CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
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Project Number
S1913

Project Title
Focusing Sound Using Non-Linear Acoustics

Abstract

Objectives/Goals
We have managed to focus light, microwaves etc. Now we reach a new goal, a way to focus sound. In general, most if not all loudspeakers invented use magnets, which vibrate by using the piston movement to change the air pressure. The main flaw with this design is that a high amplitude is need to transmit the sound over long distances. Therefore, the people who don't want to listen to the sound are greatly disturbed. The objective is to reduce the range of sound, while keeping the volume constant and directing sound in one direction.

Methods/Materials
The basic idea is to use the method of destructive interference. If two sound waves interact in a destructive interference with frequencies of 21 Hz and 20 Hz respectively, a new frequency of 1Hz is created. Although mathematically speaking a frequency of 1 Hz must be created, the laws of friction between air molecules state that the energy of the original wave must be lost as heat. What would actually be produced would be much lower than 1 Hz. But if one were to use ultrasound instead of regular frequency the energy lost as heat would be insignificant to the energy that the wave already possesses. So if 30 kHz and 40 kHz waves were to interact a new frequency of 10 kHz is created. Ultrasound is very directed in nature so the new frequency produced gets the direction of ultrasound.

Results
Ultrasound is created by piezoelectric ceramic. The ceramics use electricity very efficiently and have very little resistance. The ceramics are therefore highly effective. One creates the device using 196 piezoelectric ceramics and divides that into two groups. One group creates one frequency while the other group creates another, thus only one difference frequency was created. If one could program better one could probably create complex frequencies of music.

Conclusions/Discussion
The device worked fine. One made two people, one standing in front of the speaker and the other beside the speaker. Only the person in front of the speaker could hear the difference frequency. The sound disappeared after a range of 3.5 meters and in this range the volume remained constant. The direction was very precise and was very close to the simulation created in MATHLAB.

Summary Statement
Focusing sound in a very specific direction using destructive interference and non linearity in air.

Help Received
The entire project was done by me without the help of anyone else