How to set up the EE380 Control Systems Lab module

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1 Things to buy

1. Motor unit (motor, gear, quadrature encoder (QE))

   Note that the number of pulses of our QE is used in the .c files. In our cases, this number is 500.

   The gear is used in the disturbance observer experiments. The gear ratio of our gear is 62:1 (motor speed:output speed).

   Table 1.1 (parameters of the dc servo motor) of the lab manual shows the information about the motor that is used in the experiments. This information is taken from the datasheet of the motor.

   The permitted starting current of the motor is limited by the Solarbotics H-bridge board's current carrying capability. This current can be up to 3 A.

2. Components that go on to the dsPIC board are listed in the bill of materials provided on this webpage.

3. Solarbotics L298 H-bridge board can be bought from `http://www.solarbotics.com/products/ k_cmd/resources/`

4. PICkit 2 from `www.microchip.com` .

5. PC with serial port.

6. RS232 cable compactible with the PC's serial port and the dsPIC board's serial port connector, which is a DB9 connector.

7. Power supply.

   At the least the power supply has to provide ±15 V, 3 A. The current rating of the power supply depends on the starting current of the motor.

8. Appropriate connectors.

2 Things to fabricate

1. Fabricate dsPIC board using the schematic files `.PcbDoc` and `.SchDoc`. These files were created by the authors using DXP Protel 2004.

2. Pulley with an approximate radius of 1 – 2 cm to mount on gear shaft.

3. Choose an object of known mass that will serve as the load on the motor in experiments 5, 6, and 7.

   The mass depends on the torque T that is available on the output shaft of the gear. If the radius of the pulley is r m, then the maximum mass that can be lifted by the motor equals $T/(rg)$, where $g = 9.8\ \text{m/s}^2$.

4. Assemble the Solabotics board using the instructions that come with it.

5. Fabricate a suitable base on which to mount the motor unit, dsPIC board, and Solarbotics board.

   The base needs to be such that the pulley projects out of it, and such that when the base is on the workbench, the pulley the string that carries the load and winds on the pulley does not rub against the bench.

3 Software to be installed

1. MPLAB IDE and C30 compiler from `www.microchip.com` .
   IDE stands for Integrated Devlopment Environment.
2. PICkit 2 driver that comes with PICkit 2.
3. Bray's terminal `terminal.exe` .
4. GNU Octave.

4 Creation of project file

1. Open MPLAB IDE.
2. Under the `Project` menu, open the `Project Wizard`. Click `Next`.
3. Select `dsPIC30F4012`. Click `Next`.
4. Select `MPLAB C30 C compiler`. Click `Next`.
5. Create a project file in the desired folder.
6. Include the following files: `p30f4012.h`, `p30f4012.gld`, `main-prog.c` (for Experiment 6, include `main-prog-exp6.c`), `settings-prog.h`.

5 Connections and additional information

`CS-EE380-Lec01-Demo.pdf` shows the connections, how to open a project file in MPLAB IDE, and where to place the controller code in `main-prog.c` or how to apply a step input to the pmdc motor, how to compile, how to burn the code to the microcontroller, how to read the data into the PC, and how to plot the data.

6 Setting up GNU Ocatve on Windows, problems with GNU Octave and their solutions

To see what GNU Octave is, you may visit the following URL:

`http://www.gnu.org/software/octave/`

Help on this software is available by following the links

Mailing lists –> Search the Mailing Lists (using Nabble).

The following functions of MATLAB that we use in the introductory course on classical control have same-name and same-purpose approximate equivalents in GNU Octave:

`acosd, angle, arg, asind, atan, atan2, atand, bode, complex, cosd, dlmread, do, elseif, for, feedback, grid, if, impulse, legend, linspace, logspace, lsim, max, min, nyquist, parallel, place, plot, poly, print, rlocus, semilogx, semilogy, series, sind, size, step, subplot, tand, tf, title, xlabel, ylabel, while, zeros.`

The following functions or tools of MATLAB do not have equivalents in GNU Octave:

`bodemag, pole, ramp, sisotool, zero, zpk.`

Additionally, the following arithmetic operations work with the same effect in both software:

```
*   /   ^   +   -   .*   ./   .^
```

GNU Octave for MS Windows can be downloaded from `http://octave.sourceforge.net/` or specifically from

```
http://sourceforge.net/projects/octave/files/Octave_Windows%20-%20MinGW/
Octave%203.2.4%20for%20Windows%20MinGW32%20Installer/
Octave-3.2.4_i686-pc-mingw32_gcc-4.4.0_setup.exe/download?use_mirror=citylan
```

To install the full distribution, check all the packages during installation.

On MS Windows, Octave 3.2.4 has a problem in displaying plots. The problem is described at the following URL:

```
http://octave.1599824.n4.nabble.com/
Gnuplot-freezes-in-Win7-3-2-4-td2279218.html#a2279218
```

A link to the solution is also given in the answer at this URL.

The problem is: `"Plots do not show up, or freeze in GNU Octave"`

The solution is as follows:

```
Try the following:

    pkg rebuild -noauto oct2mat

at the octave prompt and then restart octave.
The operation results in the oct2mat package
not to be auto-loaded in startup. When you
want to use oct2mat, execute "pkg load oct2mat"
command.
```

This tip is from

`http://wiki.octave.org/wiki.pl?OctaveForWindows`

We found this URL at

`http://octave.1599824.n4.nabble.com/Gnuplot-freezes-in-Win7-3-2-4-td2279218.html`
