Structural Solutions Private Limited

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Technology News

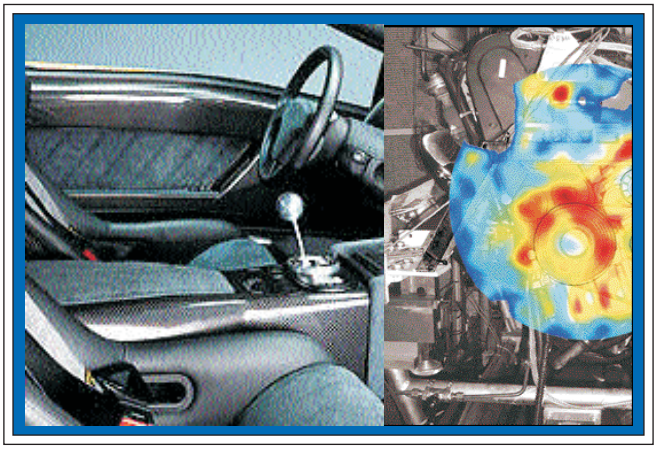
Near Field Acoustic Holography

A method for accurately and effectively diagnosing noise sources

Pacific Noise and Vibration (PNV) is a member of the RDA group of companies, specializing in the development and implementation of acoustics-based capabilities in monitoring, analysis, utilization and remediation of vibration within systems and subsystems

NearField Acoustic Holography (NAH), a proven signature measurement method is being used by PNV for noise source identification. NAH provides a complete mapping of the tested unit, and delivers a high definition representation of the acoustic source in the structure. **PNV have an operational NAH system - dbVision.**

Structural Solutions Private Limited exclusively represents Pacific Noise and Vibration in India. Structural Solutions Private Limited is a professional engineering company engaged in offering high end technology intensive products and system solutions to Indian industry for Acoustic measurements, analysis and Calibrations



Noise Source Identification Methodology

Oftentimes, in diagnosing noise sources, the spectra of sound pressure and sound power, and radiation pattern are measured. These data, together with the experiences of the engineers who are carrying out these measurements, are utilized to locate the noise sources and identify their causes.

Noise source identification is based on the following approaches:

- Sound Pressure
- Sound Intensity
- Intensity Peak Search
- Selective Intensity
- Spatial Transformation of the SoundFields (STSF)

The Sound Pressure approach does not represent energy flow, gives Poor resolution, Easy to misinterpret and Sound power cannot be calculated.

The sound intensity peak search method Works only for dominating sources and does not allow for the quantification or the documentation. Direct Intensity measurements, such as those made using a two-microphone probe, are capable of determining the energy flow pattern at a point, but those measurements can have difficulty in locating sources in complex acoustic nearfields which may contain many sources and sinks of acoustic energy.

The limitations of these approaches and also the fact that these approaches could be very costly and time consuming leaves us with studying the alternative method NEAR FIELD ACOUSTIC HOLOGRAPHY.

Nearfield Acoustical Holography

Nearfield acoustical holography (NAH) allows for the visualization of acoustic radiation from an arbitrary source. It is a method which allows one to study spatial and time dependence of energy propagation in low-amplitude acoustic fields.It is al so known as spatial transformation of the sound fields. It reconstructs acoustic quantities in a 3D field based on measurement across a hologram plane (measurement plane) in the vicinity of the source (in the Near Field).

It enables one to identify noise sources and acquire a good understanding on how sound is generated and propagated into the field. The knowledge gained can be invaluable to noise control engineers in developing the most cost-effective measures to meet noise criteria and to produce a premium quality product

Based on a measurement over a "scan plane" using a microphone array, the sound field can be calculated over parallel planes using some algorithms which transform it spatially to other planes, giving the resulting sound field in these new planes in the near-field region. The measured 2D sound field data can be "transformed" to other surfaces enabling a complete 3D description of the sound field

This allows a whole range of sound field parameters to be calculated at any point in the vicinity of the test object including pressure distribution, intensity mapping and vector intensity for the near field and directivity patterns, SPL along a line, and contribution analysis can be performed to investigate the effects in the far field

The theory of NAH is based on the Helmholtz integral equation and the two-dimensional Fourier transform. Complex pressure on a plane parallel to the hologram plane is computed by inverse 2D FFT of product of hologram pressure spectra and modified Green function for required distance. Acoustic velocity vector is then acquired using Euler's equation, active and reactive intensity vector as real and imaginary parts of product of computed complex pressure and conjugate acoustic velocity.

NAH is capable of completely describing the acoustic field generated by a structure. However, its limitations with respect to frequency range and test boundary conditions can be severe compared to traditional intensity measurement systems.

In Short NAH provides: 1) Acoustic imaging of the source 2) Identification of Source Noise centres & paths 3) Localizing the acoustic sources on the body 4) Far Field signature of the source

The NAH approach for the noise source identification:

- Perform acoustic measurements in the nearfield through an array of microphones
- Decomposition of the acoustic field in plane waves
- Wave number filtering
- Reconstitution of the waves on the source surface
- Localizing the noisiest radiating area on the structure
- Compute global farfield directivity of the radiated noise;
- Apply farfield prediction (forward-propagation) using Rayleigh-Sommerfeld or Helmholtz integrals at a single or multiple point location on the farfield directivity sphere of the platform.

Nearfield acoustical holography can be used as a very cost-effective tool for diagnosing sound. It provides all the acoustic information needed including acoustic pressure, acoustic intensity, and particle velocity that are otherwise hard to obtain using conventional techniques. This is a robust and powerful way to visualize sound at the source and its transmission path through a complex structure. The depth, breadth, and clarity of the information acquired can be very helpful to an engineer in devising an effective noise abatement measure to tackle various noise and vibration problems.

dBVision

dBVision, a tool available from PNV relies on the processing techniques of near-field acoustical holography in order to:

- characterize the different sources responsible for the noise radiation of the tested structure,
- synthesize their contribution to the global acoustic performance,
- simulate the impact of structural modifications linked to the optimal use of adequate material solutions.

dBVision is a complete system designed to fulfil the various needs of technical centres, laboratories and industrial engineering teams for performing efficient acoustic measurements, imaging and analysis.

The acoustical imaging system dBVision is made up of five components:an acoustic antenna on which transducers are mounted,

- an acquisition platform (ORCHESTRA or VXI front ends),
- a powerful holography processing software,
- a contact-less Instrumentation Positioning System for interior measurements
- a robot system for automated testing on exterior applications.

The acoustical imaging system dBVision offers a wide range of solutions to fit with general and specific customers requirements according to both the dimension of the tested structure and the application fields

With its combined approach (exterior/interior measurements), dBVision demonstrated the benefits of near-field acoustical holography and is now the most cost-effective recognized solution for industrial acoustical investigations to deal with a wide range of structures and components, from the sketch project phase through tuning modification stages up to final acoustic optimization.

Benefits

- Leading-edge NAH technique for better accuracy
- Unique 3D visualization capability
- Far Field Acoustic prediction
- Drastic reduction of the overall measurement time
- Patented IPS methodology for interior investigations
- Quality assessment of measurements and processing results

Acoustic Holography Testing and analysis report with recommendation can be given by our specialists on a consultancy basis using our own instrumentations. Call us for a measurement appointment

Technical Specifications

dBVision standard software package (Standard):

- Data acquisition and database management
- Near-field pressure measurement
- Spectral analysis, holography mapping, source, and defects localisation
- Visualisation of pressure and intensity results (spectra, 2D colour maps)

dBVision advanced software modules (Advanced):

- IPS interface:Data acquisition/management with the Instrumentation Positioning System of dBVision
- ROBOT interface: Data acquisition/management with a robot operated antenna
- DIF pre-processor: Computation of regular grid measurement points from arbitrary antenna locations
- POWER post-processor: Partial power computation
- RANK post-processor: Source ranking according to selected zones
- FAR post-processors: Far-field predictions capabilities (standard or advanced)
- 3DV post-processor: 3D results display - enhanced interpretation capability
- Report: Batch functionality for data processing and automatic export to standard office tools

Antenna and transducers:

- Reference transducers (microphones, accelerometers, …)
- Measurement antenna:
  single line of microphones - typical dimensions 1 m (16 transducers)
  square array of microphones - typical dimensions 20 cm by 20 cm (64 transducers)
  modular array of microphones - from 0.20 x 0.20 m² to 2.0 x 3.0 m²
- Typical microphone spacing:
  2.5 cm to 10 cm for in-air measurements (up to 6,700 Hz)
- Dedicated conditioning unit

Spatial positioning and measurement automation:

- dBVision Instrumentation Positioning System (METRAVIB patent) Simple, contactless geometry positioning device based on ultrasonic technology
- 2D, 3D, 5D and 6D robots for easy-to-go testing

Data acquisition systems:

Full compatibility with:

- Stand-alone hardware: compact ORCHESTRA or VXI front ends
- Multi-purpose open test systems (IDEAS, …)
- PC integrated data acquisition cards and software (01dB, …)
- **Operating system required:**
- PC Pentium III+ computers (RAM 256+ MB, disk requirements 50+ MB)
- Windows TM 2000+

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