Matlab-based GUI User's Guide

Running Common Routines of the ISHMP Toolsuite without the Command Line Interface

Illinois Structural Health Monitoring Project

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Overview

This guide outlines how to use the Illinois Structural Health Monitoring Project (ISHMP) GUI to run common routines of the ISHMP Toolsuite without the command line interface. The GUI is a reference implementation that can be used as is, or can provide a foundation for building your own interfaces to the Imote2. This guide assumes the user has followed either the "Getting Started for New Users" or "Getting Started for Advanced Users" guides and has Imote2s configured with the ISHMP Version 3.0.0 Toolsuite.

Following the instructions in this guide will allow you to:

- Collect and visualize acceleration data using *RemoteContSensing* or *RemoteSensing* from a network of Imote2s using ISM400 sensor boards
- Run basic commands, such as listing nodes in the network and determine battery voltage

The hardware and software required to use this guide is:

- Computer running the Windows operating system
- Matlab (version 2009a or higher)
- USB to mini cable
- IPR2400 or IPR2420 Imote2 loaded with the ISHMP Toolsuite
- IIB2400 interface board
- IBB2400CA battery board
- ISM400 (formerly the SHM-A) sensor board

Several additional files, ISHMP-GUI-2.0.0.zip, are required to successfully follow this guide. The files are available for download at the ISHMP website at: http://shm.cs.uiuc.edu/files/ISHMP-GUI-2.0.0.zip .

You will need at least two Imote2s to create a "network." One Imote2 will connect to the PC via the USB and act as the gateway between the PC and your network of remote sensors. This guide will refer to an Imote2 connected to the PC as a gateway node and nodes in the network as leaf nodes.

Note that in this document, Matlab commands appear in `Courier New` font, Imote2 applications appear in the *Italicized Calibri* font, and filenames appear in the `Lucida Console` font.

Comments and Questions:
If you have questions about the software or this guide, or run into problems, please join us on the Imote2 discussion forum: http://vibration.shef.ac.uk/imote2_forum.

1 Starting the GUI

Initially, start Matlab and set the path to the folder containing the GUI files. Prior to starting the GUI, the default constants can be edited in `guiconstants.txt`, shown in Figure 1. The file allows you to set the default parameters for running *RemoteContSensing* or *RemoteSensing* including the COM ports, leaf nodes, sampling values, and output filename. Note that these can all be adjusted later within the GUI. The key parameters in the file highlighted by the red outline in Figure 1 are the scaling and offset factors for the accelerometer that will be used to process the data.

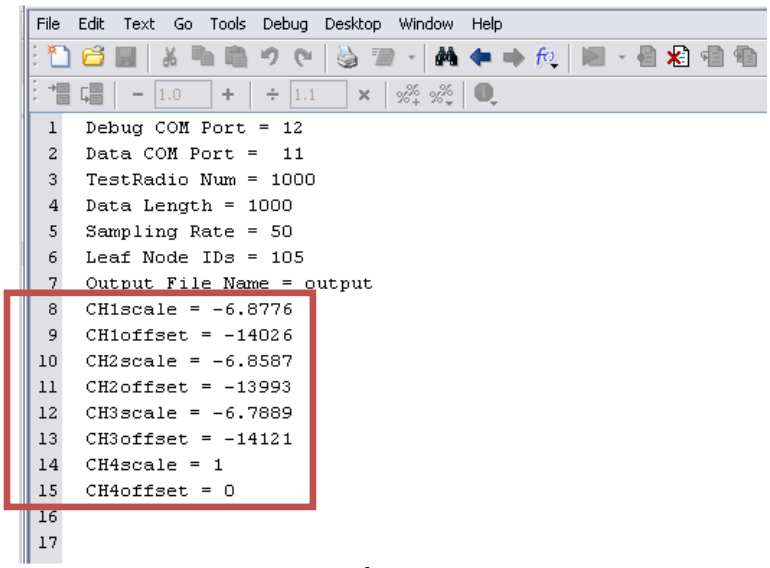

Figure 1: `guiconstants.txt`

Once the parameters have been set, run `imote2guircs` or `imote2guirs` in the command window to run *RemoteContSensing* or *RemoteSensing*, respectively. This is the main file which operates the GUI. A pop-up window will appear initially providing the GUI details and then GUI will open. The initialized GUI is shown in with important elements that will be mentioned throughout the guide labeled. Note that all the commands run in the GUI and the resulting output will be stored in `guilogfile.txt` for future reference.

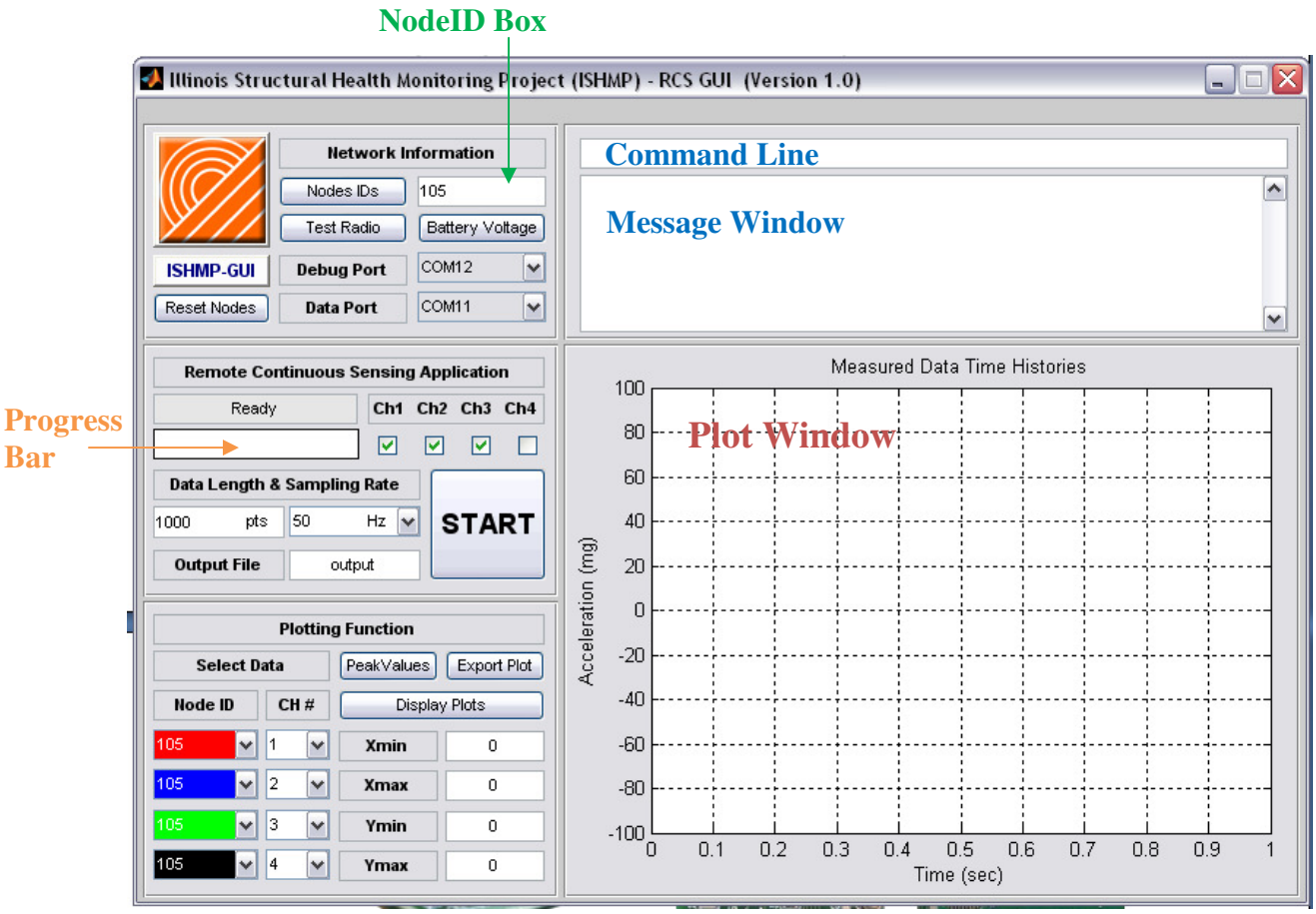

Figure 2: ISHMP GUI at startup with key elements highlighted.

2 Running Utility Commands

This section outlines how to run several utility commands on the Imote2 using the ISHMP GUI. Prior to running commands, the gateway node should be connected to the computer using the IIB2400 interface board and the appropriate debug and data ports should be selected.

2.1 List Nodes

In order to list the responsive NodeIDs in the network first click the button labeled "ISHMP-GUI" to clear the GUI and then click on the button labeled "Node IDs". This step will run the command *ListNodes* and include the responsive nodes in the NodeID box to the right of the corresponding button. The output of the command is shown in Figure 3.

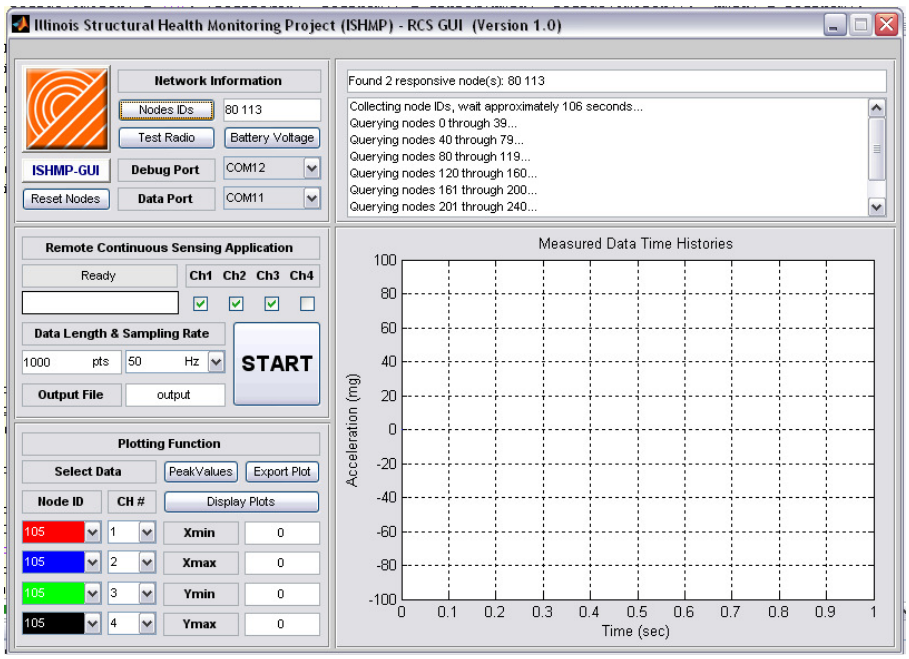

Figure 3: List Nodes completed.

2.2 Battery Voltage

The service *RemoteCommand vbat* is available to determine the battery voltage of leaf nodes. First, make sure the desired nodes are listed in the NodeID box. Second, click the button labeled "Battery Voltage". This will run the remote command for each node listed. The resulting output is shown in Figure 4.

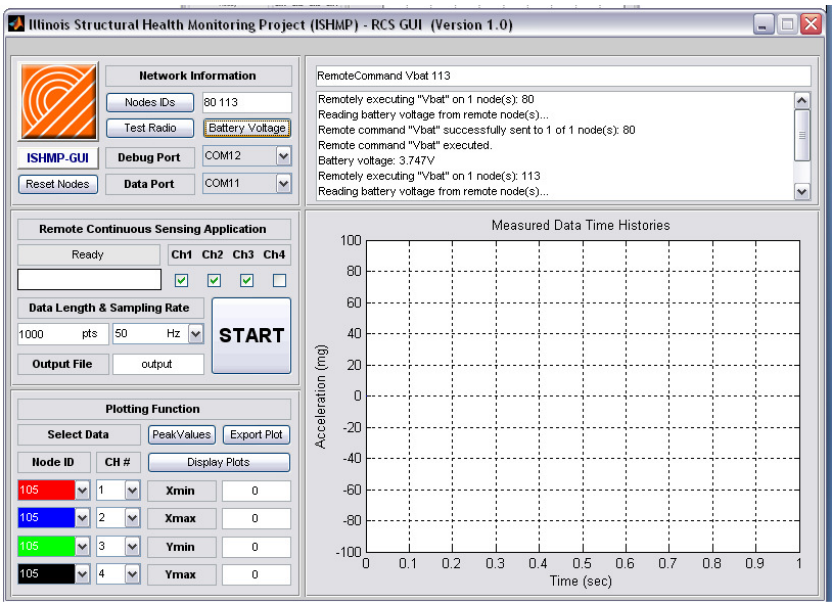

Figure 4: Battery voltage output.

2.3 Test Radio

To evaluate the communication environment, *TestRadio* is available. First, make sure the desired nodes are listed in the NodeID box. Second, click the button labeled "Test Radio". This will send 1000 packets to the nodes listed. The progress of the application is shown in the progress bar and the debug output is printed in the message window. Figure 5 illustrates the command in progress. To see the final results scroll down in the message window as shown in Figure 6.

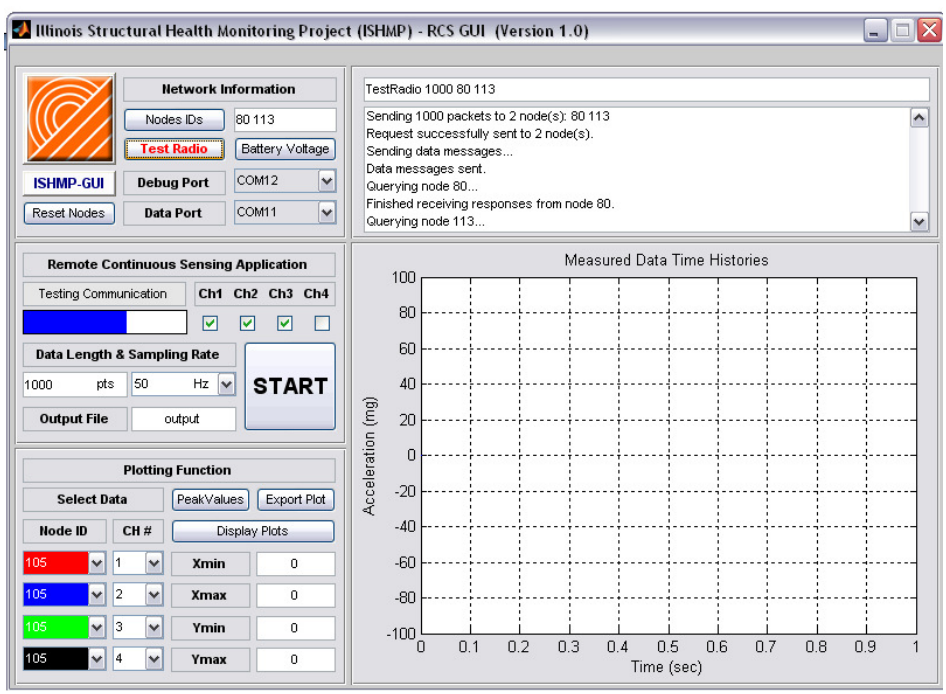

Figure 5: *TestRadio* in progress.

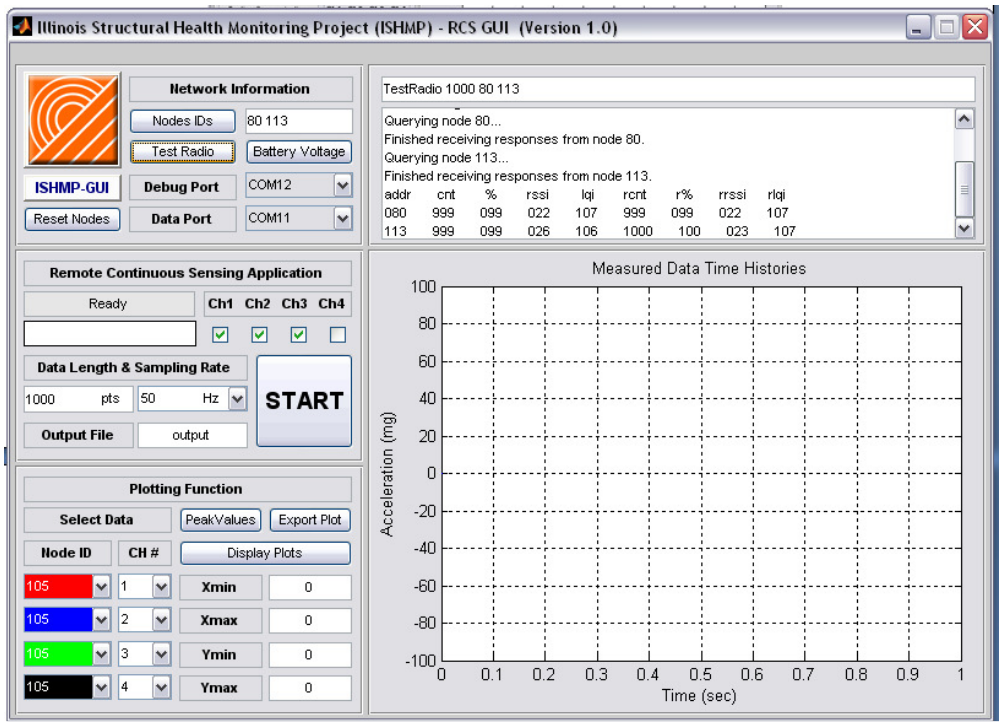

Figure 6: *TestRadio* output after completion.

2.4 Reset Nodes

In order to reset the gateway and leaf nodes, first make sure the desired leaf nodes are listed in the NodeID box. Second, click the button labeled "Reset Nodes", which will run the two commands: *LocalCommand Reset, RemoteCommand Reset.* The command output is shown in Figure 7. Scroll down in the message window to see the full output.

Figure 7: Reset nodes output.

3 Data Collection using GUI

The GUI allows the user to acquire acceleration data using either *RemoteContSensing* or *RemoteSensing* and visualize the output. The acceleration data is displayed in near real-time if *RemoteContSensing* is running. Furthermore, various combinations of the output can be plotted and the accompanying peak values can be calculated.

3.1 Starting Data Collection

Prior to running the *RemoteContSensing* or *RemoteSensing* application, the parameters need to be set using the following steps:

Under "Network Information"

1. Make sure the desired leaf nodes are listed in the NodeID box.
2. Select the appropriate debug and data COM ports.

Under "Remote (Continuous) Sensing Application"

3. Select the desired acceleration channels to be sampled.
4. Determine the number of samples.
5. Select the desired sampling rate in Hz from the dropdown menu.
6. Input the output filename. Note that no extension should be included; the output format is automatically ".txt".

Once all parameters have been selected, click the button labeled "START". See Figure 8 below for a sample set of parameters selected prior to starting the application.

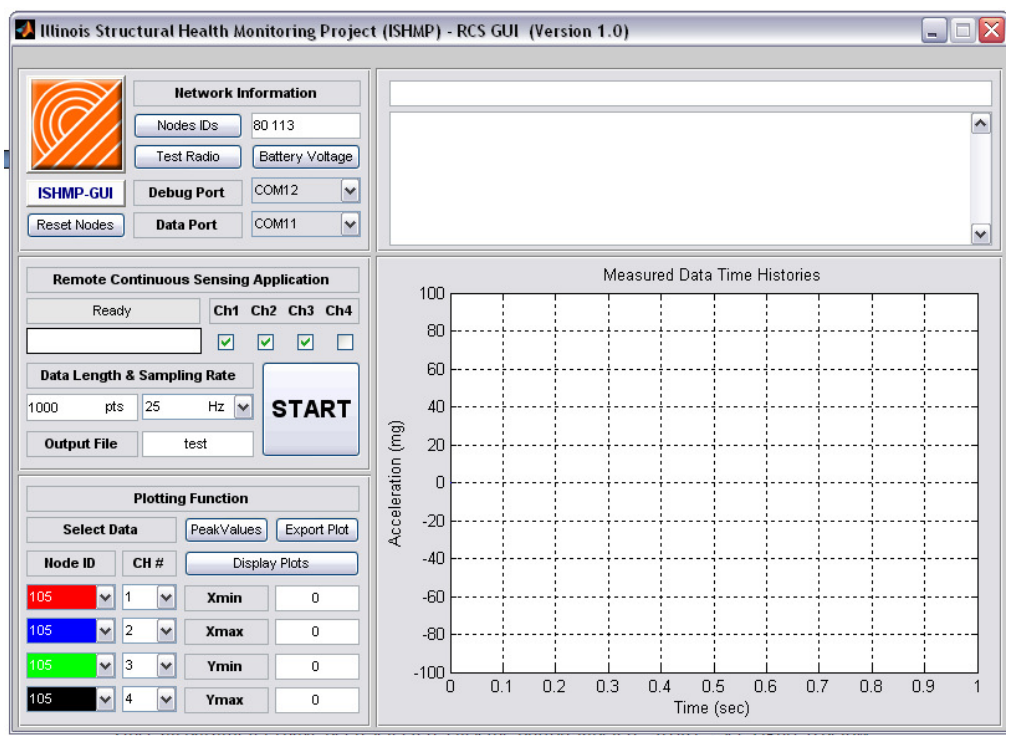

Figure 8: Sample parameters selected prior to starting *RemoteContSensing*.

3.2 Running *RemoteContSensing*

The application takes place in several steps that will be shown in the progress bar and will be outlined below.

Initialization and Set-Up for Sensing

The first few steps include initializing the application by setting up the network and sensing information, completing time synchronization of the nodes, and waiting for sensing to start. The debug output is shown throughout these steps in Figure 9 - Figure 11.

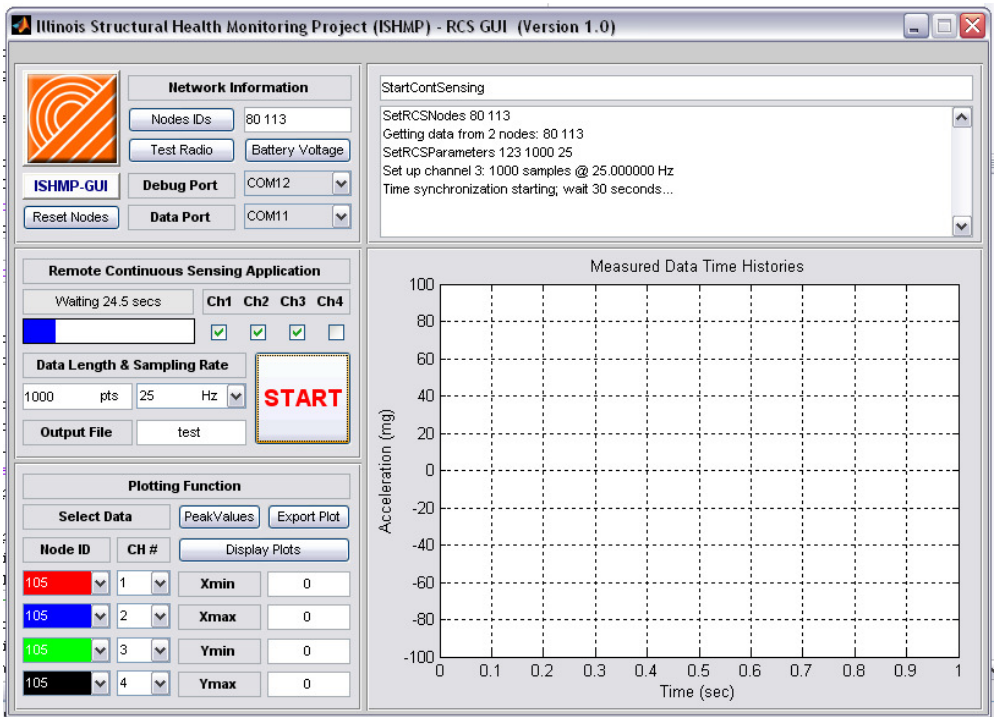

Figure 9: Remote Continuous Sensing during time synchronization.

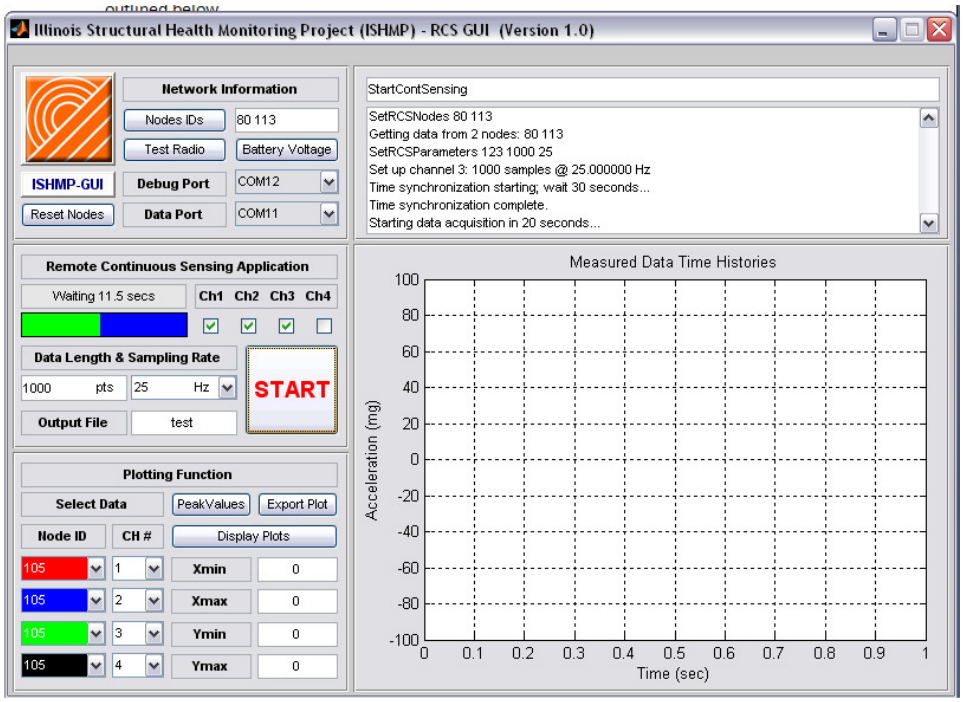

Figure 10: Remote Continuous Sensing while waiting for data acquisition to start.

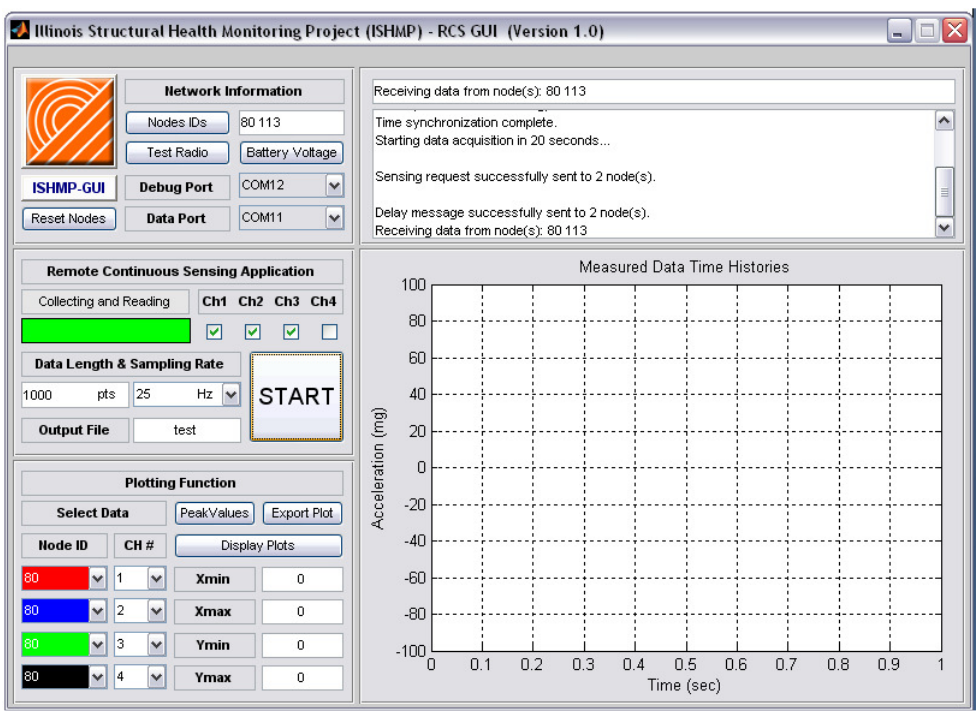

Figure 11: At the start of data acquisition.

During Collecting and Reading

The data will be collected continuously and output to the GUI in increments to be plotted while the leaf nodes are sensing (Figure 12). There is a slight delay between acquisition and plotting, which depends on the number of nodes and sampling rate used. For example, if sampling 3 nodes at 50 Hz, the GUI waits 2 seconds prior to reading in data for plotting. Once the data has

started plotting, the nodes and associated channel numbers for the plot can be adjusted as desired using the dropdown menus (Figure 13). However, the other plotting functions are unavailable during this time.

Figure 12: During data acquisition.

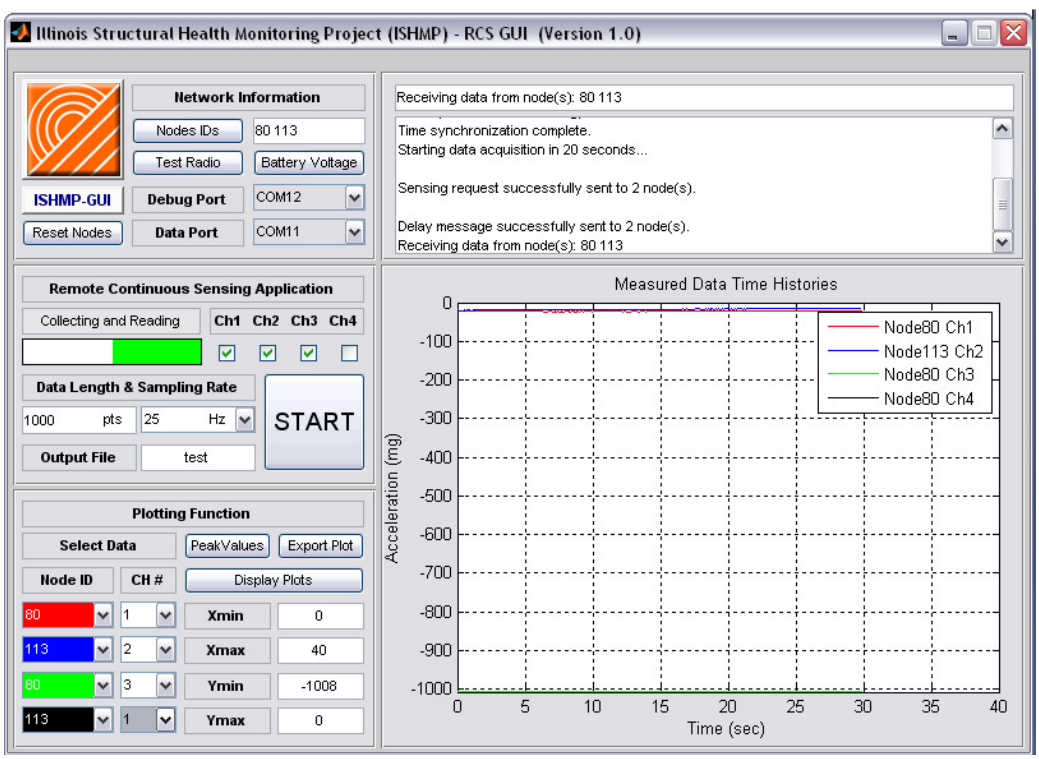

Figure 13: Plot parameters adjusted during acquisition.

End of Collecting and Reading: Data Processing and Output

At the end of "Collecting and Reading", when all the data has been acquired, the data is detrended and output to text files for each node in the same directory as the GUI files. The files are named `Node<Node ID>_<output filename>.txt` and the format is shown below:

NodeID	Time (s)	Ch.1 (mg)	Ch.2 (mg)	Ch.3 (mg)	Ch.4 (mg)

Within GUI, there are several plotting functions available. These are discussed in more detail in Section 4.

3.3 Running *RemoteSensing*

RemoteSensing collects and displays data once sensing is finished as opposed to *RemoteContSensing* that nearly continuously acquires sensor data, *RemoteSensing* and *RemoteContSensing* share similar steps described in the previous section.

Initialization and Set-Up for Sensing

RemoteSensing sets up the network and sensing information, prepares flash memory to store data, and performs network-wide time synchronization as shown in Figure 14 - Figure 16.

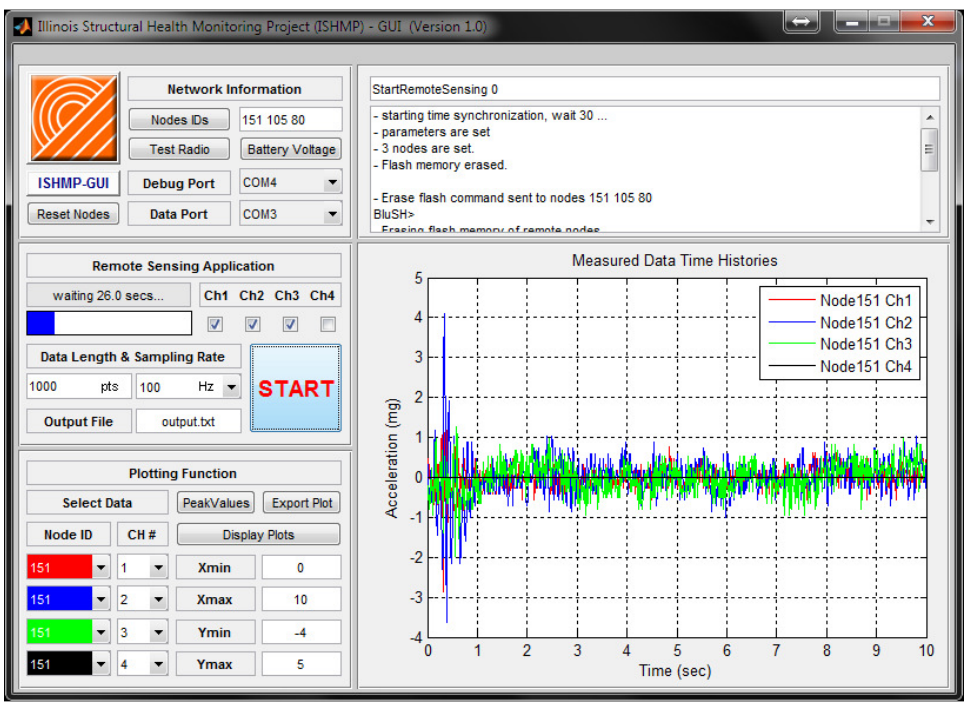

Figure 14: Remote Sensing during time synchronization.

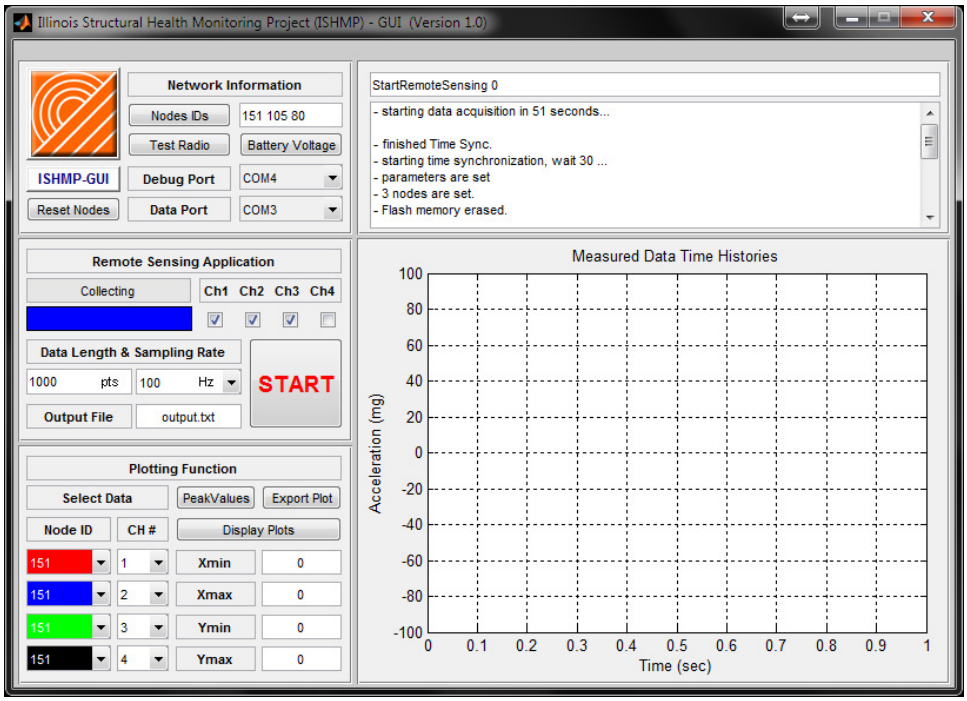

Figure 15: Remote Sensing while waiting for data acquisition to start.

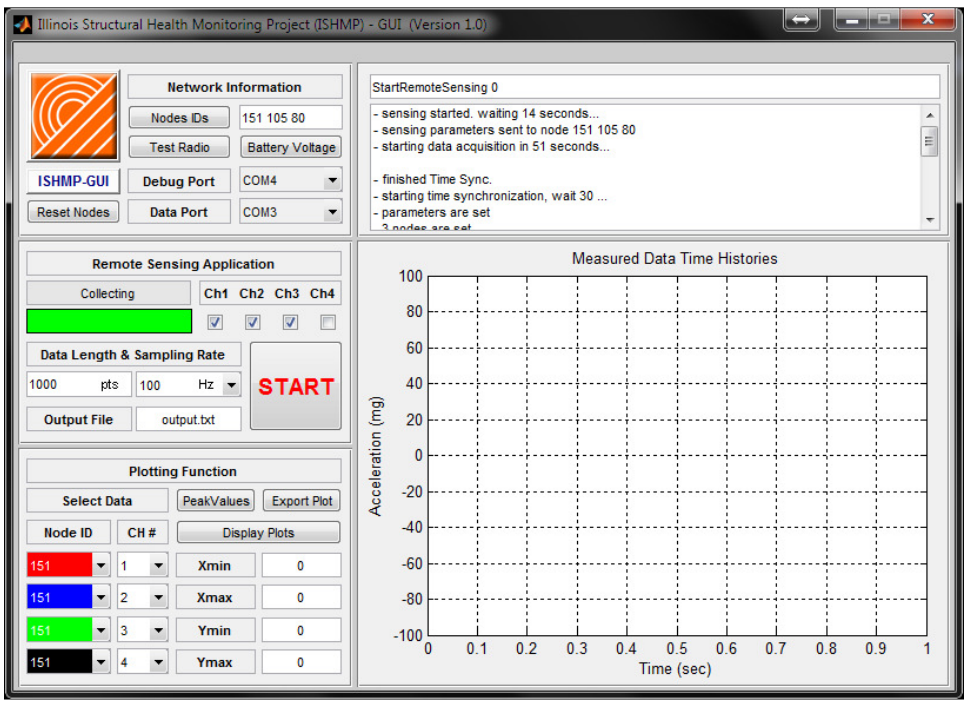

Figure 16: At the start of data acquisition.

During Collecting and Reading

Acceleration data measured in each leaf node is collected at the base station and displayed in the plot window as shown in Figure 17 - Figure 19.

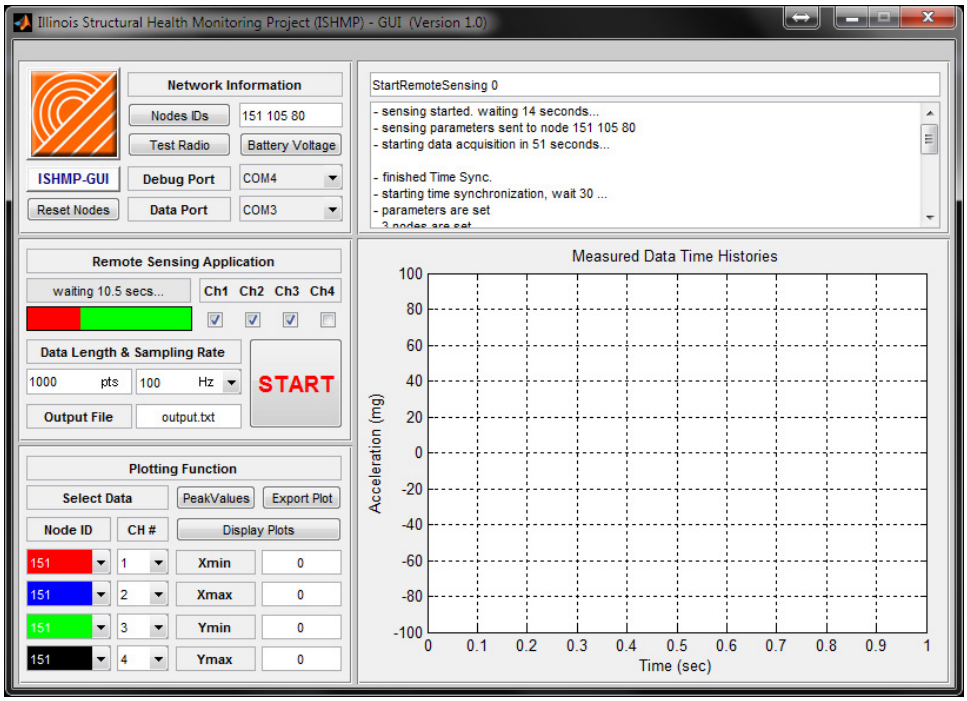

Figure 17: During data acquisition.

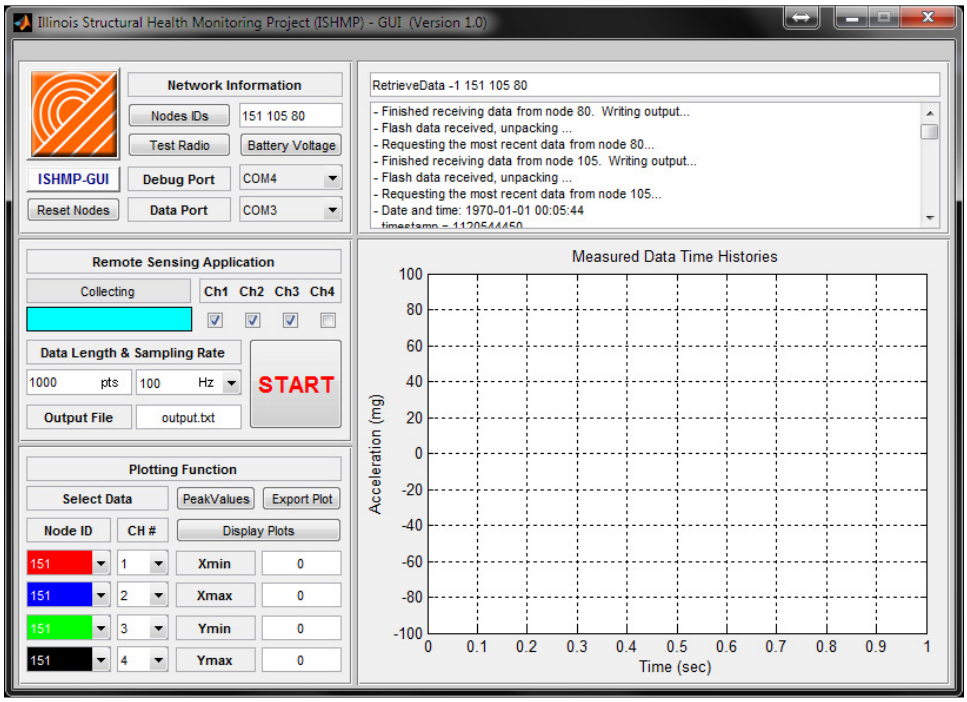

Figure 18: Retrieving data.

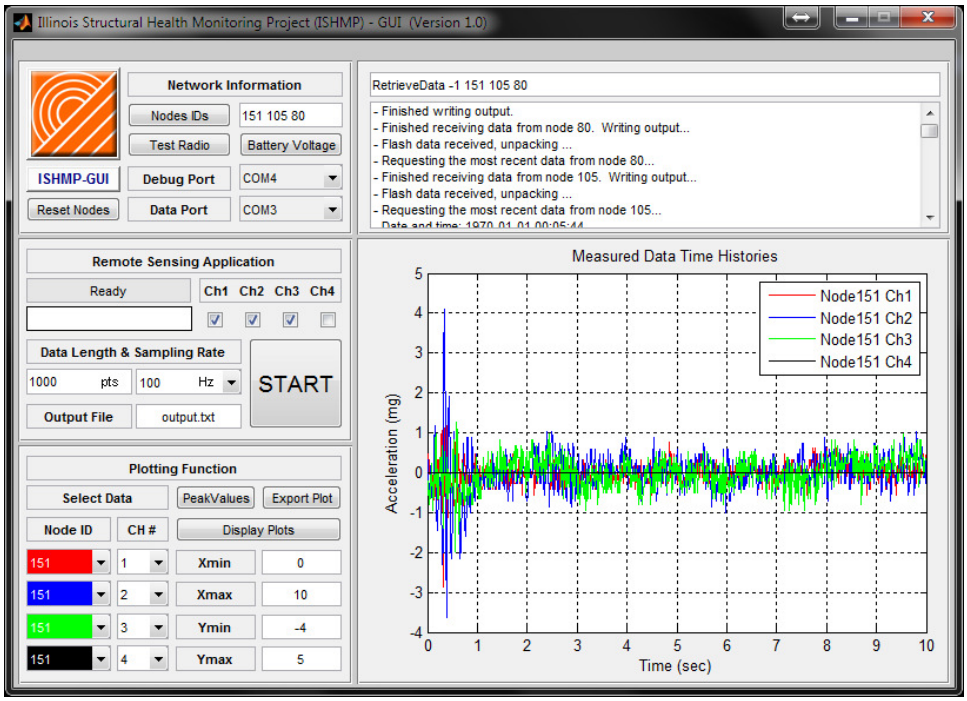

Figure 19: At the completion of data collection.

4 Plotting Functions

After "Collecting and Reading" is completed, there are several plotting functions available within the GUI. They are described in this section.

Create an Individual Plot

To create a plot of an individual record, select the leaf node and associated channel from the dropdown menus for the color desired. The plot will appear in the plot window to the right as shown in Figure 20.

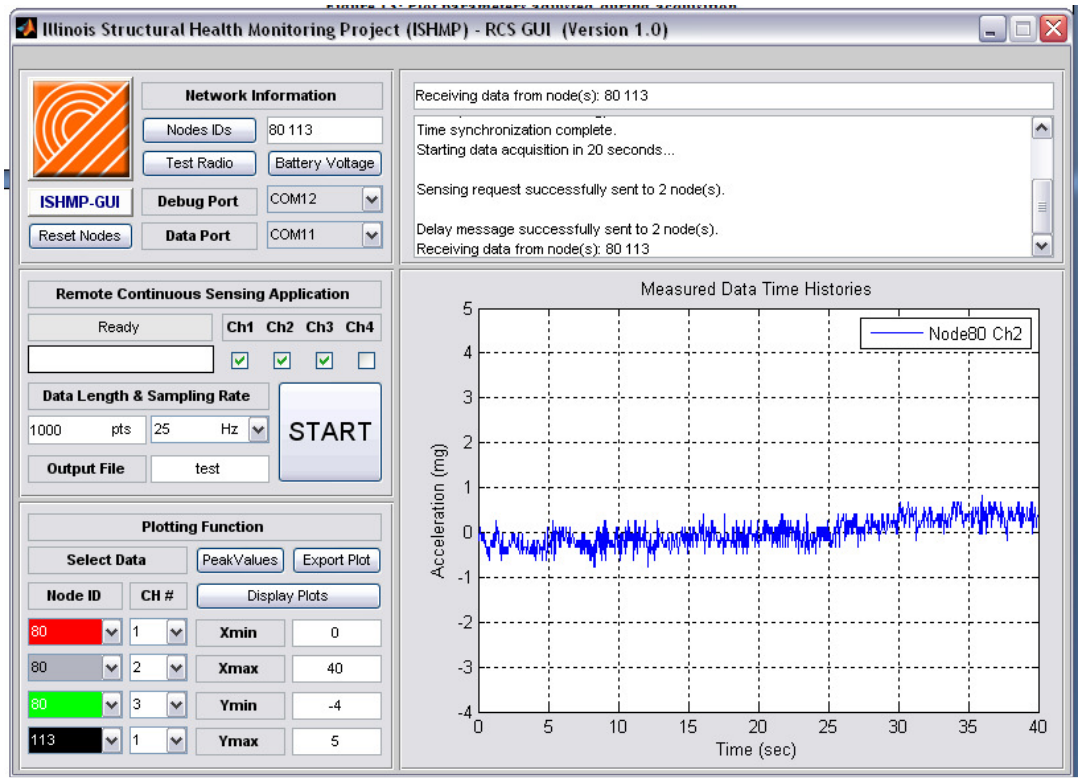

Figure 20: Creating an individual plot.

Displaying All Four Records in One Plot

To display all four records in one plot, select the leaf nodes and associated channels desired from the dropdown menus for each of the colors. Individual plots will be displayed as you make your selections. Next, click the button labeled “Display Plots” and all four records will appear in the plot window to the right (Figure 21).

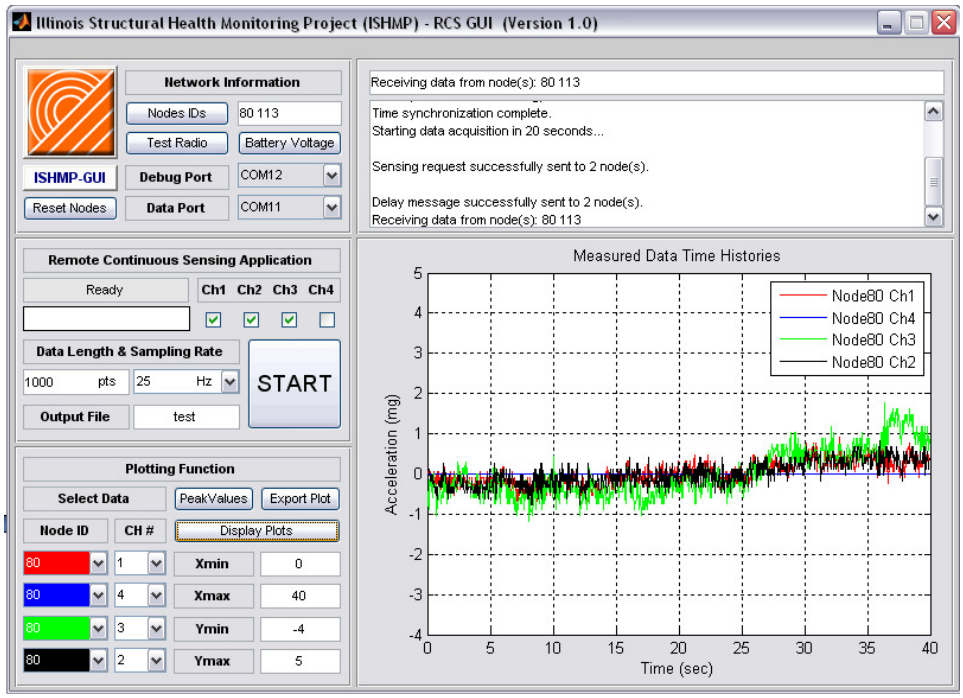

Figure 21: Display all four records in one plot.

Select Axis Limits

The axis limits can be set for the x- and y- axes using the input boxes under the "Display Plots" button. After all the desired values have been input, click the "Display Plots" button to apply the changes or select the individual record to be plotted (Figure 22).

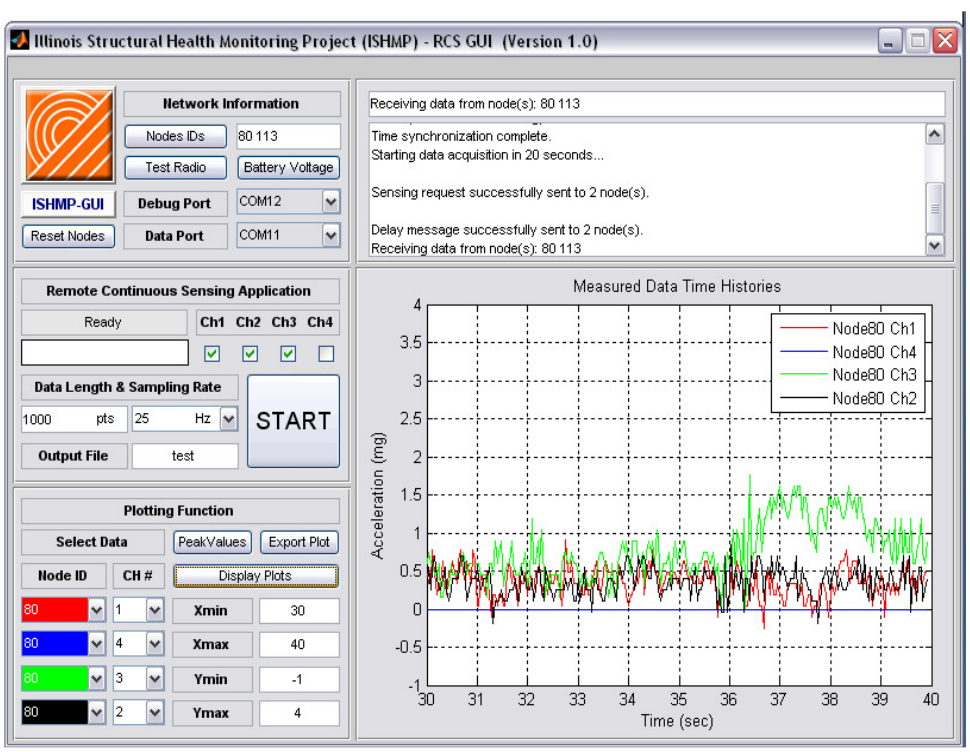

Figure 22: Applying axis limits.

Calculating Peak Values

First, select the desired leaf nodes and associated channels from the dropdown menus. Second, click the "Peak Values" button. The peak values of the selected data records will be listed in the message window as shown in Figure 23. Note that these values will also be stored in the log file (`guilogfile.txt`) for future reference.

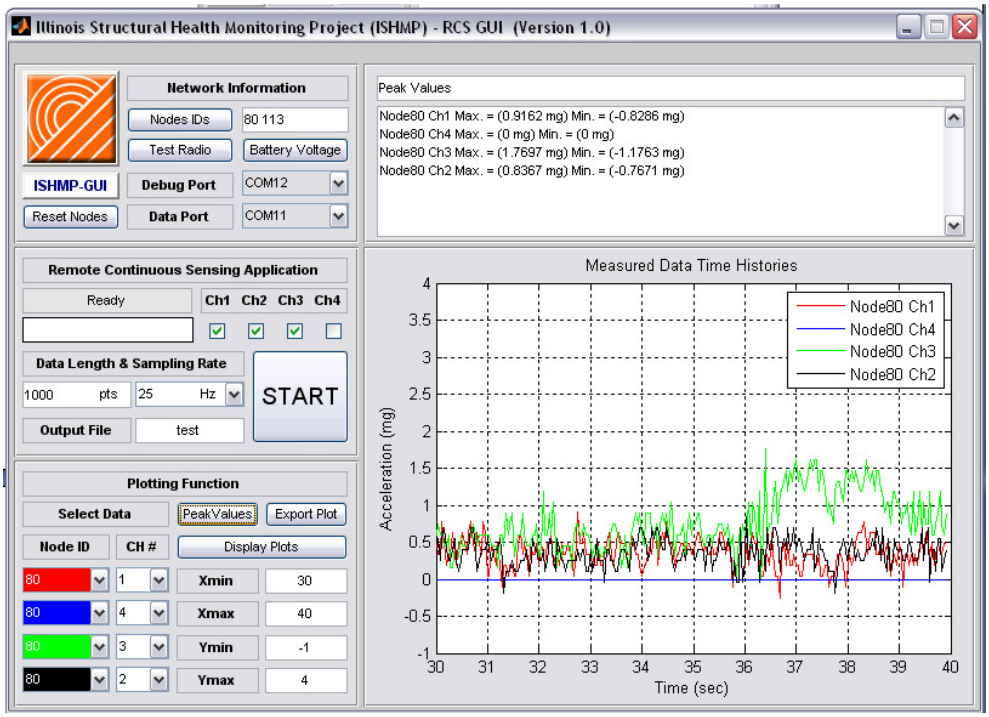

Figure 23: Calculating peak values.

Export Plot to Individual Window

Once the desired figure is obtained in the figure window of the GUI, select the button "Export Plot". The plot will be exported to an individual figure window and all the Matlab figure editing tools can be used.

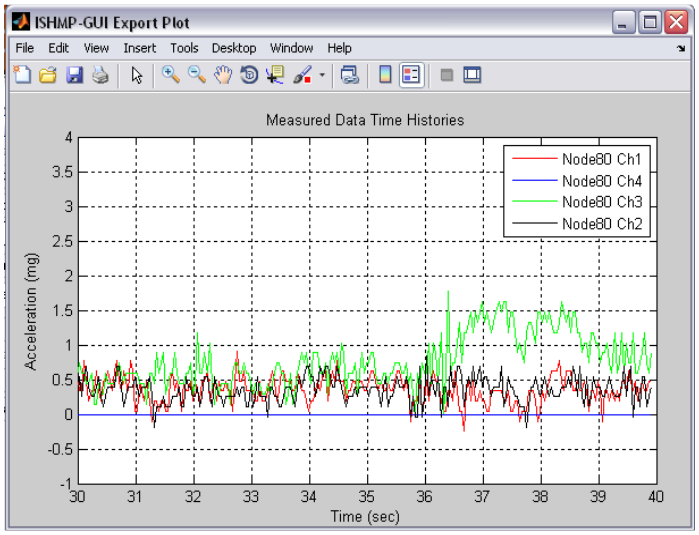

Figure 24: Exported plot.

5 User Functions

Clear the GUI

To clear the GUI, including the NodeID box, message window, command-line window, and plot window, click the button labeled “ISHMP-GUI”. Figure 25 shows the cleared GUI.

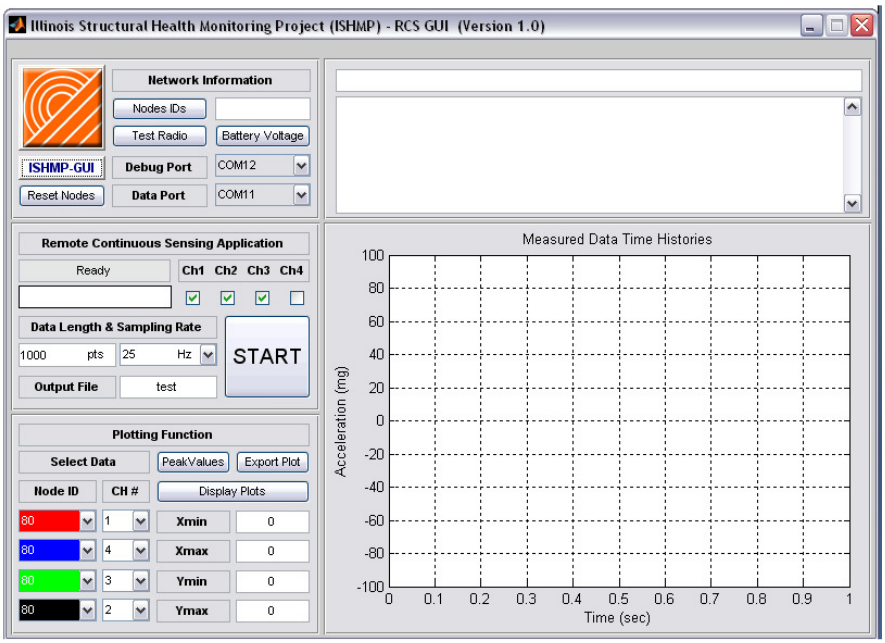

Figure 25: Cleared GUI.

Display the ISHMP Software License

To display the ISHMP software license, click on the ISHMP logo (orange) button. This will display the license in the message window (Figure 26).

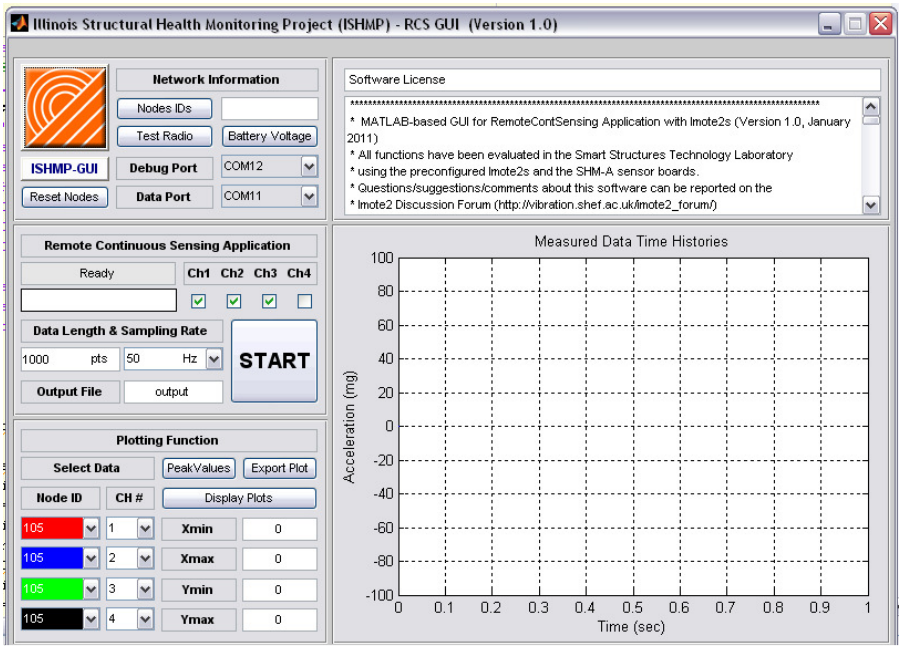

Figure 26: Display software license.

6 GUI Troubleshooting

- If selecting the COM ports causes an error, make sure the gateway node is properly connected, powered on, and that no other serial port is open with the node.
- If no data is returned in *RemoteContSensing*, reset the nodes and make sure the sensing parameters selected are valid, i.e. sampling rate is supported in your software installation.
- If *RemoteContSensing* is not successful, i.e. no data is returned, make sure to close the "gui.bat" DOS window that is opened to establish the serial port window before trying again.

7 Conclusion

This guide outlined how to use the ISHMP GUI to run common ISHMP Toolsuite routines without using the command line interface. For more information regarding these routines, network implementation, and troubleshooting, see the ISHMP User Guides at http://shm.cs.uiuc.edu/software.html.

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