Virtual Education Lab: What is the Speaker Boundary Interference Response and how can it be mitigated?

As we have discussed, the combination of a direct sound and a delayed reflection introduces audible comb filtering. There is another type of interference that is created when the omnidirectional low frequencies from a woofer or subwoofer combine with reflections from nearby room boundaries at the listening position. This is called the Speaker Boundary Interference Response (SBIR). The illustration in Figure 1 shows a free-standing speaker and its virtual images associated with each nearby room boundary. This type of construction is useful because the delay time from each boundary reflection is simply the distance between the virtual image and the listening position, divided by the speed of sound (1.13 ft/ms). The SBIR occurs when all of the virtual image speakers, i.e. boundary reflections, combine with the real speaker at the listening position.

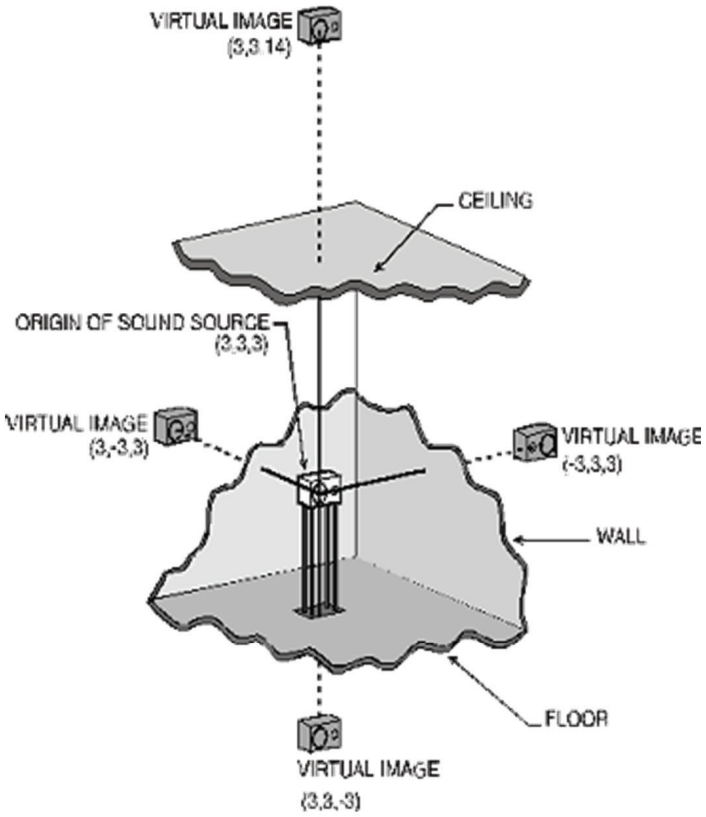

Figure 1. A free-standing loudspeaker and its 4 virtual image sources on opposite sides of each nearby room boundary are shown.

This interference is illustrated in Figure 2 when the speaker is plcaed 4' from one nearby wall, two nearby walls, and the floor. The response is characterized by a comb filter in which the first null moves from 100 Hz to 90 Hz to 80 Hz for 1,2, and 3 boundaries, respectively. The depth of the null progressively increases from -2.5 dB, -5.6 dB, to -23 dB. Once this null is created by the placement of the loudspeaker, it is difficult to remove without the addition of thick and potentiallya rchitecturally intrusive efficient low-frequency absorption. Interestingly, if the louspeaker is moved to 1' from each boundary, the null broadens and is shifted to 320 Hz, a frequency that is more easily addressed with absorption.

Fortunately, it is possible to minimize the SBIR without absorption using a wave-based software called NIRO (www.rediacoustics.com), which iteratively searches for the optimal locations of both loudspeaker and listener. Flush mounting the loudspeaker will remove that boundary interference. When a separate subwoofer is used, it is typically located on the floor, thus removing that boundary, and NIRO can be used to optimally locate its position with respect to the other nearby wall boundaries.

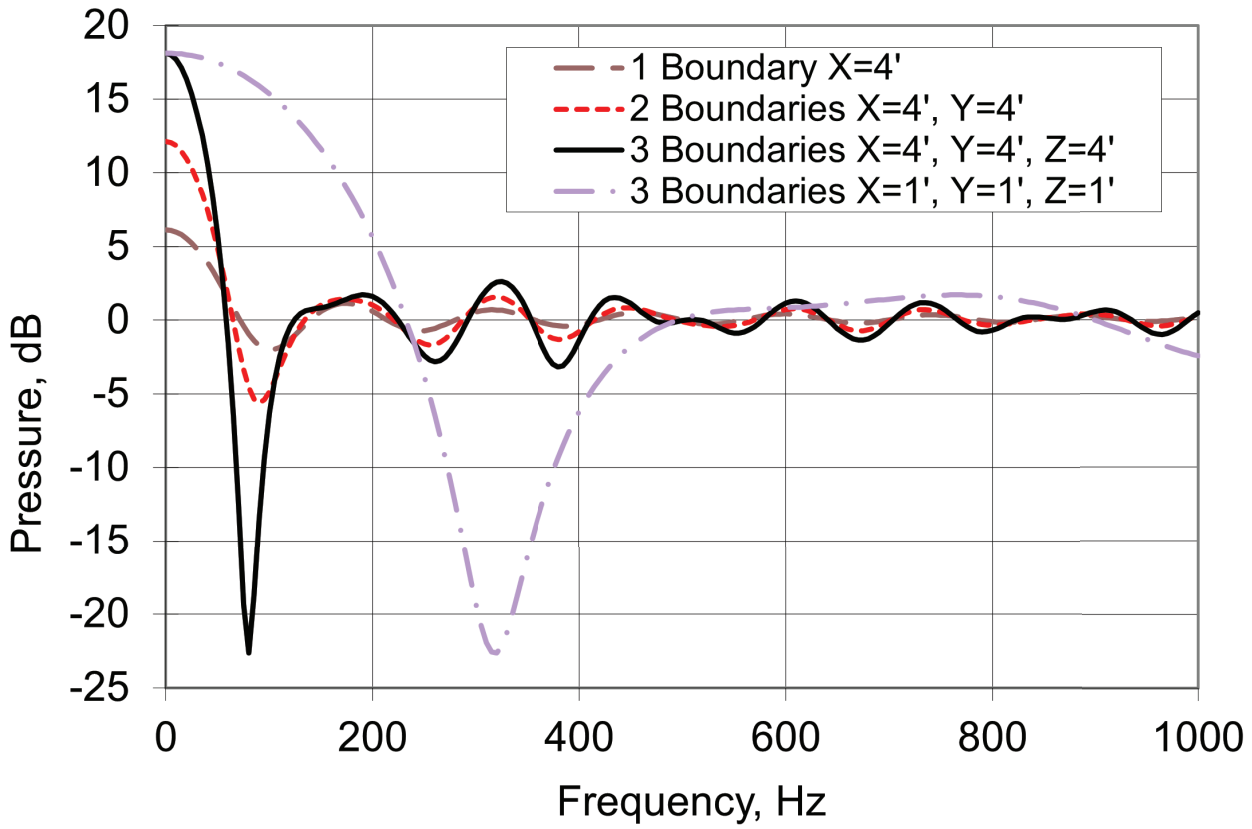

Figure 2. SBIR interference from 1, 2, and 3 boundaries spaced 4' from the speaker. The response is also shown when the distance to each boundary is reduced to 1'.

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