Automobile Engine Nearfield Acoustic Holography with Array 24

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Background

• Beamforming = Processing method for incoherent sources
  - Often ideal for aeroacoustics
  - Resolution is poor at low frequency
  - Can be confused by coherent source distributions if the array is in the nearfield
    -- Supersonic jet noise
    -- Mechanical vibrations
    -- Fan tones

• OptiNav GINV
  - Developed in a Navy SBIR project
  - Generalized Inverse implementation of Nearfield Acoustic Holography
  - Works best when the array is in the nearfield and at least as wide as the source
  - Most efficient at low frequency (below 6 kHz for Array 24)
  - Not restricted in array design; works with Array 24 and Array 48 existing products
  - Not confused by coherent or incoherent source distributions
  - Can produce quantitative far field projections (not shown here)
Array 24 in Nearfield Configuration

Spotlight used to provide light for array camera
Beamform Interactive Dialog

3000 RPM, 4 cylinder, 4-stroke engine

Lowest tone frequency:
Cylinder Firing Rate = 3138/120 = 26 Hz
Engine Order = 1/2

Engine Firing Rate = 105 Hz
Engine Order = 2

Data acquisition time = 6 seconds
Time used for analysis = 0.68 sec.
Results (1/6)

Beamforming

26 Hz
EO = 0.5
CFR

52 Hz
EO = 1.0

NAH (GINV)

24.9-27.8 Hz
0.292 m

24.9-27.8 Hz
0.292 m

48.3-51.3 Hz
0.292 m

48.3-51.3 Hz
0.292 m
Results (2/6)

**Beamforming**

- **78 Hz**
  - EO = 1.5

- **101.1-104.0 Hz**
  - EO = 2.0

**NAH (GINV)**

- **78 Hz**
  - EO = 1.5

- **101.1-104.0 Hz**
  - EO = 2.0

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(OptiNav)
Results (3/6)

Beamforming

130 Hz
EO = 2.5

157 Hz
EO = 3.0

NAH (GINV)
Results (4/6)

171 Hz
EO = 3.27
(not cylinders)

183 Hz
EO = 3.5

Beamforming

NAH (GINV)
Results (5/6)

Beamforming

209 Hz
EO = 4.0

221.2 - 224.1 Hz
EO = 4.28 (not cylinders)

NAH (GINV)

206.5 - 209.5 Hz
EO = 4.0

221.2 - 224.1 Hz
EO = 4.28 (not cylinders)
Results (6/6)

Beamforming

235 Hz
EO = 4.5

261 Hz
EO = 5.0

NAH (GINV)