Sensing

-

Options for WSN

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Calibration & making sense

If we need absolute values,

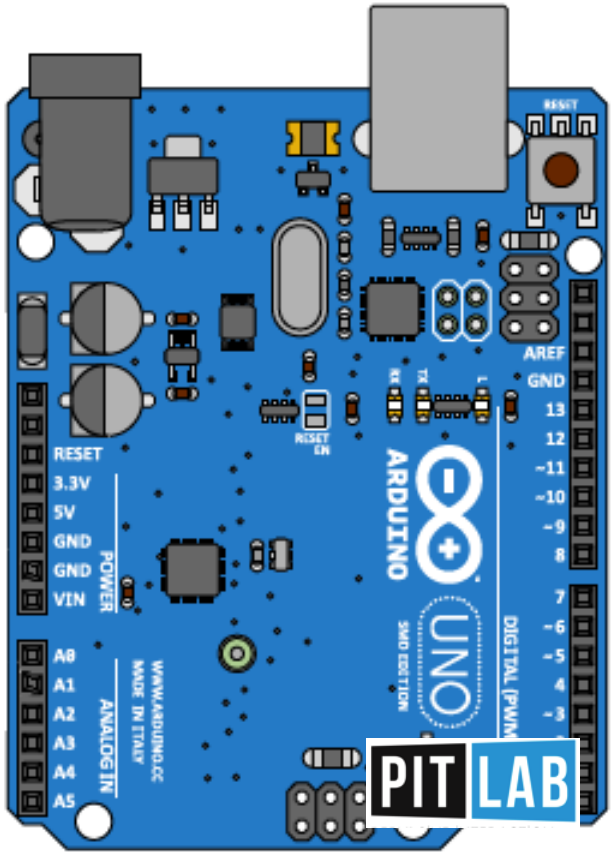
we need

calibration against a trusted reference system.

More points to consider:

- **Linearity**
- **Drift over time**
- **Saturation**
- **Dependency on other environmental factors**

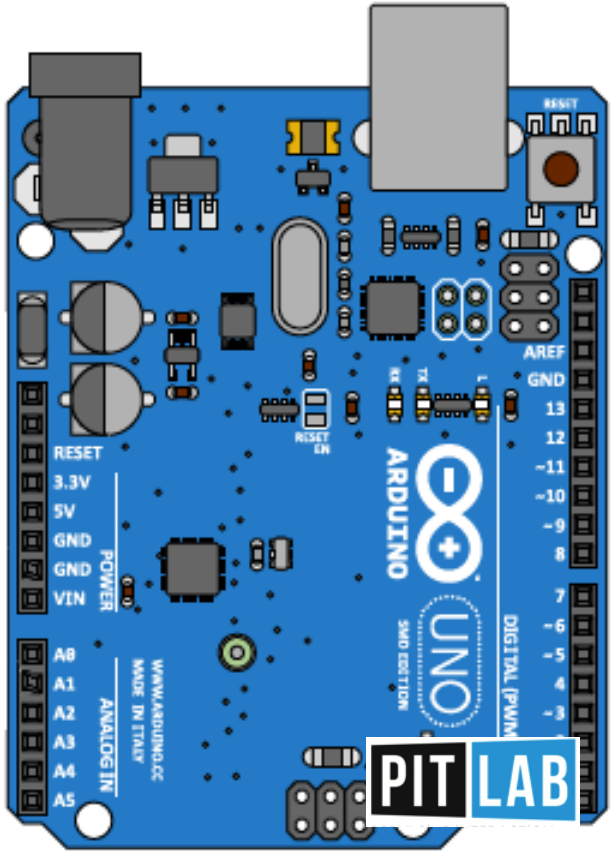
So what do we know so far?



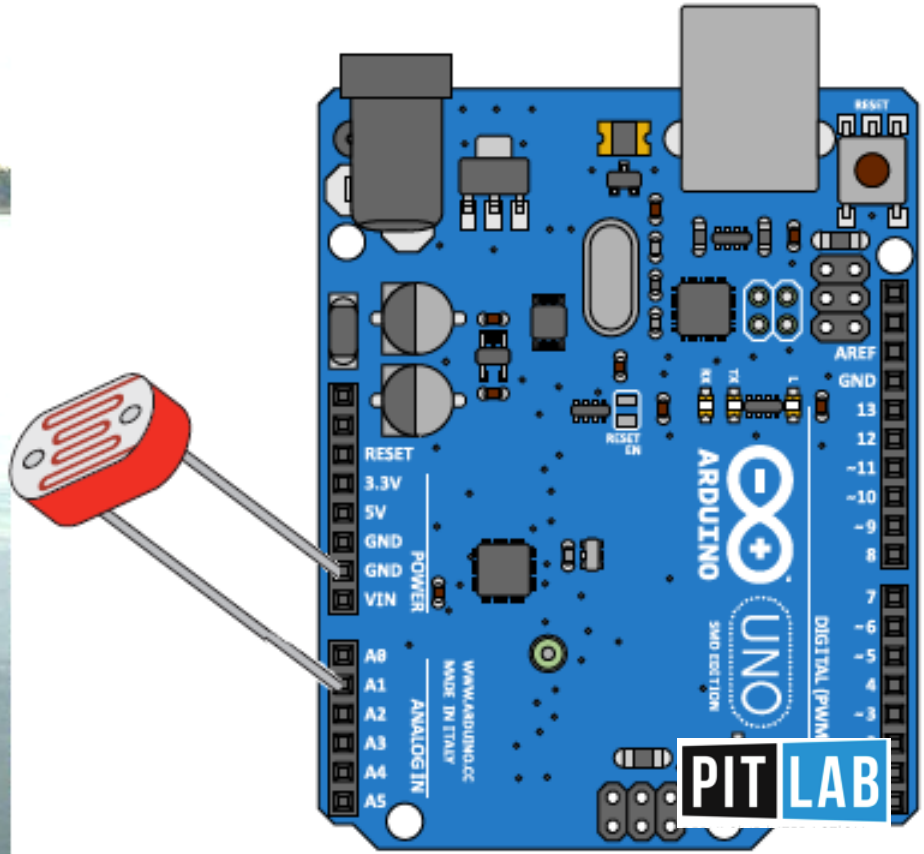
So what do we know so far?

We have a world out there

And a board on the other side



Inbetween we have a sensor



Definition of a sensor

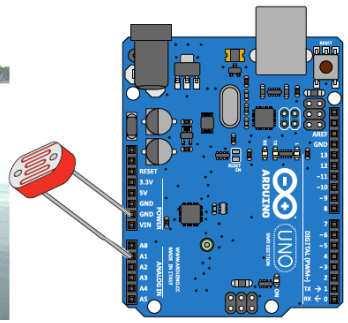
A **sensor** is a converter

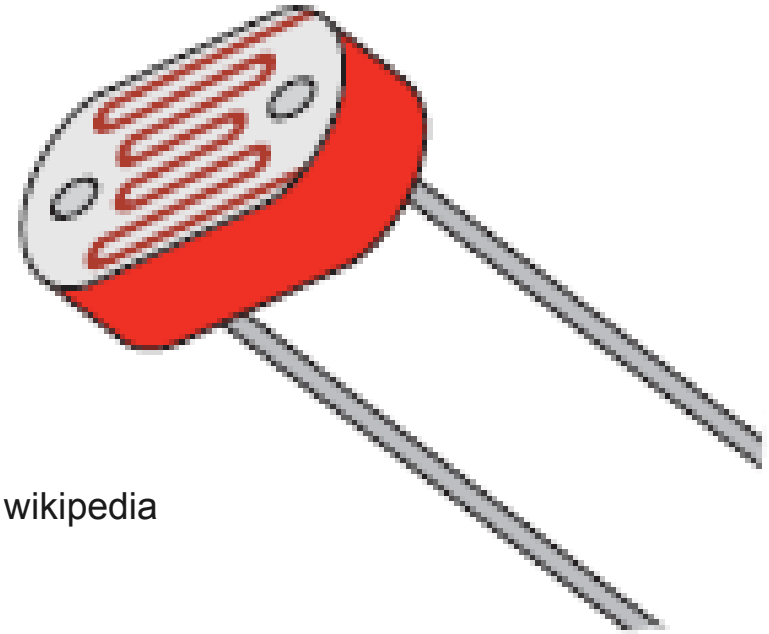
that **measures a physical quantity**

and **converts it into a signal**

which can be read by an observer

or by an (today mostly electronic) instrument.





Source: wikipedia

For the board ...

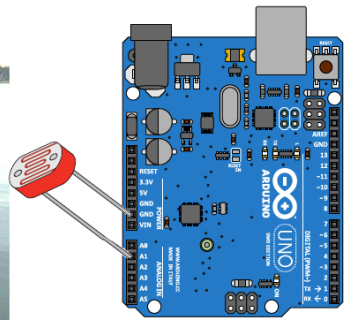
... the **sensor** is just something that provides a voltage to the boards' analog inputs.

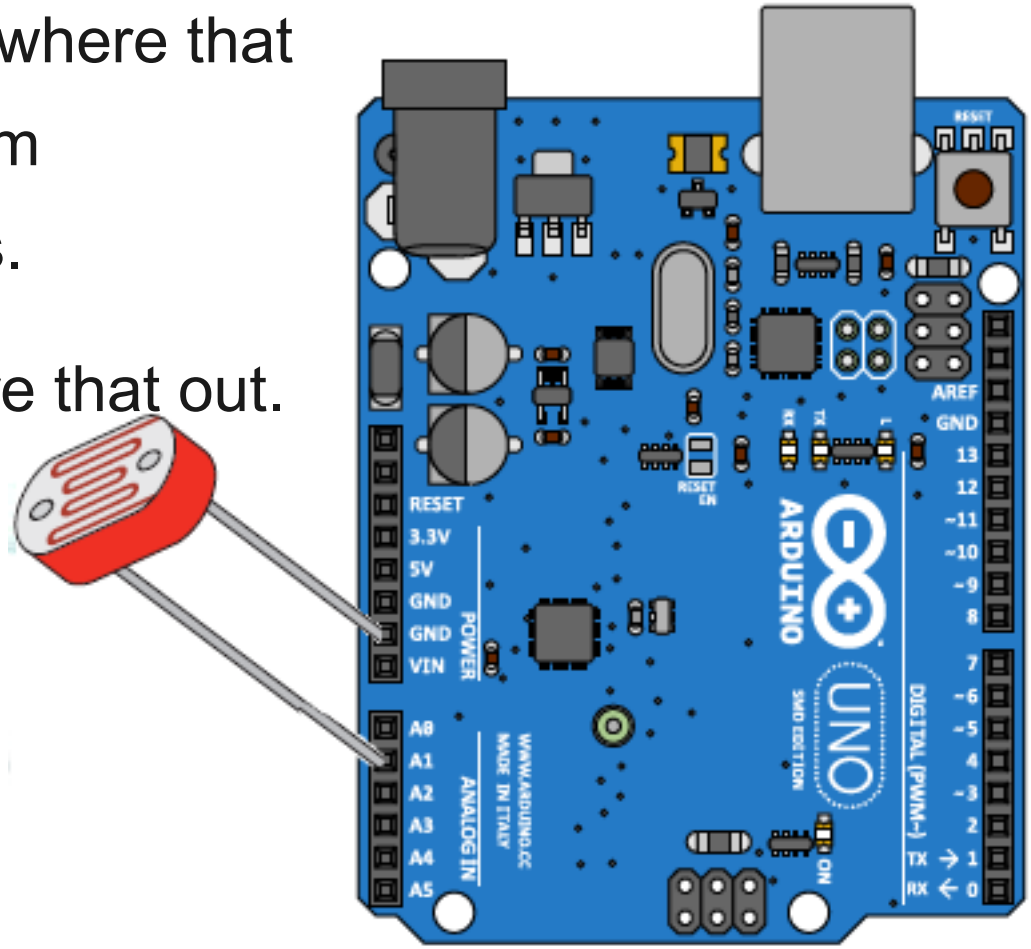
It does not care where that

value comes from

or what it means.

We have to figure that out.

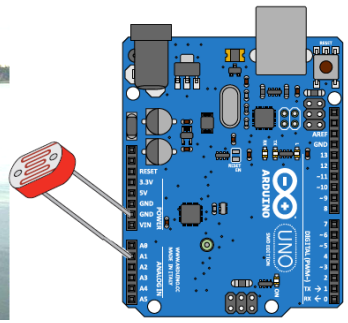


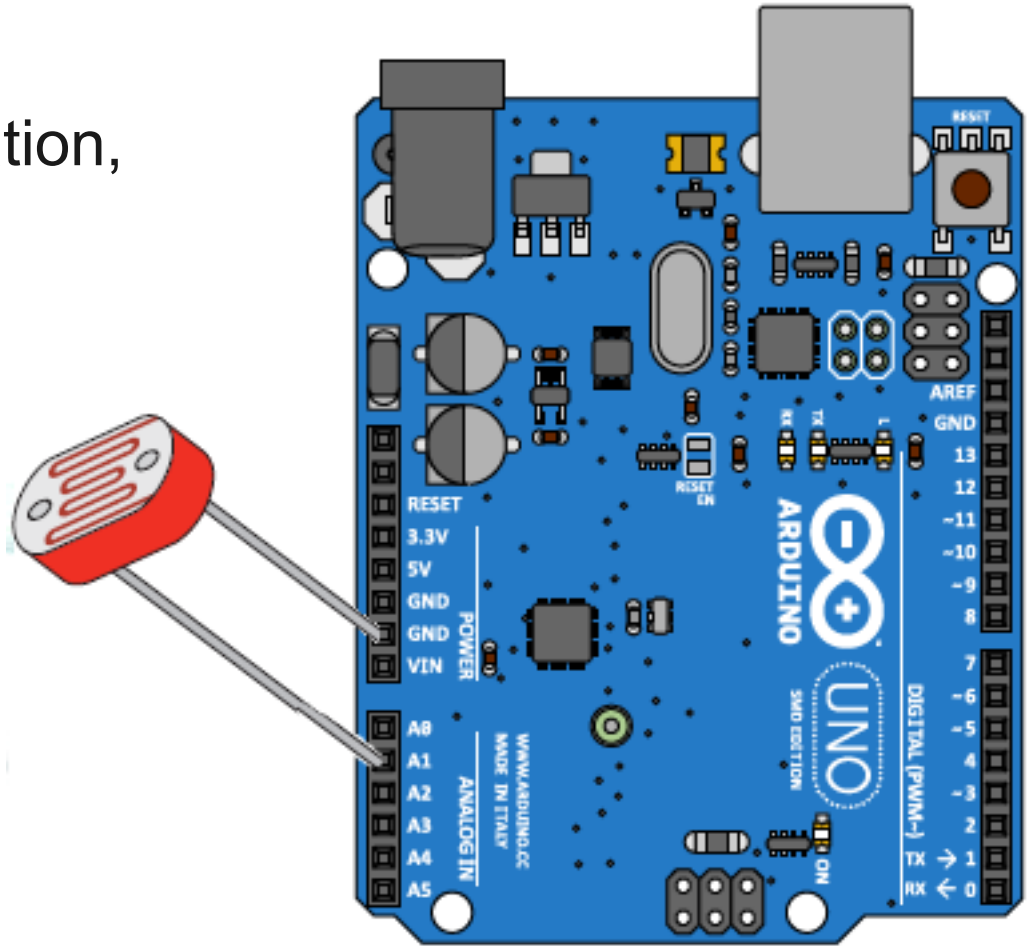


In this talk

... focus only on analog sensors – there are also digital ones

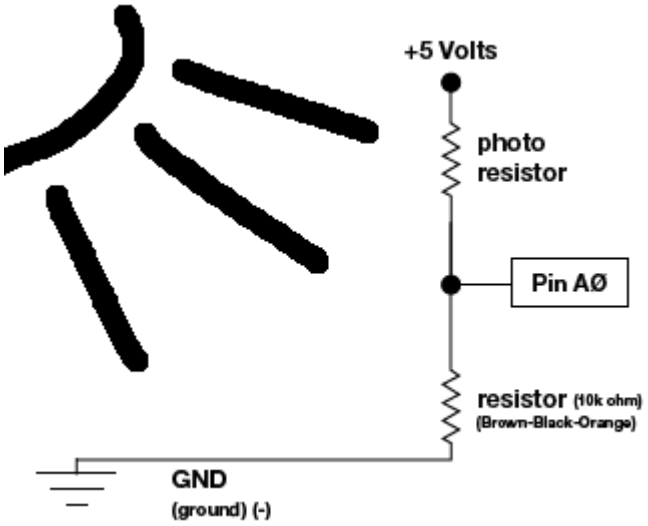
... no focus on
data communication,
processing,
management





An example: sensing light

A Light Dependant Resistor
changes its resistance dependant on light intensity.
We build a little voltage divider, and read a voltage.



It gives us a value from, say, 200 to 800 ...

Now, what does that mean?

From real word to voltage

There are several steps on the way:

Physical property (e.g. Light)

--->

Physical effect that processes this property

(e.g. Light dependent electronic property)

--->

Some form of translation to an output voltage

--->

Voltage goes to analog input

Calibration

The value we are measuring only makes sense with some form of **calibration.**

A simple form of calibration could be:

Put it into total darkness and call that ZERO.

Put it into the brightest light and call it MAXIMUM.

But, neither the one or the other means something absolute.

Why not?

What can we do about it?

Calibration & making sense

If we need absolute values,

we need

calibration against a trusted reference system.

More points to consider:

- **Linearity**
- **Drift over time**
- **Saturation**
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Calibration & making sense

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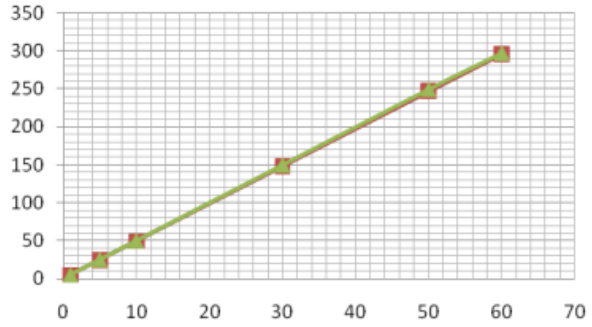

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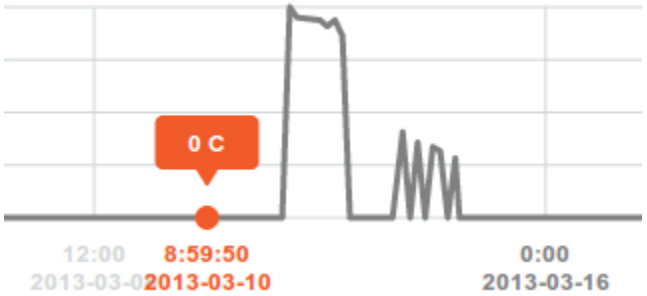


Data collection without

Making sense of data is meaningless.

An example discussion

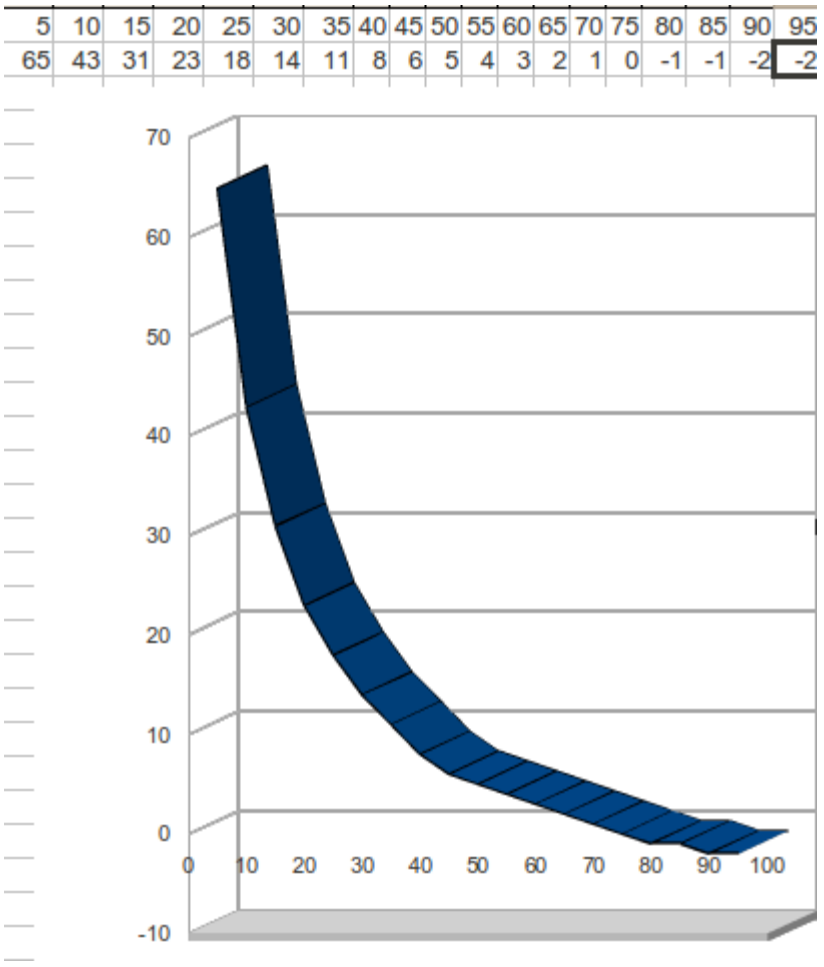
This is a time series over 100 ms,

measuring the decay of light

in a fluorescent material

after exposure to LED light.

What **are** we measuring?



Sensors: Problematic features

- Moving parts
- Windows, optical surfaces
- Anything a bird can sit and *** on
- Sensors exposed to drastic environmental changes (e.g. under water <-> on dry land)

Overview over sensors

Property: What we aim to measure

Physical effect: The effect we are using to measure it

Sensor: some examples

Sources:
http://sparkfun.com

http://satistronics.com

And others listed at

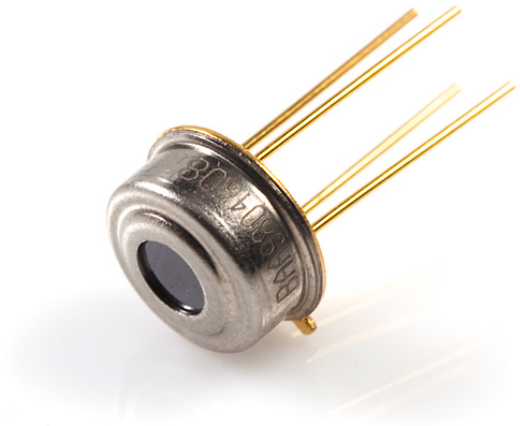
http://pitlab.itu.dk/content/sensors

Temperature

Property: Temperature

Physical effect: Infrared radiation (non-touching), thermoelectrical effects

Sensors:



Distance

Property: Distance

Physical effect: Ultrasonic reflection

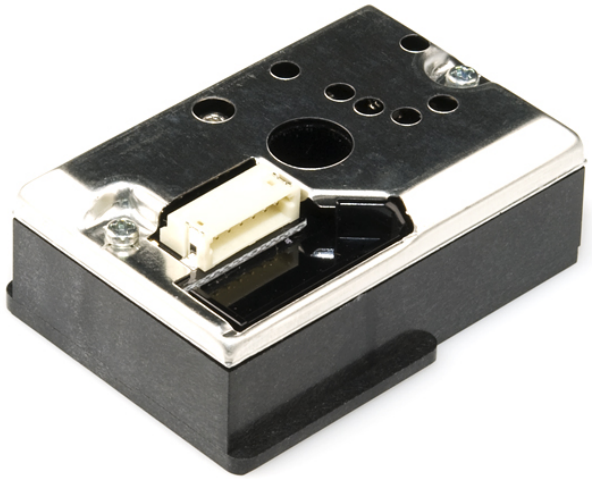
Sensors:

Dust

Property: Dust particles in air

Physical effect: Optical (light scattering etc)

Sensors:

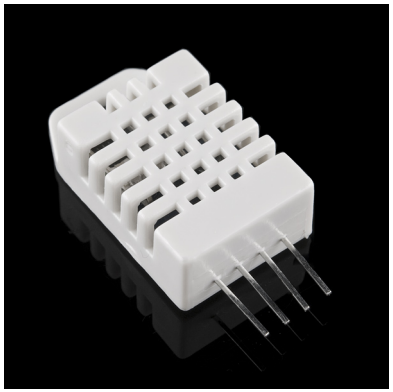


Humidity

Property: Air humidity

Physical effect: Capacitative

Sensors:

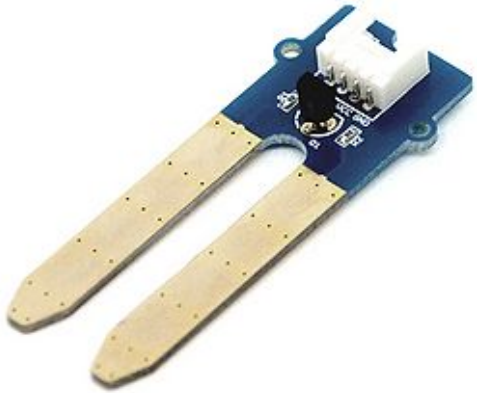


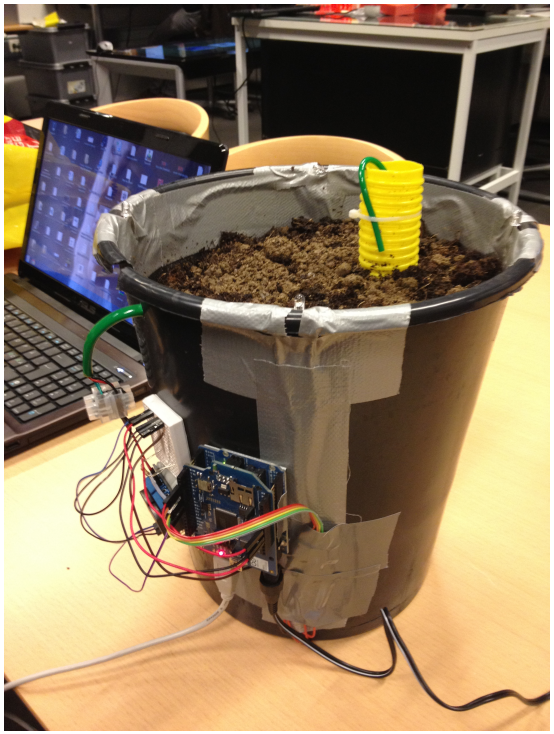
Moisture

Property: Moisture in soil

Physical effect: Resistance

Sensors:





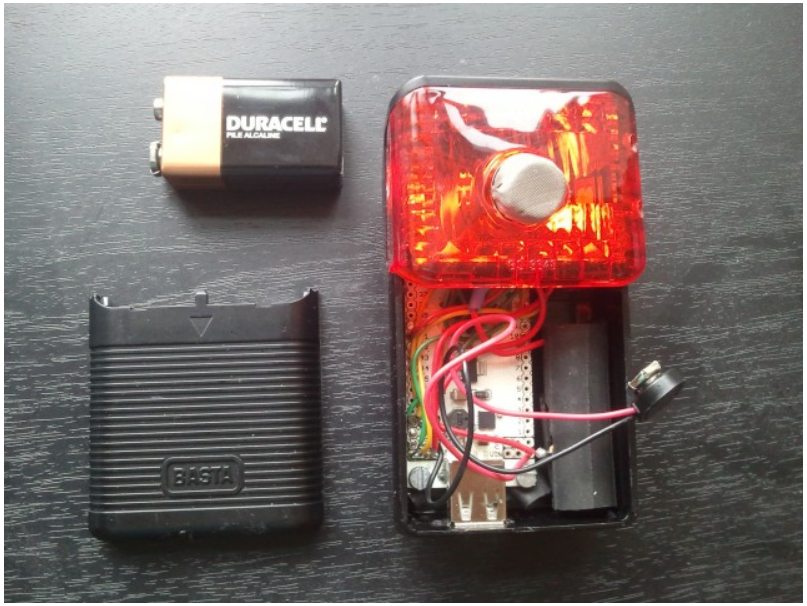
e.g. http://iPlant.dk

Air quality

Property: Gas concentrations

Physical effect: Many, e.g. resistive

Sensors:



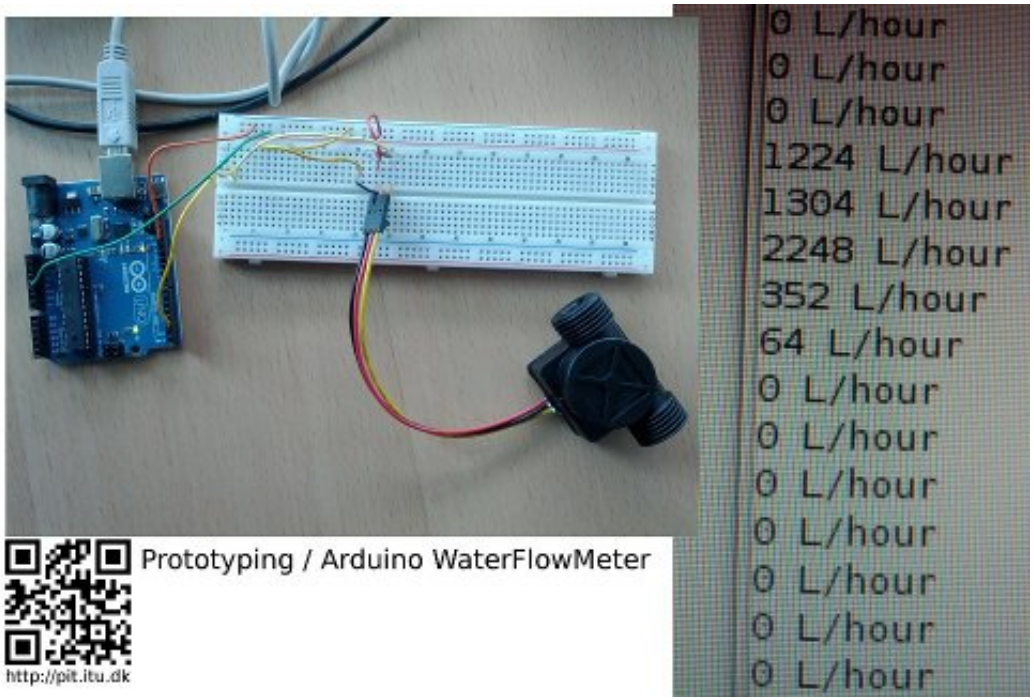
e.g. **http://noxdroid.org**

Water flow

Property: Flow through tube

Physical effect: Induction

Sensors:

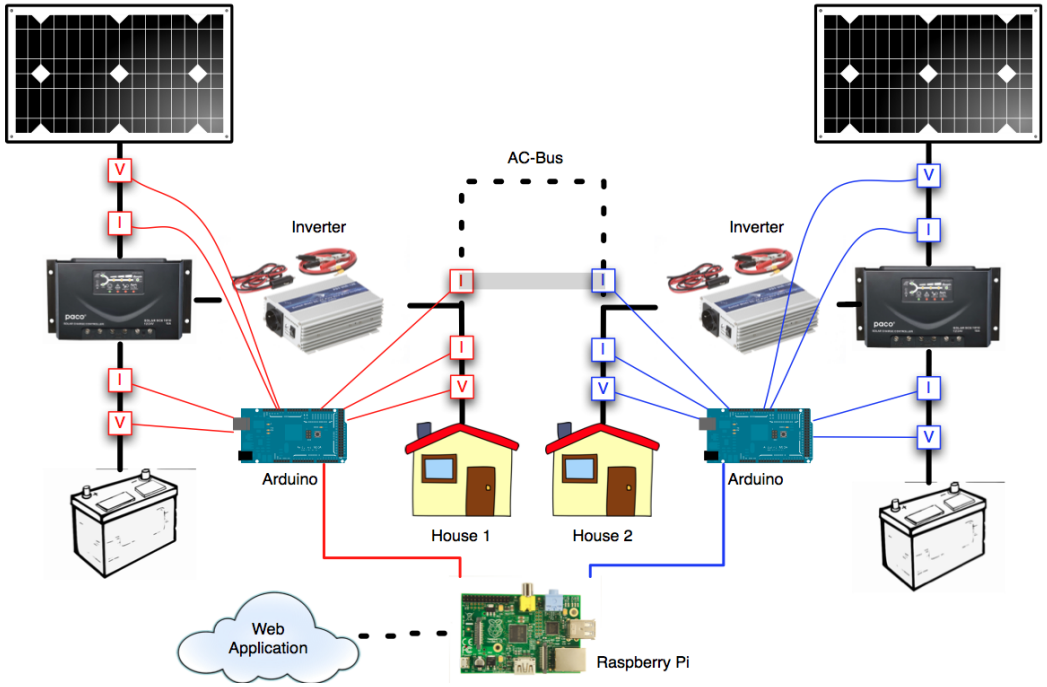


Current

Property: Current through wire

Physical effect: Hall effect

Sensors:



Other standard sensors

What we have not shown:

Acceleration

Force, flex

Touch, Proximity

Heart rates and other bio/medicine

And many many more ...

Sensors we are exploring ...

Challenge:

to get

from closed expensive data

to open affordable data

if we want citizens data and environmental research to come together,

we can not work with sensor stations for $10,000.

Example: water, lakes, ...

pH: https://code.google.com/p/phduino/

Dissolved oxygen:
https://www.sparkfun.com/products/11194

Various:
http://www.circuitlake.com/polysensor-low-cost-water-impurities-tester.html

Nutrients?

Heavy Metals?

Example: water, lakes, ...

MANA Wetlabs WQM

IT UNIVERSITY OF COPENHAGEN

PIT LAB

Arduino - sensors

We keep a little list at: http://pitlab.itu.dk/content/sensors

Arduino and similar platforms are a relevant choice for prototyping and deploying sensors and (wireless or wired) sensor networks. As an inspiration, not as a complete list, here are some suggestions for how one would measure ...

1.1 ... Air pollution

http://www.satistronics.com/air-quality-control-sensor-mq135_p2770.html

1.2 ... Current

Non-invasive, clip-on:
http://www.sparkfun.com/products/10341

1.3 ... Distance

MaxSonar Ultra Sonic Range finders
http://www.maxbotix.com/products.htm