AN-411

XY Directional Microphone Implementation Guide for Webcams

Introduction

High-quality audio in webcams is crucial for effective communication in video conferences and enthusiast content creators. By implementing Soundskrit directional microphones, a webcam can have professional high-quality audio so that users will be heard clearly on calls and will not need additional equipment to start making digital content. Directional MEMS microphones have several unique design considerations compared to traditional microphone approaches. This guide will walk through implementing Soundskrit directional microphones in a webcam using the XY configuration.

The XY Configuration

Two dipole microphones oriented orthogonally will record the entire sound field surrounding the pair with vectoral information. This allows a system to understand from where sounds originate around the webcam. This additional information allows for three key features. First, the webcam microphones can be used to focus on the user in front of the camera and isolate them from environmental noise in their surroundings and reverberation from the room, thus reducing distractions and increasing vocal clarity. Second, this ensures multiple users in 360° can be recorded with excellent clarity. A single dipole microphone will only record users in one direction, why using an XY pair, a beamformer can be steered in any direction. Finally, this accurate spatial information is crucial to high-fidelity stereo recordings. A pair of omnidirectional microphones can record in stereo, but with the size constraints of a webcam, the effect will be minimal. Professional audio devices use directional microphones to create stereo recordings with wide sound stages and accurate imaging. An XY pair of Soundskrit microphones miniaturizes this technique to a small form factor that can be integrated into a webcam. An XY pair of dipole microphones enables a unique feature set that provides high-quality audio for video calls and content creators without requiring additional equipment.

Implementing the XY Configuration

To integrate XY configuration, several parameters must be considered. Large objects, such as the outside shell of the webcam and the screen on which the camera is mounted, create acoustic reflections that can alter the response of a microphone. To mitigate the effects of acoustic scattering, the sound ports of the microphone are best located on the top surface of the webcam. Additionally, designing the two microphones to have symmetry between them is always advantageous as the signal processing tries to leverage the output of the two microphones to further enhance the directionality of the system.

Figure 1 below shows a mockup of a webcam with two Soundskrit microphones oriented in the XY configuration:

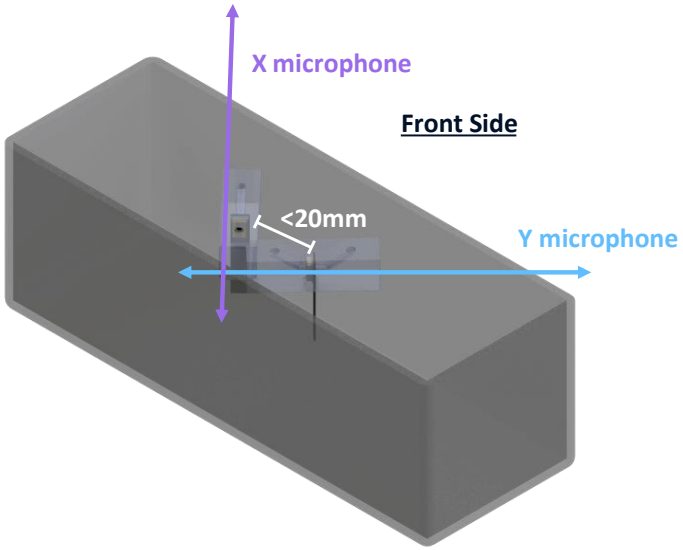


Figure 1 Webcam mockup with the XY configuration

When positioning the two microphones on the top surface of the webcam, it is desirable to minimize the spacing between them as much as possible. The smaller the spacing between the microphones, the better the performance. In general, the spacing between the microphones **should not exceed** 20mm, though spacings smaller than 20mm are desirable.

The XY microphone pair are oriented so that they point outwards relative to the front face of the webcam, where the user would sit. This is done to ensure that the XY microphone pair maintains a proper stereo image. If the orientation of the XY pair was reversed, so that the microphones were pointed inward rather than outward, than the voice of a user sitting on the left side of the webcam (facing the webcam) would first hit the Y microphone, and then the X microphone. However, the voice of the user on the left side of the webcam would be louder on the X microphone (since the voice would be on axis to the X microphone and off axis relative to the Y microphone). When playing back the audio captured on stereo speakers, the X microphone could be mapped to the left speaker while the Y microphone would be mapped to the right speaker. However, when playing back the audio, the voice on the left ear would be louder than the right ear but arrive at a later time than the right ear. This would create a discontinuity that would compromise the perceived stereo effect by the user. By pointing the dipoles outward, it can be ensured that the sound played back on the left speaker (in this case, now the Y microphone) is always louder and arrives earlier than the right speaker.

It should be noted that if the microphones are sufficiently close to one another, then the dipole can be pointed either inward or outward, since the voice will hit both microphones at effectively the same time. The discontinuity introduced by orienting the dipoles inward is only introduced when there is a nontrivial

amount of space between the two dipoles. The farther the spacing between the dipoles, the greater this effect.

To integrate the actual microphones into the webcam, a V-configuration should be used as described by application note AN-130. Figure 2 below shows an example gasket design for the Soundskrit microphones with the recommended dimensions. Note that each of the two microphones will use the same gasket.

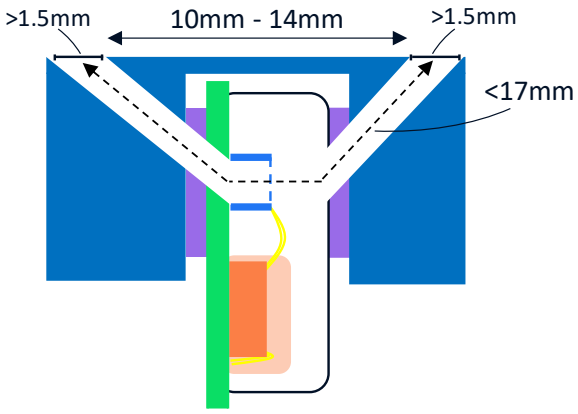


Figure 2: Microphone gasket dimensions

As shown in Figure 2, several key dimensions must be taken in consideration when designing the microphone gasket:

- The spacing between the two sound ports should be between 10mm - 14mm
- Each sound port should have a diameter of at least 1.5mm
- The acoustic channel length of the gasket should not exceed 17mm

There are several ways in which this gasket could be built and integrated into the webcam. In one implementation, a two-part gasket can be used which uses a soft material to seal on the microphone and then attach to the product shell. The gasket can be attached to the shell of the product using adhesives or even physical fasteners. The gasket should seal well to the part and also to the product shell. As shown in Figure 1, each of the two microphones should be tilted 45° with respect to the edge of the webcam. This can be achieved by physically rotating the gasket by 45° when mounting it onto the top surface of the webcam, as shown in Figure 3. Alternatively, a 45° bend of the acoustic channel can be introduced into the gasket itself.

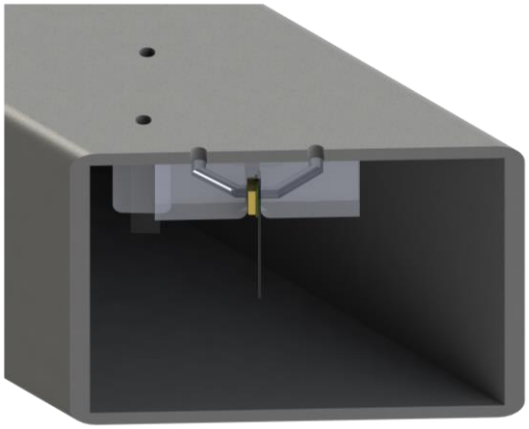


Figure 3: Two-part gasket integrated into the webcam

Experimental Results

A 3D printed mockup of the described webcam was created, and the microphones were placed inside the webcam in the XY configuration using gaskets as discussed. The directionality of each microphone was then measured, and is shown in Figure 8:

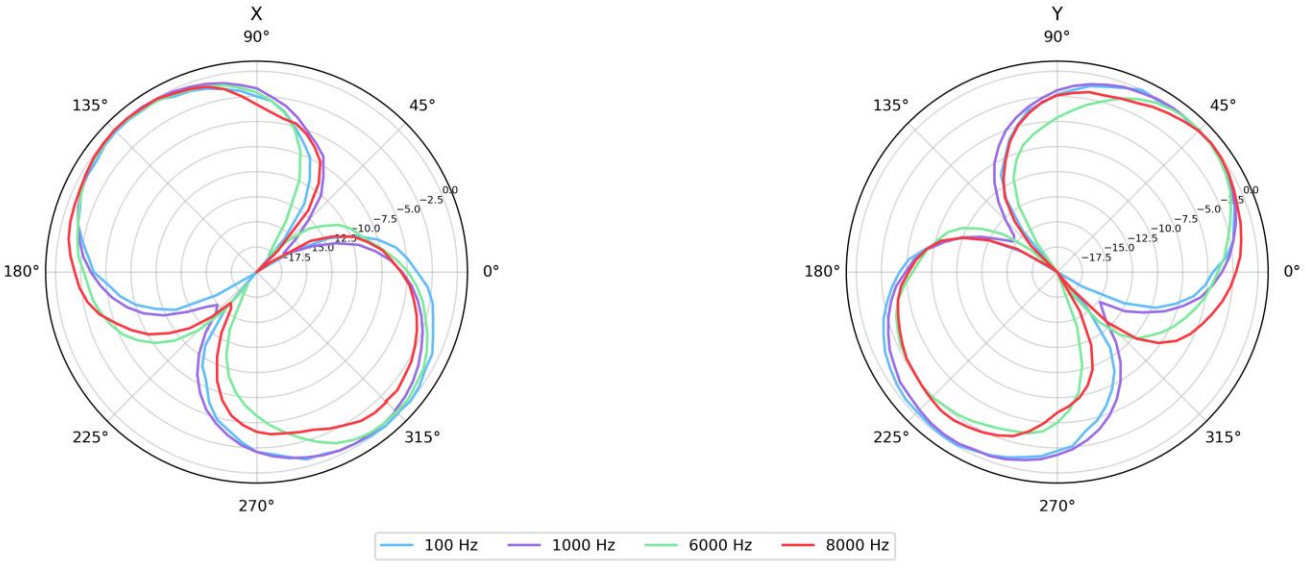


Figure 8: Polar pattern of the X and Y microphones

As seen from the polar plots in Figure 8, both microphones exhibit excellent directionality in the vocal frequency range. Both dipoles show a very similar (symmetric) response with each one exhibiting nulls

greater than -20dB up to 8kHz, even after integration into the webcam body. It should be noted, that with careful design of the webcam body to avoid unwanted acoustic scattering effects, the directionality performance could be further optimized.

Summary

Directional microphones can help create a superior audio experience to traditional microphone technology. This is important as a larger share of the worlds daily communication occurs remotely. Directional microphones can help users communicate effectively and be understood by their audience. Soundskrit's directional microphones provide superior audio quality in an easy to integrate form factor which is the same size as existing omni-directional microphones.

Additional Support

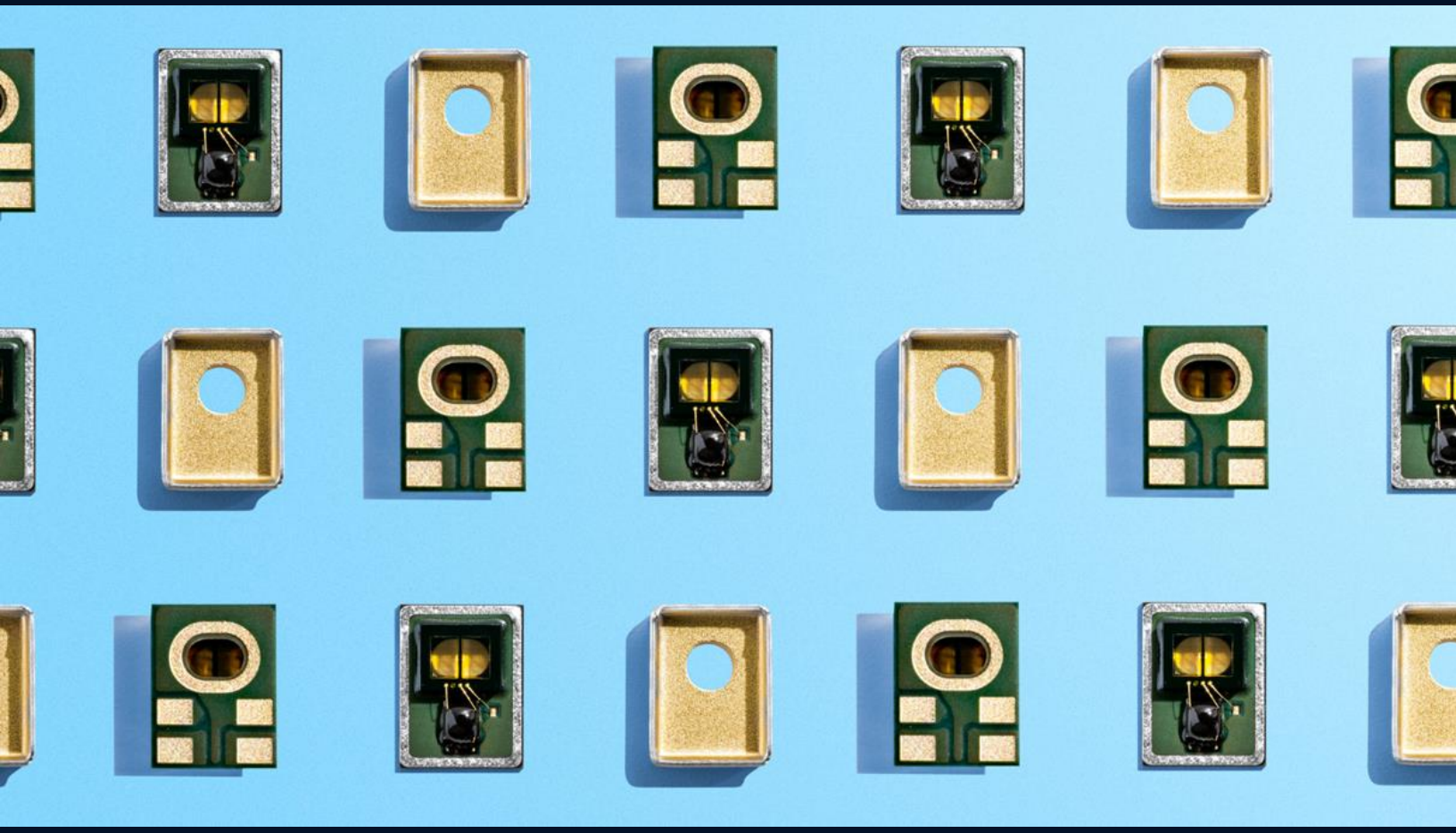
For further information on Soundskrit's products, visit our website at http://www.soundskrit.ca where you can find more application notes, datasheets, and purchasing information. If you have any questions or need technical support, please reach out to applications@soundskrit.ca.

Revision Label	Revision Date	Sections Revised
-	November 2022	Initial release

ABOUT US

Soundskrit has developed the world's first bio-inspired high-performance directional microphone that eliminates background noise and reverberation. Our intuitive sensory technology isolates the speaker's voice from all other ambient sounds, creating immersive audio experiences. Soundskrit replaces traditional microphone arrays in a wide range of devices and consumer electronics, including laptops, webcams, headsets, conference systems, smart home devices, smartphones, hearing aids, wearables and more.

Soundskrit was founded in 2019 and is headquartered in Montreal, Quebec with an R&D facility in Ann Arbor, Michigan.



soundskrit
Hear the impossible.