

CNAM - RSX206 - 2008

Un peu de physical computing

P. Cubaud <cubaud@cnam.fr>

- 1. Définitions, exemples**
- 2. La wiimote**
- 3. La carte Arduino**
- 4. Couplage Arduino/Processing**

1] Physical computing ?

Physical computing

From Wikipedia, the free encyclopedia

- *Have questions?*

[Find out how to ask questions and get answers.](#) •Jump to: [navigation](#), [search](#)

Physical computing, in the broadest sense, means building interactive [physical systems](#) by the use of [software](#) and [hardware](#) that can sense and respond to the [analog](#) world. While this definition is broad enough to encompass things such as smart automotive traffic [control systems](#) or factory [automation processes](#), it is not commonly used to describe them. In the broad sense, physical computing is a creative framework for understanding [human beings](#)' relationship to the [digital](#) world. In practical use, the term most often describes handmade [art](#), design or [DIY](#) hobby projects that use [sensors](#) and [microcontrollers](#) to translate analog input to a [software system](#), and/or control [electro-mechanical](#) devices such as [motors](#), [servos](#), [lighting](#) or other hardware.

INTRODUCTION

In the last decade, various movements embraced human-computer interface designs that include physical user interfaces augmented by computing power. These include *ubiquitous computing* and *calm technology* [15], *pervasive computing* [1], *tangible user interfaces* [7], *information appliances* [12] and *context-aware computing* [3].

Researchers in these areas have demonstrated many simple but exciting examples of physical user interfaces. Ishii and

Physical Computing is an approach to learning how humans communicate through computers that starts by considering how humans express themselves physically. In this course, we take the human body as a given, and attempt to design computing applications within the limits of its expression.

(Interactive Telecom. Program ITP NYU)

Les « phidgets » (S. Greenberg, C. Fitchett, U. Calgary, 2001)

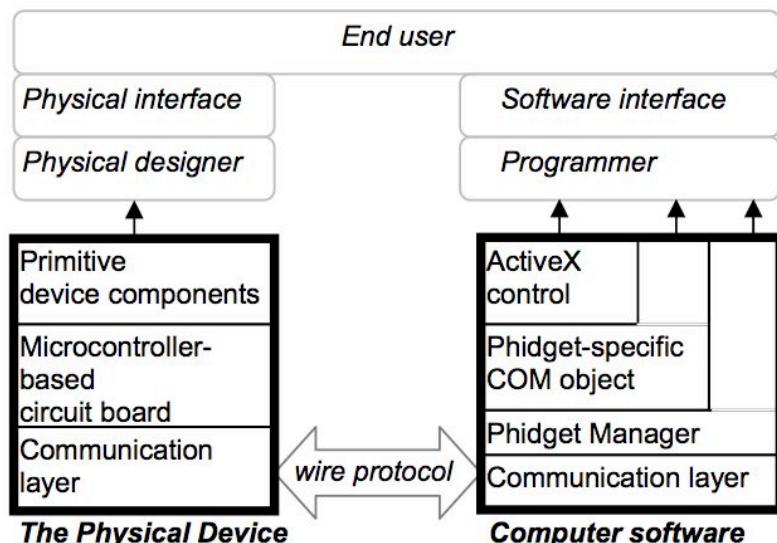


Figure 5. Phidget Architecture

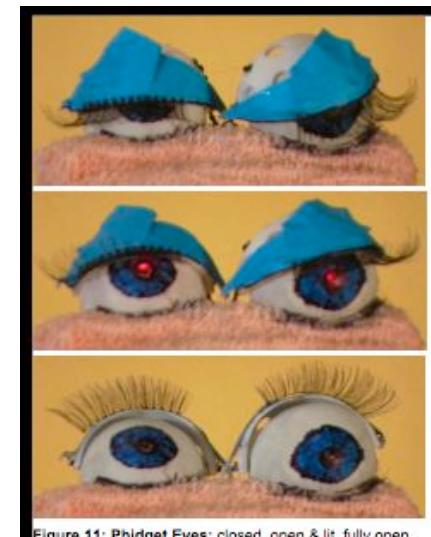
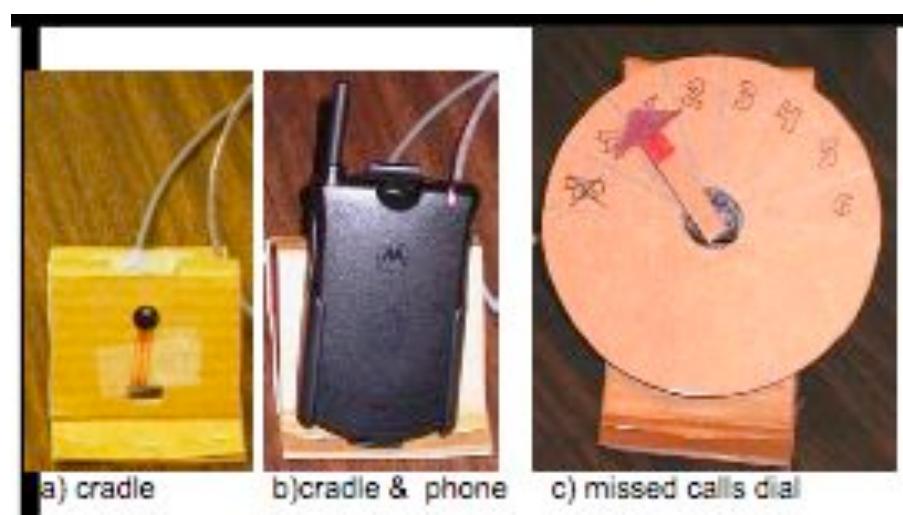
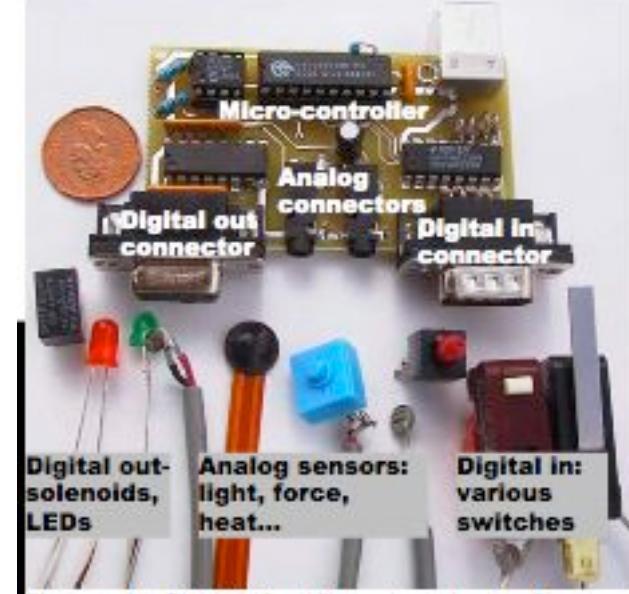
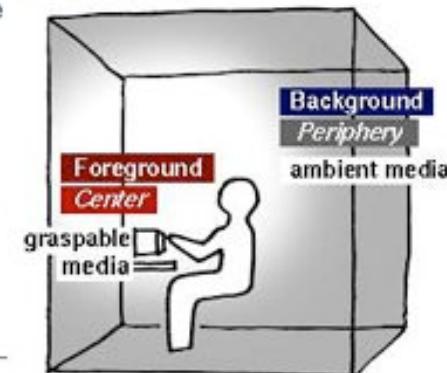


Figure 11: Phidget Eyes: closed, open & lit, fully open

Les interfaces tangibles

Tangible Bits is our vision of Human Computer Interaction (HCI) which guides our research in the Tangible Media Group. People have developed sophisticated skills for sensing and manipulating our physical environments. However, most of these skills are not employed by traditional GUI (Graphical User Interface). Tangible Bits seeks to build upon these skills by giving physical form to digital information, seamlessly coupling the dual worlds of bits and atoms.

Guided by the Tangible Bits vision, we are designing "tangible user interfaces" which employ physical objects, surfaces, and spaces as tangible embodiments of digital information. These include foreground interactions with graspable objects and augmented surfaces, exploiting the human senses of touch and kinesthesia. We are also exploring background information displays which use "ambient media" -- ambient light, sound, airflow, and water movement. Here, we seek to communicate digitally-mediated senses of activity and presence at the periphery of human awareness. The goal is to change the "painted bits" of GUIs (Graphical User Interfaces) to "tangible bits," taking advantage of the richness of multimodal human senses and skills developed through our lifetime of interaction with the physical world.

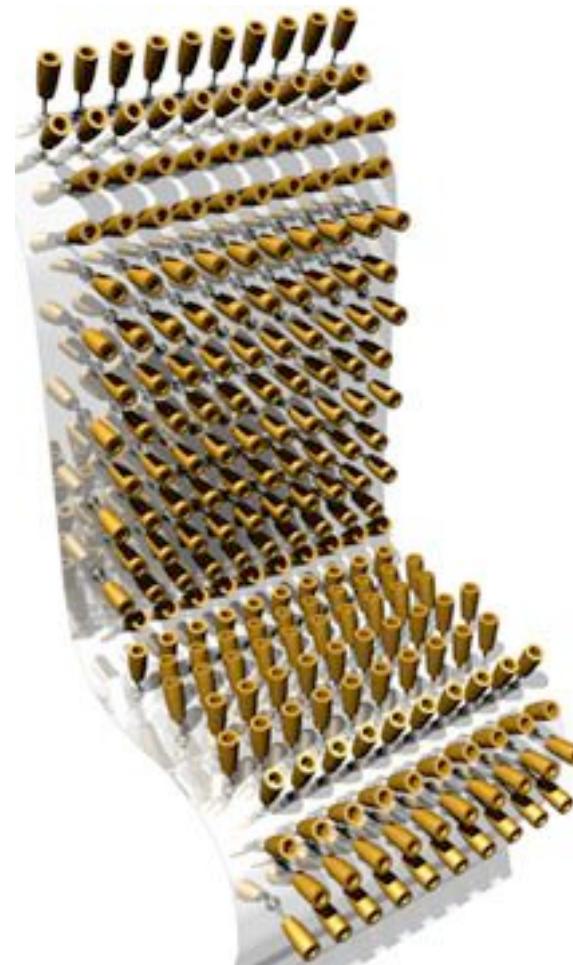


[Tangible Bits full paper presented at CHI 97](#)

drawing: Hiroshi Ishii

Prof. Hiroshi ISHII <http://web.media.mit.edu/~ishii/>

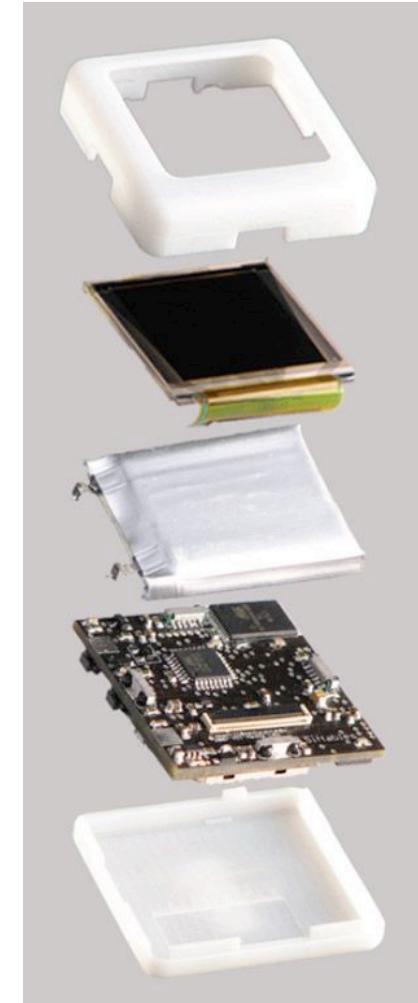
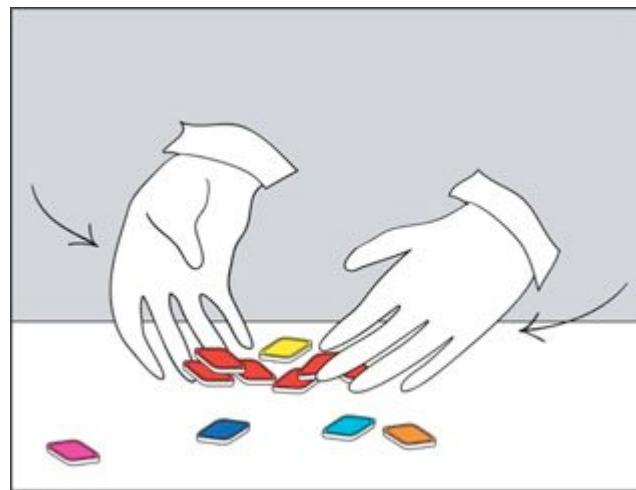
Ex. de projet de l'équipe : super cilia skin



Scentsory (Nokia)



Le projet « siftables » (David Merrill, MIT, 2007)



<http://web.media.mit.edu/~dmerrill/siftables.html>

Déjà une
industrie !



ACHETER UN LAPIN
L'adopter en ligne ou en magasin

J'AU UN NOUVEAU LAPIN
Enregister mon Nabaztag

MON AMI(E) A UN LAPIN
Lui envoyer des messages

J'AU DEJA UN LAPIN
Login →

COMMENT
ÇA MARCHE?

QUE
SAIT-IL FAIRE?

SCÈNES
DE LA VIE QUOTIDIENNE

ADOPEZ
UN LAPIN

home | developers & educators | news | email signup

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Search Our Site Search Site go

Choose your robot type:
Vacuum Cleaning
Floor Washing
Shop Sweeping

IL BOUGE

receive
n iRobot

iRobot® ConnectR™ Virtual Visiting Robot

Stay close to those you love – no matter where you are!

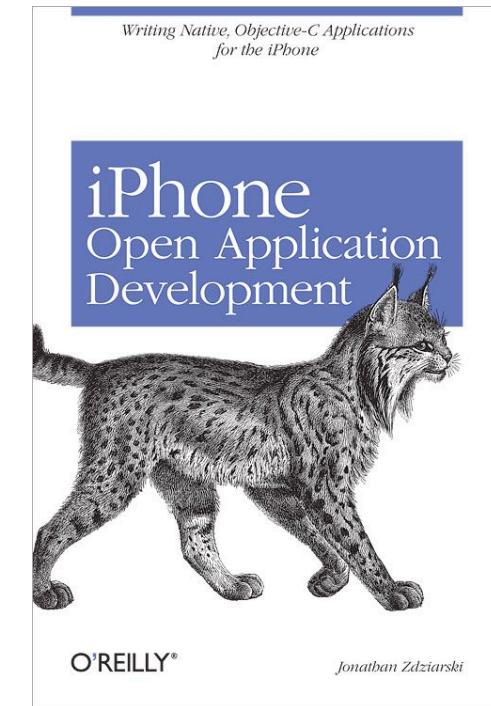
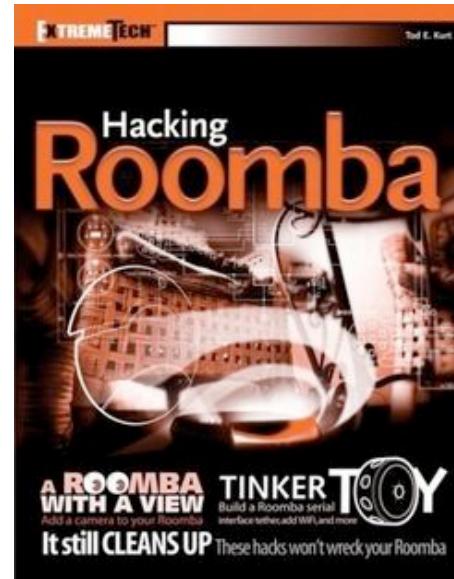
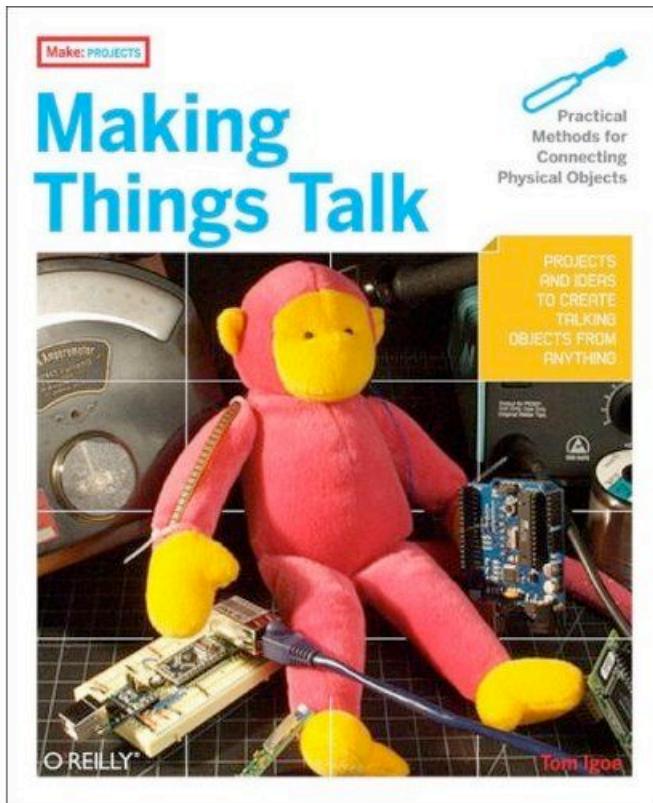
Don't miss out on special moments at home even when you are away. The iRobot ConnectR is a fun new way to see, talk to and interact with your loved ones, friends and pets – when you can't be there in person. Combining the latest in Internet communications and robot technology, ConnectR lets you virtually visit with loved ones, relatives and pets anytime you wish – seeing, hearing and interacting with them in their home as if you were there in person.

- Participate in family moments even though you're working late
- On a business trip? Read your kids a story and see their faces light up
- Join the fun from near or far
- Throw a party from a thousand miles away
- Tell Fido he's a "good boy" even while you're on vacation



skyscout

Bibliographie



+ Designing gestural interfaces
Dan Saffer (O'Reilly ≥2008)

DIY (do it yourself) : les revendeurs

The screenshot shows the SparkFun Electronics homepage. At the top, there's a navigation bar with links for Home, Customer Service, and Tutorials. Below this is a search bar with the placeholder "enter your search" and a magnifying glass icon. A sidebar on the left lists various product categories under "PRODUCTS", including New Products, Top Sellers, Featured Products, Feedback, Breakout Boards, Cables, Cellular, Components, Development Tools, Dings and Dents, Gift Certificates, GPS, LCDs, Port-O-Rotary, Programmers, Prototyping, Robotics, Sensors, Accelerometers, Capacitive Flex / Force, Humidity, ID, IMU / Gyros, Infrared, Light / Imaging, Magneto, Pressure, Proximity, Temperature, and SFE Widgets. A "Recent News" section features a post titled "VAWT?" with the text "We like to bu". At the bottom of the page is a footer with the URL "kfun.com/commerce/categories.php".

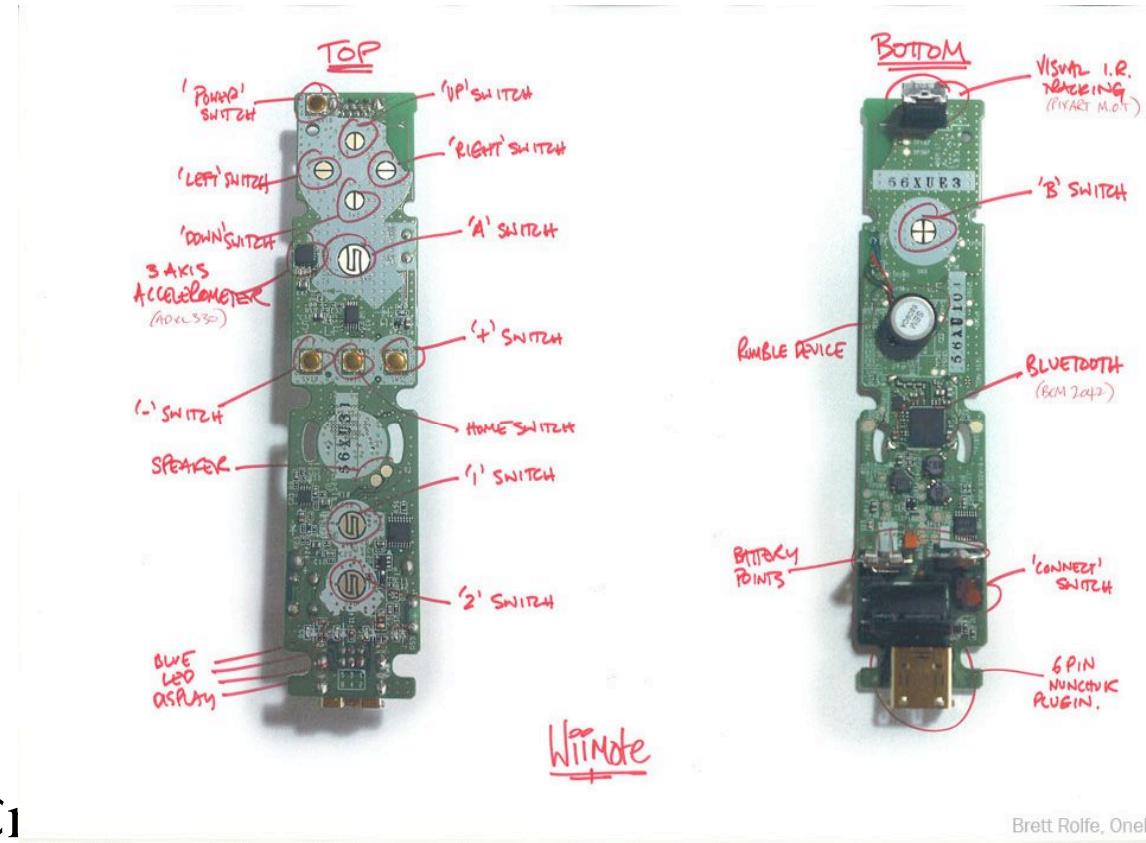
The screenshot shows the ROBOPOLIS website. It features a search bar at the top with the word "RECHERCHER" and an "ok" button. Below the search bar is a section titled "MEILLEURES VENTES" showing images of a Roomba 530, a Bioid comprehensive kit, a Tondeuse Automower 220AC, an R2-D2 vidéoprojecteur, and a MINDSTORMS NXT V41. To the right of these products are several small images of other electronic components and robots.

The screenshot shows the LEXTRONIC website. At the top, there are links for Accueil, Devis / Commandes, and Recherche. The main search area has a "Recherche" input field, an "OK" button, and a shopping cart icon showing "Panier d'achat 0 article(s) / 0.00 €". Below this is a "Catalogue" section listing Radiofréquence, Outils de Développement, Intrusion / Vidéo, and Distribution Electronique. There are also sections for "Espace clients" (Create account, Log in, Modify account, View cart, Track orders) and "Espace information" (About company, Partners, Useful links, Legal mentions, Sales conditions, Contact us).

The screenshot shows the CONRAD FRANCE website. At the top, there are links for Accueil, Qui sommes-nous ?, Magasin, and RECHERCHEZ. The search bar contains "MOT-CLE : Mon produit" and "CODE ARTICLE : 123456 - 62". Below the search bar is a large red banner with the text "CLIQUEZ ICI" and "DÉSTOCKAGE". To the right of the banner is a vertical sidebar with categories: ALARMES - SURVEILLANCE, LOISIRS, ELECTRICITÉ - LUMINAIRES, PILES - ACCUS - CHARGEURS, INFORMATIQUE - BUREAU, COMMUNICATION, AUDIO - VIDEO - HI-FI, SONO - LUMIÈRE, AUTO - MOTO - VÉLO, OUTILLAGE - Soudage, MESURE - ENVIRONNEMENT, KITS - MODULES, COMPOSANTS, LIBRAIRIE, and HORLOGE.

+ à Paris : StQuentin Radio, Perlor radio, etc.

2] La Wiimote de Nintendo (2006)



40 € wiimote + 20 €₁

- accelerometre 3axes
- Camera IR + rec. Blobs
- HP, vibreur
- Plein de boutons + joysticks
- Bluetooth (et i2c avec le nunchuck)

Totalement « hacké »
=> www.wiili.com

Brett Rolfe, OneDigital

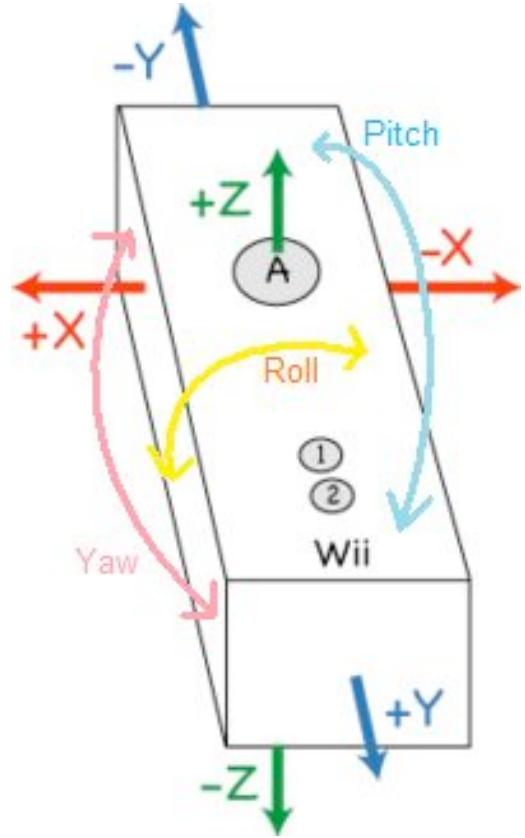
C. Verplaetse IBM Systems Journal 35(3-4) 1996 !!

Inertial proprioceptive devices: Self-motion-sensing toys and tools

by C. Verplaetse



Utilisation de l'accéléromètre



On pose la wiimote de manière à avoir successivement les trois axes X Y Z à la verticale et on collecte les valeurs renvoyées.

$$+Z : x_1, y_1, z_1$$

$$+Y : x_2, y_2, z_2$$

$$+X : x_3, y_3, z_3$$

d'où les coordonnées du point origine:

$$x_0 = (x_1 + x_2)/2$$

$$y_0 = (y_1 + y_3)/2$$

$$z_0 = (z_2 + z_3)/2$$

On obtient alors les coordonnées du vecteur force (exprimées en g) :

$$ax = (x_{\text{raw}} - x_0)/(x_3 - x_0)$$

$$ay = (y_{\text{raw}} - y_0)/(y_2 - y_0)$$

$$az = (z_{\text{raw}} - z_0)/(z_1 - z_0)$$

Pour le nunchuk, il est plus difficile de faire cette calibration du fait du facteur forme. L'examen de photos d'amateurs sur le Web permet d'éviter un démontage et suggère que l'accéléromètre est placé sur un plan horizontal lorsque le nunchuck est pris en main comme un pistolet.



Calcul d'orientation pitch et roll :

Si la wiimote n'est pas en mouvement accéléré, la mesure des coordonnées du vecteur gravité permet de d'obtenir l'orientation dans l'espace du dispositif en pitch et roll :

$$\text{pitch} = \arctan(ax / \sqrt{ay^2 + az^2})$$
$$\text{roll} = \arctan(ay / \sqrt{ax^2 + az^2})$$

source : Kionix. *Tilt-sensing with Kionix MEMS Accelerometers*. Application note AN005. 2005 (en ligne sur www.kionix.com)

On peut vérifier le repos en s'assurant que la norme $ax^2 + ay^2 + az^2$ est proche de l'unité.

Le filtrage : de la moyenne mobile au filtre de Kalman



Dans le cas où il s'agit d'estimer une seule valeur constante subissant un bruit blanc constant de mesure (moyenne nulle, écart type R), l'itération du filtre de Kalman s'écrit en notant :

$X(n)$ le processus étudié (dans notre exemple, l'angle de pitch ou de roll)

$Z(n)$ la n-ième mesure : $Z(n) = X(n) + V$ avec V suivant une loi normale $N(0,R)$

$x(n)$ la n-ième valeur de l'estimateur du processus étudié

$K := 1/(1+R)$; $x := 0$

répéter

acquerir la mesure Z

$x := (1-K)*x + K*Z$

$K := K/(K+1)$

utiliser l'estimateur x

jusqu'à fin des mesures

On remarque que le cas $R=0$ correspond pour x à un calcul de moyenne des $Z(i)$ $i=1..n$

Si le processus n'est pas constant et évolue de manière aléatoire : $X(n) = X(n-1) + W$ avec W suivant une loi normale $N(0,Q)$, on a :

$P := 1$; $x := 0$;

répéter

acquerir la mesure Z

$K = (P+Q)/(P+Q+R);$

$x = (1-K)*x + K*Z;$

$P = (1-K)*(P+Q);$

utiliser l'estimateur x

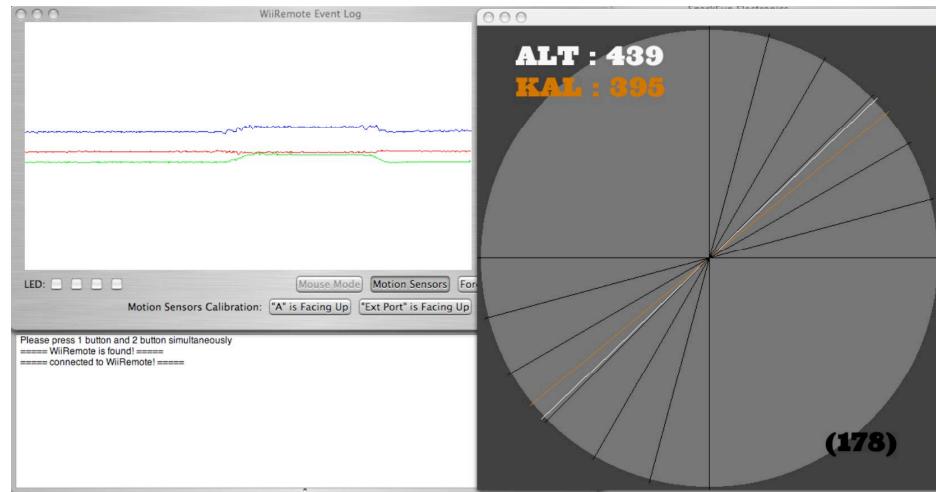
jusqu'à fin des mesures

Nous avons utilisé cette dernière procédure pour l'estimation de l'angle de pitch de la wiimote. Avec $R = 0.1$ et $Q = 0.0001$, on obtient une estimation de l'angle avec une précision d'un degré, comparable à celle d'un clinomètre de randonnée, au prix d'un temps de stabilisation assez long, de l'ordre de quelques secondes.

Un exemple d'utilisation avec Processing



Ma lunette Takahashi



Accéder à la wiimote
sur mac : JarwinRemote

(production d'un fichier txt :-()

le code

```
void draw(){

    //saisie des infos + calculs
    wiimote_file = loadStrings("/wiimote.txt");
    if (wiimote_file.length == 1) {
        wiimote_values = wiimote_file[0].split(";");
        accX = Integer.parseInt(wiimote_values[0]);
        accY = Integer.parseInt(wiimote_values[1]);
        accZ = Integer.parseInt(wiimote_values[2]);
    }
    ax = (accX - 130.0)/26.0;
    ay = (accY - 129.5)/27.0;
    az = (accZ - 127.5)/24.0;
    //pitch = atan2(sqrt(ay*ay+az*az),ax)*180/PI;
    roll = atan2(sqrt(ax*ax+az*az),ay);
    roll += PI/180; //pour ameliorer le calibrage

    // filtrage Kalman
    K = (P+Q)/(P+Q+R);
    xhat = xhat*(1.0-K)+K*roll;
    P = (1.0-K)*(P+Q);

    background(0);
    // dessine la lunette normale
    translate(width/2,height/2);
    rotate(PI/2-roll);
    stroke(250);
    line(-width/2,0,width/2,0);
    resetMatrix();

    // dessine la lunette Kalman
    translate(width/2,height/2);
    rotate(PI/2-xhat);
    stroke(204, 102, 0);
    line(-width/2,0,width/2,0);
    resetMatrix();

    // rajoute une mire
    stroke(0);
    for (int i=0; i<=90; i = i+ 15){
        translate(width/2,height/2);
        rotate(-i*PI/180.0);
        line(-width/2,0,width/2,0);
        resetMatrix();
    }
    noStroke();
    delay(100);
}
```

Très nombreuses autres applications / détournements...

Johnny Chung LEE
HCII - CMU



Xsens

Autres produits du même genre:



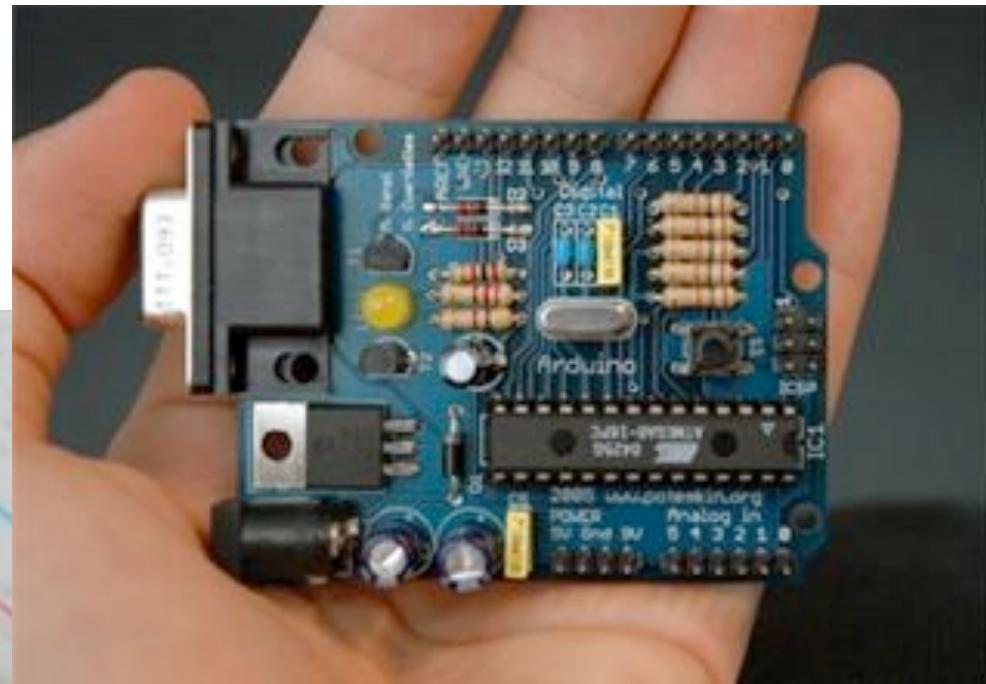
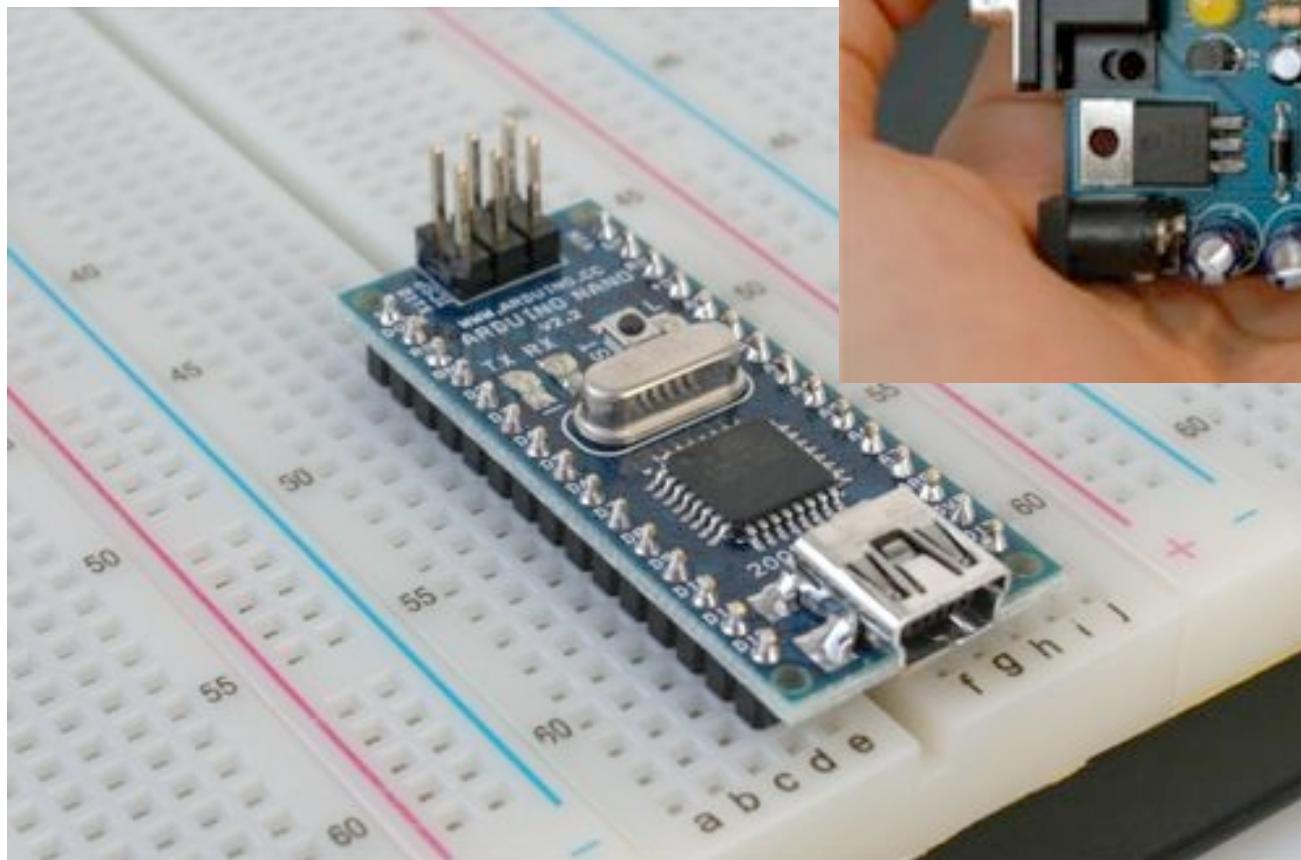
Sparkfun 450\$

http://www.sparkfun.com/commerce/product_info.php?products_id=8454



3] La carte ARDUINO

www.arduino.cc



+ une version
bluetooth

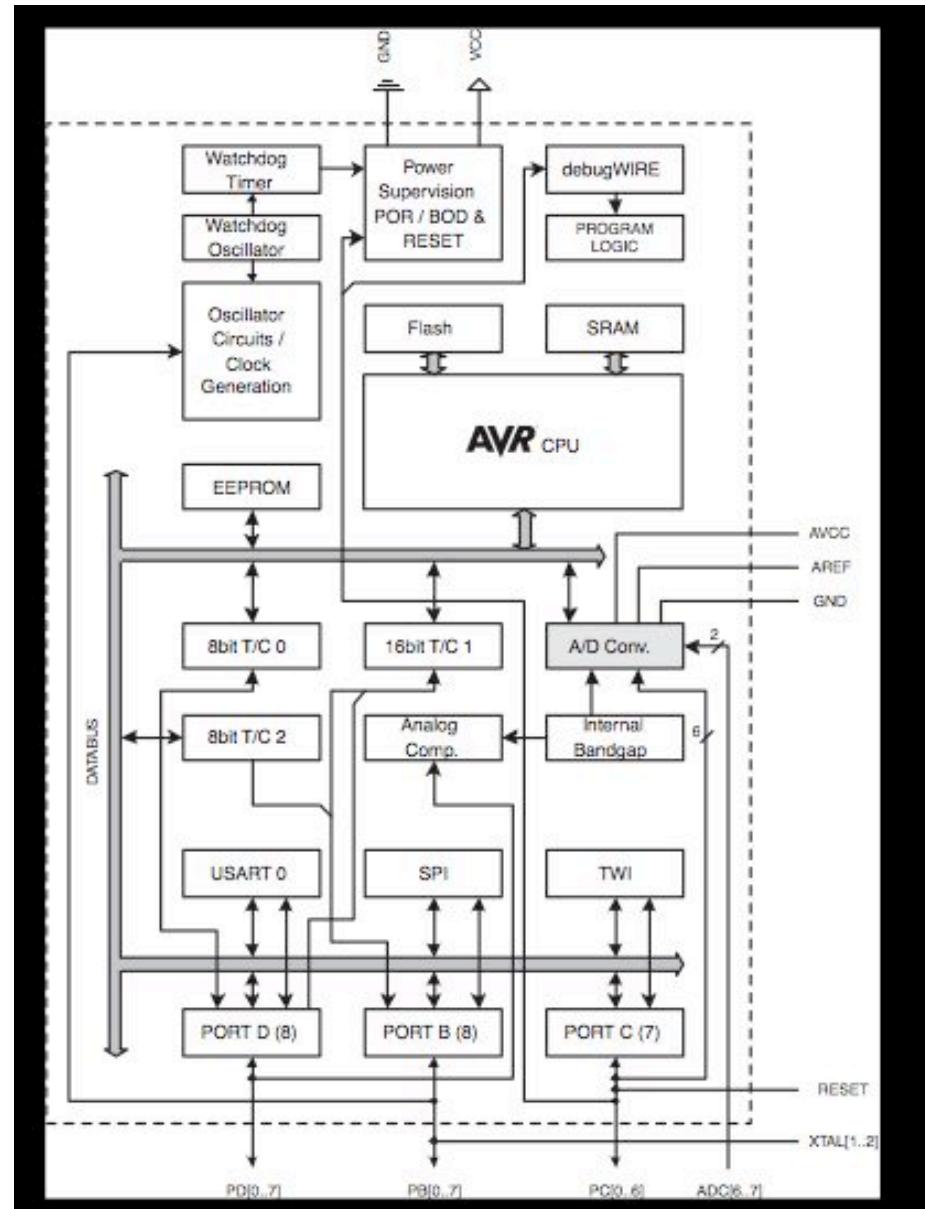
En France : AlyaSoft (à Bézier) : 22 euros

Le μ contrôleurs ATMega de ATMEL:

Risc 24 MIPS / 24 MHz horloge
131 instructions, 32*8 registres
16 Ko FLASH + 1 Ko SRAM
+ 512b EEPROM

La carte ARDUINO reprend toutes ses E/S :

- 6 E. analogiques 10bits
- 6 E/S numériques (PWM)
- port série
- + alim
- + port usb vers l'hôte



L'environnement Arduino

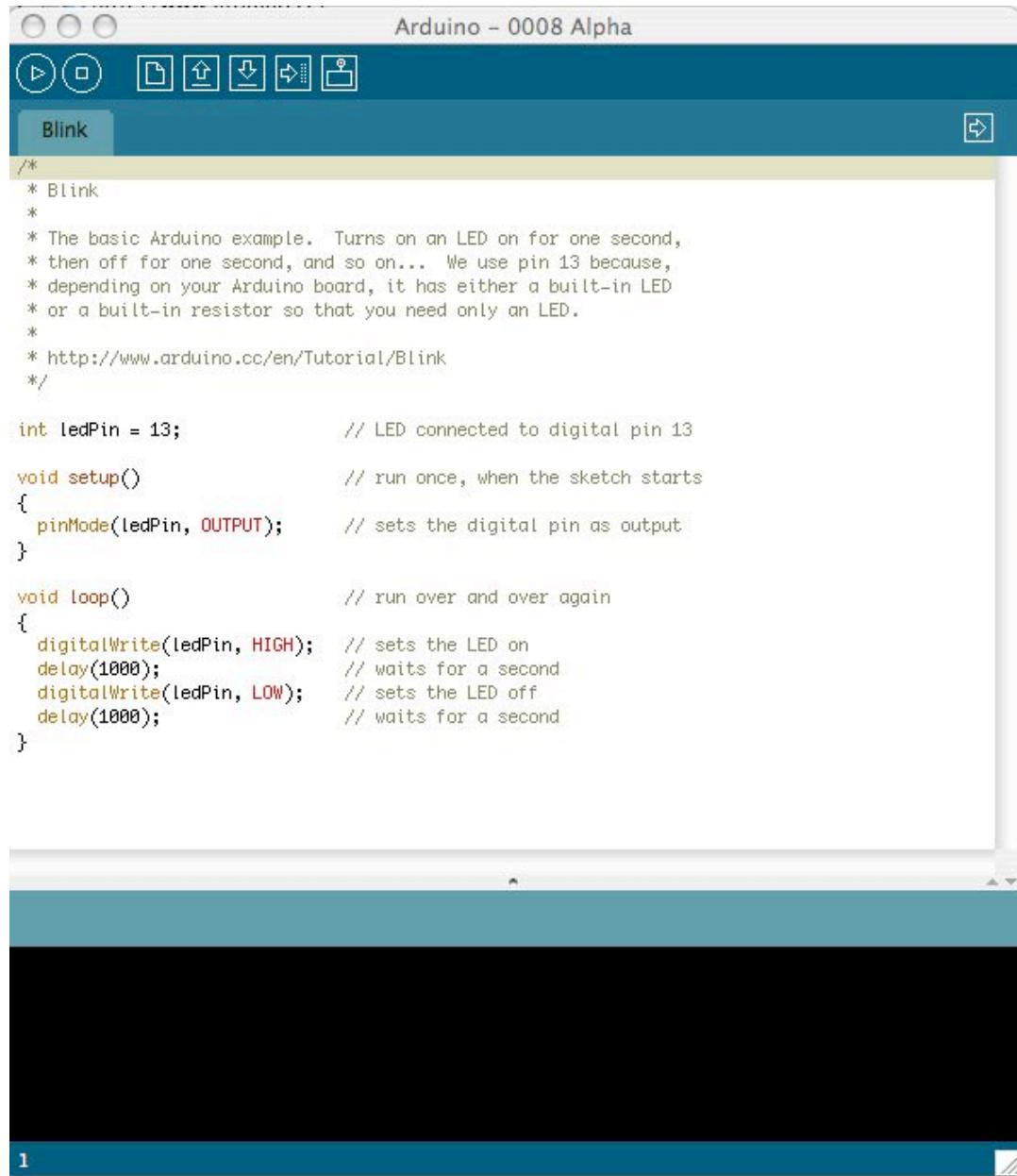
Multiplateforme !
Open source !

Basé sur C/C++

Types flottants !!
fcts math
tableaux

Librairies de com
Serie, i2c (Wire)

Contrôle servos ...



The screenshot shows the Arduino IDE interface with the title bar "Arduino - 0008 Alpha". Below the title bar is a toolbar with various icons. The main area displays the "Blink" sketch. The code is as follows:

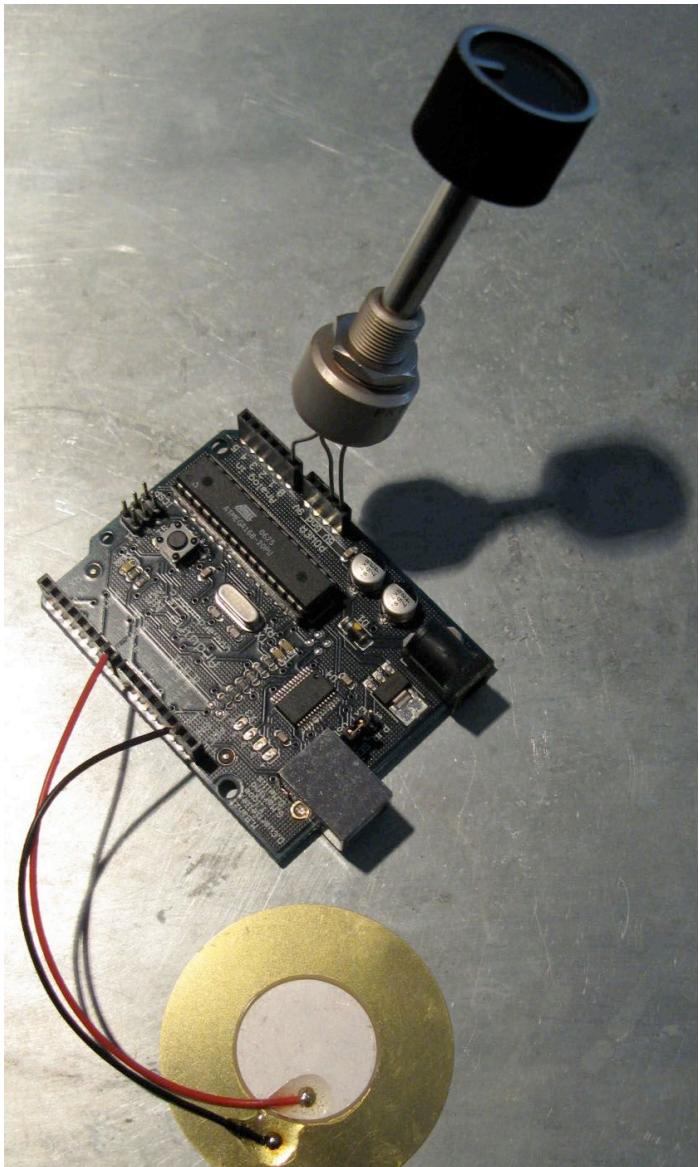
```
/*
 * Blink
 *
 * The basic Arduino example. Turns on an LED on for one second,
 * then off for one second, and so on... We use pin 13 because,
 * depending on your Arduino board, it has either a built-in LED
 * or a built-in resistor so that you need only an LED.
 *
 * http://www.arduino.cc/en/Tutorial/Blink
 */
int ledPin = 13; // LED connected to digital pin 13

void setup() // run once, when the sketch starts
{
    pinMode(ledPin, OUTPUT); // sets the digital pin as output
}

void loop() // run over and over again
{
    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
}
```

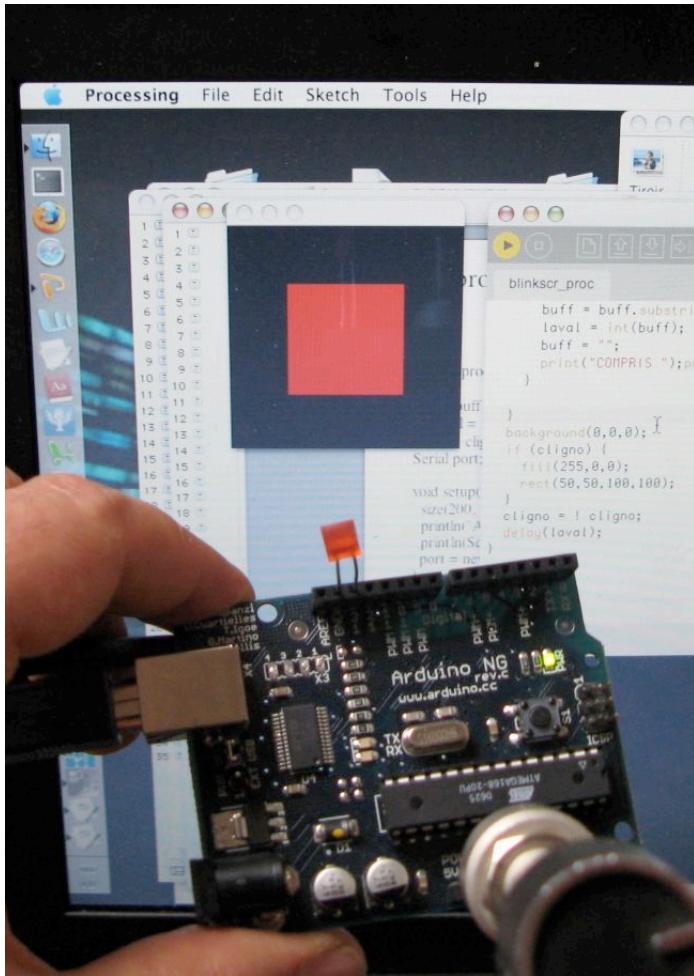
« blink » : le Hello world de l'Arduino

Buzzer :



```
/* copyleft 2006 Tod E. Kurt <tod@todbot.com  
* http://todbot.com/  
*/  
  
int potPin = 0; // select the input pin for the potentiometer  
int speakerPin = 7;  
  
int val = 0;  
  
void setup() {  
    pinMode(speakerPin, OUTPUT);  
}  
  
void loop() {  
    digitalWrite(speakerPin, LOW);  
    val = analogRead(potPin); // read value from the sensor  
    val = val*2; // process the value a little  
    for( int i=0; i<500; i++ ) { // play it for 50 cycles  
        digitalWrite(speakerPin, HIGH);  
        delayMicroseconds(val);  
        digitalWrite(speakerPin, LOW);  
        delayMicroseconds(val);  
    }  
}
```

Blink, cette fois sur l'écran (avec processing)



Sur l'arduino =>

```
int potarPin = 0;  
boolean ledState = LOW;  
int laval;
```

```
void setup()  
{  
    Serial.begin(9600);  
    pinMode(13, OUTPUT);  
}
```

```
void loop()  
{  
    laval = analogRead(potarPin);  
    Serial.println(laval);  
    ledState = ! ledState;  
    digitalWrite(13, ledState);  
    delay(laval);  
}
```

sur processing :

```
import processing.serial.*;

String buff = "";
int laval = 100;
boolean cligno = true;
Serial port;

void setup() {
    size(200, 200);
    println("Available serial ports:");
    println(Serial.list());
    port = new Serial(this, "/dev/tty.usbserial-A50018tg", 9600);
}
```

Rque : le println d'Arduino envoie
un CR et LF après laval

Les deux processus synchrones ???

```
void draw() {
    if (port.available() > 0) {
        String buff = port.readStringUntil(13);
        if (buff != null) {
            print("RECU ");println(buff);
            buff = buff.substring(0, buff.length()-1);
            laval = int(buff);
            buff = "";
            print("COMPRIS ");println(laval);
        }
    }
    background(0,0,0);
    if (cligno) {
        fill(255,0,0);
        rect(50,50,100,100);
    }
    cligno = ! cligno;
    delay(laval);
}
```

Pour continuer :

<http://todbot.com/blog/spookyarduino/>