CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

34400

Project Title

Acoustic Insulation: Propagation and Reflection of Sound Waves of Various Frequencies for Different Materials

Abstract

Objectives/Goals

The objective is to determine which materials have best sound-proofing properties. Both propagation and reflection of sound waves of different frequencies are studied for various materials. This information, for example, can be helpful for insulation of my piano practice from a sensitive neighbor and explain why we hear low pitch voices through the walls.

Methods/Materials

The sound insulation properties of these materials were studied: thick drawing paper, aluminum foil, foam, wood, cardboard, foam paper, insulation material, and velvet paper.

A dedicated measurement system was built. The square tube (4 feet by 6x6 inch) was built from ½ inch thick insulation foam. Two speakers were placed at one end of the tube. A set of 7 microphones was installed along the tube. Each microphone is connected to a separate sound amplifier followed by a frequency splitting circuit. Their outputs are connected to an Arduino board, which measures the signal amplitude for 5 frequency bands. These values are sent to the computer.

Inserts are installed inside the tube. The variation of sound amplitude before and after the barrier or along the reflecting inserts is measured for 0.4, 1, 2.5, 6.25 and 16 KHz.

All sound amplitudes are also visualized in real time on an 8x8x8 LED cube to demonstrate the measured values.

First I measure the background level in each microphone, then sound in the empty tube, then with inserts. Ratio of amplitudes for empty/with inserts is the result of measurements. That way only the change in sound amplitude due to the inserts is measured.

Results

Among the materials measured it was found that wood had the lowest sound transmission. It effectively blocks sounds of >1 KHz frequencies. The lowest measured frequency is not blocked by the wood as efficiently as the higher frequency sounds. This explains why we hear neighbors with low voice, drums, and bass instruments better than those sounds with a higher pitch. The cardboard was the least blocking material. The reflectivity was the lowest for the textured foam and the velvet paper. I also discovered that inserts physically touching the speakers easily transmit the sound.

Conclusions/Discussion

My results indicate that sound from low pitch sources (e.g. drums, bass, etc.) is harder to block. Combination of wood and foam is best for sound-proofing. Also the sources of sound should be mechanically insulated from the walls (e.g. with rubber pads).

Summary Statement

In my experiments it is measured and displayed in real time how various materials transmit and reflect sound of various frequencies helping in materials selection for sound-proofing of loud instruments or music from sensitive neighbors

Help Received

My father helped me to design the electronics for the sound amplifier and the band filter, as well as helped me to build the LED cube.

Preliminary