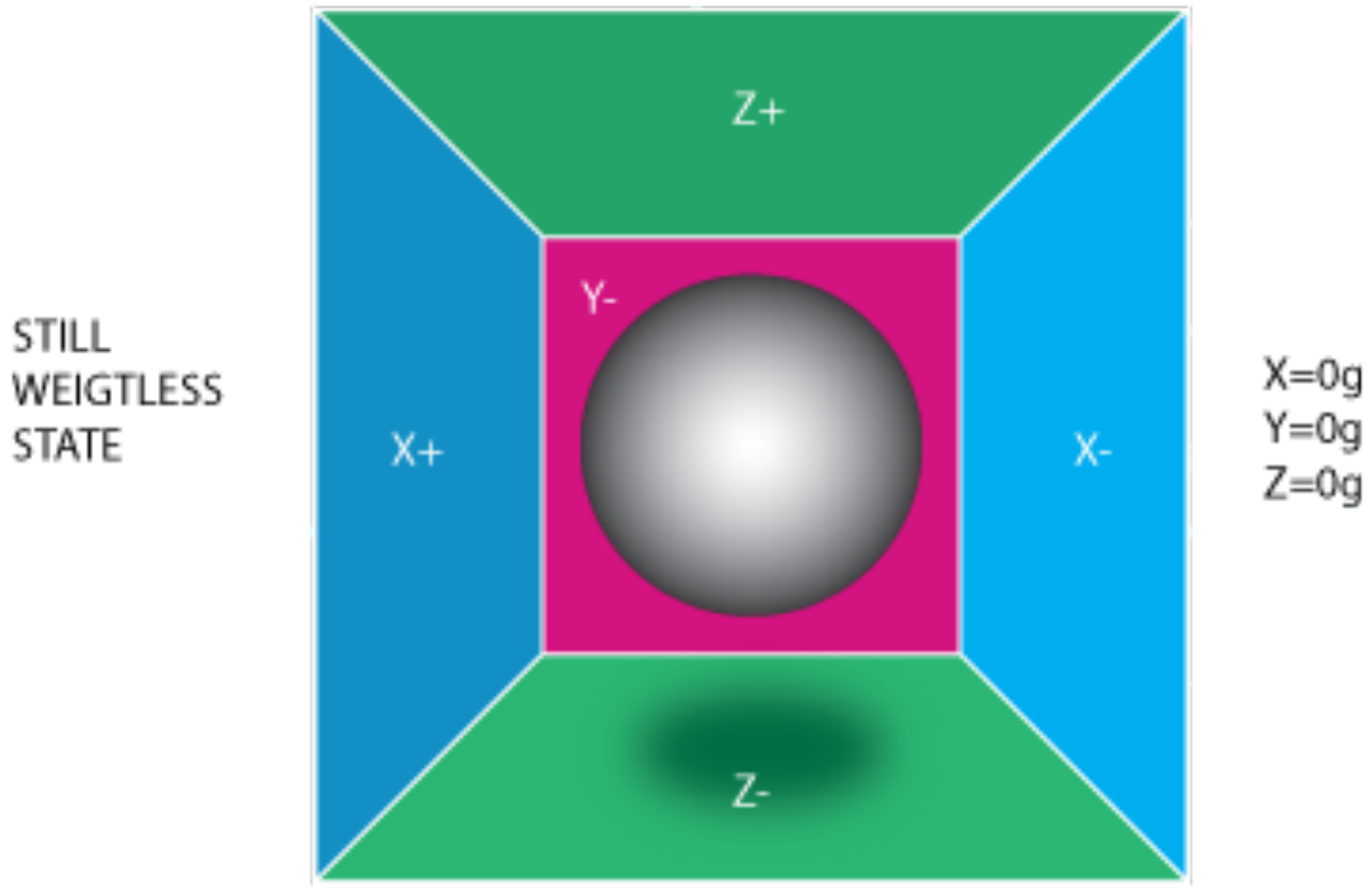
Acceleration

$$\vec{a} = \frac{d\vec{v}}{dt}$$

$$F = m\,a$$

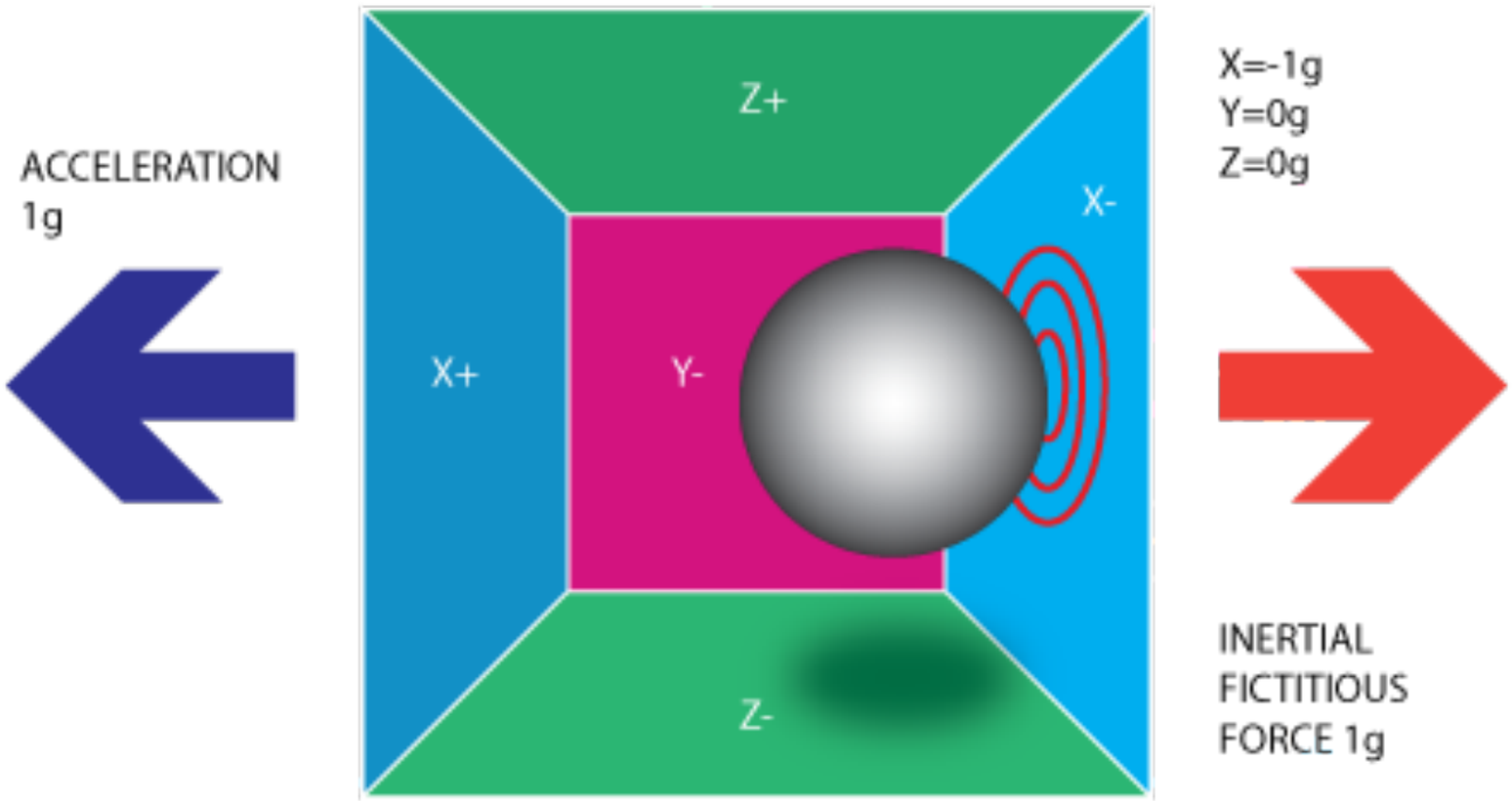
$$a = F / m$$

Source: instructables.com



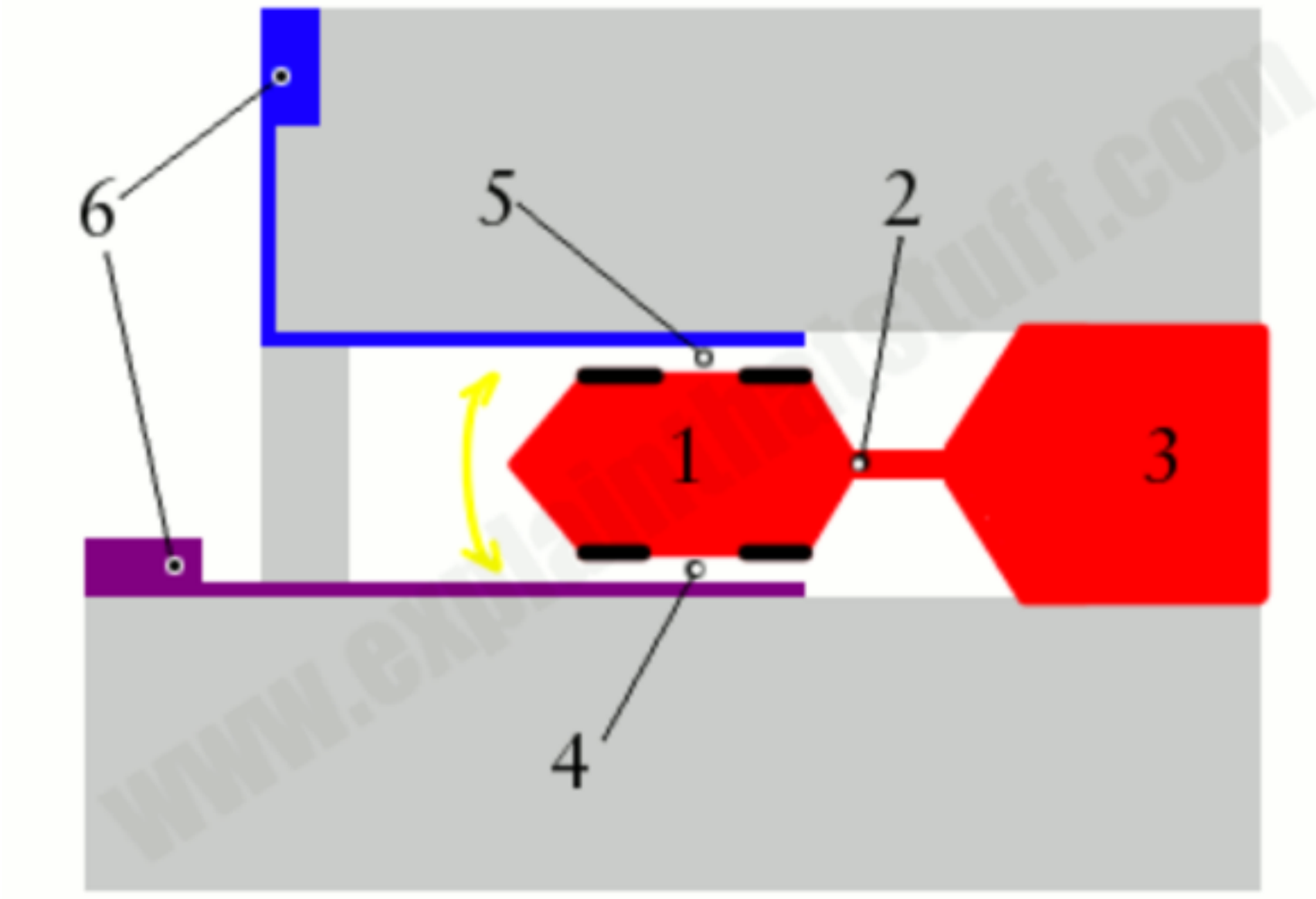
Accelerometers

Source: instructables.com



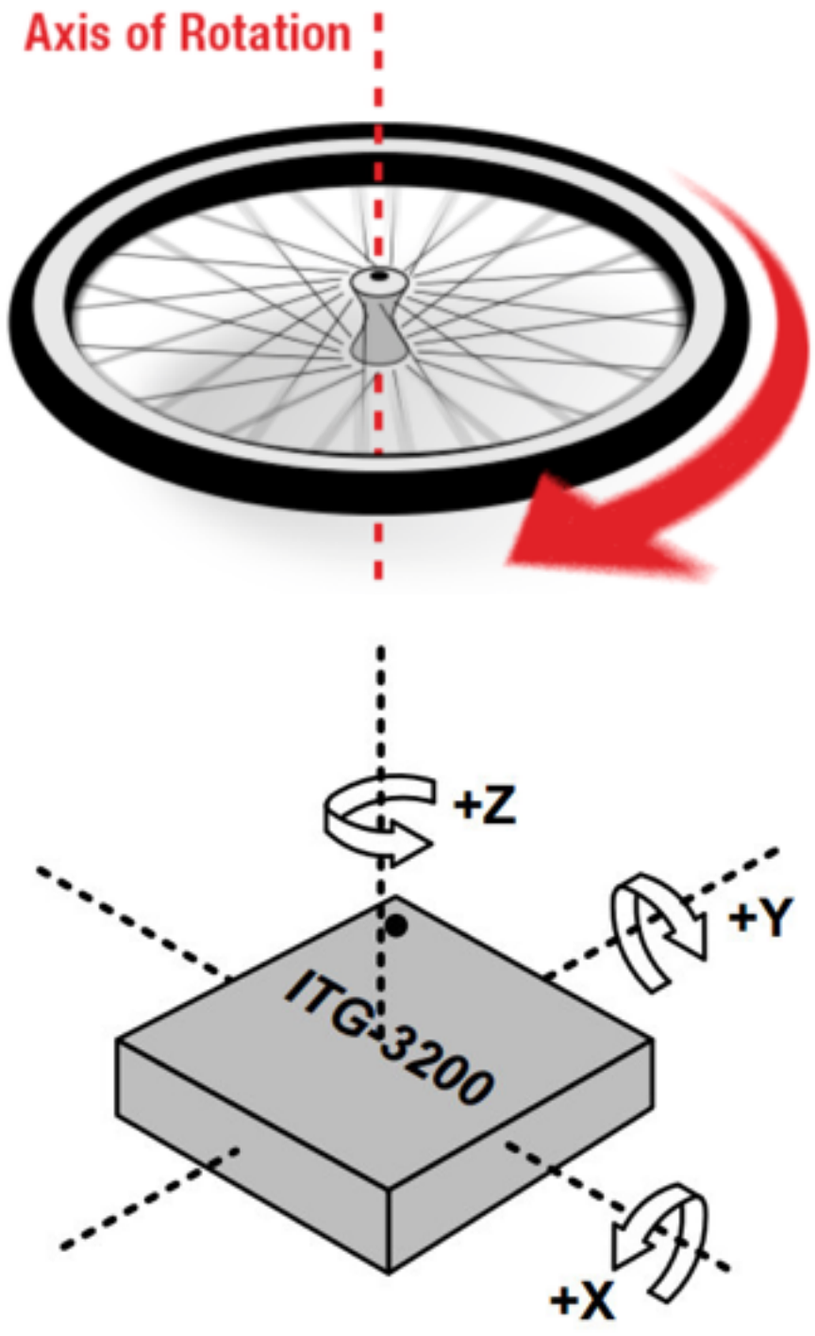
Accelerometers

Source: explainthatstuff.com



Accelerometer on a chip

Gyroscope

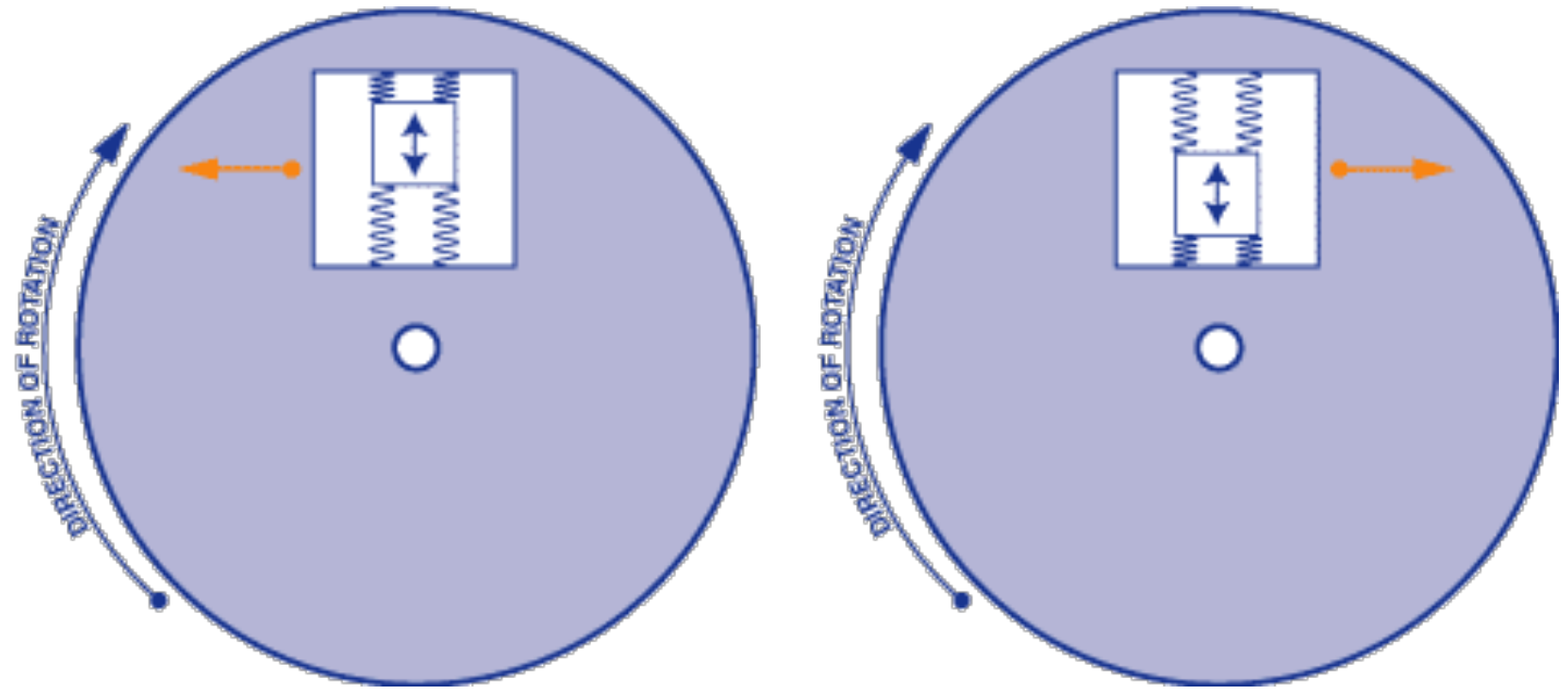


Measures Angular Velocity

1 spin/sec = 360˚/sec

Source: https://learn.sparkfun.com/tutorials/gyroscope/how-a-gyro-works

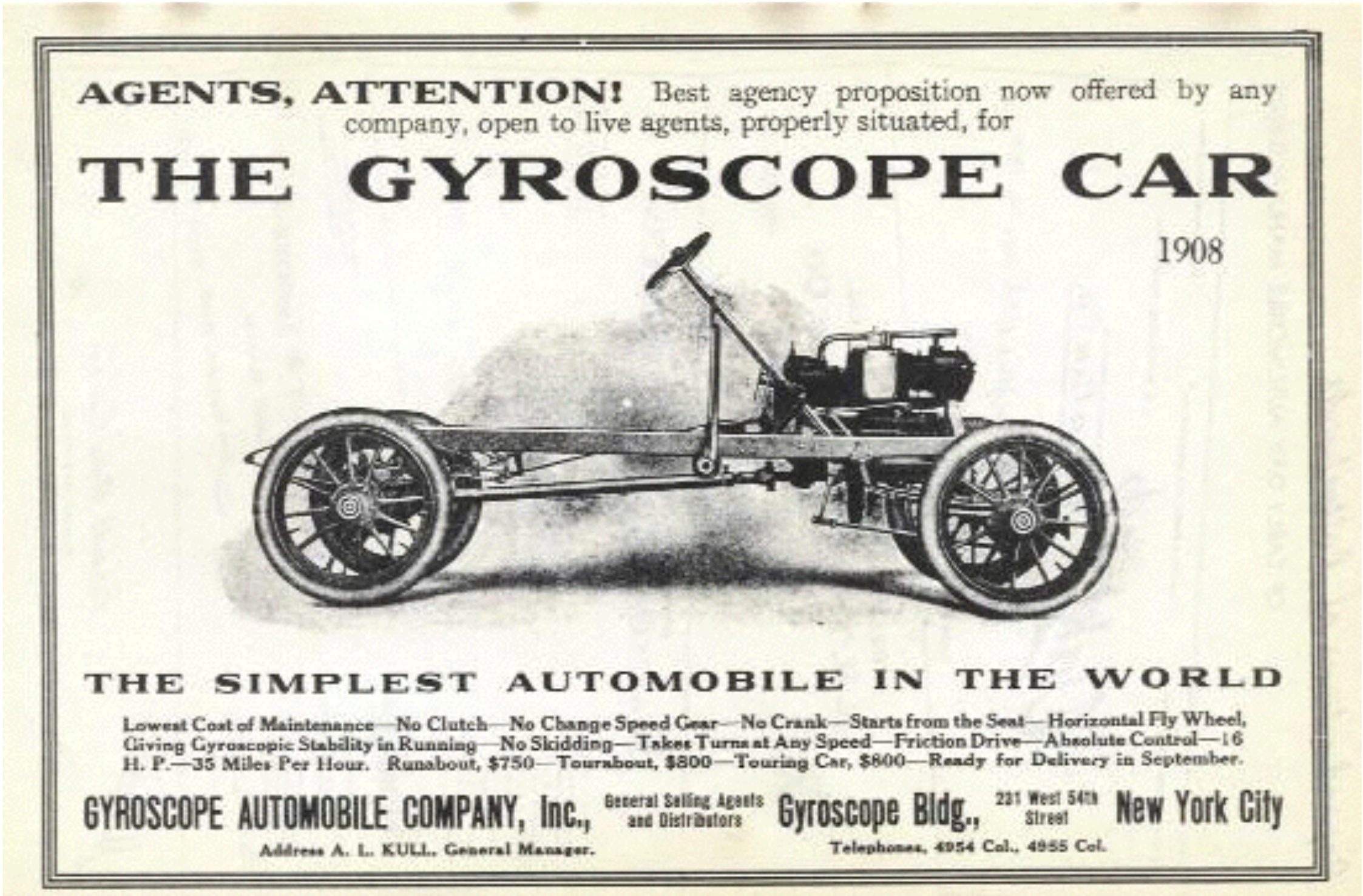
MEMS Gyroscope



Gyro rotates, a small mass is shifted in proportion to angular velocity

Source: https://learn.sparkfun.com/tutorials/gyroscope/how-a-gyro-works

Gyroscope Car



Gyroscope Car II

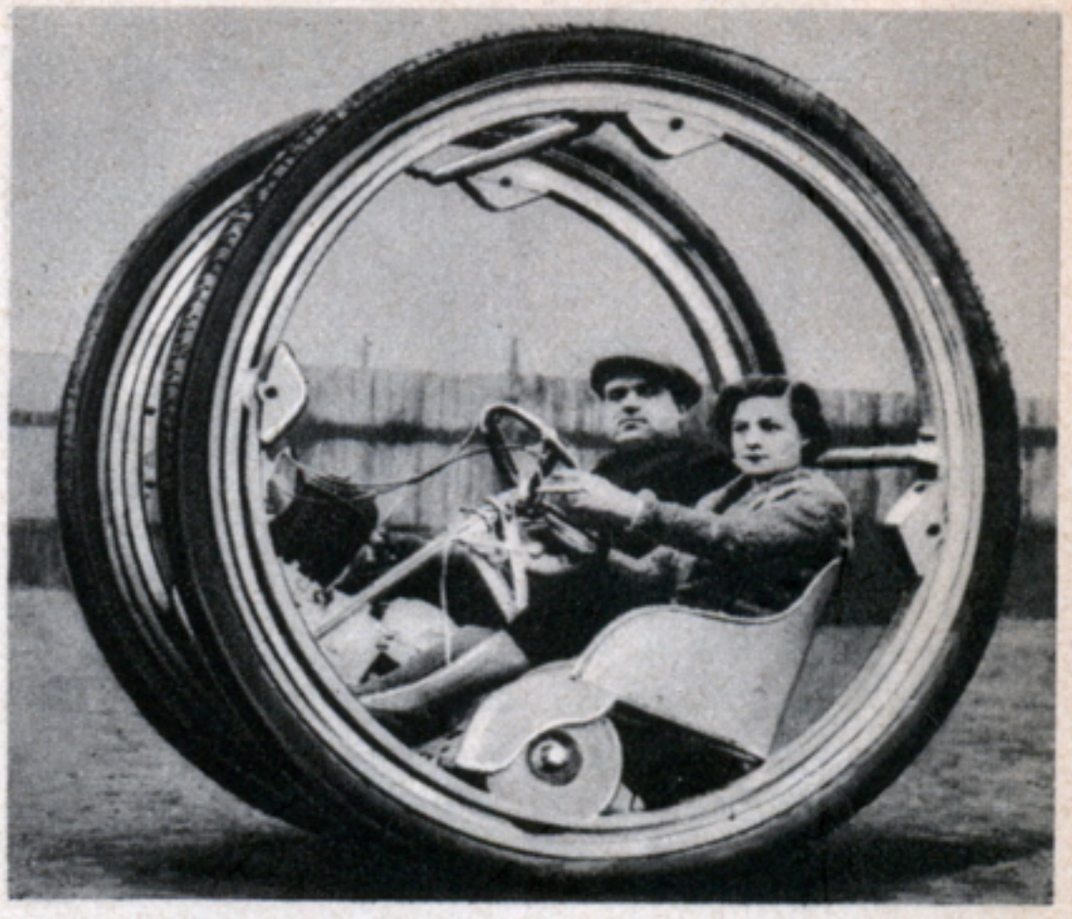
Gyro-Wheel Car Zooms Along On Giant Tires At 116 m.p.h.

RADICAL in design, a pleasure vehicle, known as the "gyrauto," has been introduced in Europe to replace the orthodox type of automobile in use today.

Designed by Ernest Fraquelli, young Italian engineer, the gyrauto is said to be capable of attaining a speed of 116 miles per hour and to operate at a much lower running cost than do more conventional cars. Seats, engine and all controls are suspended between two huge rubber-tired wheels which revolve as the car moves forward. There are accommodations for an extra passenger in addition to the driver.

The unusual piece of apparatus was demonstrated recently in Brussels, Belgium.

Fraquelli's unique vehicle is similar in general design to the Dyno-Wheel motor bus featured on the cover of this issue of MODERN MECHANIX AND INVENTIONS and described on page 87.



Ernest Fraquelli, Italian engineer, is shown above demonstrating his revolutionary motor car to a fair passenger.

Barometer

Air Pressure

Altitude

Relative Elevation

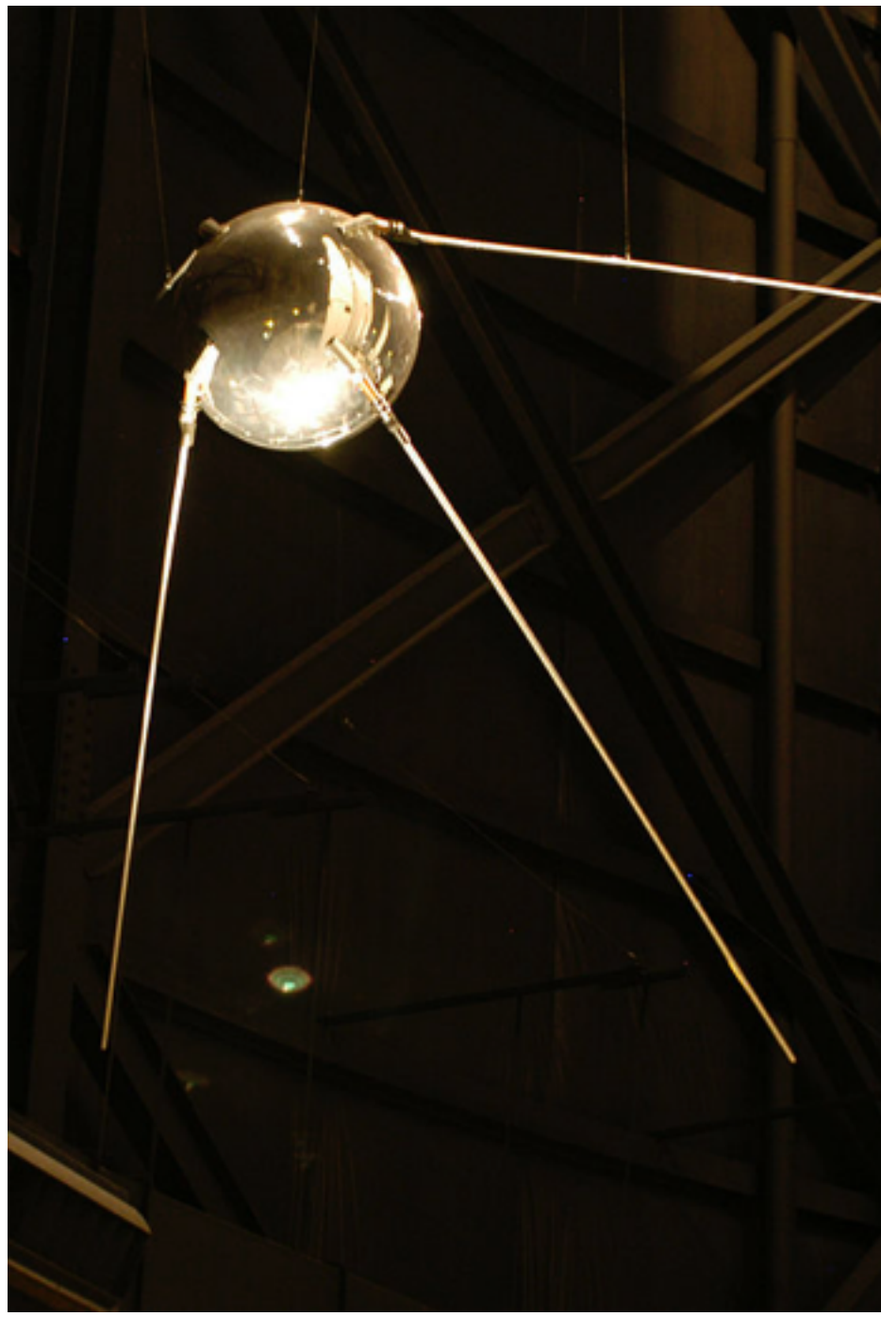
Global Positioning System (GPS)

History

Motivated by launch of Sputnik

Scientists figured out they could track the satellite along its orbit due to Doppler effect

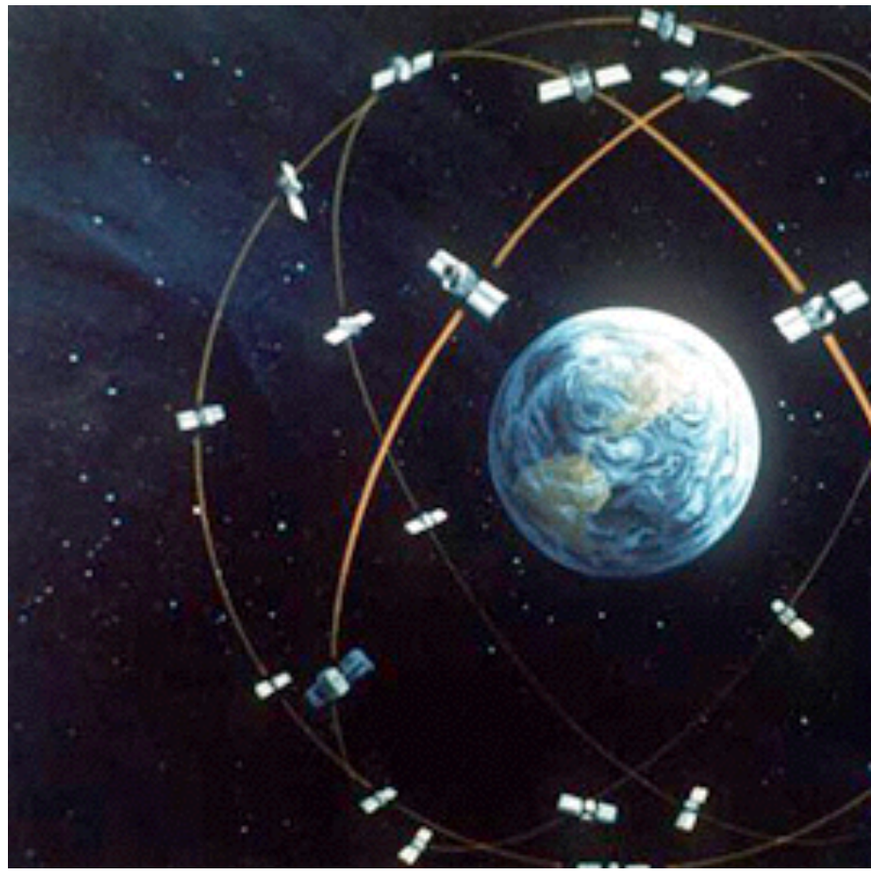
1978: First experimental satellite



Global Positioning System (GPS)

Today

Transmit Location and Time



Anywhere on or near Earth,
all weather conditions

24 satellites orbiting Earth

6 orbital planes, 4 satellites per plane

Four satellites must be in view of the receiver for it to compute four unknown quantities (three position coordinates and clock deviation from satellite time).

Assisted GPS

Enhances GPS using cell tower data

Help acquire satellites more quickly

Help with position calculations

GLONASS

Глобальная навигационная спутниковая система

Globalnaya navigatsionnaya sputnikovaya sistema

GLObal NAvigation Satellite System

Russian space-based satellite navigation system

“an alternative to GPS and the second alternative navigational system in operation with global coverage and of comparable precision”

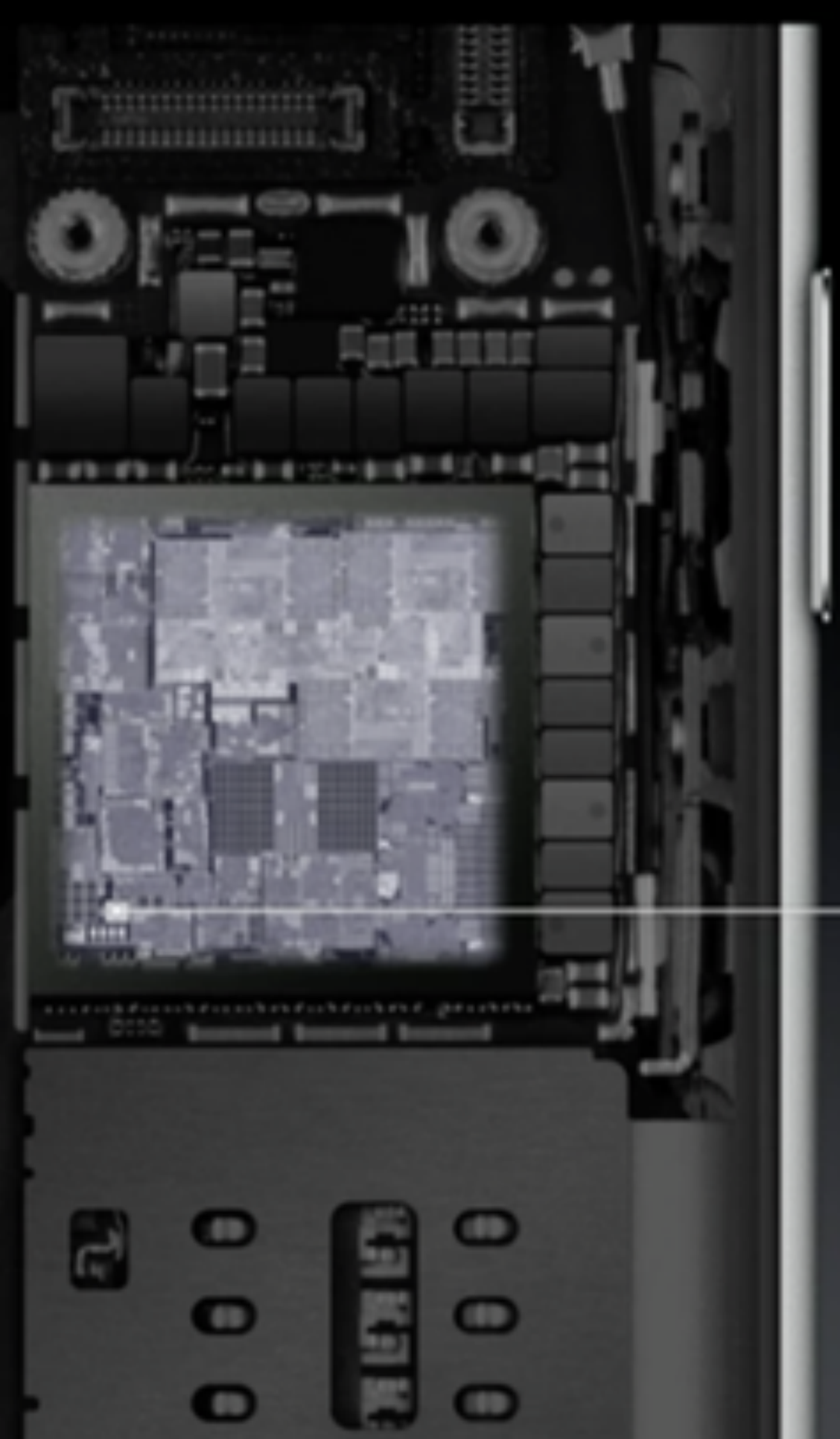
What are mobile phone sensors used for?

Accelerometer + Gyro	Changes in orientation Physical Activity Tracking Games
Ambient Light	Adjust display brightness Battery conservation
Proximity	Turn off display Block screen input

What are mobile phone sensors used for?

Barometer	Weather forecasting
	Step Count (Stairs)

What about the battery?



M9 motion coprocessor
Embedded & always on

Wearables

Accelerometer

Magnetometer

Gyroscope

Compass

Optical HRM

Accelerometer

Magnetometer

Gyroscope

Compass

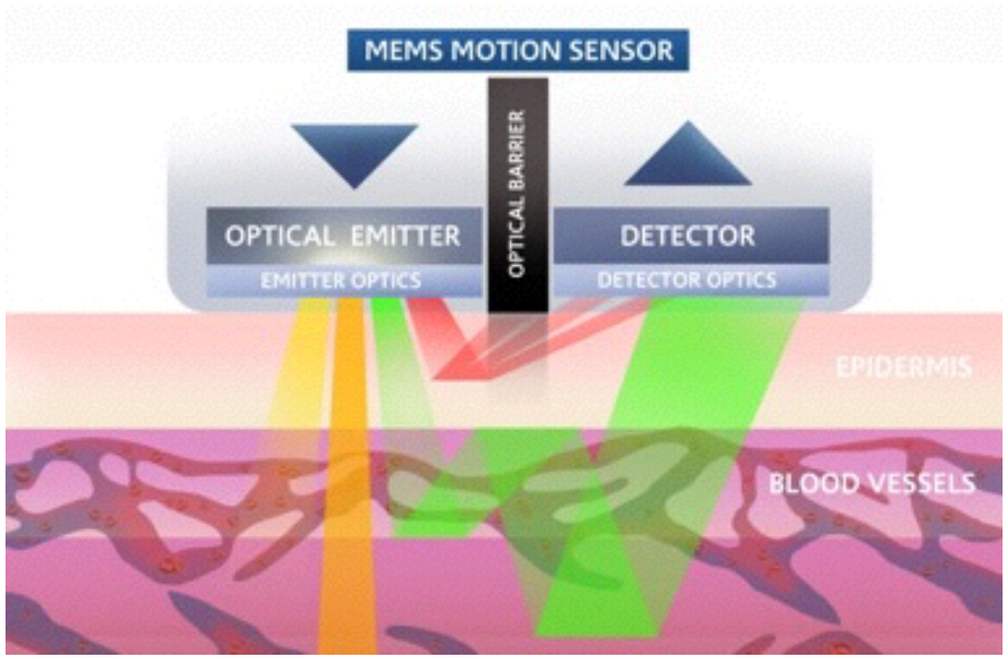
Optical HRM

Optical HRM

Photoplethysmography (PPG)

Measure the amount of light that is scattered by blood flow

Source: Valencell, Inc.



Optical HRM

Optical Emitter

Send lightwaves into skin

Multiple wavelengths based on skin morphology

DSP

Captures and processes refracted light

Accelerometer

Motion measurements to assist with PPG

Data Analysis

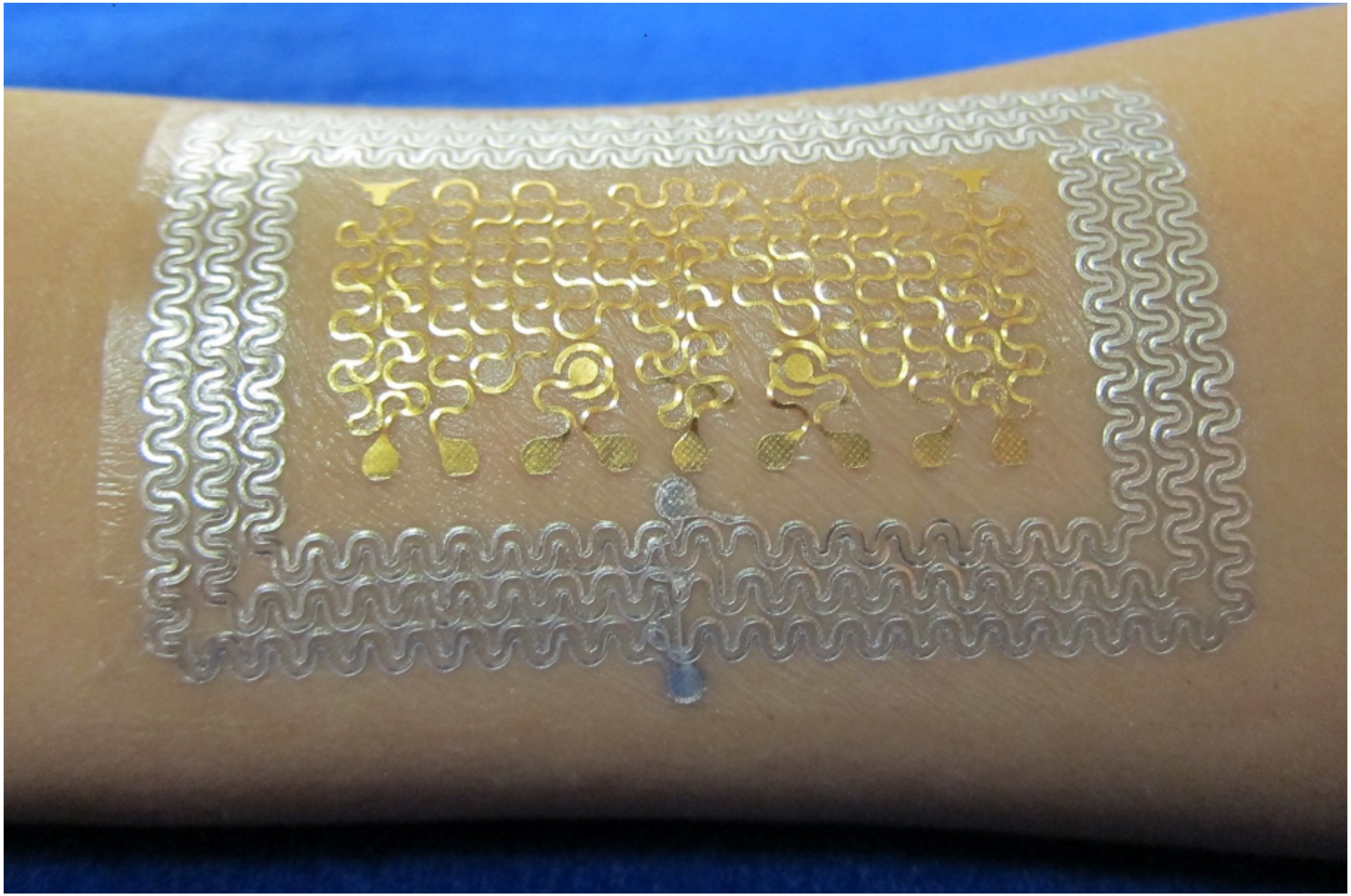
Calculates HR data, HRV, VO2, Calories, Metabolites, etc.

Source: Valencell, Inc.

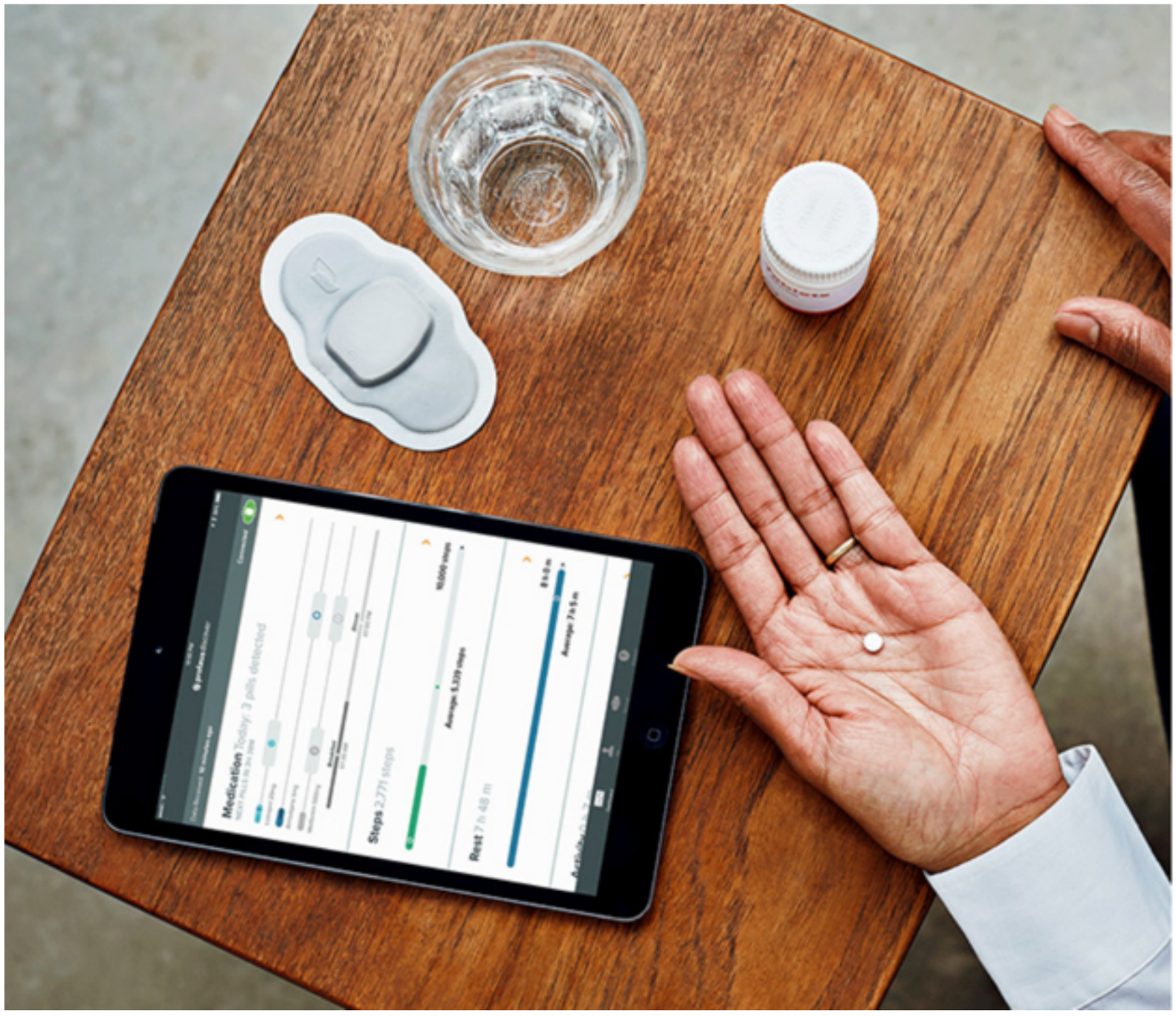
Optical Lactate Threshold Measurement

Source: BSX Insight

Sensing “On” and Inside Body



Epidermal Sensing Systems (ESS) - Prof. Nanshu Lu



Ingestible Sensor

Source: Proteus Digital Health