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Ultrasonic Array Based Audio Spotlighting

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ABSTRACT: Audio spotlight is a state-of-the-art far-reaching audio technology that engenders focused beam of sound akin to light beams emerging from a flashlight. By shining sound to a peculiar location, definitive listeners can be targeted with sound sans others nearby perceiving it. The concept of nonlinear acoustics is used as its basic fundamental. The acoustic device encompasses a speaker that hurls off inaudible ultrasound pulses with minuscule wavelength analogous to that of the scanty column. The ultrasound beam masquerades as an airborne speaker and as the beam transit through air piecemeal distortion comes to pass in a foreseen way due to the nonlinearity property of air. This prompts to audible components that can be unerringly predicted and explicitly controlled. Audio spotlight constitutes a processor, an amplifier, and a transducer. The audio spotlight can either be directed or pinpointed at a legit listener or to a locus where it is reflected.

KEYWORDS: Audio Technology, Focused Sound, Parametric Speaker, Ultrasonic Array

I. INTRODUCTION

The audio spotlight which is a hypersonic sound technology operates ultrasonic energy to disseminate extremely slender beams of sound that spoofs beam of light. The audio spotlight exploits the non-linearity property of air [1]. The inaudible ultrasound pulses when transpired into the air, it spontaneously metamorphoses the inaudible ultrasound into audible sound tones, hence proving that comparatively like water sound propagation in the air is just as nonlinear and mathematically calculable. A device so-called parametric array [3] employs the nonlinear property of air to generate the audible buy products from inaudible ultrasound in ensuing an exceptionally directive beam like a wideband acoustical source. The source can be projected about an area bordering on the spotlight and creates an authentic specialized sound aloof from the transducer. The ultrasound column gestures as an airborne speaker and as the beam pass through or transit through air gradual distortion happens in an anticipated way [4]. This gives rise to the audible components that can be predicted on target and precisely controlled.

II. LITERATURE SURVEY

The audio spotlight implements ultrasonic sound with an eye towards generating narrow beam of sound after the fashion of beam of light. In an attempt to focus the sound, ultrasonic sound is plied as it has compact wavelength and beam angle consequently making the beam better focused. The audio spotlight exploits the non linearity property of air [1]. The nonlinear property is referred as if two high frequencies with high amplitude are send off into a nonlinear medium, for example, air a third frequency can be heard, namely the difference frequency, that is, inaudible sound is converted to audible sound. There are two types of listening mode basically described in acoustics videlicet direct mode and projected mode [2]. With the proviso that sound can be focused at a specified area, it is known as direct mode. A direct line of approach from the emitter is indispensable in this case. The second mode is more of a virtual mode or reflective mode. An unbroken line of approach is essential from the emitter in this case and the emitter is to be pin-pointed at the spot with the same aim of hearing the sound. As name, for this mode, the sound from the emitter is happened to reflect from the reflective surface such as a wall surface. By dint of using a parabolic reflector [3] we can lucidly construct a directional speaker. A miniaturized emitter fixed at the focal point of immense parabolic shape dish, which is in turn made up of sound reflecting material, for instance, polycarbonate plastic is used. The sound waves generated from the emitter, on reaching the end or mouth of the paraboloid emerges at an equal phase. The design is painless but it imbibes a larger space.

III. PROPOSED SYSTEM

The proposed system consists of the input section, a processing section, and a transmission section. The input section collects the audio input from one of the possible choices and transfers it to the processing section. These signals on

reaching the processing section converts and conditions the signals to make them efficient for transmission through the transmission section. The processed signals are then fed to the transmission section so that they can be transmitted to the air. In the transmission section, the signals are fired to the air by using the high-frequency array.

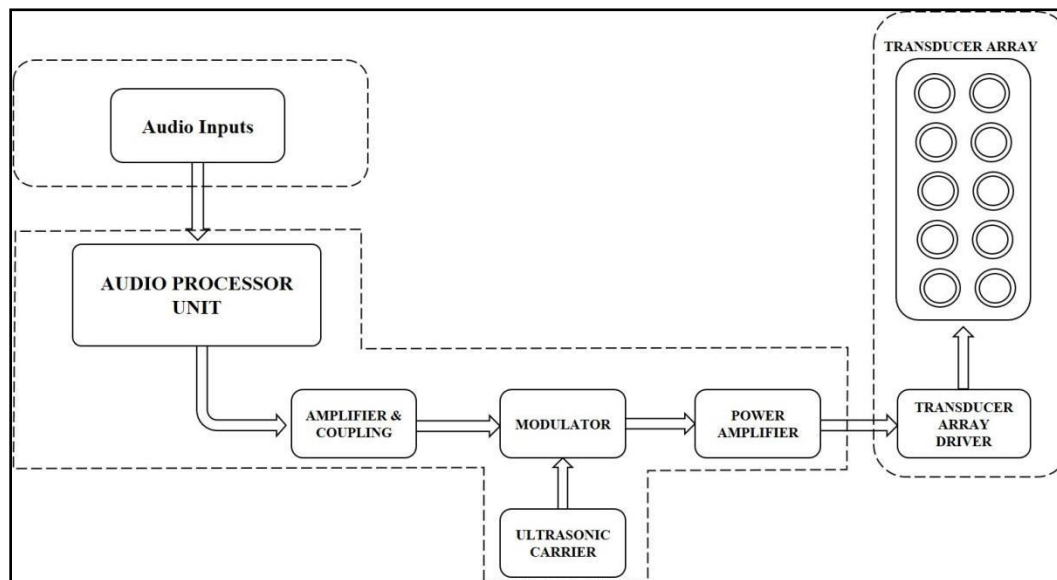


Fig.1. Block Diagram of Proposed System

IV. SYSTEM DESIGN

The audio input signal is fed to the audio decoder (car speaker) via Bluetooth, AUX, and USB. The output coming from the audio decoder is fed as input to the processing unit or the driver circuit. The driver circuit consists of a NE555, L293DNE, and LM7805. NE555 is used for generating Frequency Modulated (FM) waves, FM is the encoding of information in a carrier wave by varying the instantaneous frequency of the wave, a carrier signal of 40 KHZ is generated using NE555. The power to the driver circuit is given by the LM7805 voltage regulator where 12-volt power is regulated to 5 volts. Whenever you want to drive heavy loads with a small TTL signal you use a transistor, BJT, or a MOSFET. In case the circuit becomes complex and you need to drive a load with two, three, or four TTL signals you use a combination of transistors or MOSFET to provide high power output to load. This transistor or MOSFET combination is known as the H-bridge circuit, but here we only use one MOSFET. Making an H-bridge circuit on breadboard or PCB (printed circuit board) requires many wires to be connected and it seems like a mess also the circuit takes too much space. Luckily this issue can be overcome by using L293DNE. The output of the 555 timer is given to the L293DNE which is used to drive the array of ultrasonic transmitters. Then the output from the driver circuit will be transmitted through the ultrasonic transmitter. Due to the nonlinearity property of air, the high-frequency ultrasonic signal weak gets demodulated in the surrounding, and we will be able to hear our normal transmitted audio.

Music or recording from the mobile device is fed as an input signal or message signal to the audio decoder. The audio decoder is in turn connected to the driver circuit. A supply of 12 volts was initially given to power up the driver circuit. The message sent from the audio decoder passes to the FM modulator where it gets modulated with the ultrasonic carrier. To transmit the signal over a distance, sufficient power is required to transmit the signal to that range. This power is obtained from the quadrupled motor driver which provides enough power gain to drive the output stage. The quadrupled motor driver or H driver is driven by 5 volts which are provided from the voltage controller. This modulated signal or audio wave from the quadrupled H driver circuit is then fed to the transmitter array from where the modulated high-frequency signal is shot off into the air and is transmitted through the air. Now comes the non-linearity property of air. The audio transmitted from the transmitter array being ultrasonic will not be heard generally. But due to this non-linearity property of air the modulated audio transmitted gets demodulated while transmission in air and we can hear the original sound or music that was sent from the device.

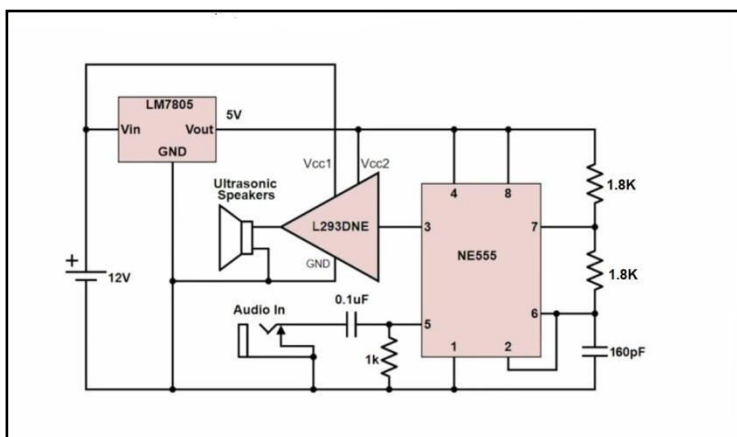


Fig.2. Circuit Diagram

V. RESULT

The model of the Audio Spotlight is shown in Fig. 3. The sound emitted from the transmission array could be heard normally without the use of any other devices due to the property of non-linearity of air explained earlier. In the case of a normal speaker, the sound emitted from it tends to move or spread in all directions. But in the case of Studio Spotlight, having sharper directivity, it does not spread out and follows a line of a path for its transmission. For Audio Spotlight, an FM Modulator, i.e. IC 555 is used for frequency modulating the original sound signal from the audio decoder and a quadruple H motor for boosting the power of the signal and circuit. The beam angle is less as ultrasound is being used which is known for its high frequency and low wavelength. So the sound does not spread out and is audible only to the area that the ultrasonic array is pointed towards. Depending on the number of transmitters used and the power delivered to the system, the quality and the range of the transmission can be improved.

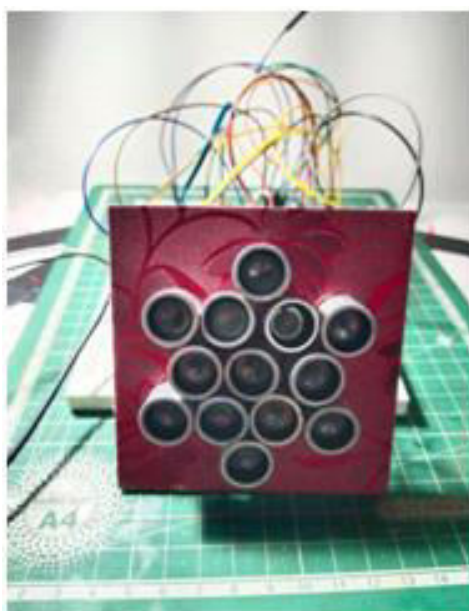


Fig3. System Implementation

VI. ANALYSIS

From the use of an ultrasonic array consisting of 12 ultra-sonic transmitters, the following analysis was deduced. The first graph, Fig.4, the directivity, i.e., the first graph posts the intensity versus the angle. The distance from the emitter is fixed at 20cm and the angle subtended is varied accordingly and the intensity variation is observed.

The second, Fig. 5, explains about the range of the system, i.e., the angle being fixed at 90 degrees and the distance

from the transmitter array is varied and the intensity variation with respect to the distance is measured.

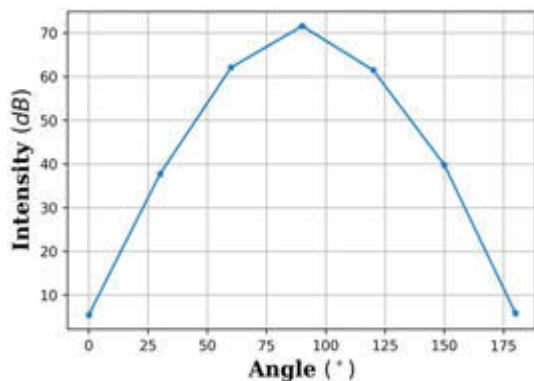


Fig4. Intensity v/s Angle

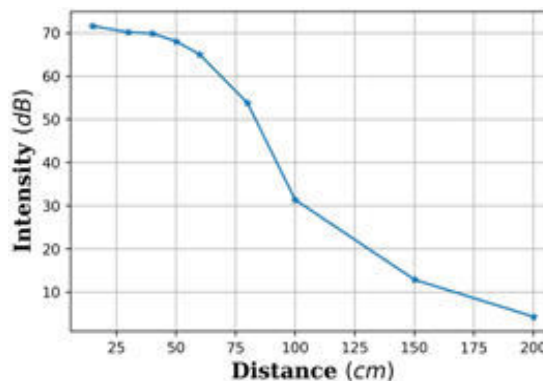


Fig5. Intensity v/s Distance

VII. CONCLUSION

Audio Spotlighting is going to change our view on sound transmission. Audio spotlight creates spatial environments without the acoustic isolation and mechanical stress pressing the ears caused by the traditional headphones. The audio spotlight is definitely way ahead of normal speakers in both its design and technology. The wide bandwidth and the vast directivity of the normal speaker can be neglected with the upcoming audio spotlight. As mentioned, the audio spotlight enables only the specific target to hear the sound and not anyone else. The user can decide the direction of the sound in which it should propagate. Since audio in this system gets transmitted in a single direction, it is applicable in several fields. Audio Spotlighting will be an experience for the users.

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BIOGRAPHY

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