Bouncing Sound Power

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Objective

To research the feasibility of recapturing wasted sound as power.

Introduction

Humans can hear around zero decibels or 10^{-12}Watts. To put this in perspective, the human breath has a dB rating of 10^{-11} Watts, or 10 decibels. A turbo jet-engine emits around 170 Watts. We decided to use a Porter Cable Shop Boss 25-gallon air compressor for our analysis and reference point. This compressor is rated at 75 decibels as a shroud is used to dampen the vibrations internally for noise reduction. This compressor requires 120 volts AC to be supplied and draws 15 Amps during operation.

Process

Sound power cannot be captured in its entirety without obstructing it in all directions. The obvious answer to this problem is to set up a large array of microphone receivers in a spherical pattern around the object, but such an array would still have many problematic gaps and would be tremendously expensive and inconvenient.

Instead, we chose to treat the sound waves like rays, and reflect them from all sides of the noisy object toward a single point, that is, a microphone receiver. In this way we could utilize special geometry to require only one microphone.

We developed a mathematical model to describe the shape of such a room, describing the angle of the wall at any given point in polar coordinates. By integrating the result, we found a general equation for the half-shape of the room. By inspection, we could see that it was not quite the shape we needed. Further inspection showed that the equation required more input values and may not be simply integrable. We later found that a simple ellipse would meet our needs very well[1]. The noisy device would sit at one focus and the receiver at the other.

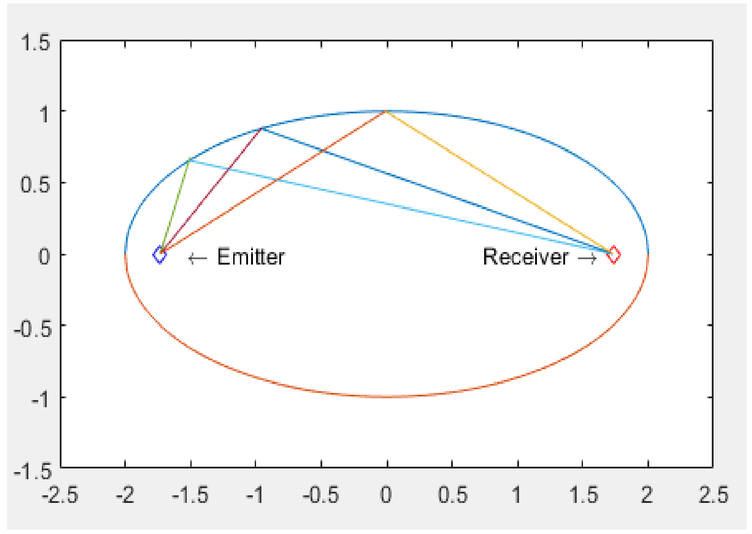

Figure 1: Elliptical Room

We also found that we would need to use walls thicker than the wavelength of our sound so that it can bounce, that is, be treated as a ray. [2]

For our microphone, we selected the Audio-Technica U853 for capturing the power.[3] As a cardioid omnidirectional microphone, it could pick up sound from many angles. It also has a wide range of frequency resonances, as seen below.

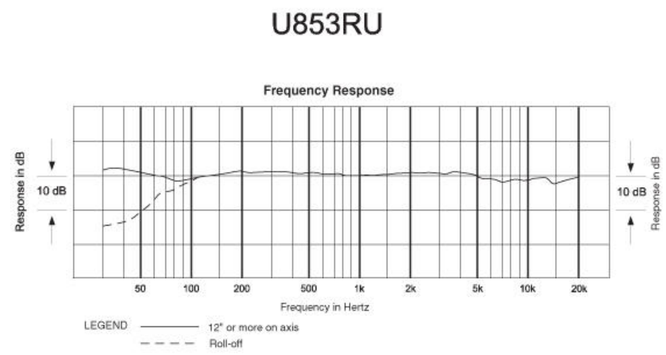

Figure 2: Frequency Resonances of AT U853

Results

An air compressor generates 75 db. The possibility exists to harvest a low amount of energy efficiently from the noise produced using a microphone to capture the sound like the one mentioned above. The energy harvested would be converted from mechanical energy contained in pressure waves to electrical energy with a sensor. Sound is considered to be a pressure wave consisting of compressions and rarefactions which can be used to capture energy.

Acknowledgements

[1]Dr. Riggs
[2]Dr. Guilaran
[3]Suggestion by Dr. Nettles

References

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