Scalable Advisory System for Structural Health

Product Manual

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Overview

One of the key components of SASSH is the command interface. The command interface is written in LabVIEW. It responsible for communicating with the SASSH modules, saving their raw data and calculating all realtime analysis of that data. The software was developed and tested on a Mac with LabVIEW 2009, but should work on all recent LabVIEW distributions regardless of operating system.

To run the program, click "Run" from LabVIEW. (Note: do not "Run Continuously" as this will have adverse effects.) The top banner of the command interface contains three important features. Two of these are the *High Amplitude Vibrations* warning light and *Possible Structural Damage* warning light.The warning lights are the most significant outputs of SASSH and are display prominently because of this. More details of these warning lights are available under the Monitoring Tab section. The quit button, also on this top banner, should always be used to quit the program. Using the quit button ensures that the serial connection to the wireless modem is always closed properly.

Communication Tab

The Communication tab, shown in Figure 1, is usually the first tab the user should start in. This tab provides controls for setting up the wireless serial communication link between modules. The first step is to plug in the wireless USB modem included with SASSH. Then, the corresponding *Serial Port* can be chosen. (Hint, it is usually the highest number serial port listed.) Once this is completed, the desired modules can be switched on (both in the software and on the actual modules.) Flipping the *Data Capture* switch to on should now start the system. Once running, modules can be turned on and off without affecting the flow of the program.
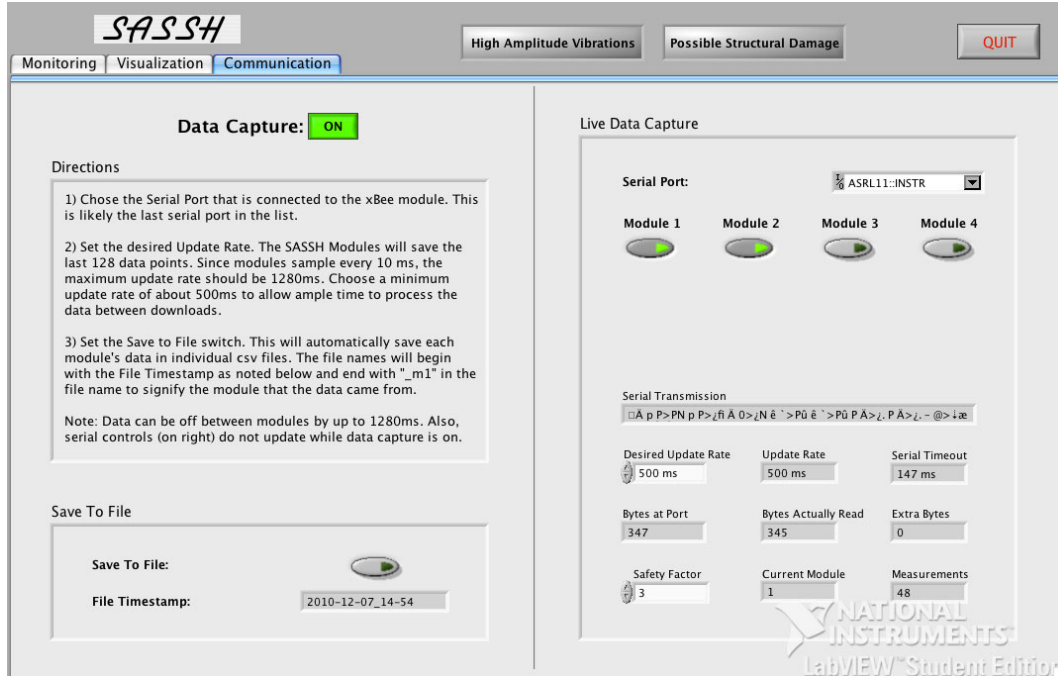

Figure 1: The Communication tab of SASSH. This tab controls which modules are active, whether or not to save data to files, and whether or not the entire system is running. Additional fields at the bottom right provide debugging information.

Advanced Serial Configuration

A few advanced serial configuration options are available in the *Live Data Capture* panel. If the everything seems to be working, then these options do not need to be adjusted. However, these options might need to be changed if the system is being pushed past its tested boundaries. The options to change would be the *Desired Update Rate* and the *Safety Factor*. The *Desired Update Rate* is how often the command interface will request data from each module. At its default value of 500 ms and with two modules active, there are 250 ms of time allotted for each module to send its data and the live analysis of that data to be completed. The *Safety Factor* changes the *Serial Timeout* field. This value should be as small as possible to allow the maximum time of other tasks without being too small such that the entire serial stream cannot be read. It can be determined that the serial read command does not have a large enough time out when the *Extra Bytes* field becomes non-zero.

Saving Data to Files

The tab also includes a control to save data to file. By turning this option, a file will be created in the same directory of the SASSH.vi file for each module. The file names will be in the form "2010-12-09_01-15_m0.csv" which denoted the current data, time and module (0 means module 1.) The data is stored in the files in comma separated value format with columns t(s), x, y, z. The units of the acceleration are never converted to any real units, but represent the percentage of total range of the accelerometer.
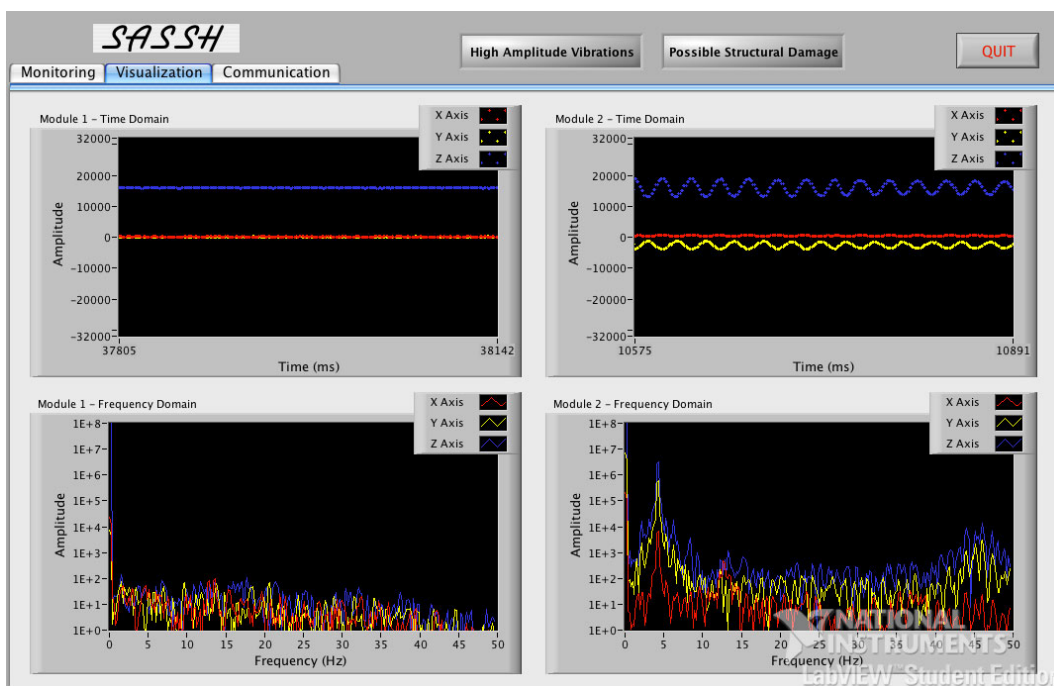

Figure 2: The Visualization tab of SASSH. This tab shows a visual representation of the accelerometer data. Data is shown for the first two modules in both the time domain and frequency domain.

Visualization Tab

The Visualization tab, shown in Figure 2, graphically outputs the response of the first two SASSH modules. At the top are time domain graphs of the measured accelerations. All three axes for both modules are represented here. Currently the modules are set to read accelerations of up to two g's.

One can note how the X and Y axes are nominally zero, the but Z axis is nominally half of the positive range as seen in the figure. This is the case when the SASSH module is motionless and oriented with its base parallel to the earth so that only the Z axis is effected by gravity.

Monitoring Tab

The Monitoring tab, shown in Figure 3, shows the calculated values of natural frequency, damping ratio and average amplitude for each axis of each module. Controls are present in the Monitoring tab to augment the sensitivity of the peak finding features and the sensitivity of the warning functions.
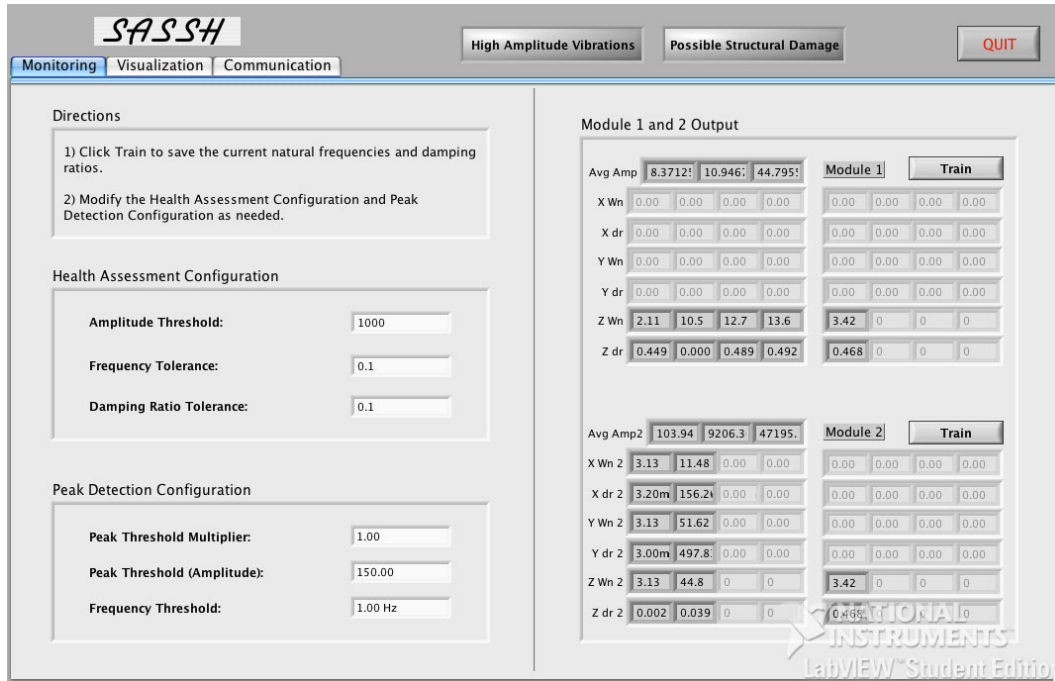

Figure 3: The Monitoring tab of SASSH. This tab shows the natural frequencies and damping ratios as processed from the accelerometer data. This tab also provides methods for configuring the high amplitude and damage warnings.

Peak Detection Configuration

This section provides controls to augment the peak detection algorithm. The *Peak Threshold Multiplier* acts as a low pass filter and causes the algorithm to not detect peaks that are lower than the product of the average amplitude for all frequencies and this constant. the *Peak Threshold (Amplitude)* also acts like a low pass filter, but is simply a cutoff and is not based on the average amplitude. The *Frequency Threshold* acts a low pass filter and forces peaks less than the configured value to not be detected. This is useful for skipping over the pesky zero Hz peaks.

Module Output

The module output section shows all of the data that is calculated for each accelerometer axis. Present is the average amplitude for all frequencies for each channel, the natural frequencies (denoted as Wn) for each channel, and the damping ratios (denoted as dr) for each channel. Identical boxes on the right portion of the panel indicate any values that the program has retained while being "trained."

These values where to be used to calculate the differences in natural frequency and damping ratio, but this functionality was not completed. (Also, the training feature was only implemented for the first module.)

Health Assessment Configuration

This section provides controls to augment the warning algorithms. When the average amplitude for any channel surpasses the *Amplitude Threshold*, the *High Amplitude Vibrations* warning light will active. When any trained frequency and damping ratio has changed with 10% (corresponding to the default value of 0.1), the *Possible Structural Damage* warning light will active. Again, the functionality to detect changes in natural frequencies and damping ratios was never completed, so the *Possible Structural Damage* warning light will not actually activate.

Problems

This command interface is pretty reliable, although it does have a few short-comings. While much of the software supports up to four modules, it has only been tested with two modules. (Only two could be made due to budget constraints.) Additionally, some of the functions are only implementd for two or even just one of the modules. Occasionally, the second module seems to drop out when both modules are active. This drop out is usually brief, but annoying.

Finally, the possible structural damage warning light has not been fully implemented for any of the modules. While the barebones subVI has been constructed to facilitate the detection of changes in natural frequencies and damping ratios, the necessary logic to complete this task was not programmed in. While not overwhelmingly difficult, the task of detecting changes in natural frequencies and damping ratios of peaks that are sometimes present and sometimes not is not easy for a computer. A successful implementation of this task will involve additional constants that will need to be tuned or some very smart automatically tuning detection algorithms.