

GUI

The EnRoute 2.0 GUI has been written in MATLAB. It supports manual control of all functions as well as selecting Simulink defined control algorithms. Additionally, communication can be handled over the serial port or over IP so that the test-bed may be controlled remotely from any location. Here we will discuss how to use the GUI and any nuances that may be encountered.

Control Tab

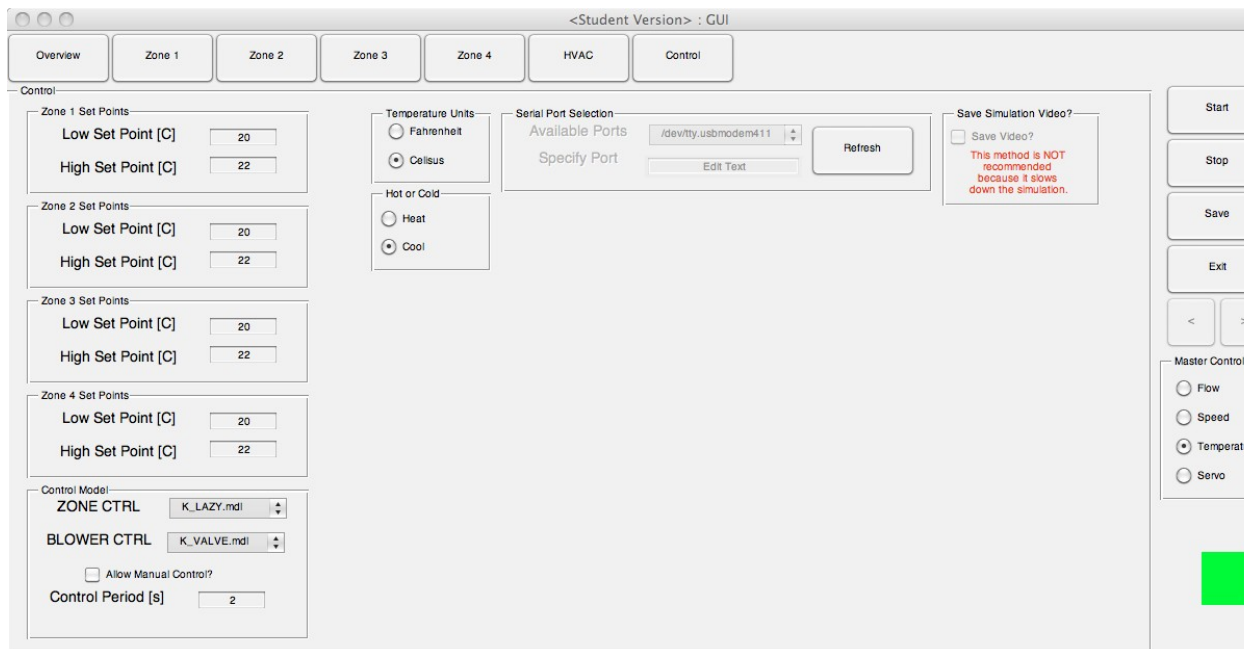
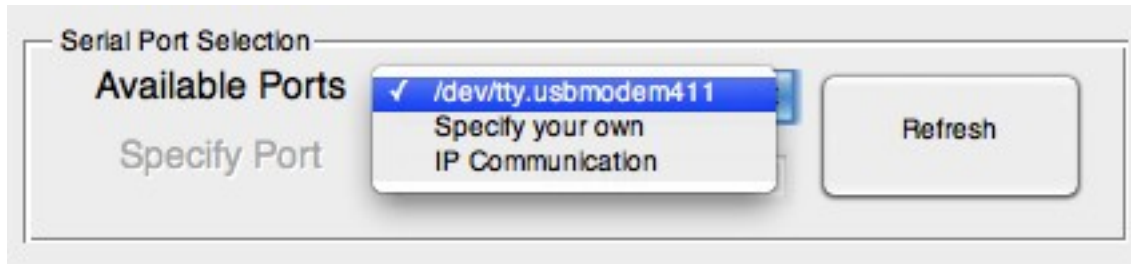


Figure 1: Control Tab

- The control tab, shown in Figure 1, is the first tab that should be considered before starting a simulation. This tab provides the following functions:
- Serial Port Selection
 - IP Selection
 - Save Video Option
 - Temperature Unit Selection
 - Heating or Cooling Selection
 - Set Point Entry
 - Control Model Selection



The

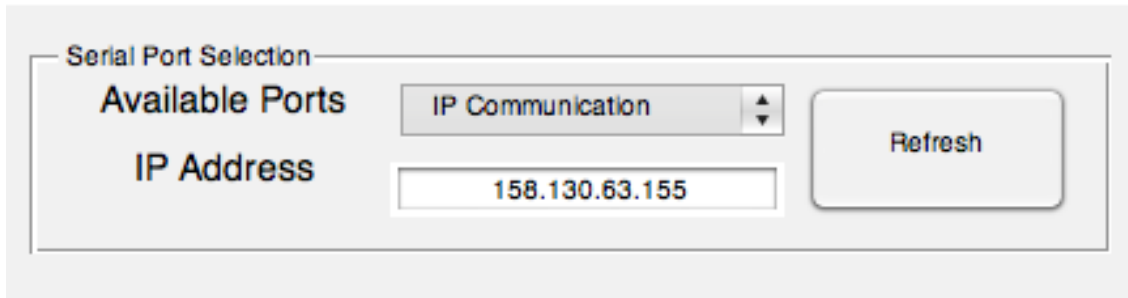


Figure 2: Serial Port/IP Selection Box

Serial Port/IP selection box, shown in Figure 2, allows the user to choose between serial communication, IP communication, and allows for choosing the serial port or IP address for connecting. MATLAB should find any serial port that is connected to the computer, though this feature will only work on MAC or UNIX systems. This functionality can be seen in the SERIAL PORT/findPorts.m file. The ports will be updated when the program starts or the Control tab is selected, but you can manually update any time by pressing the refresh button. If your port is not listed, or you wish to set it manually, you can select the 'Specify your own' option and type the port name in the text field below the drop-down menu. As a final option, you can select 'IP Communication' and specify the IP address (the default address listed is correct unless any settings are changed on the IP side of things).

NOTE: There is a switch on the mbed circuit that toggles between IP or Serial communication. When the light is YELLOW it is set to Serial Communication, when the light is GREEN, IP Communication is selected. The mbed MUST be restarted after changing the state of this switch.

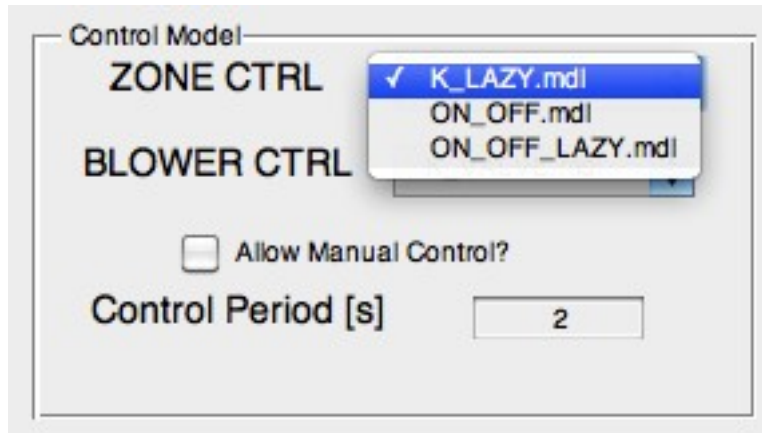


Figure 3: Control Model Selection

The Control Tab also allows you to set the high and low set points for each of the rooms separately, and choose the control method from the drop down list, shown in Figure 3. The ‘Allows Manual Control’ checkbox disables all control methods when selected, but allows the user to manually control all valves. The Control Period text box allows the user to enter how frequently the controlled states should be updated in the code.

NOTE: The Control Period should NEVER be set to less than 1 second.

There are two drop-down menus, one will select the control algorithm used to specify the zone angles, and the selects the control algorithm for specifying blower speed based on the current valves or flow rates into the rooms. Designing new Simulink control models is discussed below.

The Temperature Units selection box allows you to change the displayed units to either Fahrenheit or Celsius.

NOTE: All temperature data stored in the output struct is in Celsius units.

The Save Video box allows you to specify whether or not you wish to save a video of your simulation. This will take screenshots of the GUI as you run a simulation and concatenate them all into a video.

NOTE: The video file will be rather large (hundreds of megabytes) for short simulations. It would be unrealistic to record a video for long simulations.

NOTE: When you start the simulation it will prompt for a video name; however, if you enter a name that already exists in the current directory the original file will be overwritten.

NOTE: The video recording will slow down the simulation.

NOTE: The output video will not be real time when played back.

The Heating/Cooling Selection box allows the user to specify whether the system is in heating or cooling mode. This checkbox will handle the double valve, and turn the heater on if needed. The heater has upper and lower bounds (37 C and 40 C) that are handled on the mbed to ensure it does not get hot enough to damage the system.

Overview Tab:

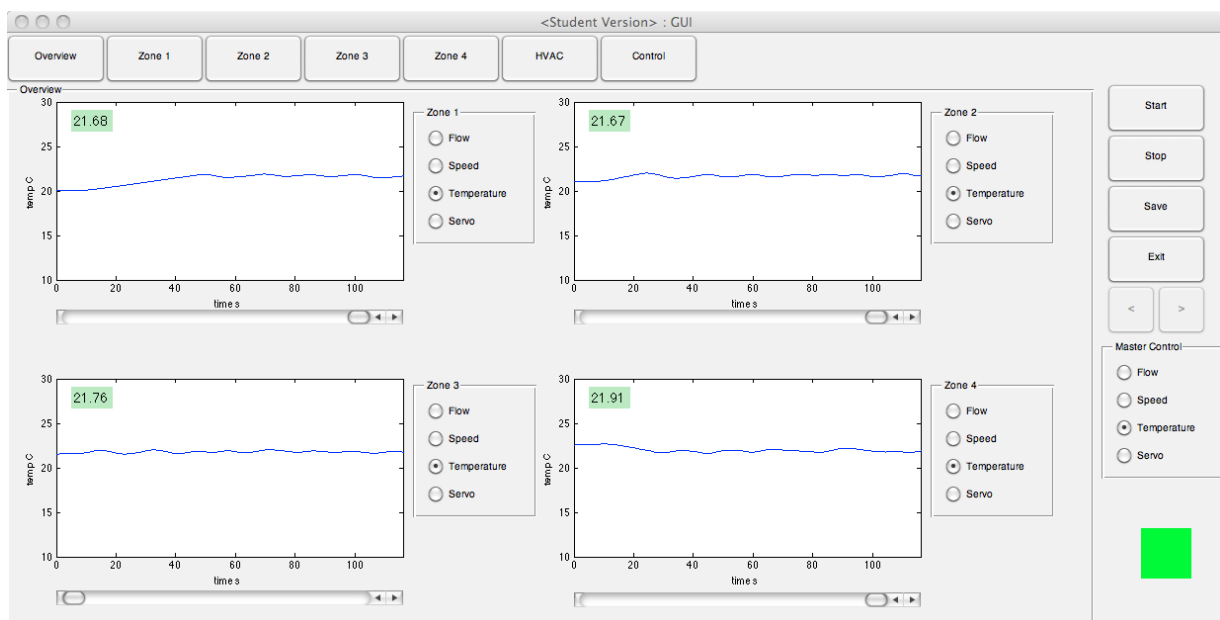


Figure 4: Overview Tab

The Overview Tab, shown in Figure 4, allows the user to view all data from all the rooms on the same tab. The user can select individually what data to be plotted for each room using the radio button selection box to the right of each plot. Additionally, the data plotted in each graph can be synchronized using the master radio button selector all the way on the right of the GUI.

Each plot has the current numerical value listed in the top left hand corner of the plot.

The sliders allow for changing the servo position in each room

There are four (4) master control buttons on the right-hand side of the GUI: Start, Stop, Save, and Exit. Start will begin the simulation and Stop will end it. Exit will close the GUI. Save can be called after a simulation to save data to the current working directory. When you press the Save button you will be prompted to enter the name of the data to be saved and allows you to choose what should be saved from a series of check boxes. There is also a left and right arrow button, which allows you to scroll through the plotted data after the simulation is complete.

There are a variety of checks within the code that may present warnings after Start is pressed if the Serial Port is not specified correctly or working correctly.

NOTE: When you enter a Save As name MATLAB will check to see if any files with this title exist already, and will not allow you to overwrite any other files. However, this also means that you cannot save anything to the same name as other files, even if they have different extensions.

NOTE: It is highly recommended to press the Stop button before pressing the Exit button. Closing the GUI in any way either than the Exit button will cause errors to be displayed in MATLAB.

Zone Tabs:

The Zone Tab, shown in Figure 5, displays all the data for an individual zone. The radio button selector chooses which set of data is displayed in the large plot. All functionality is the same as the Overview Tab.

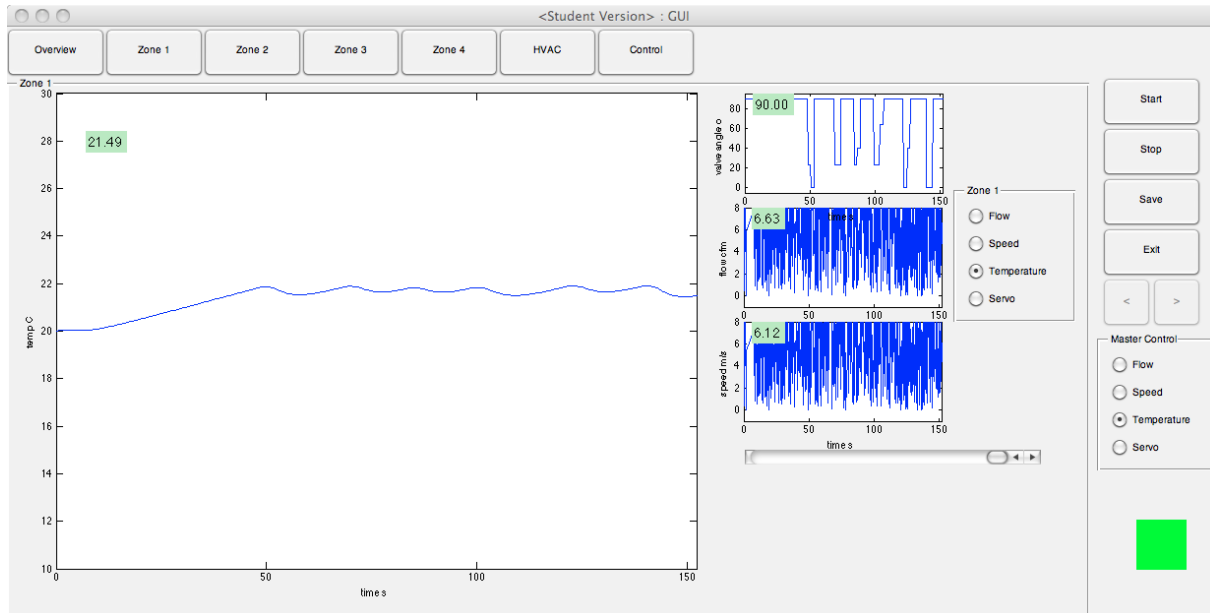


Figure 5: Zone Tab

HVAC Tab:

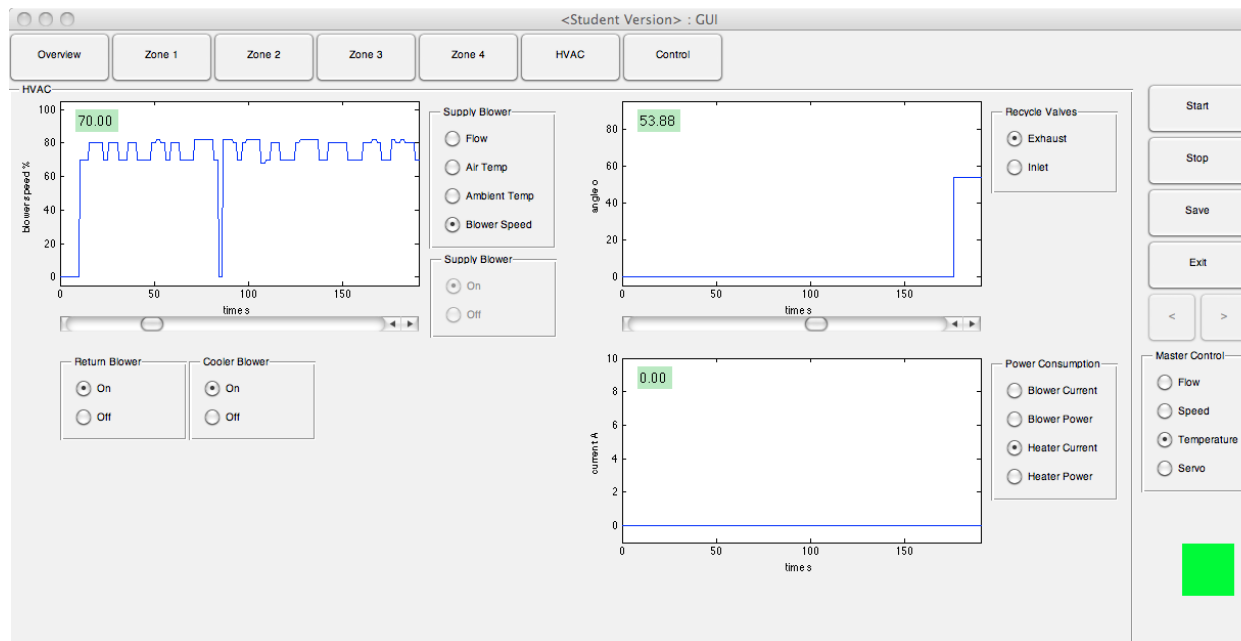


Figure 6: HVAC Tab

The HVAC tab, shown in Figure 6, controls all blowers, the recycle valves, and reads the temperature, flow, and power characteristics of the HVAC. The Return Air Blower and Cooler Blower are only ON-OFF controlled, but the Supply Blower has a variable control from 60%-100% of 12 V power applied to the blower (via an h-bridge). On the top left hand corner you can view the blower speed (60-100%), air flow, air speed, and HVAC outlet temperature. On the top right hand graph you can view the valve angle for the exhaust and recycle air valve. Selecting the valve from the menu on the right and moving the slider changes the valve position. Finally, the bottom right hand graph displays blower current, blower power, heater current, and heater power. At the moment, heater current and power are not measured.

Control Models in Simulink

This GUI is designed so that users can define control structures in Simulink and run them directly from the GUI without any programming. The Simulink .mdl files must be placed in the correct folder (for blower control models place them in the CONTROL MODELS/HVAC folder, and for valve control models place them in the CONTROL MODELS/ZONE folder) for them to be found in the drop down menu.

If you wish to define a new model it is recommended you just save a copy of an existing model and rework it. Blower control models require eight (8) inputs (valve_1, valve_2, valve_3, valve_4, flow_1, flow_2, flow_3, flow_4) and one (1) output (blower state). Zone control

models have eight (8) inputs (temp_1, temp_2, temp_3, temp_4, valve_1, valve_2, valve_3, valve_4) and four (4) outputs (valve_1, valve_2, valve_3, valve_4). If there are other inputs desired they can be manually entered using Constant blocks, or using Constant blocks and defining their states in the CONTROL MODELS/initControl.m file. Examples of this can be seen in the ON_OFF_LAZY.mdl file where additional inputs are applied with Constant blocks and the values for those constants are set in the initControl.m file.

Additionally, ON_OFF_LAZT.mdl shows how to code your own algorithm using a MATLAB function block in Simulink. This way, you can design your own controller without using standard Simulink blocks if you wish too.