Scanning Laser Vibrometer

Description of Requirement:

The Structural Acoustics Branch has a requirement for an instrument to enable rapid measurement of the vibration velocity of lightweight aerospace structures and materials ("targets") over a wide spatial area (from multiple centimeters on each side to multiple meters on each side) and a frequency range, including audible frequencies. The structures and materials being measured are lightweight, hence a non-contacting measurement method is preferred, such as that provided by a scanning laser Doppler vibrometer. The instrument will be used in a variety of laboratory settings where it is difficult or costly to control access by personnel, so all lasers associated with the instrument must be eye-safe. Some degree of portability is desired since the instrument will not be permanently fixed in one place, but will be periodically moved from facility to facility depending on research requirements.

The instrument shall:

1. Provide non-contacting measurement of the normal velocity of a target surface at user-specified measurement points
2. Be capable of measuring vibrations over an effective frequency range of 1 Hz (or less) to 20 kHz (or greater).
3. All lasers associated with the device shall be eye-safe and visible
4. Operate at a range of standoff distances from the target, from 0.25 m (or less) to 5 meters (or greater)
5. Have velocity sensitivity ranges as listed below:
    a. At 1 Hz: 0.5 µm/s or less to 0.1m/s or greater
    b. At 20 kHz: 1 µm/s or less to 0.5 m/s or greater
6. The instrument shall be capable of scanning points within an arc of at least ±20° horizontally and at least ±20° vertically, measured about a central axis. The angular resolution between scan points shall be 0.01° or less.
7. Include a video camera that allows a user to view the test structure from a point near the laser source. This video camera shall have a frame size of at least 1280 by 720 pixels and an optical zoom level of at least 15x to allow the user to accurately specify the scan points on the test article.
8. The angular stability of the instrument shall be less than 0.01° drift per hour.
9. Include software that provides the following functionality:
    a. Allow the user to specify, via the integrated video camera, the spatial area and specific points on the structure where the velocity is to be measured
    b. Support measurement scans consisting of velocity measurements at a number of points, ranging from a single point to at least 500 points
    c. Specify the scan dwell time for each measurement point, where the dwell time ranges from 0.5 seconds per point to multiple seconds per point.
    d. Select reference excitation signals for exciting the structure, including sine wave, chirp, pseudo-random, and random excitations

    e. compute relevant signal characteristics from the acquired laser signal including spectra, cross-spectra and coherence (when a reference signal is used)
    f. save the measured velocity data with associated geometric information for each measurement point on an attached computer system
    g. monitor progress of the measurement scan
10. Include a signal generator that can be used as a reference signal for exciting the structure
11. Include a signal acquisition capability for acquiring an external reference signal and at least one other voltage signal synchronously with the laser velocity measurement