Acoustic Camera

Performance Benchmark

sevenbel
EFFECTIVE SOUND IMAGING

01 Introduction

Scope and Purpose

The image quality of an acoustic camera in terms of spatial resolution and dynamic range is largely driven by the size of the measurement surface and the number as well as the alignment of microphones across that surface, respectively.

This performance benchmark guide compares the image quality of three acoustic cameras having varying specifications with respect to the size of the measurement surface and the number of microphones.

The purpose of this guide is to show the impact of these quality parameters on actual image quality by

- using a reproducible measurement setup with three loudspeakers in an anechoic chamber as well as
- performing high accuracy localization of sound emissions from a motorcycle operated on a roller dyno in an anechoic chamber.

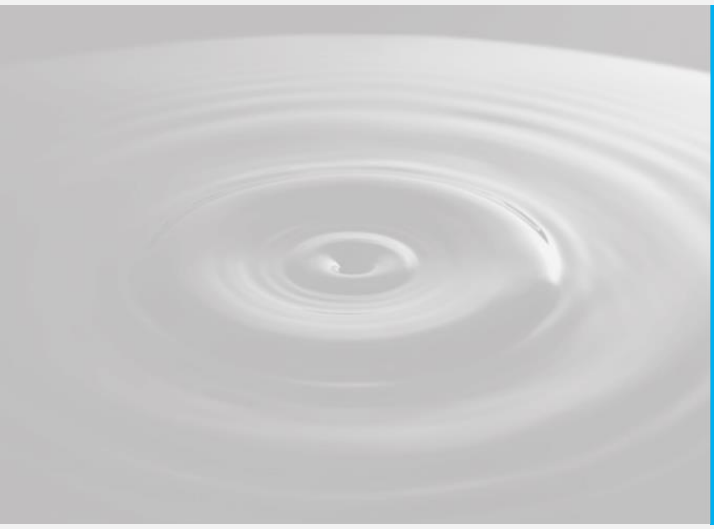
The acoustic cameras under test

The following models have been selected for the benchmark study:

- **Seven Bel Sound Scanner P132**
- **CAE Systems Bionic M-112**
- **Müller BBM SPS980**

While the Seven Bel Sound Scanner system uses the coherence scanning holography method, the systems from CAE Systems and Müller BBM are based on beamforming.

The Seven Bel Sound Scanner system has both the largest measurement surface (+32% vs CAE Systems, +52% vs Müller BBM) and the highest number of distributed microphone positions (3,5x vs CAE Systems, 11x vs Müller BBM), see the table of specifications on the next page.



Specifications of acoustic cameras under test

MANUFACTURER	Seven Bel	CAE Systems	Müller BBM
MODEL	Sound Scanner P132	Bionic M-112	SPS980
DIAMETER OF MEASUREMENT SURFACE	132cm	100cm	86,6cm
NUMBER OF MICROPHONES	> 400	112	36
MEASURMENT PRINCIPLE	Coherence Scanning Holography	Beamforming	Beamforming
MICROPHONE TYPE	Digital MEMS	Digital MEMS	¼“ Microphone MPA436A

Table 1
Specifications of acoustic cameras under test.

02 Multi-Loudspeaker Test

Test setup

The following measurements were all performed in an anechoic chamber provided by a renowned European supplier of systems for the development and testing of powertrain components.

Three loudspeakers are horizontally aligned. The acoustic camera faces the measurement setup at a distance of 1 meter.

This distribution of sound sources is typically encountered in a test setup comprising a combination of engine, gearbox and other powertrain components.

The speaker in the center is driven with white noise and harmonics in the frequency range between 100Hz and 10kHz while the left and right speakers are driven coherently with same audio signal but at a reduced volume of -10dB.

The challenge lies in separating the individual sources at pre-defined frequency bands and dynamic ranges.

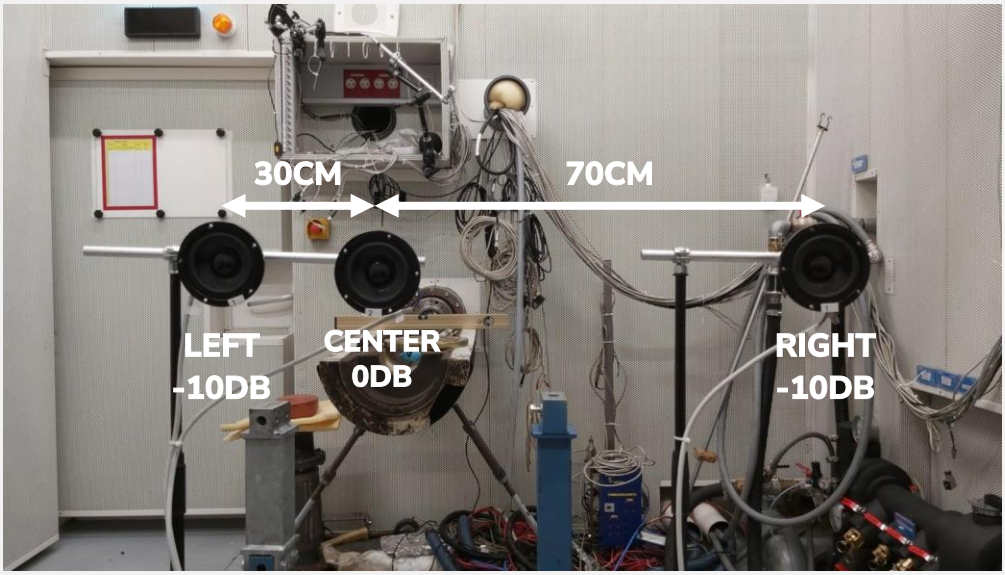
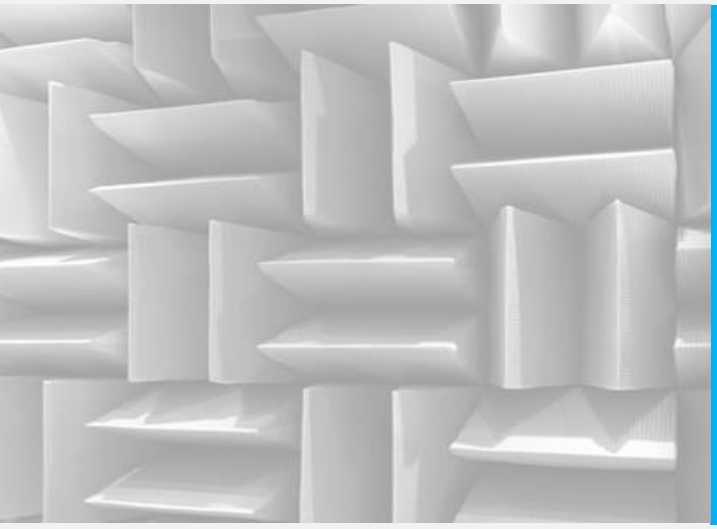


Figure 1
Test setup with three separated loudspeakers driven with white noise and harmonics at different levels of loudness.



Results

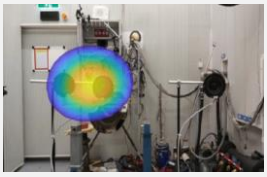
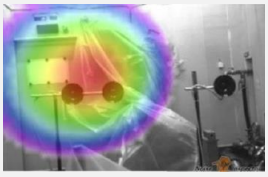
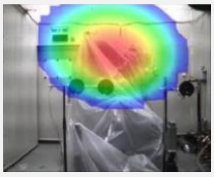
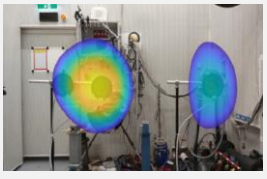
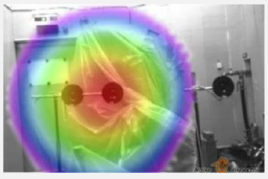
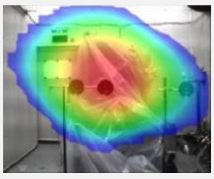
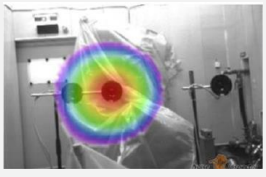
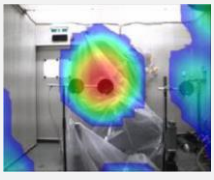
Frequency range / Dynamic range	Seven Bel	CAE Systems	Müller BBM	Comments
400Hz +/-11 Hz 1dB				Seven Bel shows best spatial resolution and highest localisation accuracy w.r.t. center speaker. CAE Systems and Müller BBM show significant vertical offset of true hotspot.
1200Hz +/-11 Hz 15dB				Seven Bel separates out right loudspeaker with correct level of loudness. CAE Systems heatmap seems being pulled to the floor indicating floor relection. Both CAE Systems and Müller BBM fail to separate out right speaker.
2000Hz +/-11 Hz 15dB				Seven Bel localizes all three sources with correct level of loudness. CAE Systens only shows center speaker. Müller BBM has localization inaccuracy w.r.t. center speaker along with artefacts around the edges.

Table 2
Performance benchmark at different frequency bands and dynamic ranges.

03 High Accuray Localization

Test setup

In order to demonstrate the benefits of a large measurement surface and a high number of distributed microphones for the purpose of high accuracy localization, we will analyze the sound emissions of a motorcycle operated on a roller dyno at full throttle (50kph in 3rd gear).

The motorcycle under test is a KTM Adventure 790. The Seven Bel Sound Scanner P132 and the CAE Systems Bionic M-112 are used for this investigation.

Result

Figure 2 shows the results provided by the two acoustic cameras for the frequency range of interest between 615Hz and 850Hz.

For a selected dynamic range of 3dB, the Seven Bel system shows a very compact heatmap right above the chain guard while the CAE Systems instrument displays a very coarse heatmap stretching over multiple engine/powertrain components which makes isolation of the actual component very difficult.

Figure 2
High accuracy localisation of low frequency sound emissions from a motorcycle operated at full throttle on a roller dyno. Acoustic images are recorded with same dynamic range of 3dB.