Virtual Vibration Analyzer

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Category:

Maintenance/Field Test

Products Used:

- LabVIEW™
- DAQ

The Challenge:

To build a cost-effective and easy to operate vibration analyzer specifically designed for Predictive Maintenance.

The Solution:

A system running National Instruments LabVIEW under Windows that read a signal previously recorded in the field and performs the calculations to obtain all the information necessary to evaluate and diagnose the mechanical and electrical condition of industrial equipment.

Abstract

There are several vibration analyzers in the market that offer software designed for predictive maintenance but they are very expensive and require a lot of training to use them.

The virtual vibration analyzer described here, is a very easy to use instrument that reads a 30 second recorded signal and produces the following information:

- Low frequency spectrum (0-64 Hz)
- Medium frequency spectrum (0-1000 Hz)
- High frequency spectrum (0-16.000 Hz)
- Low frequency time domain signal (3 sec.)
- Medium frequency time domain signal (0.2 sec.)
- High frequency time domain signal (0.012 sec.)
- Synthesized constant percentage bandwidth spectrum plotted on log scales (4to. 16.000 Hz)
- 3D-tendency graph of the synthesized spectra (reference, today, and two previously filed spectra). See figure 1.

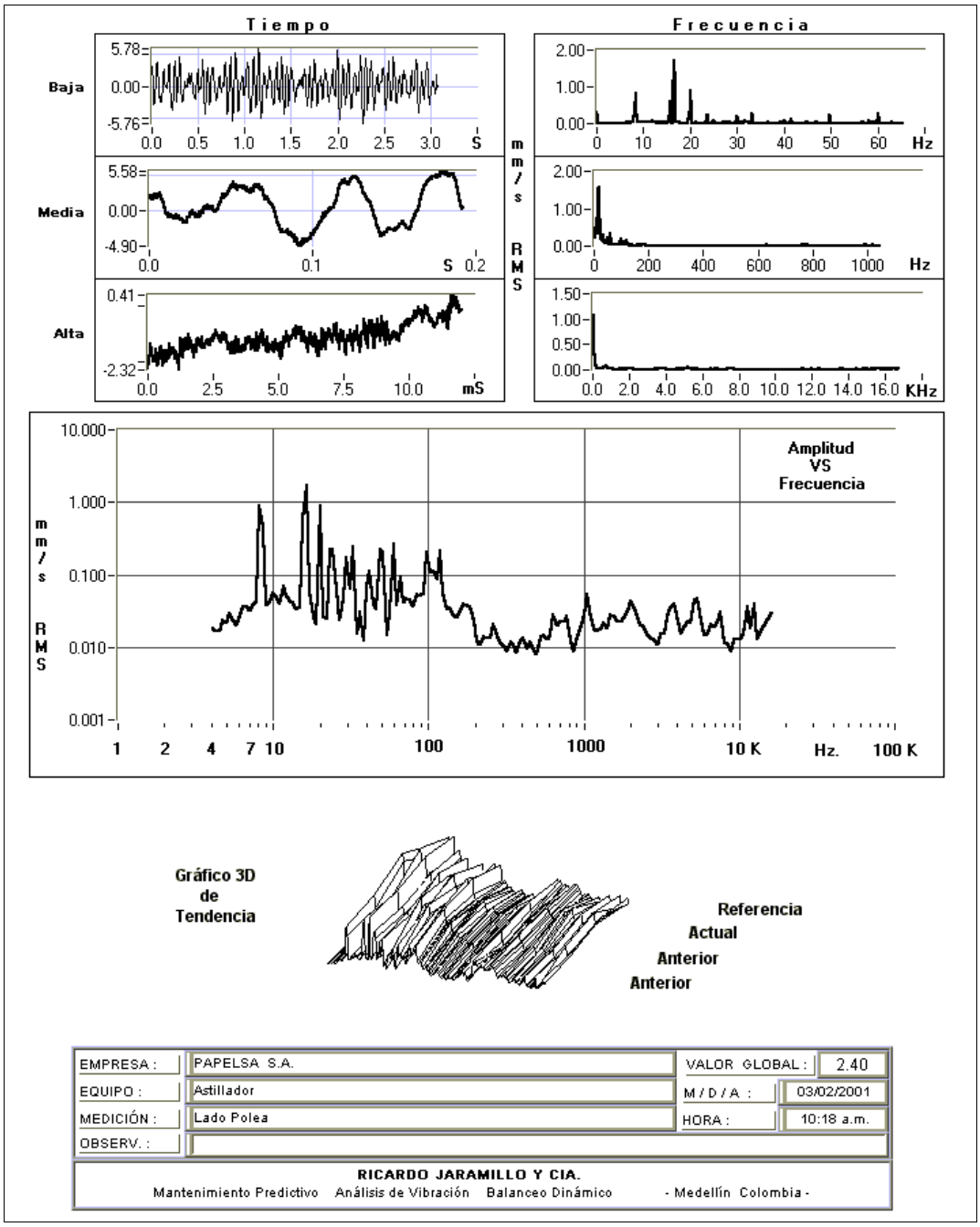

Figure 1: Report.

System Configuration

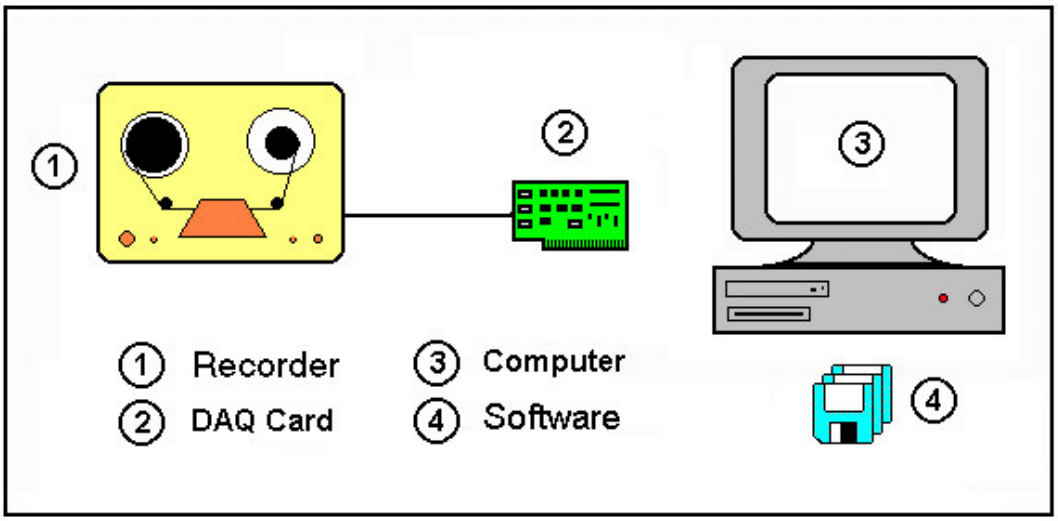

Figure 2: System configuration of the vibration analyzer.

The equipment is composed by the following elements (see figure 2):

- Recorder: Any analog, or digital recorder can be used, but it is important to know that the quality of the signal depends on its specifications.
- DAQ Card: The Card to be used depends on the type of computer, desk or laptop. The minimum requirements are: 50 KHz sampling rate and 12 bits of resolution. National Instruments has a wide variety of cards that meet the requirements.
- Computer: A Pentium II at 233 MHz with a 64 megabytes of ram will do the job.

Instrument Description:

The first front panel (see figure 3) is a menu with the following options:

- Acquisition.
- Create a new equipment file.
- Edit a file.
- Erase a equipment file.
- Print report.
- Exit.

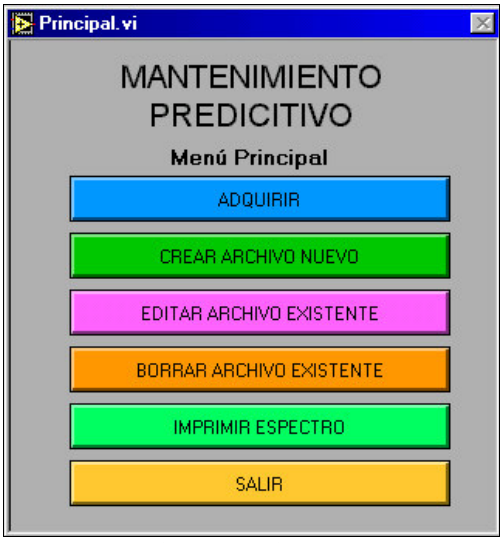

Figure 3: Main menu

In the acquisition stage the instrument performs the following procedures

- Acquisition of 880.000 values at a 40 KHz sampling rate.
- Antialias filtering and decimate by factors of 1, 16 and 256 to produce signals at 3 different sampling rates.
- Obtain 10 amplitude spectra (7 for low frequency) using a overlapping Hanning window for each sampling frequency and then averaging.
- Save of the 3 averaged spectra and the 3 time domain signals sampled at low, medium and high frequencies.

The analyzer saves up to 12 measurements, discarding the older one when it is full. Any of these measurements can be tagged as reference.

For the printing of the report, the analyzer, synthesizes a log-log spectrum of 156 lines and a 5% bandwidth using the 3 spectra (low, medium and high frequency) of 512 lines each and bandwidths of, 0.15, 2.44 and 39 Hz.

ADVANTAGES:

- COST- The cost of this analyzer is ten times lower than the analyzers commercially available for predictive maintenance.
- EASY OF USE- A person with some experience in MS Windows can be ready to operate the program in less than 1 hour.
- FAST- The time for acquire, file and print the reports of one hundred measurement points is about 2 hours.
- LINEAR AND LOG FREQUENCY SCALES: Most vibration analyzers do not use log scale for the frequency axis because the spectra are produced by the FFT algorithm that renders a linear frequency scale. The use of a log scale for frequency is very important in predictive maintenance for the following reasons:
- To display in only one graph all the information with a good resolution up to 16.000 Hz (5% resolution in all the frequency scale). By comparison a 400 line linear frequency spectrum up to 16.000 Hz has a resolution of 16.000 /400 = 40 Hz and this is a very poor resolution in the lower frequency range.
- To compare two spectra taken at slightly different velocities of the equipment (for example a variation in the speed of a motor from 1750 to 1730 RPM due to an increase in the load). If you have a linear scale and shift the spectrum taken at 1730 CPM by 20 CPM up to line up at 1750 CPM with the other spectra, the harmonics will not coincide (3.460 + 20 Vs 3500, 5190 + 20 Vs 5250…), so you cannot take the difference. But if you have a log frequency scale, all the harmonics shift the same percentage, so they will line up.

Characteristics of the software:

- Programming language: National Instruments LabVIEW™ 5.1.
- Operating system: Windows 95/98.
- Number of VIs: 28 created by the authors and 31 taken from LabVIEW™.
- Number of hours to develop: 200.
- Number of signals processed in the last two years of use: 30.000

Concluding Remarks

This virtual analyzer has all the desirable characteristics that one of its authors with 25 years of experience in vibration analysis and predictive maintenance thinks it must have.

Virtual instrumentation is very successful because it is standing over the shoulders of a giant: the personal computer, and this vibration analyzer is not an exception to that rule, none of the manufacturers of electronic vibration analyzers can compete in technology with the computer manufacturers and the reason for that is the size of the market available to them.