Lab Introduction

ME 328: Medical Robotics
Stanford University ◆ Winter 2019

Room access and guidelines

Laboratory work for several ME 328 assignments will be conducted in Bldg. 550, Room 108. You may enter this room at any time to work on your lab assignments. The entry code for the room was given in class, and you also have access to Bldg. 550 after hours using your Stanford ID card.

For problems involving teleoperation of the Phantom Omni, there are 4 stations available. Do not wait until the last minute to complete lab assignments, or you may not be able to find a spot in the lab!

This room sees heavy use throughout the year, so please adhere to the following guidelines so that everyone can enjoy this lab as a resource for assignments and projects:

- Keep the lab clean and safe. Please take responsibility for your own work area *and* either fix or notify the instructors as soon as possible if there is a cleanliness or safety issue.
- If something is broken, please let the instructors know right away.
- If there is an urgent safety issue, call ME Lab Manager Jaime Eredia's cell phone (650-996-0531), and/or 911 (9-911 from a campus phone).
- Conserve energy and maintain safety by closing the door and turning out the lights if you are last out.
- Please have our lab benches be in the same or better condition when you leave it compared to when you entered. We will have an end-of-quarter cleanup session to ensure that everything is clean.

Computer login and general software

Log in to a computer by using the class-specific username "ME 328" and password "medicalrobotics".

If you need Internet access on a lab computer, please use the format <SUNetID>@stanford.edu as the username, along with your SUNet password to connect to "eduroam" WIFI.

We will copy the code template for each assignment to a folder called "ME328 Templates" on the desktop. Please do not modify these templates. Instead, make a local copy (identified with your name) and work off of that. (Note that the template files are also available on the course website if you would like to download them and work on a personal computer.) When finished, you can save your work to the computer but it will be only available on that specific machine. To avoid the issues that could arise from this constraint, please email the files to yourself or save them to your personal flash drive (USB stick) for data analysis, printing, and electronic submission. The main program you will be using in the lab is Microsoft Visual Studio. It's best to do any data analysis in either MATLAB or Excel on your own computer.

Set up and Physical Handling of the Phantom Omnis

The Phantom Omni is a haptic interface/robotic device that we will use extensively in this course as an example system to be controlled and analyzed. It has 6 degrees of freedom (DOF) of motion and 3 degrees of freedom of actuation. The Omni linkages are fragile, so be sure to only pick up the Omni by its base. Some Omnis have already lost some functionality with time, such as DOF of wrist sensing (marked) – they are not needed for Assignment 2. All stationed Omnis have the appropriate DOF for the assignment.

When plugging in the Omni to power or recalibrate, make sure the stylus is snapped into its "inkwell". Be careful when removing the stylus from its inkwell – lift up, don't press down. The Omni is actually more

prone to damage when the stylus is in the inkwell, so it should be out of the inkwell unless you are calibrating or done using the Omni. When teleoperating, make sure the "patient-side" robot has its stylus removed, and that the free "wrist" degrees of freedom are tied up with electric tape. The same goes for when an Omni is being controlled as an autonomous robot in later labs.

For teleoperation, the Omnis are daisy-chained. That is, the first firewire cable will connect the first Omni directly to the computer. The second firewire cable will connect the two Omnis together. Each Omni has two FireWire ports to enable this. For the first lab, all the Omnis will be properly set up and registered at four stations, so you should not unplug or move them. Only an administrator (e.g., one of the teaching staff) has the necessary permissions to re-configure an Omni to a computer.

Programming the Phantom Omnis

As described above, you can download the code templates for programming the Phantom Omni from the course website: http://web.stanford.edu/class/me328/#assignments. They will be available as zip files.

Templates can also be found in a folder "ME328 Templates" on the desktop. Make sure to use the appropriate template for each assignment – they will not always be the same.

After you unzip the file, go into the directory called "ME328_Ass2" (or similar), and open the project in Microsoft Visual Studio 2010 by double-clicking on "ME328_Ass2.sln" (or similar). Once the project (also called a "solution" in MS VS terminology) opens, you might need to navigate through the project files in the left pane to find and open the main.cpp file, called "ME328_Ass2.cpp" (or similar). The easiest way to compile and build your program is to click on the green "play" arrow, which will automatically recompile/rebuild if changes have been made or no executable exists, and then run the executable. The executable itself will reside in the folder called "Debug", one folder level up.

```
switch (part) {
    // Problem 3
    case PART_A:
        break;

    case PART_B:
        break;

    case PART_C:
        break;

    case PART_D:
        break;

    case PART_E:
        break;

    case PART_F:
        break;

    case PART_G:
        break;

    // Problem 4
    case PART_H:
        break;

    case PART_I:
        break;
```

In the Assignment 2 template, you will build various controllers (for each part of the Problems) by building on the "switch" function, shown on the left. Data recording is only done in the x-direction and lasts for 10 seconds starting from the time you press R. The data will not be saved to a file unless you quit the program. (Otherwise, the process of writing to the disk might take too much time and make your controller behave badly.) The data file will be saved in the same directory as the main .cpp file, and for Assignment 2 the template code is set up to name the file to match what part of the problem you have specified (e.g., A, B, etc.). The data is currently set up to save as a tab-delineated text file, with one row of data for each sample (at about 1000 Hz). The data saved are the time stamp, the position of the master and follower, the velocity of the master and follower, and the force commanded to the master and follower. You can view the text file on the lab computers, but you should process the data in Excel or MATLAB on your own computer for easier handling.

Note that the position units of the Omni is mm. Force units are N. The x, y, and z directions (which can be accessed by [0], [1], and [2], respectively, in your programs) are as defined in Assignment 1.

If you encounter an "Error Code: HD_INVALID_VALUE. Internal error code: -5", please reboot your computer. This error indicates that one or both Omnis are not being detected. If the problem persists, please post to piazza and note which of the stations is causing the problem.