

PHYSICAL COMPUTING, LAB EXERCISE 3 (Part 1 and 2)

ARDUINO, Part II

The purpose of this exercise is for you to continue familiarizing yourselves with microcontrollers and how they can be used to interface the digital and physical worlds. This week, you will learn more advanced uses of Arduino and how to combine knowledge from various exercises in order to create new circuits and uses of the microcontroller. You will also learn more about physical space markers for locative media applications, and end the exercise by designing an application for urban / public space.

IMPORTANT!:

- Except for the last exercise that has to be done after all the other exercises are completed, these lab exercises do not have to be done in a specific order. As some components might run out, take turns in using them and complete exercises accordingly. Make sure to plan ahead!
- Unless otherwise specified, ALL moments of the exercises (including readings and design) have to be completed in order to pass the lab. Higher grades than pass will be based on the level of complexity and – importantly – quality of execution of the last exercise.

The following is needed (for each group):

- Computer with USB port
- Arduino microcontroller
- Breadboard (make sure the supply lines on the board are connected all the way!)
- USB cable
- Several red and green LEDs
- Potentiometer
- Diode
- 12V lamp (few available)
- BR-1050-12VDC relay
- TIP121 transistor
- 12V DC motor (computer fan)
- Servo motor (according to availability)
- Stepper motor (few available)
- ULN2003A or ULN2803 Darlington driver
- 74HC595 chip
- RFID Card Reader Serial
- Various resistors
- Wires
- Cameraphone (borrow if you don't have one)
- Printable sticker paper

Arduino Recap

About the software environment:

<http://www.arduino.cc/en/Guide/Environment>

About the foundations of working with Arduino:

<http://www.arduino.cc/en/Tutorial/Foundations>

For references about the programming language:

<http://www.arduino.cc/en/Reference/HomePage>

http://www.arduino.cc/playground/uploads/Main/arduino_notebook_v1-1.pdf

Problems? Arduino troubleshooting: <http://www.arduino.cc/en/Guide/Troubleshooting>

Exercise 1: High Current Circuits

In this exercise, you will learn how to

- Drive high-current circuit
- Work with different kinds of motors
- Control motors and other high-current devices.

Readings

Read the following webpages:

Relays and transistors: <http://www.tigoe.net/pcomp/code/input-output/controlling-high-current-circuits>

Motors: <http://www.tigoe.net/pcomp/code/motors>

Controlling DC motors: <http://www.tigoe.net/pcomp/code/motors/controlling-dc-motors>

Stepper-motors control: <http://www.tigoe.net/pcomp/code/category/arduinowiring/51>

Lamps & Relays / Transistors

Build the following circuit, using a 12V lamp and a BR-1050-12VDC relay:

<http://www.toddhoubek.com/classes/pcomp/relay/relay.html>

Build the following circuit (lamp part) using a 12 V lamp and TIP121 transistor:

<http://itp.nyu.edu/physcomp/Tutorials/HighCurrentLoads>

In the 2nd circuit, change the intensity of the light using the potentiometer.

Experiment with the other types of relays available in the lab, by building your own circuit with them to drive high-current loads.

DC Motors

Build the DC motor part of this exercise, using 12V computer fans (DC motors):

<http://itp.nyu.edu/physcomp/Tutorials/HighCurrentLoads>

(For a more detailed view of wirings and connections, see

<http://www.toddhoubek.com/classes/pcomp/transistor/transistor.html>)

Try changing the speed of the motor using the potentiometer.

Read thoroughly the following pages for alternative ways of driving DC motors:

<http://itp.nyu.edu/physcomp/Labs/DCMotorControl>

<http://www.arduino.cc/playground/Main/DCMotorControl>

Servo Motors

Read thoroughly the following pages:

http://todbot.com/blog/wp-content/uploads/2006/10/arduino_spooky_projects_class3.pdf (p. 22-37, without taking a break in the middle!)

<http://www.arduino.cc/playground/Learning/SingleServoExample>

<http://itp.nyu.edu/physcomp/Labs/Servo>

Build the corresponding circuits if servo motors are available in the lab.

Take a closer look at the code used in the servo motors exercises.

Stepper Motors

Build the following circuit: <http://arduino.cc/en/Tutorial/StepperUnipolar> (If you are using a ULN2803 Darlington driver instead of the ULN2003A, make sure to modify the connections of the circuit accordingly:

<http://www.cs.chalmers.se/idc/ituniv/kurser/06/uc/bx24/uln2803.pdf>)

Interfacing

Based on aptitudes gained during previous readings and exercises, build a circuit where you can control the speed of a DC or stepper motor by moving a cursor on the screen with your mouse.

Sensing High-Voltage Circuitry

Study the following circuits for sensing 12V or higher circuitry with Arduino:

http://www.arduino.cc/playground/uploads/Learning/Level_shifting_4_arduino.pdf

What happens in these circuits? Write a detailed description paragraph about it.

Exercise 2: Serial to Parallel Shifting-Out

In this exercise, you will learn how to extend the number of output pins on your Arduino board with shift-registers, once the pins start running out.

Read thoroughly the whole following page: <http://www.arduino.cc/en/Tutorial/ShiftOut>

Build the circuits described in the exercises.

Also read thoroughly the whole following page about how to extend the number of digital input pins on Arduino: <http://www.arduino.cc/en/Tutorial/ShiftIn>

Exercise 3: Physical Markers

In this exercise, you will learn two different techniques for tagging physical space with markers: RFID and QR Codes

RFID

Read about RFID here:

<http://www.parallax.com/Portals/0/Downloads/docs/prod/audiovis/RFID-Reader-v1.2.pdf>
<http://en.wikipedia.org/wiki/RFID>

Do the following exercise, taking turns in using the reader:

<http://www.arduino.cc/playground/Learning/PRFID>

Read various RFID tags using the reader.

QR Codes

Read about QR Codes here:

<http://reader.kaywa.com/faq/13>
http://en.wikipedia.org/wiki/QR_Code

Go to <http://reader.kaywa.com/> and browse through the scenario (“Play”).

Go to <http://qrcode.kaywa.com/>. Think of the types of information one could place onto space or objects in various situations and generate examples of QR Codes for various types of media in order to illustrate these scenarios.

Use appropriate cameraphones as available to download a QR Code reader from <http://reader.kaywa.com/> and test reading the codes you have produced.

(For a list of supported phones, see <http://reader.kaywa.com/phones>)

Comparison

What differences are there between RFID and QR Codes in terms of the type of applications they enable? List at least 6 different points (thinking about material, use, integration into space, power supply etc etc).

Exercise 4: Design

Using what you have learned during the past two weeks of lab exercises, imagine an application that interfaces the digital world to the physical one in urban / public space, by *actuating* the physical world and / or *tagging it* with digital information. This should be something feasible for you to build an implementation prototype of.

Determine a specific context of use and study its characteristics. Make a scenario for how the application would be used in this context (including user, storyboard etc) and write an algorithm for how the interaction would work.

Depending on how much time you have left before the end of the lab, prototype this system doing a combination of the following points (one or both)

- Make an a look & feel prototype
- Build the actual circuit.

“Test” your prototypes in situation by enacting their use in an identical / similar context as the one in which the application would be used, or in a simulated one.

Present the final result using all the prototypes you have built, in situation.