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# Design and construction of an omnidirectional sound source with inverse filtering approach for optimization

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ABSTRACT

The aim of this study is to design an efficient omnidirectional point source whose analysis and design is also described here. The point source was designed with the help of MATLAB and SolidWorks software respectively for calculating the optimal dimensions. This point source is composed of a base in which the speaker is settle, and a cone that provides the omnidirectionality. Three different bases with three different cones were implemented and tested to determine which combination gives less reflection on rear part of cabinet. To enhance a flat response and true omnidirectionality, an Inverse Filtering Method will be introduced to the study. As a result, we observe that the point source is best suited with a cylindrical base and a 20 cm long cone. The radiation patterns showed omnidirectional results for frequencies lower than 15 kHz, and maximum deviation of 4 dB for 30 degrees.


| | |
|---|---|
| Hardware name | *Omnidirectional Sound Source* |
| Subject area | • Engineering and Material Science |
| Hardware type | • Field measurements and sensors |
| Open Source License | *Open Source Hardware (OSHW) Definition 1.0* |
| Cost of Hardware | *$190 USD* |
| Source File Repository | *https://osf.io/rxgkd* |

## 1. Hardware in context

Since ancient times the analysis of how sound behaves, when certain variables are manipulated has kept human kind interested. It is well known that ancient American cultures modified certain angles and geometries of their structures to create an acoustic disturbance of a palace or a chamber [1]. Nowadays before planning the construction of any kind of theatre of acoustic enclosure, an acoustical analysis must be performed [2]. This is done with help of an omnidirectional sound source, which are commonly an array of directional speakers, organized in a spherical way,

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so that sound is able to propagate evenly in all directions [3–4]. Other use of this kind of sources is to perform analysis of the ground, the acoustic reflections that come from the soil after being radiated by the sound source [5]. To show concentration of certain minerals or even soils in the ground [6], it can even be used to distinguish between different kinds of surfaces i.e. the fuel consumption in a car depending on the type of road [7]; or imperfections on certain pieces while a manufacturing process is performed. Omnidirectional sources are also widely used in the music industry, they are not only used for concerts as acoustical reinforcement, but they can also be used for any kind of reinforcement in locations such as conference rooms, lobbies at airports or shopping malls [8]. One benefit of using this design is that depending on the function and the operation the user wishes to give the source, it can be resized and the performance will not be disrupted. i.e., in the music industry you can enlarge all the generator's dimensions and enhance the low frequencies, or put it in a car and make it smaller and ensure it fits everywhere and enhance high frequencies [9].

The use of an omnidirectional sound source is limitless, depending on the needs of a physical space and the client's budget [10]. Some omnidirectional sound sources can be as expensive as some thousands of USD, acquiring them in developing countries can be tricky and time consuming. That is the reason why this paper presents a solution for a home built, professional and portable omnidirectional sound source.

As mentioned above, it can be established, as part of experimentation in acoustic engineering, which many experiments such as insulation problems, acoustic conditioning issues and especially characterization of materials, become efficient experiments when carried out under environmental conditions emulating real operating conditions [11]. For this, the ideal omnidirectional sources are a model whose emission characteristics of acoustic waves that propagate in all directions with the same energy are suitable for the generation of sound fields in enclosures where a diffuse sound field is needed inside the enclosures [12]. Therefore, omnidirectional sources are desirable in rooms where acoustic experiments are going to be carried out [13]. This is the motivation to generate this type of speakers, while experimenting with an original design with suitable materials and within reach for future experimentation.

## 2. Hardware and software description.

As mentioned before, six different pieces were 3D printed. Three different cones in length (20 cm, 25 cm and 30 cm) and three different bases (conical, cylindrical and trunked cone). Figure 1 shows an image of the finished cones, and Figure 2 shows an image of the finished bases. It is important to mention that these bases have a little hole for inserting a cable and connect the speaker with an amplifier; also, the speaker has already been adjusted and attached to the base with the screws. As these pieces were 3D printed, they needed the next steps to be developed to be fully compatible with each other:

Clean the imperfections of each piece created by the printer to support and allow it to be easily removed from the printing base.
Remove support material and define small parts such as internal ropes and external.
Paste the pieces of cones and bases to create the sources.
Fill imperfections with plastic sealer (Plaster)

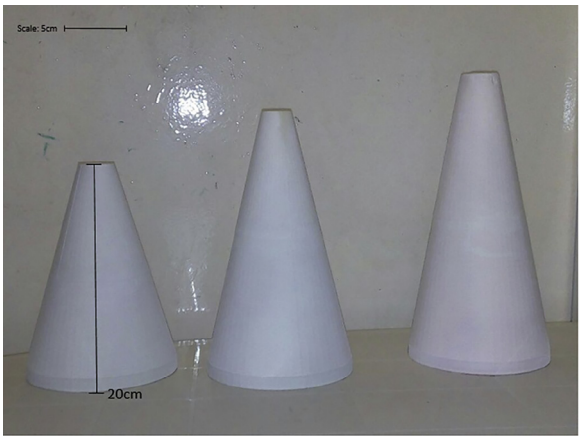


**Fig. 1.** Shows the three different cones glued using cyanoacrylate, for smoothing the surface, and the joints plaster was used as patching material, sanded with thin sand paper and painted ready for use.