

# Control Interfaces

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# Outline

## Control Interfaces

- Definition

- Taxonomy

## Electronics

- Sensors

- Basics

# Outline

## Control Interfaces

Definition

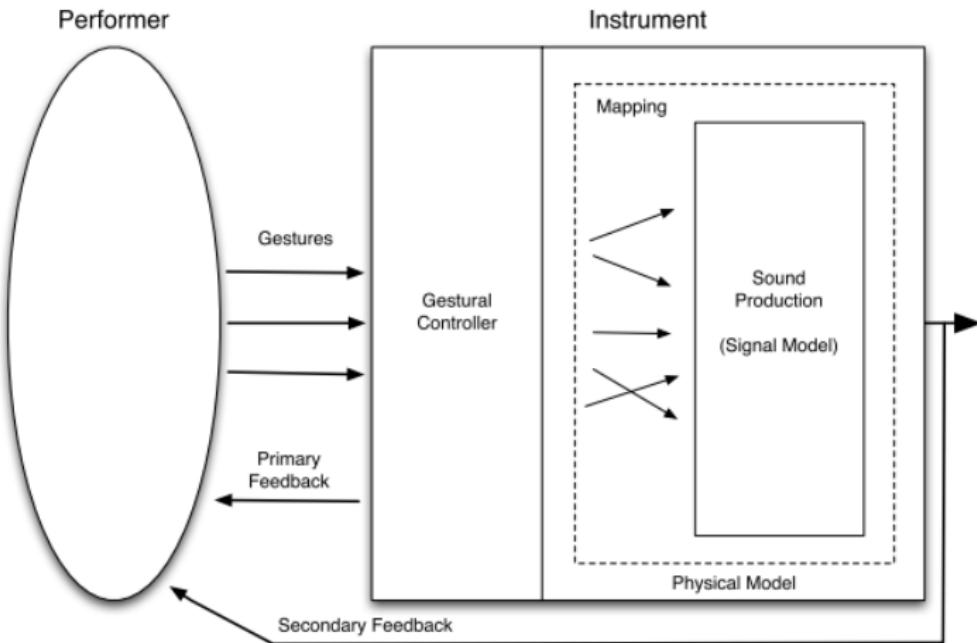
Taxonomy

## Electronics

Sensors

Basics

# Control Interfaces



Wanderley, M. M. (2001). Performer-Instrument Interaction: Applications to Gestural Control of Sound Synthesis. PhD thesis, University Paris 6.

## Control Interfaces - Definition

(Tentative definition)

The *Control Interface* (also called *Gestural Controller*, *Instrument Body*, *Input Device*, *Physical Interface*, or just *Interface* or *Controller*) is the part of the instrument with which the performer interacts through gestures.

## Control Interfaces - Definition

In the case of DMIs, the control interface can be **anything** that provides the user a way to interact, and it is capable to quantify this interaction in a digital way, to be understood by a microprocessor.

## Control Interfaces - Definition

*"The controller component can typically be a simple computer mouse, a computer keyboard, a MIDI keyboard or a MIDI fader box, but with the use of sensors and appropriate analogue to digital converters, any control signal coming from the outside (i.e. the performer, but also the audience or the environment – as in the case of interactive installations) can be converted into control messages understandable by the digital system. Changes in motion, pressure, velocity, light, gravity, skin conductivity or muscle tension, almost anything, can now become a 'music controller'."*<sup>1</sup>

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<sup>1</sup>Jordà, S. (2007). Interactivity and live computer music. Computer Music Journal.

# Control Interfaces - Definition

(Anticipated conclusion)

*"Any input device can become a good or a bad choice depending on the context, the parameter to control, or the performer who will be using it"<sup>2</sup>*

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<sup>2</sup>Jordà, S. (2007). Interactivity and live computer music. Computer Music Journal.

# Control Interfaces - Taxonomy

Wanderley's classification:<sup>3</sup>

- ▶ Instrument-like Controllers
- ▶ Augmented Controllers
- ▶ Alternate Controllers

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<sup>3</sup>Wanderley, M. M. (2001). Gestural Control of Music. International Workshop Human Supervision and Control in Engineering and Music.

# Control Interfaces - Taxonomy

## Instrument-like Controllers

- ▶ The controller design tries to faithfully replicate an existing acoustic instrument.
- ▶ Electronic versions of traditional instruments.
- ▶ Subcategory: Instrument-inspired controllers

# Control Interfaces - Taxonomy



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<https://commons.wikimedia.org/w/index.php?curid=46988058>

# Control Interfaces - Taxonomy



# Control Interfaces - Taxonomy



## Control Interfaces - Taxonomy



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GameReactor,

<https://www.gamereactor.eu/images/?productid=200&id=97749>

# Control Interfaces - Taxonomy



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By Keytar.jpg:

[https://www.flickr.com/photos/tommygunnphotography/derivative work: Clusternote \(talk\) - Keytar.jpg, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=12470544](https://www.flickr.com/photos/tommygunnphotography/derivative work: Clusternote (talk) - Keytar.jpg, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=12470544)

# Control Interfaces - Taxonomy



# Control Interfaces - Taxonomy



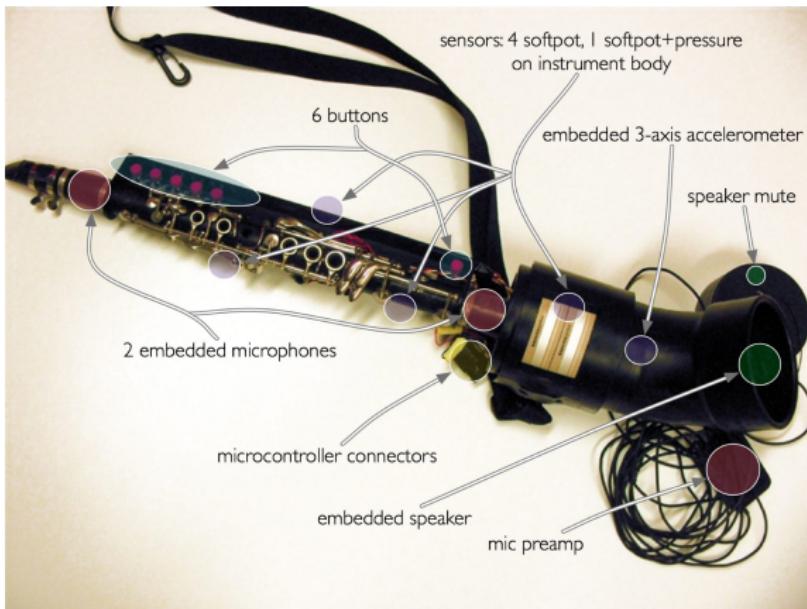
# Control Interfaces - Taxonomy

## Augmented Controllers

- ▶ Acoustic instruments with enhanced gesture possibilities due to sensors

# Control Interfaces - Taxonomy

## Augmented Clarinet by Stelios Manousakis



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<http://modularbrains.net/portfolio/feedback-augmented-sopranino-clarinet/>

## Control Interfaces - Taxonomy

Seaboard by ROLI



# Control Interfaces - Taxonomy

## Augmented Piano by A. Veinberg



# Control Interfaces - Taxonomy

Augmented Violin by M. Kimura



## Control Interfaces - Taxonomy

Does augmented reality produces augmented instruments...?

# Control Interfaces - Taxonomy

## Alternate Controllers

- ▶ Controllers which are not inspired by existing acoustic instruments

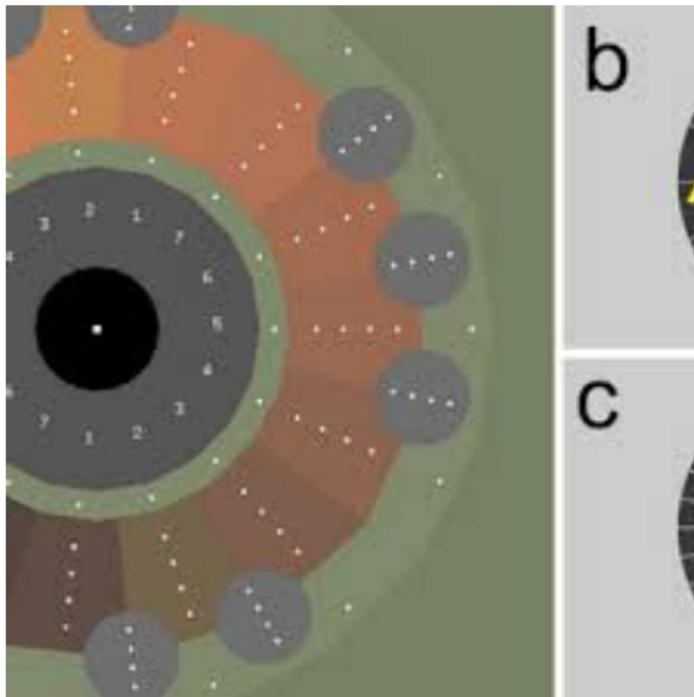
# Control Interfaces - Taxonomy

Otamaton



# Control Interfaces - Taxonomy

## Eyeharp



## Control Interfaces - Taxonomy

Myo



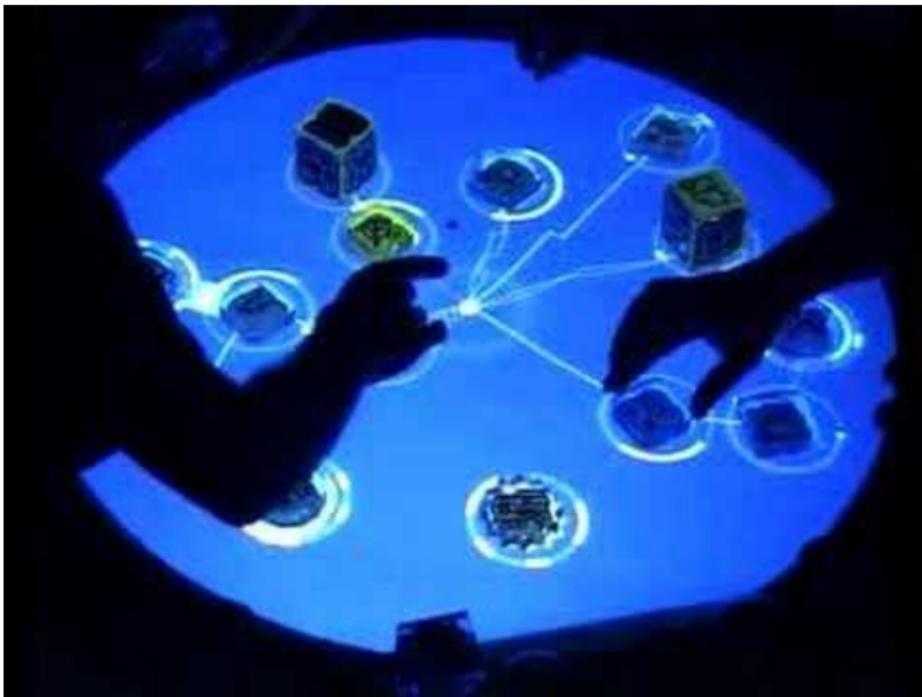
# Control Interfaces - Taxonomy

## EEG



# Control Interfaces - Taxonomy

Reactable



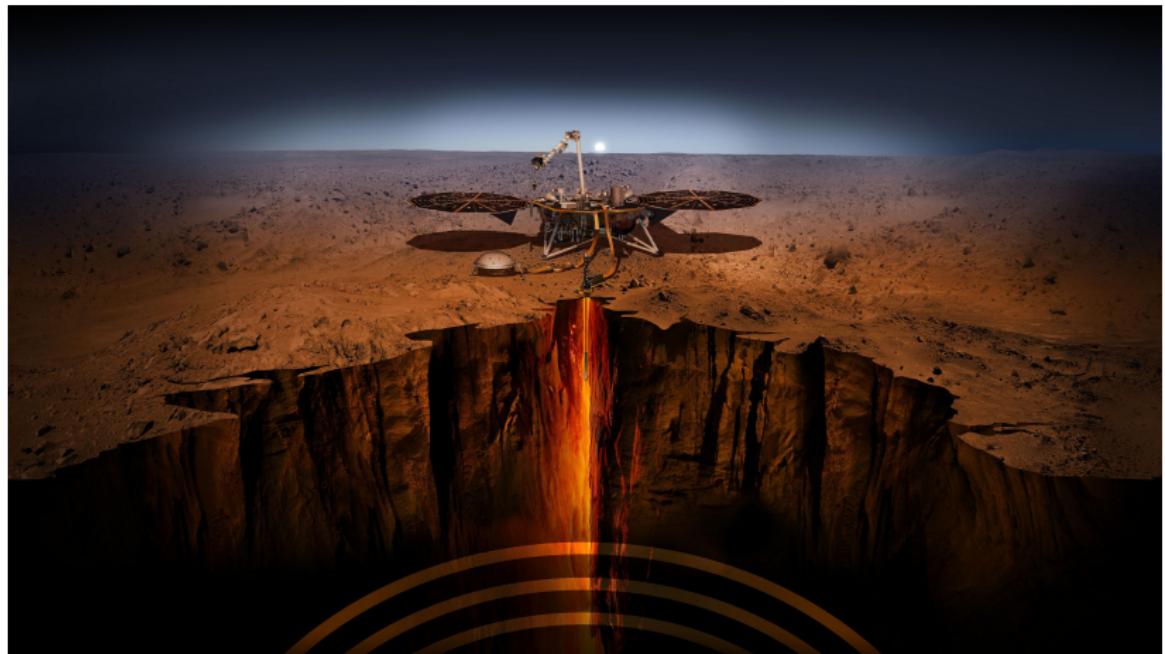
# Control Interfaces - Taxonomy

Computers as DMI interfaces?

- ▶ Live Coding
- ▶ Mierdofón

# Control Interfaces - Taxonomy

Mars InSight?



# Outline

Control Interfaces

    Definition

    Taxonomy

Electronics

    Sensors

    Basics

## Electronics - Sensors

"In the broadest definition, a sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics."<sup>4</sup>

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<sup>4</sup>Wikipedia, Sensors. <https://en.wikipedia.org/wiki/Sensor>

## Electronics - Sensors

*"Sensors are the 'sense organs of the machine'."<sup>5</sup>*

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<sup>5</sup>Bongers, A. J. "Interaction in multimedia art." Knowledge-Based Systems 13.7-8 (2000): 479-485.

## Electronics - Sensors

Sensors provide the way to convert measurable physical magnitudes "from our world" into quantified data understandable by a computer.

# Electronics - Sensors

DMI context: Vertegaal's sensor classification:<sup>6</sup>

- ▶ Physical property sensed
- ▶ Resolution of sensing<sup>7</sup>
- ▶ Type and amount of feedback provided

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<sup>6</sup>Vertegaal, Roel, Tamas Ungvary, and Michael Kieslinger. "Towards a musician's cockpit: Transducers, feedback and musical function." ICMC. Vol. 96. 1996.

<sup>7</sup>Sometimes *direction of sensing* is also considered.

# Electronics - Sensors

	<b>Physical Property</b>	<i>position</i>	<i>rotary position</i>	<i>velocity</i>	<i>rotary velocity</i>	<i>isometric force</i>	<i>isotonic force</i>	<i>isometric rotary force</i>	<i>isotonic rotary force</i>
<b>Resolution</b>	<i>discrete</i>	key button fader tablet	rotary switch bend sensor rotary pot abs. joystick mod. wheel	mouse trackpad	dial trackball	aftertouch pressure pad	accelero-meter	isometric joystick	pitch-bend wheel spring-mounted joystick
	<i>infinite</i>	tracker							

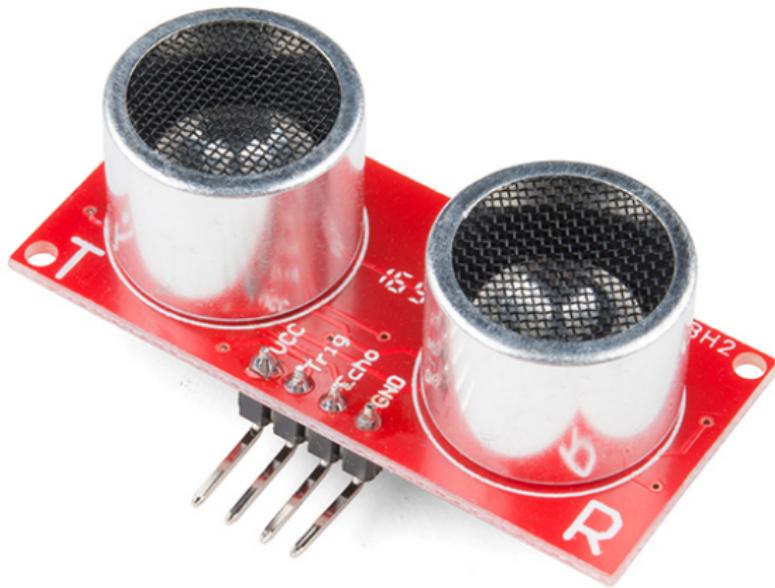
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\* *Isometric*: no motion is needed. *Isotonic*: motion is needed

from Vertegaal, Roel, Tamas Ungvary, and Michael Kieslinger. "Towards a musician's cockpit: Transducers, feedback and musical function." ICMC. Vol. 96. 1996.

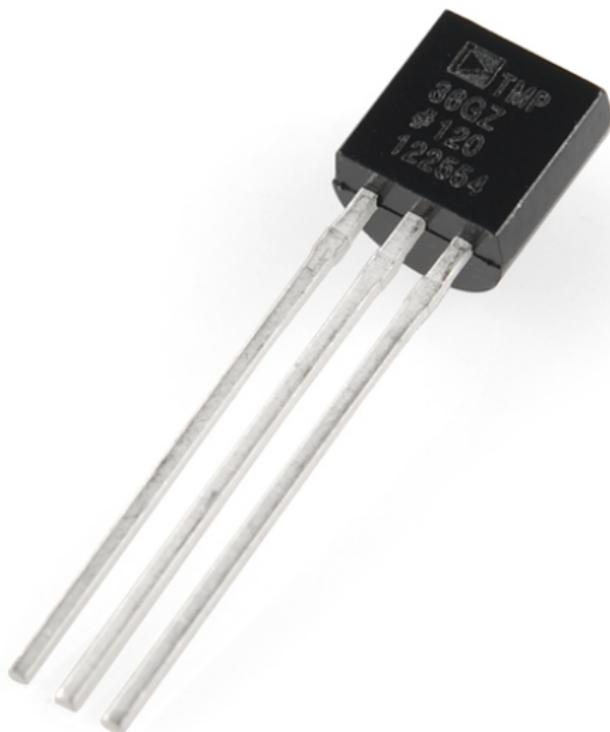
# Electronics - Sensors

## Ultrasonic Distance Sensor HC-SR04



# Electronics - Sensors

## Temperature Sensor TMP36



# Electronics - Sensors

## Photocell GL5528



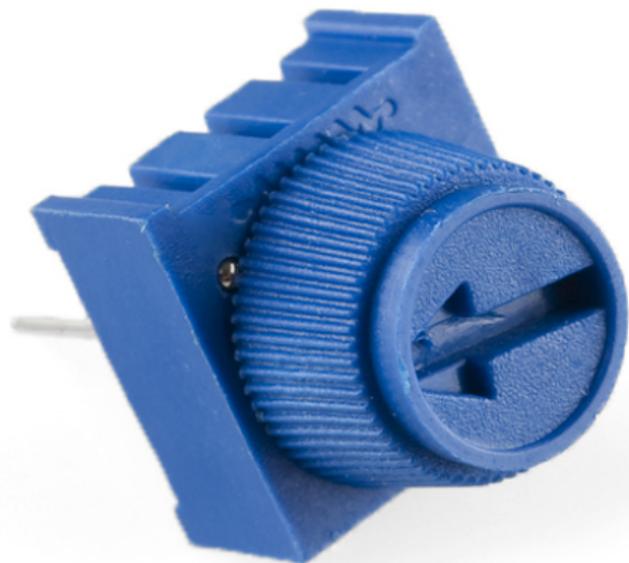
# Electronics - Sensors

## Button



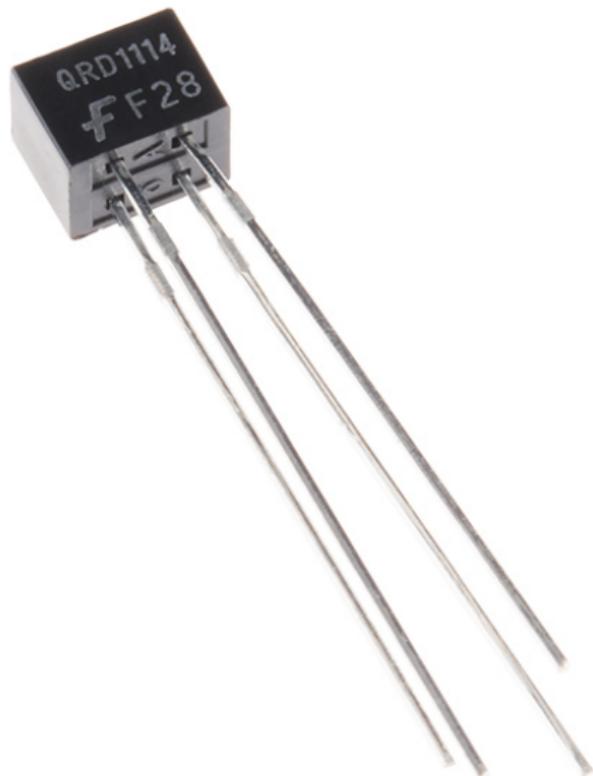
# Electronics - Sensors

## Trimpot



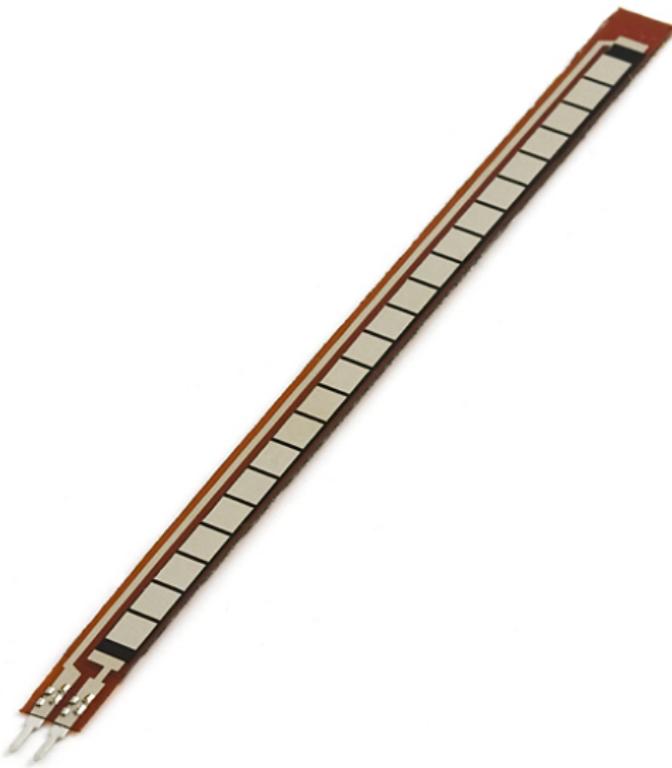
# Electronics - Sensors

Optical Detector / Phototransistor QRD1114



# Electronics - Sensors

## Flex Sensor FS7548



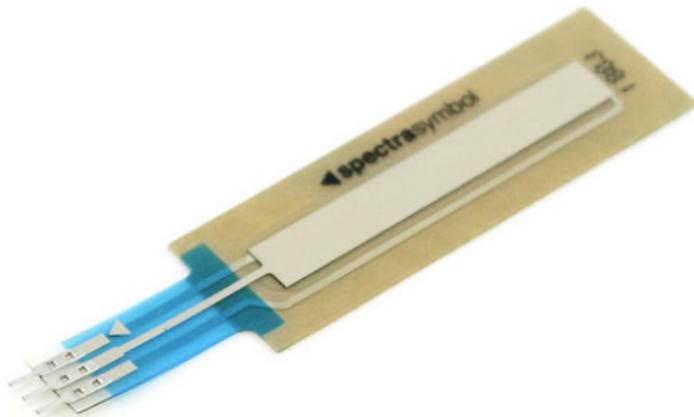
# Electronics - Sensors

## Reed Switch



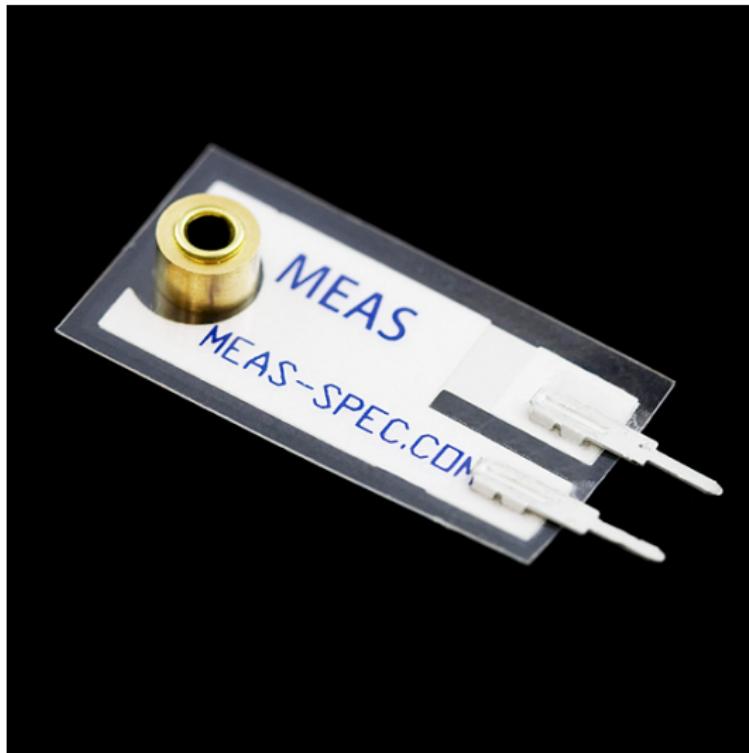
# Electronics - Sensors

## Softpot Membrane Potentiometer



# Electronics - Sensors

## Piezo Vibration Sensor



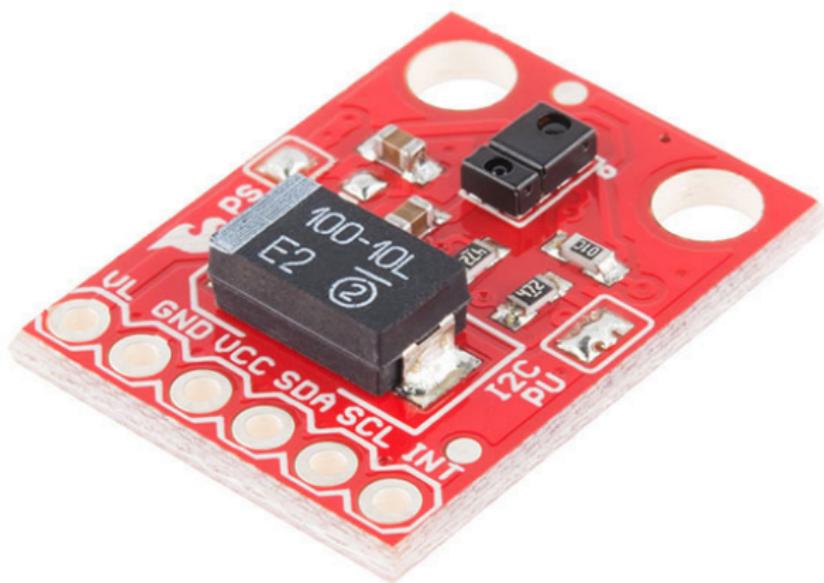
# Electronics - Sensors

## RGB and Gesture Sensor - APDS-9960



# Electronics - Sensors

## 9DoF IMU Breakout - LSM9DS1



# Electronics - Sensors

## Thumb Joystick



## Electronics - Basics

*"Electronics, branch of physics and electrical engineering that deals with the emission, behaviour, and effects of electrons and with electronic devices."<sup>8</sup>*

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<sup>8</sup>" electronics — Devices, Facts, & History". Encyclopedia Britannica. Accessed on 19/02/2019.

# Electronics - Basics

Three fundamental physical magnitudes:

- ▶ Voltage (V)  
Electric potential difference. Measured in *Volts (V)*.
- ▶ Current (I)  
Amount of transmitted charge per surface and time unit.  
Measured in *Amperes (A)*.
- ▶ Resistance (R) / Impedance (Z)  
Opposition to the electrical flow. Measured in *Ohms ( $\Omega$ )*.

# Electronics - Basics

Hydraulic analogy<sup>9</sup>:

- ▶ Voltage / Gravitational Potential
- ▶ Current / Flow Rate
- ▶ Resistance / Pipe constriction

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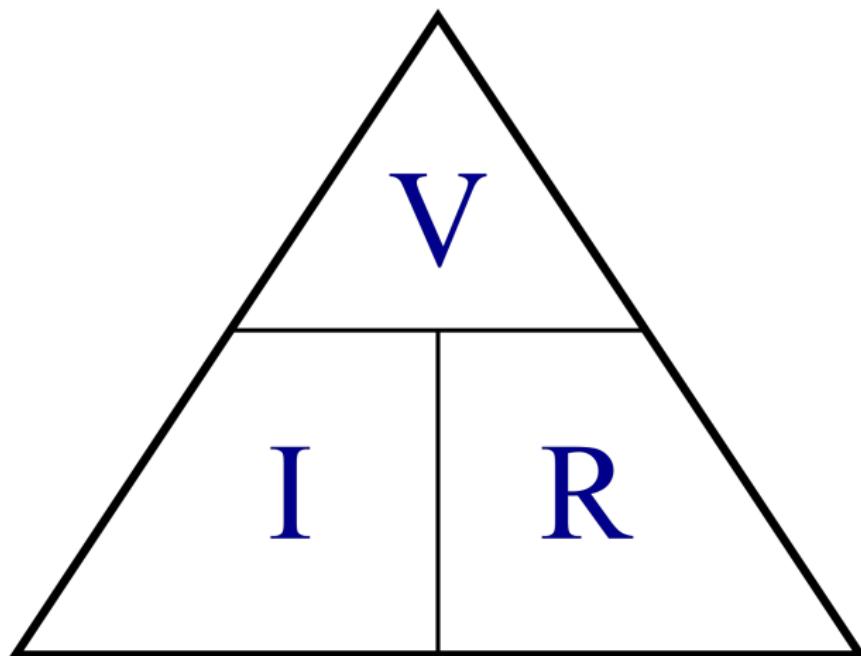
<sup>9</sup>Wikipedia. Hydraulic analogy.

[https://en.wikipedia.org/wiki/Hydraulic\\_analogy](https://en.wikipedia.org/wiki/Hydraulic_analogy). Accessed 19/02/2019

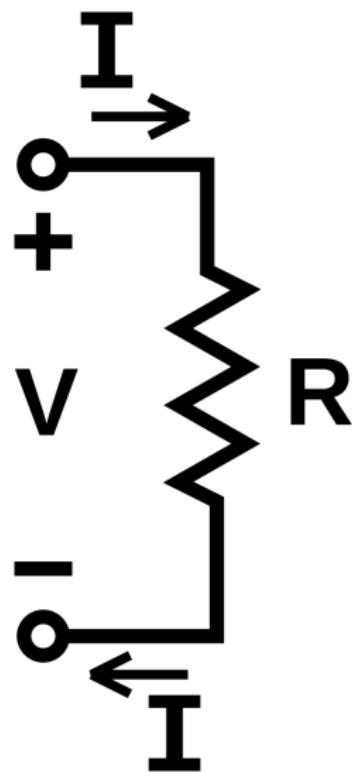
# Electronics - Basics

Ohm's Law

$$V = IR$$



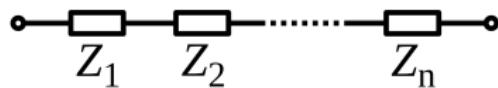
# Electronics - Basics



# Electronics - Basics

## Combining impedances

Series:

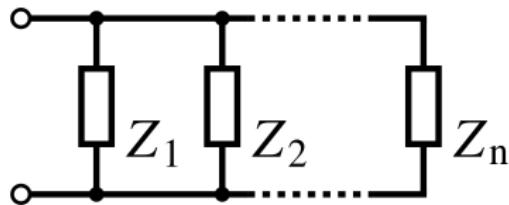


$$Z_{eq} = Z_1 + Z_2 + \dots + Z_N$$

# Electronics - Basics

## Combining impedances

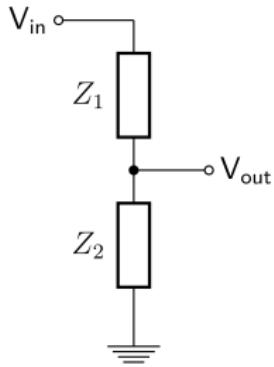
Parallel:



$$\frac{1}{Z_{eq}} = \frac{1}{Z_1} + \frac{1}{Z_2} + \dots + \frac{1}{Z_N}$$

# Electronics - Basics

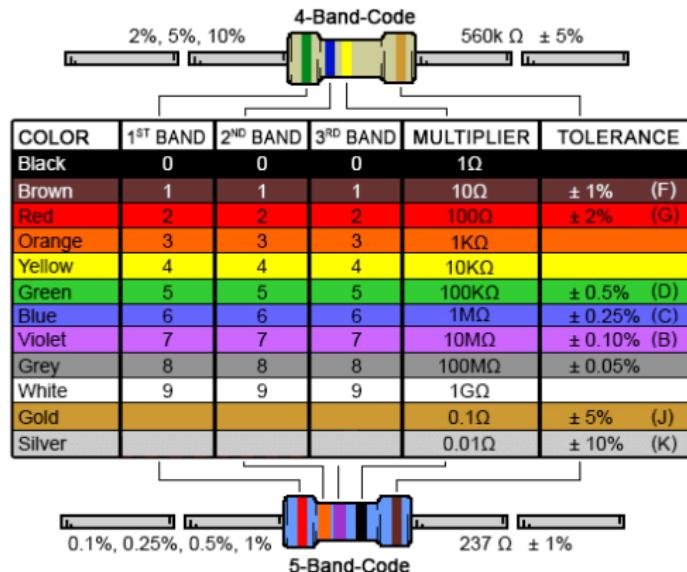
## Voltage Divider



$$V_{out} = \frac{Z_2}{Z_1 + Z_2} V_{in}$$

# Electronics - Basics

## Resistor Color Chart



Digi-Key, 4 Band Resistor Color Code Calculator.

<https://www.digikey.com/en/resources/conversion-calculators/conversion-calculator-resistor-color-code-4-band>.

## Electronics - Basics

*"Arduino is an open-source electronics platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects."<sup>10</sup>*



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<sup>10</sup><https://www.arduino.cc/>