Automatic Spectral Acquisition System (ASAS)

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NI Product(s) Used: LabVIEW, cDAQ, NI-9234, NI-9263.

Industries: Vibration, Research, Design, Aeronautics, Aerospace, Mechanics, Military, ...

Application Areas: Structural dynamics, Structural monitoring, Modal analysis, Modal parameter identification.

The Challenge
Performing automatic measurements on a specimen with high amount of points to get the Operational Deflection Shapes (ODS) or to realize modal analysis (Peak picking, LSCE, FDPI, ...).

The Solution
Building a stand-alone system (devices and software) managing automatically the geometry definition as well as the measurement acquisition (FRFs).

Body

As vibration consultant, V2i realizes measurements aiming at characterizing dynamically a structure (the company also works in fatigue testing, Finite Element Modeling, Health Monitoring, ...). In the aerospace field the needs of high frequency measurements arises. Unfortunately the higher the natural frequency to reach is, the higher the amount of needed measurement points is to represent correctly the mode shape of the tested specimen. Even if performing such measurements manually is possible, it would be time consuming and directly proportional to the number of measurement points. Dedicated commercial scanning systems being rather expensive, a more suitable solution has been developed to meet our requirements.

The solution is a stand-alone system capable of detecting the position of the item to analyze, defining the geometry (3D), performing the measurement point acquisitions, and finally ODS as well as modal analyses are carried out.

The developed system is composed by various devices :

- 2 long travel stages moving in the X-Y plane,
- a distance laser sensor to detect the item and to measure the Z coordinate (installed on the stages),
- a shaker to excite the specimen,
- a one-point-vibrometer to measure the vibrations induced to the item (installed on the stages next to the distance sensor),
- a force sensor to measure the excitation and to calculate the Frequency Response Functions.

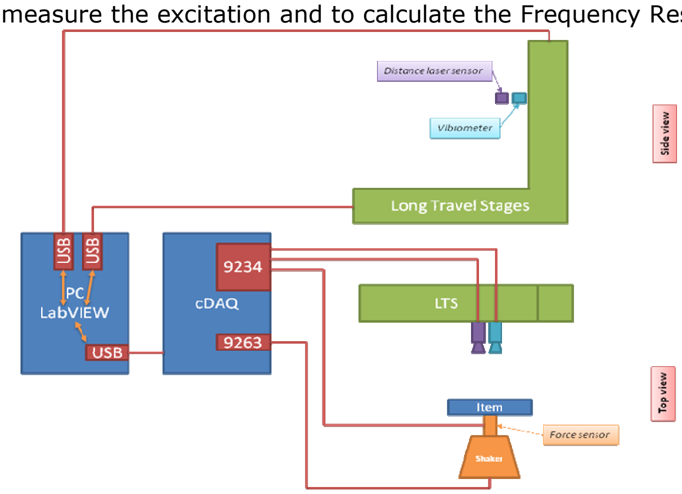

***Figure 1 -** Solution set-up*

The control of the different devices is easily ensured by the software LabVIEW, directly by USB connections (long travels stages), or through a cDAQ. The acquisition of both lasers and force sensor is done by a NI9234 module, while the control of the shaker by a NI9263 module.

Job Sequence

Once the item is installed in front of the device, and the set-up configured, the system is fully autonomous. The various parameters to be configured are shown in the next picture (geometry precision Δ and limits, excitation type, etc...) , and will be explained in the next sections.

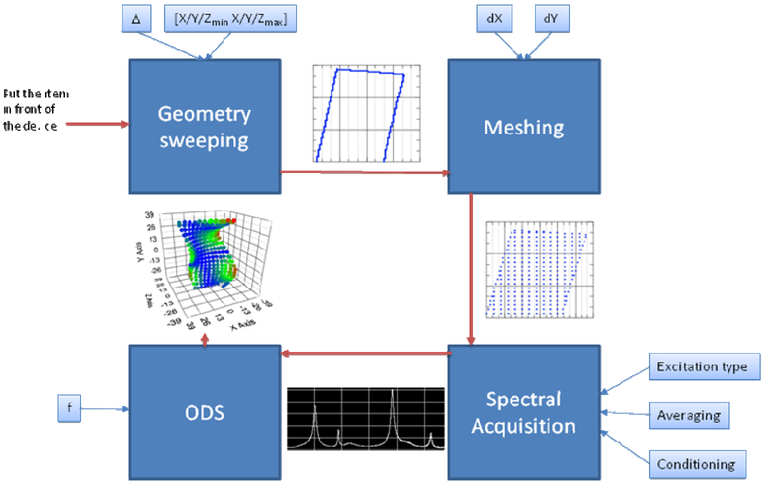

***Figure 2 -** Software architecture*

The system first starts to look by itself for the item in the space, and then uses an algorithm[1] to detect the edges of the idem. In order to limit the space, a delimiter cube is defined ([X_{min}, X_{max}], [Y_{min}, Y_{max}], [Y_{min}, Y_{max}]). And the precision Δ is fixed in the X-Y plane. This technique allows a fast geometry definition without operator.

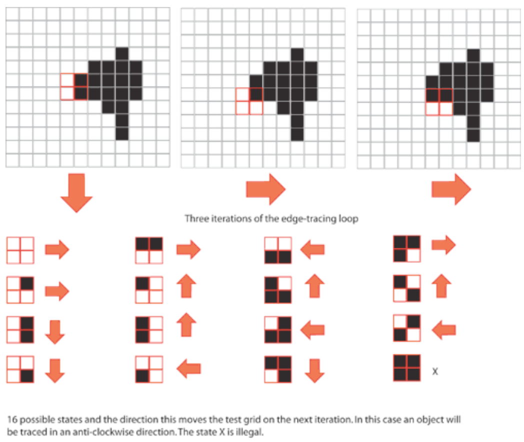

***Figure 3 -** Marching Square Algorithm*

[1] *http://en.wikipedia.org/wiki/Marching_squares*

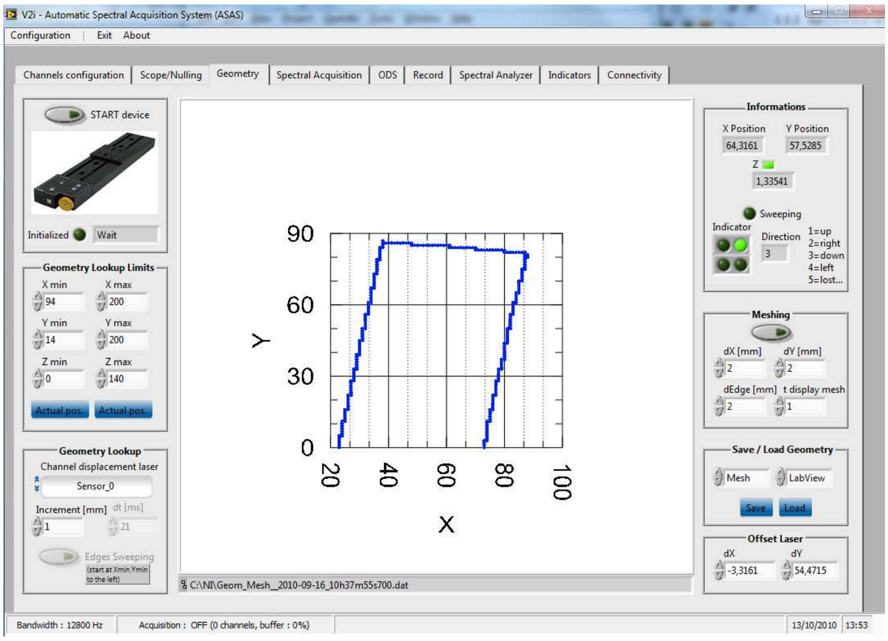

Figure 4 - *Geometry Control Panel*

When the geometry of the specimen is found and defined, the software creates a mesh using the desired precisions (dX, dY).

Once the geometry steps are finished, the system starts again to scan the item point-by-point with the vibrometer. It first moves to the point, then sends a defined excitation to the shaker while it measures the vibrations with the vibrometer and with the force sensor. All the Frequency Response Functions are saved. The excitation type has to be defined (chirp, sinus, random, ...) with various parameters; the averaging and conditioning parameters as well. The system detects and rejects bad measurements.

The data required being known : geometry (3D), FRF on all points; the software can then compute ODS or mode shapes associated with the identified natural frequencies.

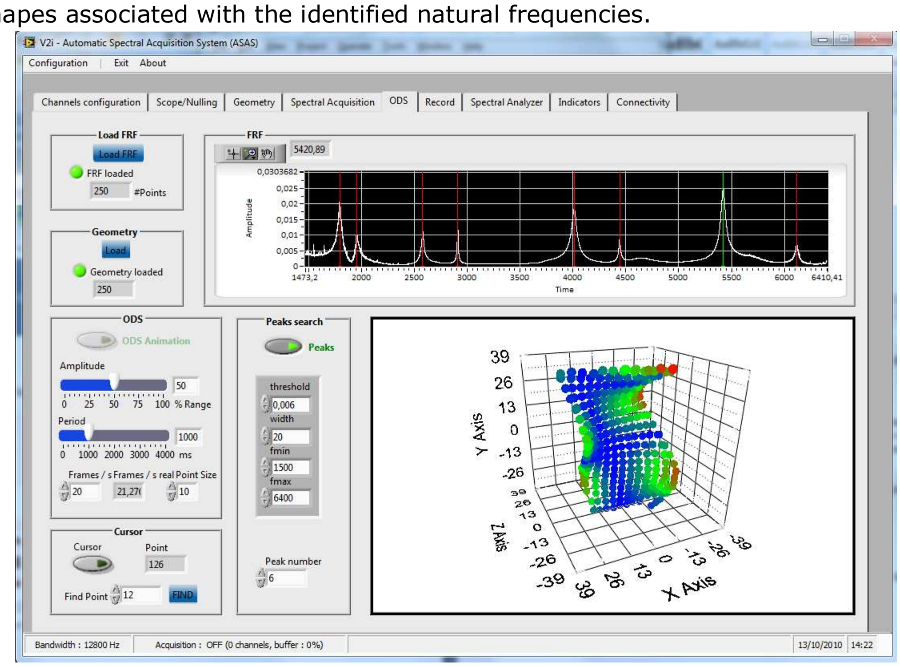

Figure 5 - *ODS Control Panel*

Conclusions

The benefits of this system are :

- the measurements are more accurate,
- the job is faster,
- and it does not need an operator.

For example, hand-made measurements for a compressor blade took one day for 35 points. With the ASAS[2], the same blade is discretized in 250 points in less than one hour. Time is saved therefore the analysis is available for high frequency.

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[2] Automatic Spectral Acquisition System