Prelab 1

Prelab 1 is due at the START of your first lab session.

Deliverables (for a complete Prelab 1 assignment) include:
- Print-out of your MATLAB m-file, to draw the 2-link arm and end effector path.
- Print-out of the final frame of your animation, showing the final position of the 2-link arm and the complete end effector path. This will look similar to Figure 1, below, except that you should see a full word written out in script, and the arm will be in a different location.
- Answers (either by hand calculations or via MATLAB code) to the questions.
- Also, bring an electronic copy of your m-file to lab. (Alternatively, email it to yourself so you can retrieve it at the start of lab.)

Lab 1 involves recording the joint angles of a simple 2-link robot arm, as you move it by hand through space, and then plotting the arm and the path traversed by the end effector. This lab is largely intended to get your familiar with our LEGO NXT setup and MATLAB interface. The lab groups are likely to be large, so it is important that you spend some time preparing before your lab section. However, this should be a relatively short assignment!
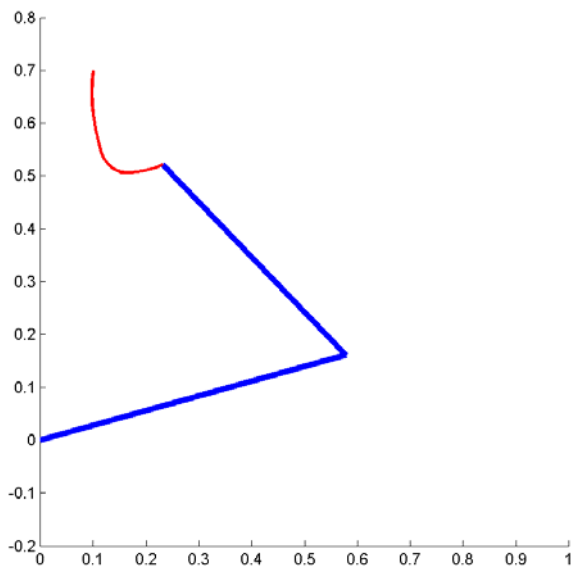

Figure 1: 2-link arm.

At left is an example frame from an animation showing the 2-link arm (in thick, blue) and the path so far for the end effector (shown as a thinner, red line).

For the purposes of the prelab, use:

```
L1 = 0.6

L2 = 0.5
```

Use the same axes depicted, too:

```
axis([0   1   -0.2   0.8])
```

1. On the course website, go to the Laboratories tab and download the following file for Lab 1:
   `prelab1_thetas.mat`

This mat-file contains two variables, `th1` and `th2`. These are the absolute angle of the first link (`th1`) and the relative angle of the second link (`th2`), with respect to the first link, as described during the first lecture.
- Write a MATLAB m-file function that takes `th1` and `th2` as inputs and animates the motion of the 2-link arm over time. Draw both the actual arm and the path of its end

effector, as illustrated in Figure 1, above. Define the lengths of the arm segments, L1 and L2, near the top of your function. In lab, you will need to measure the actual robot to get the correct values for the true LEGO robot. For this prelab, simply use L1=0.6, L2=0.5.

Hints:

- Rather than re-drawing the 2-link arm and the end effector path for each animation, create an object and redefine the Xdata and Ydata fields for each frame. e.g.,

```
p1 = plot([0 1],[0 0],'b-','LineWidth',4);
set(p1,'Xdata',[0 .9],'Ydata',[0 0.5])
```

For your code, you will have two objects: one for the arm and one for its path.

- Use thick lines for both the arm and the end effector. The 'LineWidth' setting in the previous example will do this.

- Be sure the axes have a 1:1 ratio and that they are fixed over time. For the prelab, use `axis([0 1 -0.2 .8])`, as shown in Fig. 1. The command "axis image" forces the x and y axes to use the same scaling, so the aspect ratio in your drawing is not distorted.

2. Include a print-out of the final frame of your animation in your prelab. It should look similar to Figure 1, except that the full end effector path should spell a word in cursive handwriting.

3. Consider the region 0<=x<=1 and -0.2<=y<=0.8 (i.e., the 1x1 square shown in Figure 1). Sketch (by hand or with MATLAB) the reachable workspace within this unit square for the arm's end effector. What fraction of the 1 x 1 square can the end effector reach? (MATLAB will be useful for calculating or estimating areas. Try to estimate to within 2 sig figs.)

4. Solve for the lengths, L1 and L2, needed to allow the arm to reach any point in the 1x1 square, while minimizing the length of L2.

- Copy your m-file to a USB key or email it to yourself, so you will be able to retrieve it at the start of lab. (Do not submit your code electronically to us: just make sure you will have access to your m-file in lab, for editing…)