4M20 Robotics: Robot kit instructions

Each student group should receive a 4M20 robot kit which contains a number of different items. Please check with the list at the end of this document and make sure that you indeed have everything. If something is missing, please report it immediately to Fumiya Iida (fi224@cam), or you might be considered liable for the loss.

Please take good care of all the items you got, and do not discard the packaging materials. Any careless loss or damage to the items will have to be compensated at your expense.

Important

As with any other electronic board, it is imperative to take the appropriate precautions to avoid damaging the circuit. In particular:

- As all electronic circuits, *the board might be damaged by electrostatic discharges*. Please discharge yourself (*e.g.*, by touching a grounded item) before touching any uninsulated part of the board.

- *Never place the circuit against any electrically conducing surface or element*. If you need to mount the circuit on a metallic robot chassis, please use insulating spacers, or use an appropriate insulating layer. A plastic mounting plate with spacers is provided. *Do not put insulating tape on the circuit itself*, as it might be perforated by the protruding metal parts of components, and after some months its glue might smear the PCB surface. *Also make sure that you don't have any metallic parts on your working table* when you use the board. A short circuit might of course damage the board.

- *Never connect any other power supply to the circuit if you are unsure about the output voltage and polarity*. Powering the circuit with an excessive voltage, with inverted polarity or with alternating current might permanently damage it.

- *Make sure that anything you connect to the board is compatible with the used voltages*. In particular, connecting 3.3 V electronics (*e.g.*, a Raspberry Pi) directly to the board (which uses 5 V logic signals) can permanently damage the other device.

- *Do not attempt any modification or repair of the board*. If you have any special needs for your project, please discuss them with us.

- *Handle the Lipo battery with care.* Take precautions never to pierce the battery or short circuit the leads. **Never leave the battery charging unattended**. Do not discharge the battery to less than 7.2V (3.6V per cell). Do not charge with something other than the provided charger or to more than 8.4V (4.2V per cell). When using or charging the battery, take note of the nearest fire extinguisher.

- *Power the microcontroller board via the battery power distribution board and the 6V input to the microcontroller board.*

Questions and help: Contact Fumiya Iida (fi224@cam)

First test: power the board

All the boards are supplied with a demonstration program already loaded on the microcontroller. Just connect the provided power supply to the board: the two LEDs of the circuit will start to blink in an irregular way.

Installing the Arduino IDE

To be able to program the board, you will need to install the Arduino IDE, which can easily be downloaded from https://www.arduino.cc/en/Main/Software, and is available for Windows, MacOS and Linux. Please download the version that is appropriate for your operating system:

- If you are using Windows, download the installer and start it. During the setup process, the system will display a window asking to confirm the installation of several USB drivers, please make sure you install them. If you are an advanced Windows user, you might as well use the *ZIP file for non admin install*, however please not that if you don't have administration rights on the machine, you will not be able to communicate with the 4M20 board (or with any Arduino board) if the appropriate drivers are not already installed on the system.
- If you are using MacOS, download the ZIP file containing the Arduino application and extract it to the *Applications* folder.
- If you are using Linux, please download the appropriate archive file, and follow the detailed setup instructions at https://www.arduino.cc/en/Guide/Linux.

Once the Arduino IDE is installed, make sure the 4M20 board is connected to the system over USB, then start the IDE and verify that the board is properly detected (as *Arduino Uno*) by checking the *Port* submenu in the *Tools* menu (see screenshot). In the *Tools* menu, choose *Arduino/Genuino Uno* as board type, and select the detected board under *Port*.
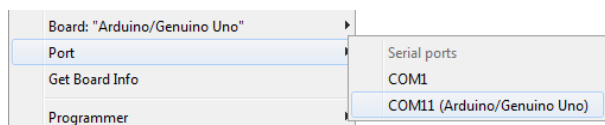

Figure 1: selecting the correct board in the menu

First programming exercises

Now load the *Blink* example (*File / Examples / 01.Basics / Blink*), and click the *Upload* (→) button in the toolbar. After some seconds, one of the LEDs on the board should blink in a regular way. Try to change some parameters in the code such as the numbers in the delay functions, and see whether you can observe different behaviors of the board.

Next load the Servo-Sweep example (*File / Examples / Servo / Sweep*) to test the servo motor commands. Connect one of the servomotor cables to the controller socket labeled "PWM3". Make sure the polarity is correct (black cable should go to ground GND, and red cable to power PWR). In the Arduino example, find a function setup() and modify the function as "myservo.attach(3);" to configure the port 3 for the connected servo. When you upload this code, the servo should go back and force.

Installing Arduino support in Matlab

If you are using a recent 64-bit version of Matlab, it includes the possibility of using an Arduino board directly from Matlab code. The support for it is not installed by default, however it can be installed very easily: just type arduino at the Matlab prompt, it will tell you that you need to install the Arduino support. Click on the link in the error message and follow the setup process. Alternatively you can download the package from here:
https://www.mathworks.com/hardware-support/arduino-matlab.html
If you already have a working Arduino environment on the computer, uncheck the *Install Arduino USB drivers* checkbox during the installation process.
Then download Matlab script "ArduinoTest01.m" from Moodle 4M20:
https://www.vle.cam.ac.uk/course/view.php?id=94122
By running this script, you should be able to see the blinking of one of the LEDs on the board. Try "ArduinoTest02.m" also on Moodle, which should control one of the servos connected to the PWM3 port. You can find other Matlab commands you can use by typing "methods arduino" in the command window.

Appendix: list of materials

You should have received the following items:

- 4M20 Arduino compatible board (1x)
- 2 m USB cable (1x)
- 2s Lipo battery (1x)
- Lipo charger (1x)
- Charger power lead (1x)
- Power distribution board (1x)
- Servo motors (3x)
- Servo horns (3x)
- 100 mm connecting piece (4x)
- 40 mm connecting piece (3x)
- Foot wide (1x)
- Foot narrow (1x)
- Foot connectors (2x)
- Microcontroller board mount (1x)
- Battery holder (1x)
- Power distribution board mount (1x)
- G-clamp (1x)
- Set of tools
- Set of screws
- Set of cables

Appendix: power distribution board