TT3010 - Audio technology and room acoustics. Exercise 5 - Microphones and loudspeakers Solutions

Jan Arne Bosnes

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1

As we know from reading chap. 20.4 on microphone sensitivity, we know that the voltage sensitivity, S_v (given in dB) is related to open circuit voltage V and pressure p as:

$$S_v = 20 \log \frac{v}{p} \quad \text{dB re. 1V/Pa}$$

We can then rearrange the terms to express voltage in terms of voltage sensitivity and pressure.

$$\log \frac{v}{p} = \frac{S_v}{20}$$

$$v = p \cdot 10^{\frac{S_v}{20}} \tag{1}$$

If v_A and $S_{v,A}$ represent the voltage output and sensitivity of the first microphone, while v_B and $S_{v,B}$ represent the voltage output and sensitivity of the second microphone, we can divide v_A by v_B to find the ratio between them, and p disappears:

$$\frac{v_A}{v_B} = \frac{10^{\frac{S_{v,A}}{20}}}{10^{\frac{S_{v,B}}{20}}}$$

$$\frac{v_A}{v_B} = 10^{\frac{S_{v,A}-S_{v,B}}{20}} = 10^{\frac{-60-(-66)}{20}} \approx 2$$

2

The output voltage of the microphone can be determined by using the formula for the sensitivity, rewritten as in Eq. (**??**)

$$v = p \cdot 10^{\frac{S_V}{20}} = 1 \cdot 10^{-60/20} \text{ V} = 10^{-3} \text{ V} = 1 \text{ mV}$$

To find the sound pressure p, we use

$$L_p = 20 \log \frac{p}{p_0}$$

where p_0 is reference sound pressure for the sound pressure level and is given as $p_0 = 20\mu$ Pa. The sound pressure level for a sound pressure of 1 Pa, will then be,

$$L_p = 20 \log \frac{1\text{Pa}}{20 \cdot 10^{-6} \text{ Pa}} = 94 \text{ dB}$$

Therefore, the sound pressure level for a sound pressure of 1 Pa is 94 dB.

3

We can find from Rossing chapter 25.3 that the angle of the sound image, θ_l, has the following relation to the angle from the median plane that the loudspeakers are placed at, θ_A, and the pressure from the left speaker, p_L, and the right speaker p_R.

$$\frac{\sin(\theta_l)}{sin(\theta_A)} = \frac{p_L - p_R}{p_L + p_R} \tag{2}$$

If the loudspeaker on the left has twice the amplitude than the one on the right, we can assume that $p_L = 2p_R$. By rewriting the formula and inserting this relation, we get the following:

$$\sin(\theta_l) = \frac{p_L - p_R}{p_L + p_R} \cdot \sin(\theta_A) = \frac{2p_R - p_R}{2p_R + p_R} \cdot \sin(30) = \frac{1}{3} \cdot \frac{1}{2} \rightarrow \theta_l \approx 10^\circ \tag{3}$$

As shown, the image will resemble figure **??** where the image is shifted 10 degrees to the left.

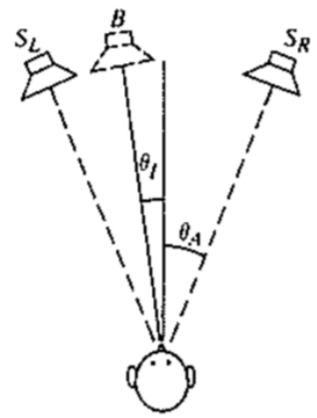

Figure 1: The changed sound image when the signal strength is increased in the left speaker.