Week 10: Input devices

8.4. 2015

This week we will learn about input devices.

The agenda: http://academy.cba.mit.edu/classes/input_devices/index.html

inputs DDR, PORT, PINS comparator A/D clocks (10% RC, 1% RC calibrated, .5% resonator, 50 ppm crystal) bit timing **switch** pySerial rx.py term.py button slide hello.button.45.cad board components traces interior hello.button.45.c makefile video **magnetic field** Hall effect hello.mag.45.cad board components traces interior hello.mag.45.c makefile hello.mag.45.py video hello.mag.45.html hello.mag.45.js **temperature** bridges NTC RTD thermistors hello.temp.45.cad board components traces interior hello.temp.45.c makefile hello.temp.45.py video **light** phototransistor hello.light.45.cad board components traces interior hello.light.45.c makefile hello.light.45.py video synchronous detection spread spectrum hello.reflect.45.cad board components traces interior hello.reflect.45.c makefile hello.reflect.45.py video **step response** resistance, capacitance, inductance, position, pressure, proximity, tilt, acceleration, humidity, touchpad, multitouch, ... loading hello.load.45.cad board components traces interior hello.load.45.c makefile hello.load.45.py video transmit-receive hello.txrx.45.cad board components traces interior hello.txrx.45.c makefile hello.txrx.45.py video dielectric spectroscopy measurement **acceleration, orientation, rotation** 2D accelerometer hello.accel.45.cad board components traces interior hello.accel.45.c makefile hello.accel.45.py video 3D accelerometer +magnetometer +gyroscope 6 DOF IMU **sound** electret op-amp hello.mic.45.cad board components traces interior hello.mic.45.c makefile hello.mic.45.py video digital **distance** sonar **motion** pyroelectric **vibration** piezo **force, loading** strain gage **image** module cameras boards OpenCV V4L2 libuvc guvcview WebRTC video.html video **assignment** measure something: add a sensor to a microcontroller board that you've designed and read it

The assignment for this week: to measure something: add a sensor to a microcontroller board that we've designed and read it

Class:

Input: http://academy.cba.mit.edu/classes/input_devices/doc2586.pdf

Py Serial: http://pyserial.sourceforge.net/

Clocking:

Going to 0 to 122

Tell it how fast to convert

Power supply as reference

Which pin to use

Sending a high byte and a low byte

NTC RTD thermistors

RTD for higher temperature, NTC for lower temperature

Make a bridge with 4 resistors

Put voltage across them and measure the difference

Measuring a small change in a small resistor

Using the gain and using the difference, how to – from the datasheet

Different libraties that do this for you...

Bi-polar transistor, mesuring positive and negative

Measuring light

Phototransistor: http://www.digikey.com/product-detail/en/OP580DA/365-1481-1-ND

A light sensor

Measuring the reflection of light

LED - ACD, Synchronic detection

2D touchpad - multi-touchpad examples

Analogue memory, takes on cycle

Just by measuring charges...

Mechanisms vs. Frequency

Art & Craft of the Vynil cutter

Acceleration, orientation, rotation

2D Accelerometers: http://www.digikey.com/product-detail/en/MXD6235MP/1267-1012-1-ND

Sound:

Electrit / Microphone: http://www.digikey.com/product-detail/en/AOM-6738P-R/668-1296-ND

Distance:

Sonar: http://www.digikey.com/product-detail/en/AOM-6738P-R/668-1296-ND

Designed to be read – target frequencies
Transmitter – receiver

Movement:

Pyroelectric motion sensor: http://www.amazon.com/Pyroelectric-Infrared-Motion-Sensor-Detector/dp/B008AESDSY

Vibration:

Piezo:
http://www.jameco.com/webapp/wcs/stores/servlet/ProductDisplay?langId=-1&storeId=10001&catalogId=10001&productId=1956784

Force, loading:

Strain-gages: http://www.omega.com/subsection/general-purpose-strain-gages.html

Imaging:

DIY camera moldules: http://www.amazon.com/sunkee-OV7670-640X480-Compatible-Interface/dp/B00AZWVZKW

WebCams: https://www.google.com/search?channel=fs&q=webcam&ie=utf-8&oe=utf-8#channel=fs&q=webcam&tbm=shop&tbs=cat:312,vw:l,p_ord:p

Opencv: http://opencv.org/

WebRTC: https://developer.mozilla.org/en-US/docs/Web/Guide/API/WebRTC

Wearable techniques:

Sow conducting threads into fabric.
Electronics and embroidary
e-embroidery
e-embroidery workshop: https://eembroidery.wordpress.com/

Measuring waves from your brain:
Bio-glasses – student example
Good electrical contact – gel or tape
Measure difference in voltages – rafleiðni líkamans

Happy sensing...

Preparing for Friday:

Think about what kind of things do I want on my board

Assignment:

Phototransistor: http://www.digikey.com/product-detail/en/OP580DA/365-1481-1-ND

Eagle:

New project
Open the schematic window
Fab.lbr. click green dot
Libraries – click none

Components to add - for hello.light.45:
Write add in command line

FTDI-SMD-HEADER = J2 FDTI

CAP-US = (CAP-US1206FAB – C1206FAB)
http://www.digikey.com/product-detail/en/C3216X7R1H105K/445-1423-1-ND/569089
RES-US = R1 10k (RES-US1206FAB – R1206FAB)
http://www.digikey.com/product-detail/en/RC1206FR-0710KL/311-10.0KFRCT-ND/731430
ATTINY45 = IC1 t45 microcontroller
http://www.digikey.com/product-detail/en/ATTINY45V-10SU/ATTINY45V-10SU-ND

RES-US = R2 49.9k (RES-US1206 – R1206)

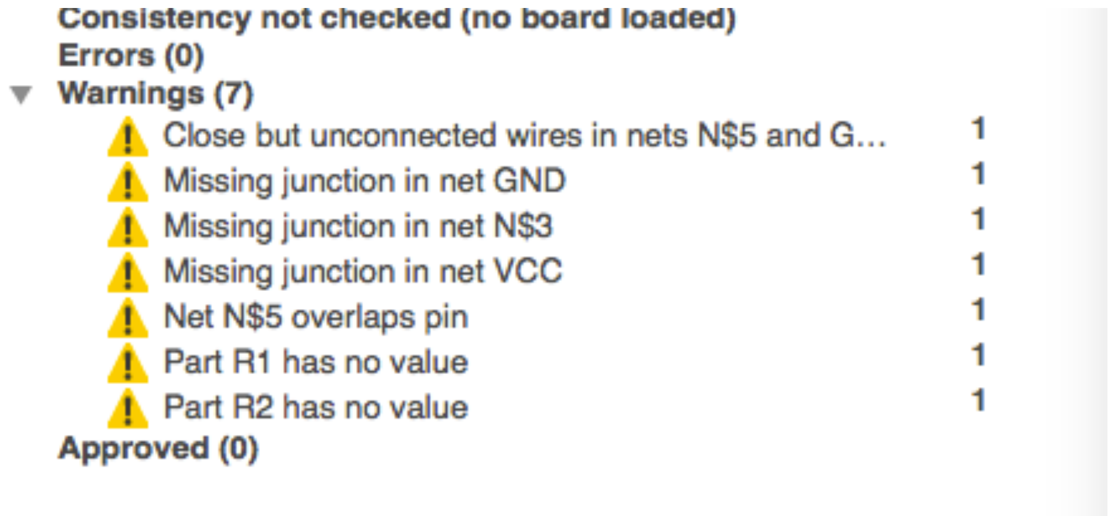
AVRISPSMD = J1 ISP

PHOTOTRANSISTOR = T1
http://www.digikey.com/product-detail/en/OP580DA/365-1481-1-ND

When the components had been added, they were all connected up according to the hello.light.45.

Use the ratnest tool to get the yellow helper lines to re-route, after you moved your component.

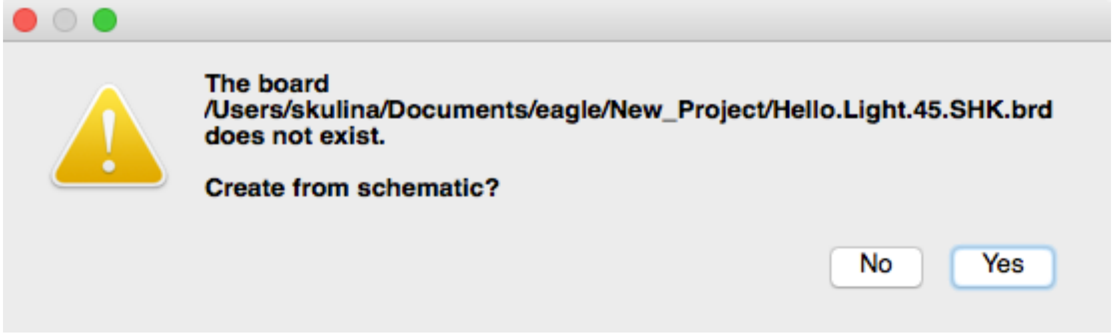
When all is connected ERC error check was performed and there were several things to correct.



Consistency not checked (no board loaded)
Errors (0)
▼ Warnings (7)
⚠ Close but unconnected wires in nets N$5 and G… 1
⚠ Missing junction in net GND 1
⚠ Missing junction in net N$3 1
⚠ Missing junction in net VCC 1
⚠ Net N$5 overlaps pin 1
⚠ Part R1 has no value 1
⚠ Part R2 has no value 1
Approved (0)

```
Wires were connected and components moved.
Parts given value.

Next: Click board and Yes.
```



The board /Users/skulina/Documents/eagle/New_Project/Hello.Light.45.SHK.brd does not exist.

Create from schematic?

```
All wires are drawn between components, making sure that they have
clearance

Clearance can in some instances be completed by taking the exported
photo into photoshop to remove a few pixels in strategic locations
where clearance could not be achieved in eagle.
```

To remove text, if it stick out of the board: Edit smash – click on the + to remove text

With the Group command ▣ draw a square around the board from the upper left corner, right click and chose move group to move the whole board to the lower left corner. Then left click on the middle of contour line and drag the other corner to fit closely to the board.

In layers – Select all – OK

In layers – Select bottom layer.

Chose ■ - Rect, and draw a square around the board circuits – approx 1 grid outside the square around it.
Possible to click info, double click the image and change the layer.

In layers – select 20 Dimensions – and export image as monochrome (resolution: 1200; image size: 2204 x 810): Name of square.

When the board is finally defined the traces are exported. Before exporting turn off all layers except the top one. Export as an image - monochrome (resolution: 1200; image size: 2204 x 810): Name of board.

Milling of the board:

Tape board to table

Turn on machine – push view to move chuck to left end of working area

In fabmodules open image.

Output format - Roland mill .rml
Process - PCB trace (1/64)

Turn off view

Calculate
Move ti xmin ymin
Adjust smin ymin settings – 2-2

If right – losen mill end and lower to surface of board
Check loaction of tool
Send if ok

The bug in Fabmodules – because the old settings

I had to adjust the cutting depth – from 1.0 to 1.5

To cut the outline/interior, first press view and change the tool to 1/32. Then load the image – outline and set to Roland Mill (.rml) and ouline - calculate.

Press xmin ymin to bring the tool to the right starting position, then lower the tool to the surface of the board and fix. Calculate again and press send.

Soldering issues:

Turning the sensor around

Glueing the FTDI in place, as it became unstable during the soldering process.

Victor 70C Digital Multimeter:
http://www.globalmediapro.com/dp/A2F8Q8/Victor-70C-Digital-USB-Multimeter/

Checking the conductivity of the board – Ground versus VCC (should not direct contact).

F: measures capacitor

Arrrow: measures

Setting the Digital Multimeter – image

Sound signal - chose

Continuity test: Measures resistance, but will beep if there is no resistance.

The continuity test worked fine – no sound, no direct contact.

Then connect the light board – the programming board to the computer.

In Arduino set 3 components – the board, processor and select the right clock source (external-internal).

Board – Attiny
Processor – 45
Clock – internal 8Mhz (datasheet, Neil's lecture). 1 Mhz use less energy than 8 Mhz
This tells the programming environment how to behave.

Tell the microcontroller to run at 8 Mhz instead of 1 Mhz

Now - burn the Bootloader.

Tools – burn bootloader, Line: Done burning bootloader
This tells the microcontroller how to behave

Next I needed to tell the microcontroller that it needs to read the input from the light sensor

I used the AVR Programmer Hookup Guide:
https://learn.sparkfun.com/tutorials/tiny-avr-programmer-hookup-guide/attiny85-use-hints

To program the input and output pins of the microcontroller.

I copied this code:

```
int pwmPin = 0;

pinMode(pwmPin, OUTPUT);

for (int i=0; i<=255; i+=5)
{
  analogWrite(pwmPin, i);
  delay(5);
}
```

And inserted it into the Arduino sketch.

Then I copied:

```
int pwmPin = 0;
int analogInPin = A1;

pinMode(pwmPin, OUTPUT);
pinMode(analogInPin, INPUT);

int analogIn = analogRead(analogInPin); // Read analog voltage on pin
2 (A1)

analogWrite(pwmPin, analogIn / 4); // Output analog reading to
dimmable LED
```

This code was not used – but cut out

The code for the sketch_input_board

Code:

// = comment

Void setup – runs once, makes everything ready for what you want to do

Void loop – does continually what it should do

Variables – put before void setup. Set to A3 (the pin of the microcontroller that reads the input from the light sensor)

Pin Configurations here:
http://academy.cba.mit.edu/classes/embedded_programming/doc8183.pdf

Read the light sensor
Microcontroller needs to tell us what the value of light reading is

Setup needed for the communication – for the user to be able to read it on the computer

USB to serial converter (inside plug)

Arduino Library – SoftSerial. Have to tell the program that I want to use it.

Sketch – import library – SoftSerial
#include <SoftwareSerial.h>

Make your microcontroller to say hello
File – Example - Software Serial – Software Serial Example
(Opens up a new window)

How does Software Serial work?
Check Arduino language reference:
file:///Applications/Arduino.app/Contents/Resources/Java/reference/arduino.cc/en/Reference/HomePage.html

Pin mapping – Arduino (desktop image):

Red – analogue pins (input)
Turquiose – digital numbers
Green – extra funcion

The SoftwareSerial was set to: SoftwareSerial mySerial(1, 2); // RX, TX

How fast is this communicating?
mySerial.begin(4800);

In void look enter:

```
mySerial.println("Hello, world?");
delay(1000);                  // waits for a second
```

Testing:

Serial monitor – Board at COM1 is not available

Arrow – Upload (image)

Tools – Port – Serial ports – usb.serial

Serial monitor – in /dev./tty.usbserial-FTF312GF set the speed to 4800 baud

The usb.serial window was empty – the board is not sending anything (image)

We took the board to testing in the Oscillascope (image)
The testing revealed that the cause was that one pin on the FTDI was not working. It was resoldered and consequently we could confirm that the contact with the board was established (image)

Reading hello world...

The board connection with the computer:
Communication – powering
Programming

Next steps will be to:
Read the light sensor
Communicate the reading to the computer

Analogue (give out voltage) and digital sensors (switch on and off)

My light sensor is an analogue sensor
Converting from analogue to digital is necessary.
Inside the microcontroller is a facility to convert.

Copying code from
file:///Applications/Arduino.app/Contents/Resources/Java/reference/arduino.cc/en/Reference/AnalogRead.html

See image

Upload (arrow forward)