CJS Labs

Technology · Research · Strategy · Solutions

Lab Notes

Electroacoustics & Audio

- *Consulting*
- *Design / Testing*
- *Training*

Volume 12, Issue 3 **October 2019**

Inside this issue:

AES International Conference on Headphone Technology

The AES International Conference on Headphone Technology, which I co-chaired, took place here in San Francisco in the Presidio at the Golden Gate Club 27-29 August 2019 and was a great success. Over 240 persons attended. Sessions on the topic of headphones included papers, posters, workshops, demo and exhibits. I also presented a paper entitled, "*Objective Measurements of Headphone Acoustic Noise Cancellation Performance*".

Training Services

CJS Labs offers customized in-house training. Our design experience, proven processes, and measurement expertise will make your product development more efficient. Learn how to optimize both your designs and test routines. Having a thorough understanding of fundamentals, correct terminology, and proper techniques will also enable you to make more informed decisions and communicate more effectively with your customers and vendors as well as within your own organization. Understand why certain failure modes are problematic, even if they are not obvious or audible. Sample course outlines and details are available on our website:

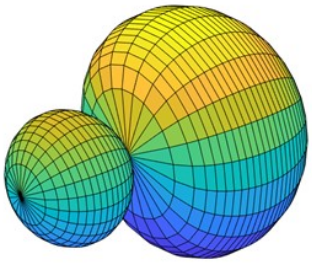
http://www.cjs-labs.com/training_seminars.html

Contact us to schedule a training course for your organization.

News and Upcoming Events

AES 147th New York—Microphone Tutorial

My tutorial at the AES 147th in New York on Microphone Electroacoustics was well received, with over 40 attendees and many requests for the PDF lecture notes. The presentation covered design, principles of operation, configurations, interfacing, performance metrics, and applications.



ASA 178th Meeting San Diego, CA

The 178th Meeting of the Acoustical Society of America (ASA) will be held Monday through Friday, 2-6 December 2019 at The Hotel del Coronado in San Diego, CA. The ASA Committee on Standards, which I chair, will meet Tuesday morning, 3 December. More information available at:

https://acousticalsociety.org/asa-meetings/

Please contact us and let us know how we can be of service to you and your organization.

Christopher J. Struck

CEO & Chief Scientist

CJS Labs

57 States Street • San Francisco, CA 94114-1401 • USA
Tel: (415) 923-9535 • Email: cjs@cjs-labs.com • URL: http://www.cjs-labs.com/

CJS Labs

"Sound Advice Spanning 3 Decades"

57 States Street
San Francisco, CA 94114-1401
USA

Tel: +1 415 923-9535
E-mail: cjs@cjs-labs.com

NCAC National Council of Acoustical Consultants Member

IEEE CNSV

CJS Labs is a consulting firm based in San Francisco, CA. We specialize in audio and electroacoustics applications. With over 30 years of industry experience in engineering and technology management, our areas of expertise include transducers, acoustics, system design, instrumentation, measurement and analysis techniques, hearing science, speech intelligibility, telephonometry, and perceptual coding. We also offer project management, tech-

Back Issues of Lab Notes are available on our website at:
http://www.cjs-labs.com/lab_notes_links.html

Summed Line Arrays

Monopole sources or receivers summed together will form an array. The elements could be microphones, hydrophones, or sound sources. Fig. 1 shows a simple microphone array.

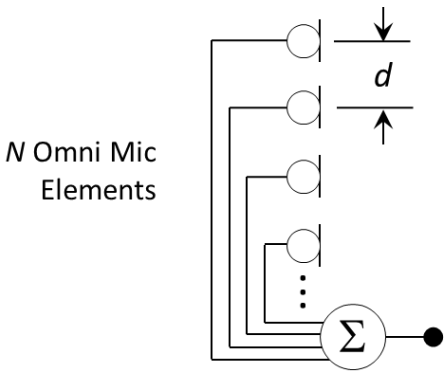


Fig. 1 Vertical microphone summing array.

The array will exhibit directional behaviour and lobing at higher frequencies where the distance separating the array elements is equal to or greater than $\lambda/2$. The response as a function of angle can be calculated as

$$R(\theta) = \left| \frac{\sin\left(\frac{N\pi d}{\lambda}\sin(\theta)\right)}{N\sin\left(\frac{\pi d}{\lambda}\sin(\theta)\right)} \right|$$

where

R	is the output
θ	is the angle [in rad]
N	is the number of elements
d	is the spacing between the elements [in m]
λ	is the wavelength [in m]

and $\lambda = c/f$

The distance separating the elements is assumed to be equally spaced and amplitude weighted with no additional delay. Note that argument for the sine of the angle is in radians. The line formed by the microphones sits along the y-axis (90° - 270°) as a vertical broadside array.

Polar patterns for a 4-element vertical summing array with the elements spaced 20 cm apart were modeled in Matlab and are shown in the following figure.

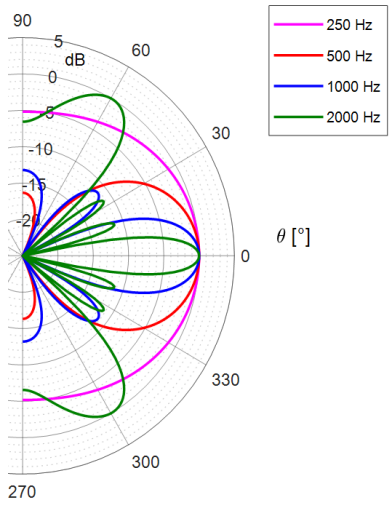


Fig. 2 Polar patterns for a 4-element array, d = 20cm.

The Directivity increases to approximately the frequency where $d/\lambda = 1$, limiting the useful range of the simple summed array as shown in Fig. 3.

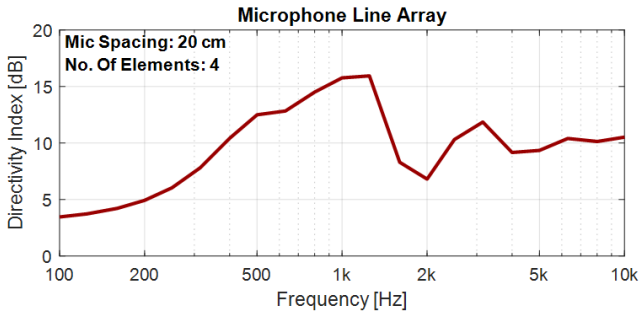


Fig. 3 Directivity Index of the 4-element array.

Control of the lobing and directivity involves changes to the spacing, amplitude scaling of the elements, and delay to summing node for each element. Numerous functions for these can be found in the literature.

Please contact us for more information.