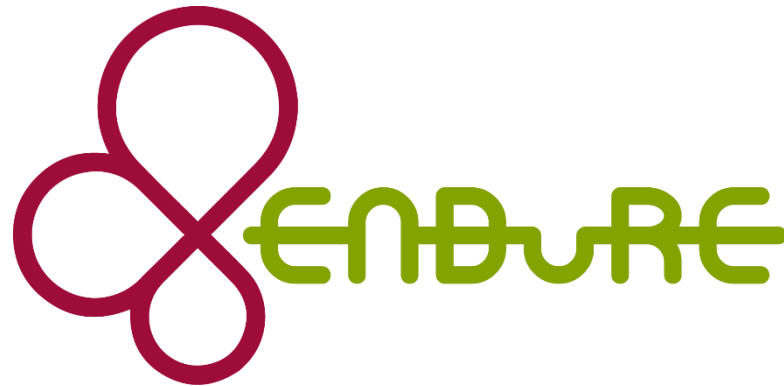




Designing connected devices

Daniele Mazzei



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of the European Union

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Connected Devices

- **Purpose-specific physical** products that exist as part of a digital **service** ecosystem
- Fully featured devices such as phones, tablets and mini PC sit slightly outside of this...



*From: Designing Connected Products, IAN BACH
<https://madebymany.com/blog/designing-connected-products>*

Make it smart!



Forget The Things

- Ignore all the possible design outputs for a minute!
- Lets start from the beginning...
- A connected product is a physical device, with a digital service at it's heart



**It is an exercise in service/experience design,
nothing more, nothing less...**

*From: Designing Connected Products, IAN BACH
<https://madebymany.com/blog/designing-connected-products>*

Exercise 1

- Describe your connected device in less than 5 words:

The perfect security system for every home.

Meet Canary. The all-in-one home security system you control from your phone. It's built to learn and sends intelligent alerts with HD video and audio directly to your phone.

[Learn More](#)

[▶ Watch video](#)



Exercise 1

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[Learn More](#)

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home security system you control from your phone



Find the differences



Exercise 2: list the functionalities



- Control
- ...
- ...



- Show
- ...
- ...

Find the differences



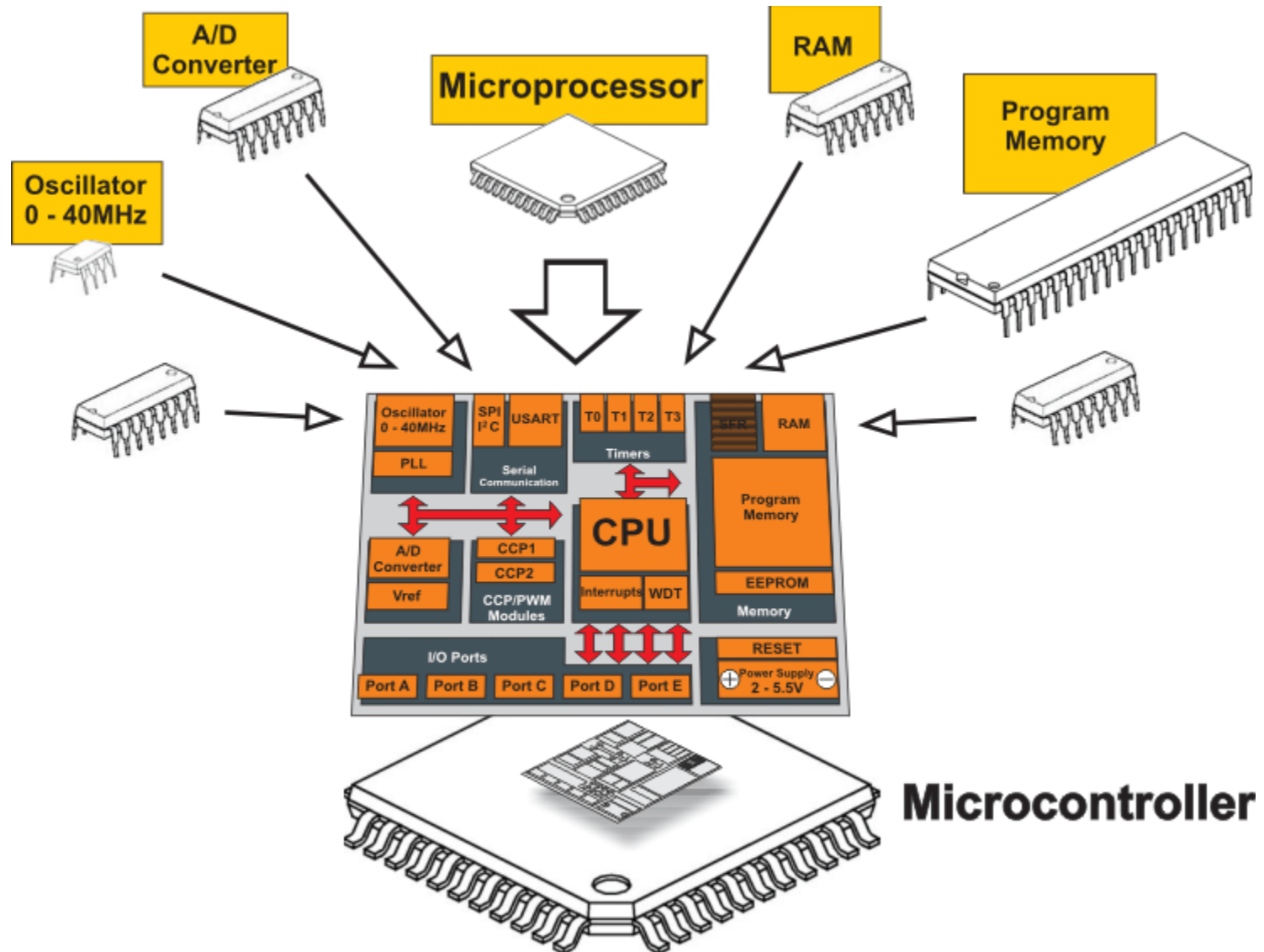
What is a MicroController?

- A **microcontroller** is a small computer (SoC) on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips.
- Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems.
- (from Wikipedia)

What is a MicroProcessor?

- A **microprocessor** is a computer processor that incorporates the functions of a computer's central processing unit (CPU) on a single integrated circuit (IC),^[1] or at most a few integrated circuits.^[2] The microprocessor is a multipurpose, clock driven, register based,programmable electronic device that accepts digital data or binary data as input, processes it according to instructions stored in its memory, and provides results as output. Microprocessors contain both combinational logic and sequential digital logic. Microprocessors operate on numbers and symbols represented in the binary numeral system.
- The integration of a whole CPU onto a single chip or on a few chips greatly reduced the cost of processing power. Integrated circuit processors are produced in large numbers by highly automated processes resulting in a low per unit cost. Single-chip processors increase reliability as there are many fewer electrical connections to fail. As microprocessor designs get faster, the cost of manufacturing a chip (with smaller components built on a semiconductor chip the same size) generally stays the same.
- (from Wikipedia)

MicroController Vs MicroProcessors



MicroController Vs MicroProcessors

Microprocessor vs. Microcontroller

Microprocessor

- CPU is stand-alone, RAM, ROM, I/O, timer are separate
- Designer can decide on the amount of ROM, RAM and I/O ports.
- Expansive
- Versatility
- General-purpose

Microcontroller

- CPU, RAM, ROM, I/O and timer are all on a single chip
- Fix amount of on-chip ROM, RAM, I/O ports
- For applications in which cost, power and space are critical
- Not Expansive
- Single-purpose

Exercise 3: How things are made

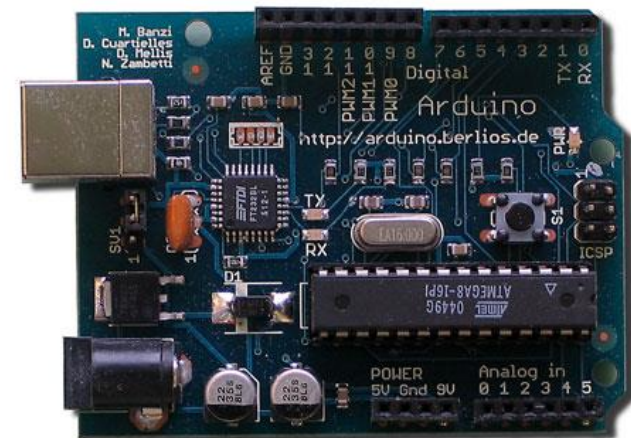
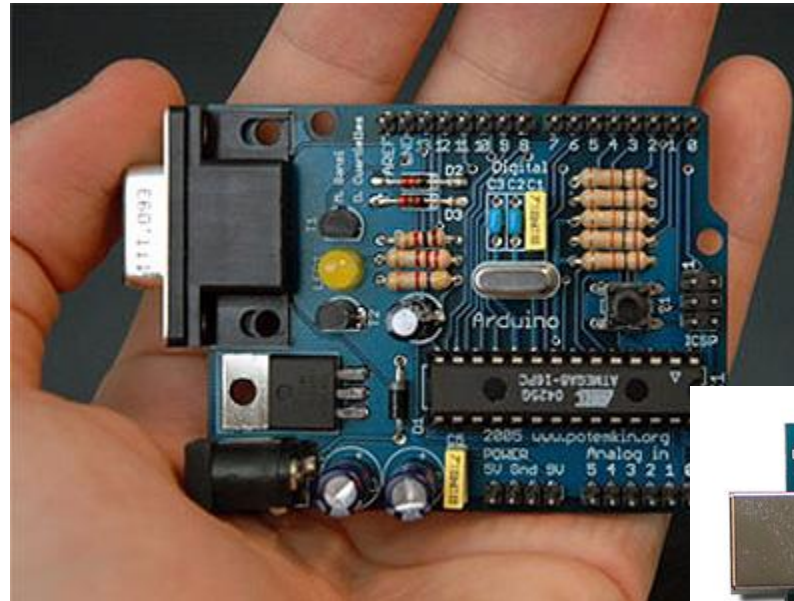
- List 5 products based on MCU and 5 based on MPU

What is Arduino?

- *"Arduino is an open-source physical computing platform based on a simple i/o board and a development environment that implements the Processing / Wiring language. Arduino can be used to develop stand-alone interactive objects or can be connected to software on your computer."*
(www.arduino.cc, 2006)

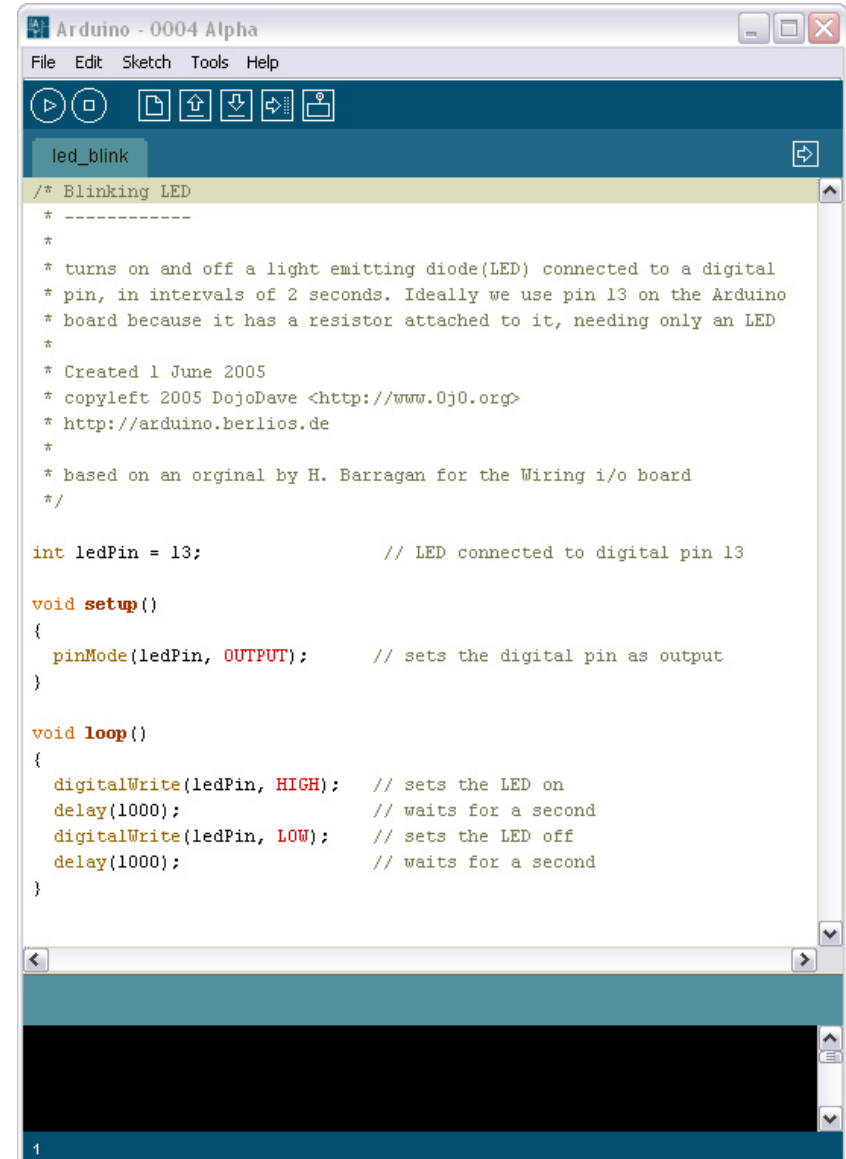
Arduino is a platform

- A physical Input / Output board (I/O) with a programmable Integrated Circuit (IC).



Arduino is a platform

- Also including an Integrated Development Environment (IDE) for programming.
- The language itself is based on C but is largely modeled upon the www.processing.org language.

A screenshot of the Arduino IDE window titled "Arduino - 0004 Alpha". The window has a menu bar with "File", "Edit", "Sketch", "Tools", and "Help". Below the menu bar is a toolbar with icons for running, stopping, saving, opening, and other functions. The main text area shows a sketch named "led_blink" with the following code:

```
/* Blinking LED
 * -----
 *
 * turns on and off a light emitting diode(LED) connected to a digital
 * pin, in intervals of 2 seconds. Ideally we use pin 13 on the Arduino
 * board because it has a resistor attached to it, needing only an LED
 *
 * Created 1 June 2005
 * copyleft 2005 DojoDave <http://www.0j0.org>
 * http://arduino.berlios.de
 *
 * based on an original by H. Barragan for the Wiring i/o board
 */

int ledPin = 13;           // LED connected to digital pin 13

void setup()
{
  pinMode(ledPin, OUTPUT); // sets the digital pin as output
}

void loop()
{
  digitalWrite(ledPin, HIGH); // sets the LED on
  delay(1000);                // waits for a second
  digitalWrite(ledPin, LOW);  // sets the LED off
  delay(1000);                // waits for a second
}
```

The bottom of the window shows a black area for serial output, with a line number "1" visible at the bottom left.

What I can do with it?

Digital IO (LEDs, switches)

Analog IO (analog sensor data)

Serial Connection (Digital Sensors, GPS, etc)

Program from your computer

The limit is your creativity!

What are microcontrollers used for?

- Physical Computing projects / research
- Interactive Installations
- Rapid prototyping
- When you wish to move beyond the traditional Mouse, Keyboard and Monitor to develop novel and custom interactions in your project work.

What can I do with it?

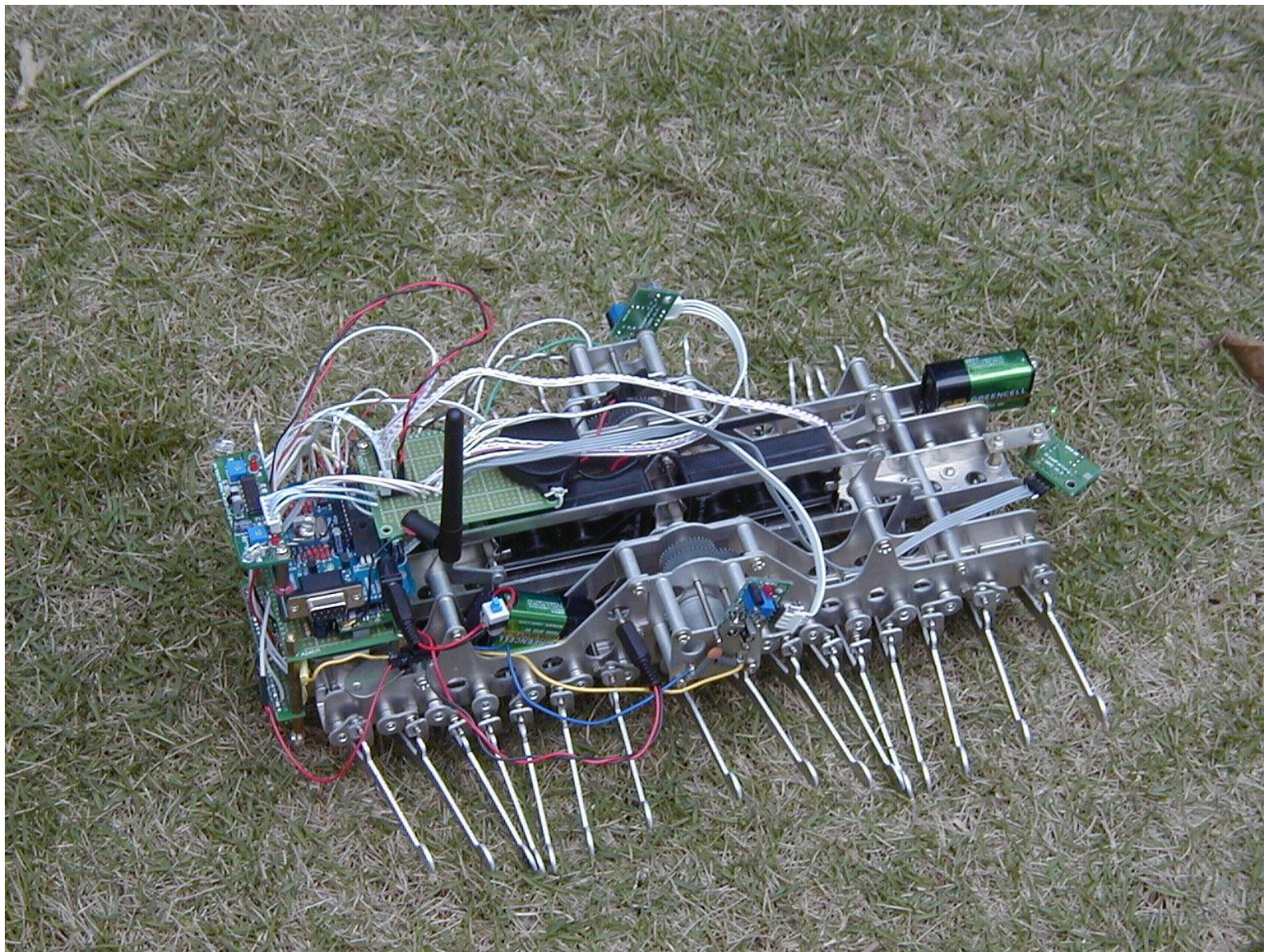
- **Sensors** (to sense)
 - Push buttons, touch pads, tilt switches.
 - Variable resistors (eg. volume knob / sliders)
 - Photoresistors (sensing light levels)
 - Thermistors (temperature)
 - Ultrasound (proximity range finder)
- **Actuators** (to act)
 - Lights, LED's
 - Motors
 - Speakers
 - Displays (LCD)

Why Arduino or similar?

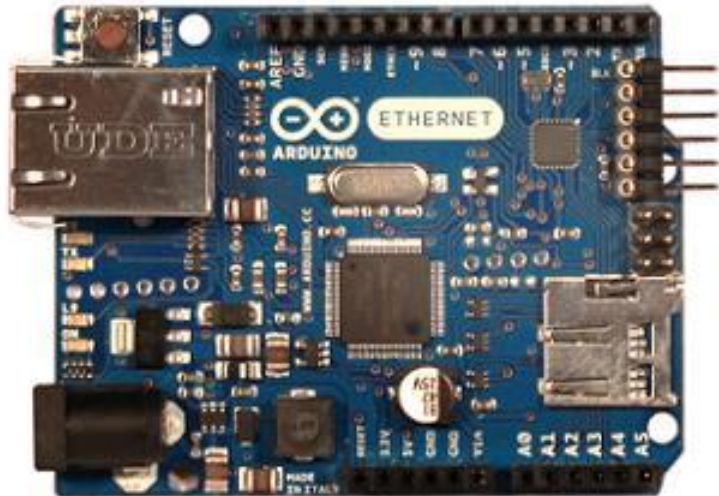
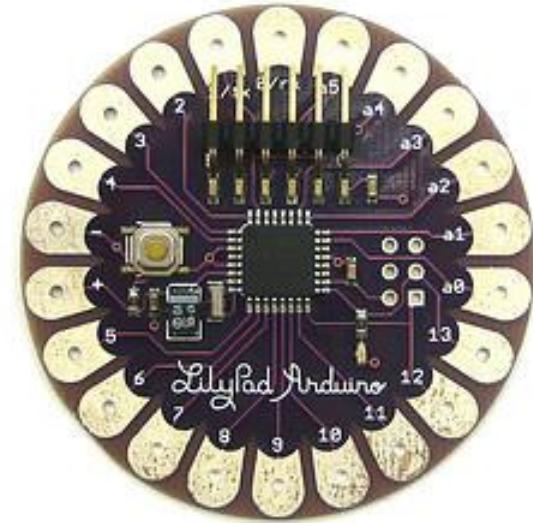
- It is Open Source, both in terms of Hardware and Software.
- It is cheap, the hardware can be built from components or a prefab board can be purchased for approx 20€
- It can communicate with a computer via serial connection over USB, ethernet, wifi, bluetooth, xbee, etc.
- It can be powered from USB or standalone DC power.

Why Arduino or similar?

- It can run standalone from a computer (chip is programmable) and it has memory (a small amount).
- It can work with both Digital and Analogue electronic signals. Sensors and Actuators.
- You can make cool stuff! Some people are even making simple robots, and we all know robots are just cool. 😊



Arduino Boards





View saved



The MPU boards

- Not in this course... Why?

The MPU boards

- Not in this course..... Why?

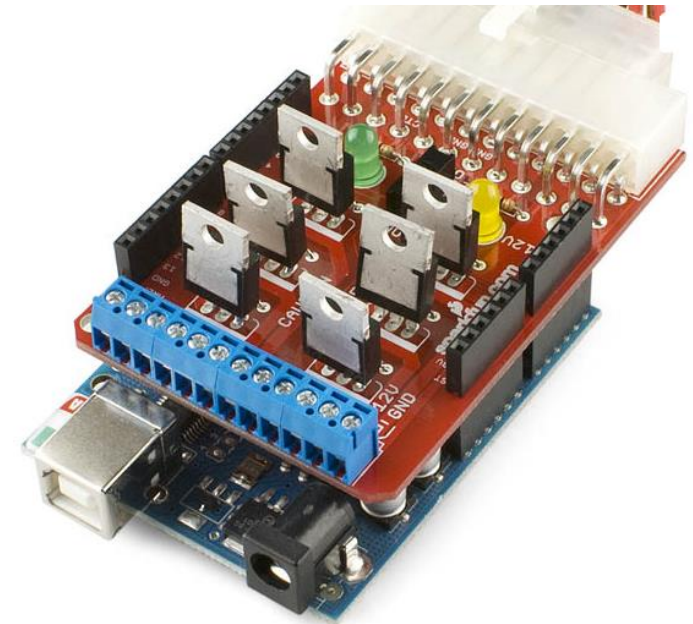
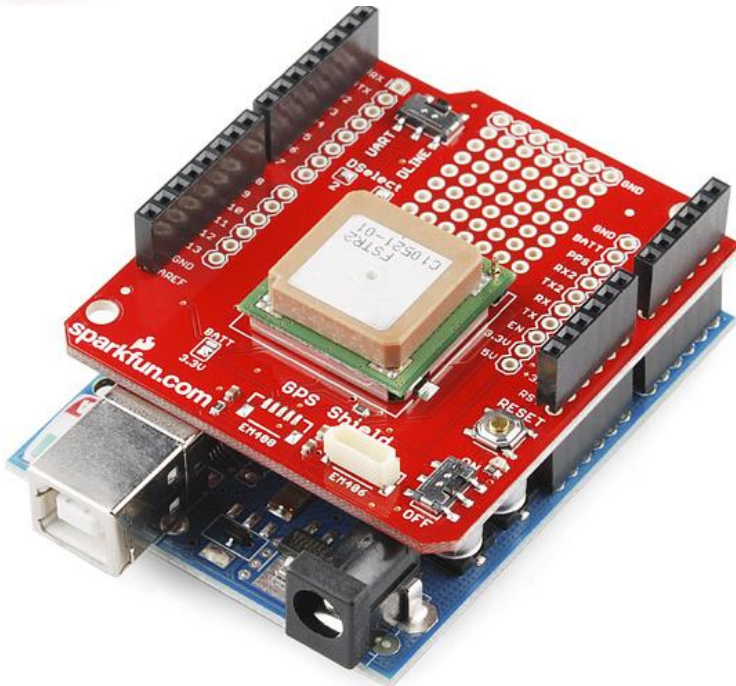
Connected Products

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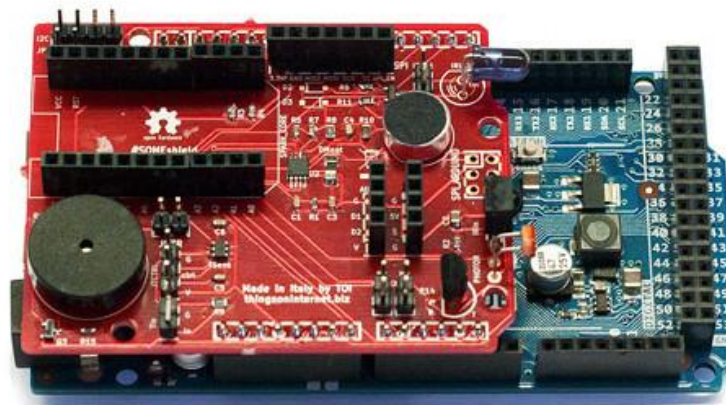
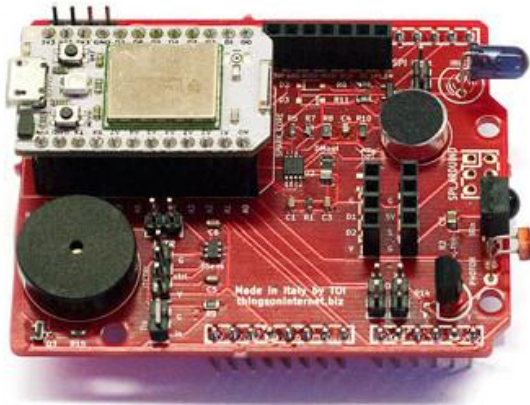
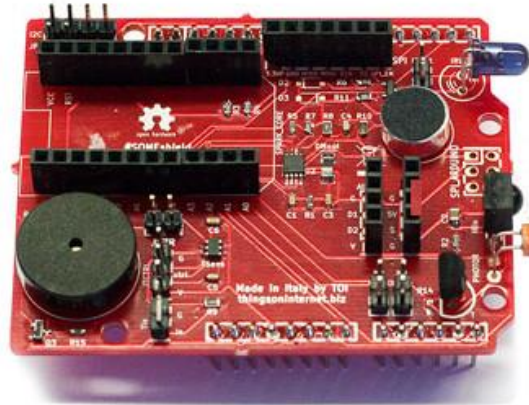
Terminology

- I/O Board - main microcontroller
- Shield - add-on boards
- Sketch - the program
- Sensor - components (thermistors, etc.)
- Modules - serial data (GPS module, etc.)

Shields



Shields



toi
SMARTIFY YOUR WORLD

Shields



More Shields...



XBee Shield

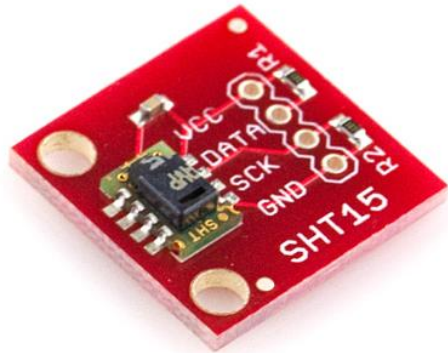


Ethernet Shield

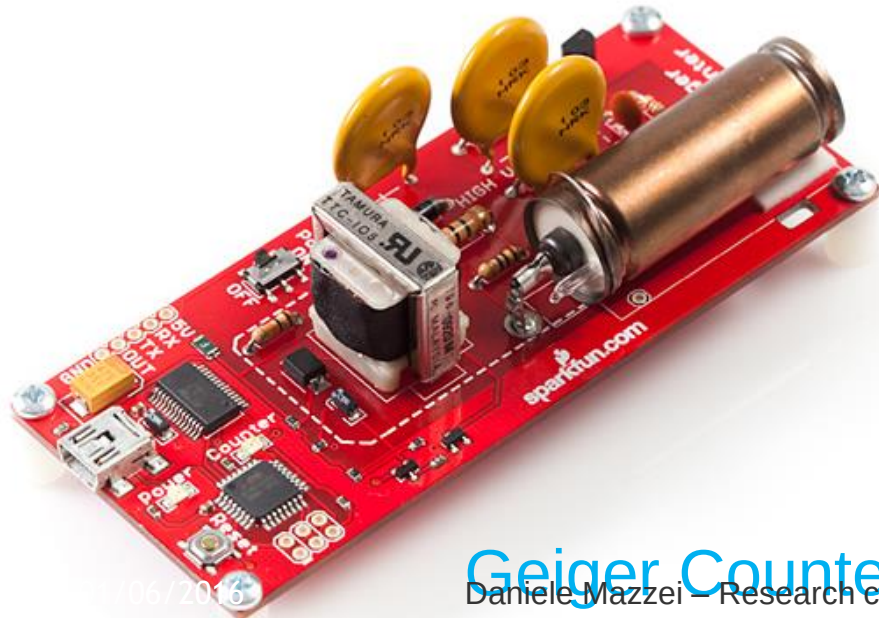


Wifi Shield

Breakout boards



Temp & Humidity



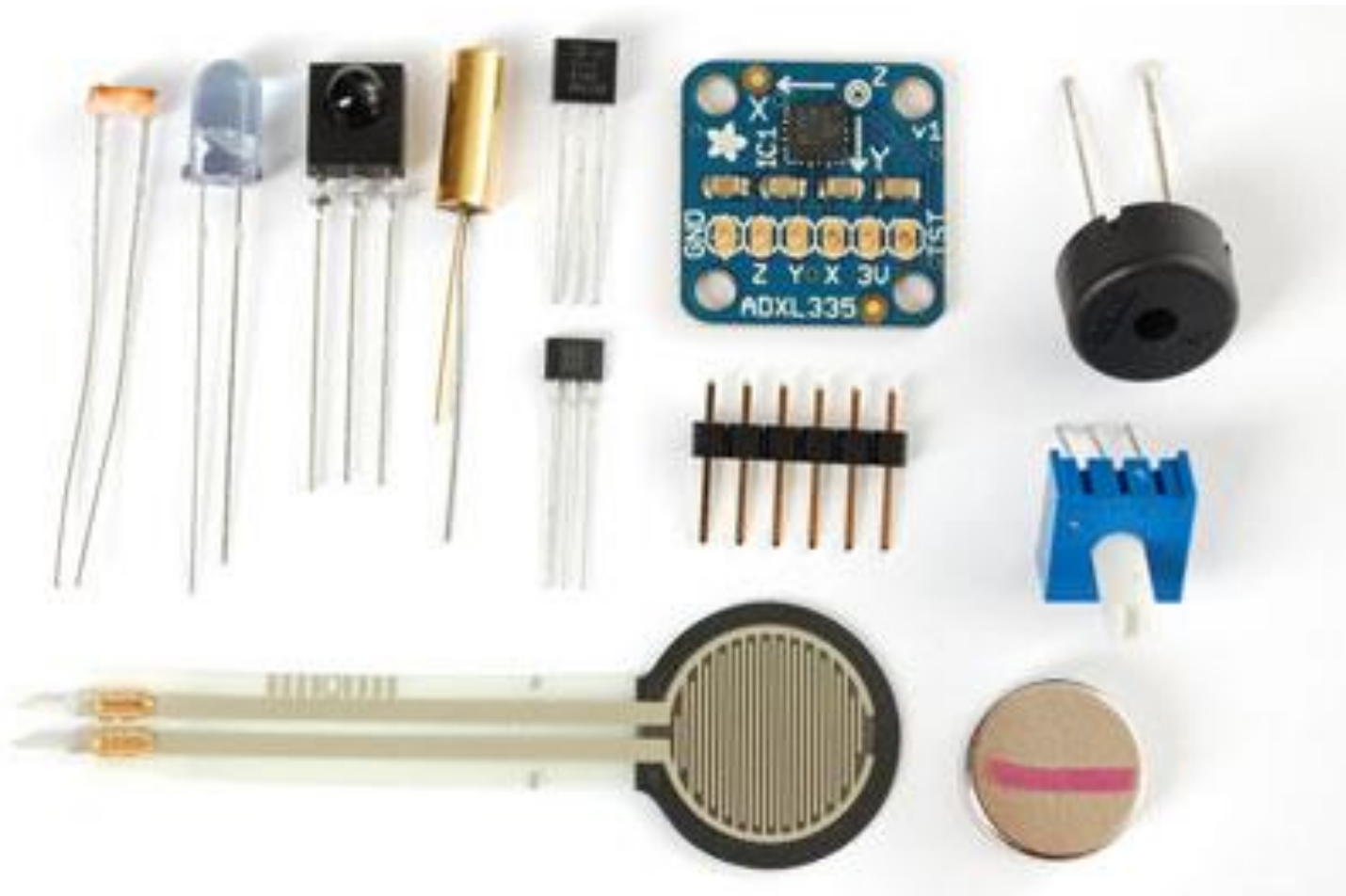
Geiger Counter

Fingerprint Scanner



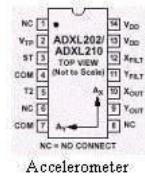
Sensors

Photo/thermistor, infrared, force sensitive resistor, Hall effect, Piezo, tilt sensor..



Know the physics of your product!

- Sensors are just world analysers!



Accelerometer



Gyro



Pendulum Resistive Tilt Sensors



Piezo Bend Sensor



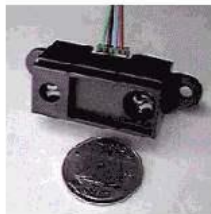
Metal Detector



Gas Sensor



Gieger-Muller Radiation Sensor



Digital Infrared Ranging



CDS Cell Resistive Light Sensor



Resistive Bend Sensors



UV Detector



Pyroelectric Detector



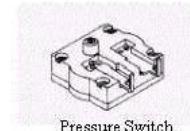
Limit Switch



Mechanical Tilt Sensors



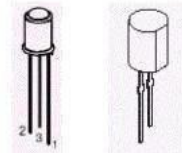
Touch Switch



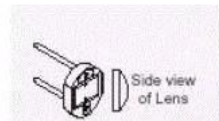
Pressure Switch



Miniature Polaroid Sensor



IR Pin Diode



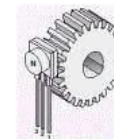
IR Sensor w/lens



Thyristor



Magnetic Sensor



Hall Effect Magnetic Field Sensors



Polaroid Sensor Board



IR Reflection Sensor



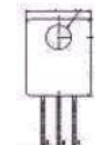
IR Amplifier Sensor



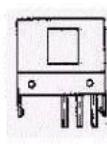
IRDA Transceiver



Magnetic Reed Switch



Lite-On IR Remote Receiver



Radio Shack Remote Receiver



IR Modulator Receiver



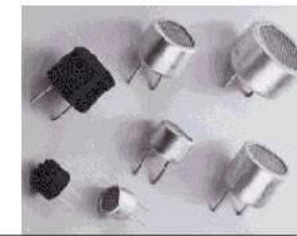
Solar Cell



Compass



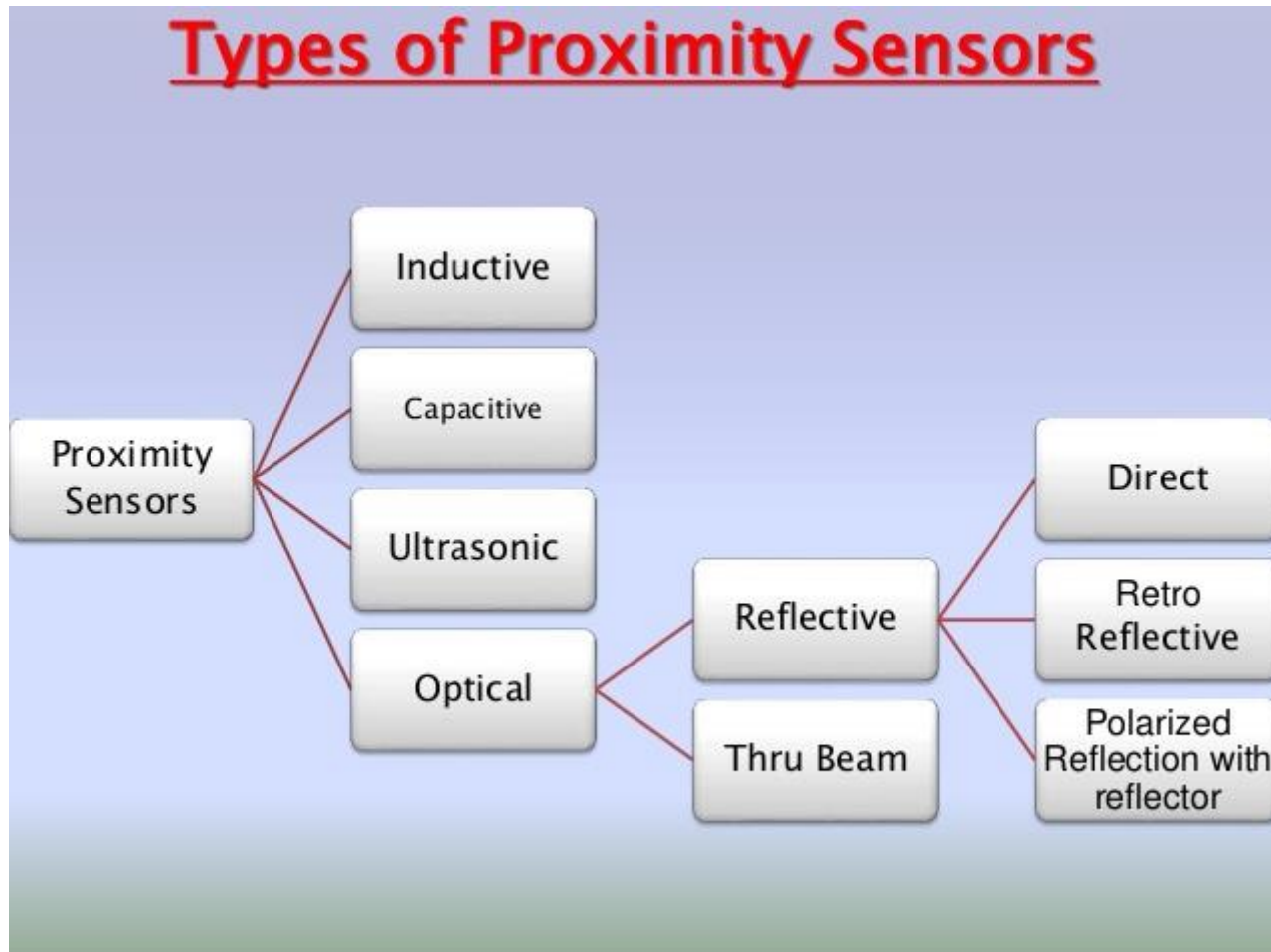
Compass



Optimized by: www.ImageOptimizer.net

Chose a sensor

- You need to chose what you realy want to measure... The sensor comes later...



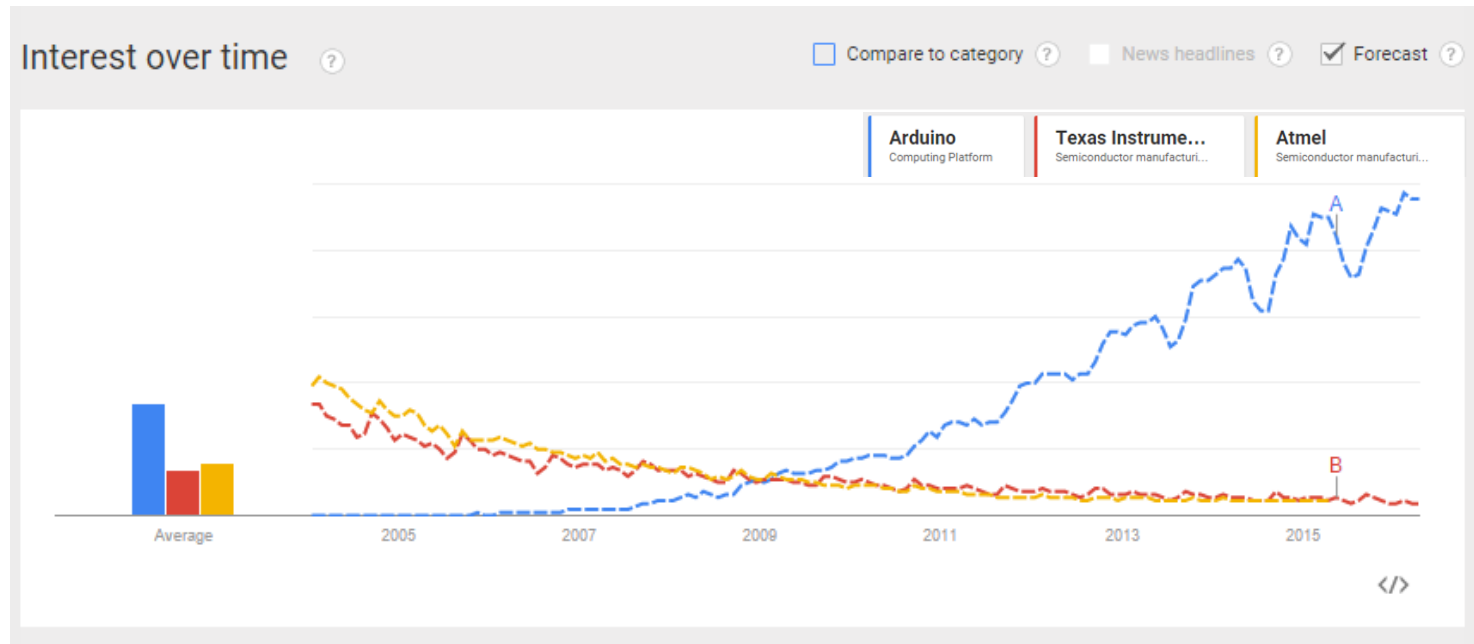
Exercise 4: Which sensors do you need in your product?

- List the sensors you would buy for prototyping your product
- Proximity sensor
- Microphone
- ...

Exercise 5: Which sensors do you need in your product?

- List the phenomena you want to monitor with your product
- Human presence
- Human walking in other rooms

The embedded revlution



The embedded revlution

Explore **442 projects**



Android/Linux + Arduino embedded

UDOO: Android Linux Arduino in a tiny single-board computer

UDOO takes your DIY projects to the next level and it's a powerful tool for education and creativity.

 by UDOO and 4,172 backers



LattePanda - A £45 Win10 Computer For Everything

LattePanda is featured with quad-core 1.8Ghz, 2/4G RAM, 32/64 GB eMMC, WIFI, Bluetooth 4.0 and USB 3.0, plus onboard Arduino processor!

 by Lattepanda and 4,060 backers



Dobot: Robotic Arm for Everyone! Arduino & Open Source

For DESKTOP. Arduino-based, 4-axis parallel-mechanism Robot Arm, 0.2mm precision! Bring industrial robot to everyone. Effective tool.

 by dobot.cc and 1,208 backers



The Electron: Cellular dev kit with a global data plan

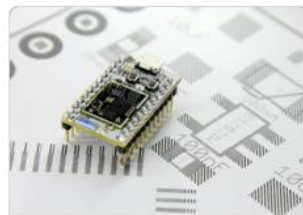
The Electron is an Arduino-like cellular development kit with a SIM card and affordable data plan from the creators of the Spark Core.

 by Spark IO and 5,564 backers



MicroView: Chip-sized Arduino with built-in OLED Display!

The MicroView is the first chip-sized Arduino compatible that lets you see what your Arduino is thinking using a built-in OLED display.



Spark Core: Wi-Fi for Everything (Arduino Compatible)

A tiny Wi-Fi development board. Arduino + Wi-Fi + ARM Cortex M3 + wireless programming + REST API = awesome.



Arduboy - Card Sized Gaming

Arduboy, the game system the size of a credit card. The easiest way to play, make and share 8-bit games! Powered by Arduino!



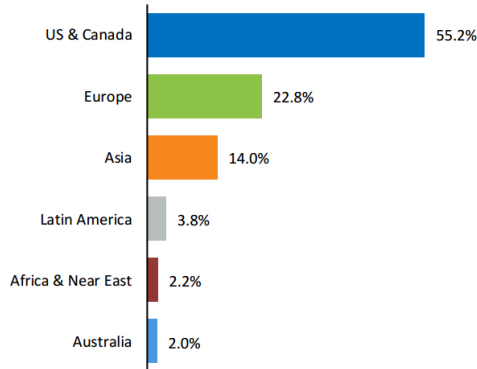
SHRUNK AN ARDUINO
AND MADE IT WIRELESS

Shrunk down an Arduino to the size of a finger-tip!

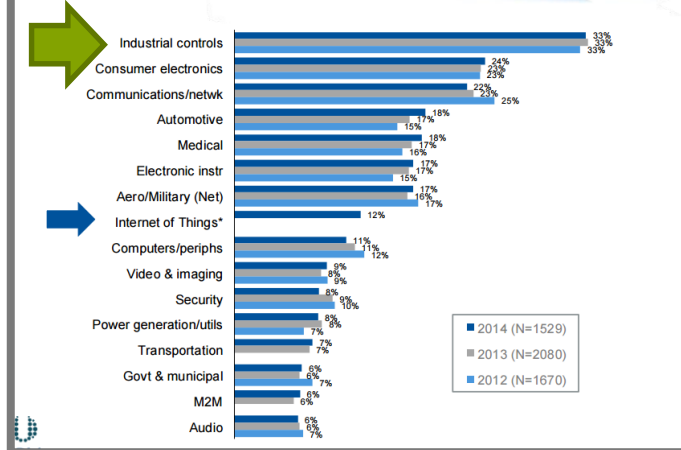
RFduino: A finger-tip sized, Arduino compatible, wireless enabled microcontroller, low cost enough to leave in all of your projects!

Sviluppare per embedded e IoT?

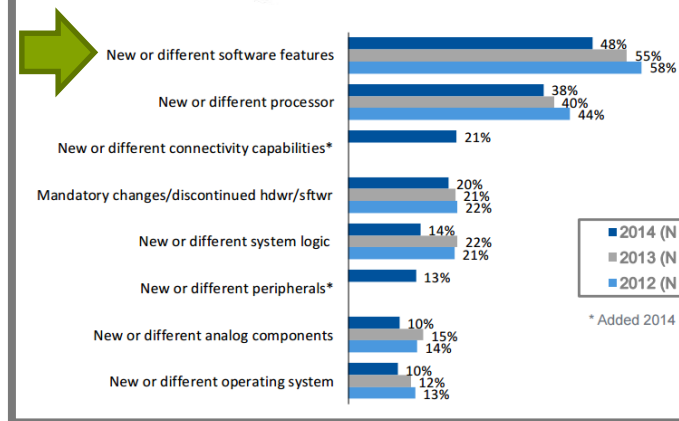
In which region of the world do you reside?



For what types of applications are your embedded projects developed?



What does the upgrade or improvement include?



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<http://bd.eduweb.hhs.nl/es/2014-embedded-market-study-then-now-whats-next.pdf>

Thank You!

daniele.mazzei@centropiaggio.unipi.it