MINIPROJECT 2 (OF 2) - CONTROLLING THE HAPTIC JOYSTICK

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1 *Overview*

The overall goal of the first two miniprojects in this course is to build and program a one degree of freedom haptic joystick. A haptic device is a physical interface that provides information to the user via touch. In this class, the haptic joystick will provide a reaction force (torque) felt by the user according to some control law that you will implement on the PIC microcontroller.

2 *Introduction*

For this second miniproject, you will write code for the PIC24 microcontroller to change the behavior of your haptic joystick. You will also develop a USB interface for changing the values of control parameters from your laptop without having to restartthe PIC or reload its firmware.

The objectives for this miniproject are:

1. Implement multiple control laws for your haptic joystick
2. Interface to your joystick via USB
3. Change joystick control parameters via your USB interface
4. Use your joystick as a haptic rendering device

3 *Materials*

- Your assembled motor driver circuit board
- Your assembled angle sensor shield
- Your assembled mechanical system with motor integrated

4 *Controlling the Joystick*

For this lab, you'll make your haptic joystick behave like simple virtual mechanical elements. Listed below are the virtual elements you should try to emulate with your haptic joystick:

Virtual Spring - To make your joystick behave like a virtual spring, you will need to write a controller that causes the motor to apply a torque that is proportional to angular displacement to the handle of the joystick. The relevant parameter over which you have control is PWM duty cycle (or the effective voltage applied to the motor), but torque is proportional to current. Your controller will therefore need to manipulate the PWM duty cycle while measuring current and angular displacement.
Virtual Damper - For the damper, recall that the viscous damping torque is proportional to the rotation speed and always acts opposite to the rotation direction. Your virtual damper will mimic a real damper in that it should feel "harder" to move the faster the user attempts to move the joystick.
Virtual Texture - A virtual texture simulates the experience of the dynamic characteristics of a material or surface changing spatially. Imagine running your fingersover a bumpy surface and experiencing a series of "stick" and "slip" events. Can you control your joystick to "display" a texture to the user?
Virtual Wall - To use a haptic joystick as a "display," it might be useful to create a virtual wall. Imagine moving objects around in a virtual environment - it mightbe helpful to feel when they've run into each other. The virtual wall allows you to display a sudden change in impedance to the user of the joystick.

5 *USB Interface*

In order to adjust the control parameters for your virtual environments, you will need to develop an interface to your firmware that uses USB to transfer data back and forth. The simplest way to do this is to create your own custom vendor requests. You can find an exampleof bidirectional data transfer using vendor requests in the hellousb project in the Elecanisms Github repository.

6 *Deliverable*

By the start of class on February 16, 2017, each group should email a short (no more than 4 pages) report in pdf format to both instructors. Your report should describe your approach to controlling your haptic joystick to emulate each of the four different virtual environments. Please include:

1. A written summary of your approach to controlling the joystick
2. Snippets of code that are relevant or important to the implementation of your controller

3. Plots of the responses of your different virtual environments (eg. for the spring, displacement versus time for some initial input). For example, for the spring control law, you may want to show the free response of the system to some intial displacement.

4. Screenshot(s) (or a link to a screen capture video) showing the interface that enables modification of the control parameters

5. A link to your repository with source code