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Design and Implementation of Acoustic Source for Analysis of Sound Perception

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Abstract—*We have proposed and designed acoustic source using Multisim and also implemented the hardware for the design proposed. Acoustic source is an important aspect in performing the acoustic experiments on the subjects. Multisim is used as simulation software and hardware is implemented to produce various sounds. The hardware is suitable to perform the acoustic experiments in various fields of acoustics. Acoustic experiments are performed on various subjects. Subjects are exposed to sound source while the frequency of sound source is fixed for all subjects for various set of experiments. Subjects are asked to score/rate the quality of sound and provide their response in a tabulated form. This experiment is created for performing listening test for analysis of the sound perception by various subjects. A suitable setup for performing acoustic experiment is provided and there are various applications in biomedical area. The test result shows slight variation in the perception of sound by the 8 subjects(aged above 50) while other (aged 22-32) have identical rating for the experiment. The response provided by the subject in the experimental analysis shows that sound perception at various frequencies.*

1. INTRODUCTION

The proposed acoustic source is a simulation model which is implemented using the hardware components to efficiently perform the acoustic experiment on various subjects. The implemented model is a suitable and simple experimental setup to help the experimenter to work in the field of acoustics. In this acoustic source user can hear the sound of frequency, amplitude for fixed time. The approach used is simple but robust and can be utilized for providing exposure to the subjects. The exposure duration is fixed as it is hardware implementation and can be varied before performing the experiment on any subject. The environment is noise free while performing the experiments. The exposure of acoustic to subject is decided as per the requirement of the experiment and also to provide a comfort while performing the experiments. Several authors have reported different techniques to perform the experiments on acoustics. Kazuhiro et. al [1] developed a simulation method for vertical sound localization, and to detect which peaks and notches in head-related transfer functions (HRTF) play important role as spectral cues, parametric HRTF model is used for localization tests in the median plane. The simulation shows that parametric HRTF recomposed using the first and second notches and the first peak provides almost same localization accuracy as the measured HRTF [1]. Fastl Hugo et. al. [4] performed the psychoacoustics experiments with subject in remote location via internet. This paper helps the experimenter and subject to save time, money for travelling and also to create a database about the subject's perception about the sound level in a particular experiment.

Abel et.al [11] described about the hearing loss in military personnel during combat operations. The experimental work suggests that the subject's ability to discriminate the speakers arrayed in front as source was good, although azimuthal discrimination was poor. From the standpoint of military field operations, these results strongly suggest that unilateral hearing impairment may seriously compromise performance in particular occupation]. Also there is a simulation work done in MATLAB which provides a toolkit that helps the user to develop new ideas in the field of multichannel surround sound to be implemented. This simulation also provides portability of simulations to Personal Computers [3]. Some author presented novel software designed to facilitate the teaching of how 3D sound is synthesized using computerized techniques. This program simplifies the fundamentals with interactive examples. A detailed description is provided of the software and real-time based systems proposed to demonstrate 3D sound using Head Related Transfer Functions (HRTF) [2,9].

From [5, 6, 7] it is clear that higher amount of efficient and modern technologies are required in this area. The application of acoustics can be seen in almost all aspect of human society with most obvious being sound localization. Several other simulation based software can be used for acoustic sound generation. Also, in [10] author outlined a computer based algorithm that localizes sounds in near-real time. The author also depicted the different application array such as detection and machine-assisted sound localization.

2. MATERIALS AND METHOD

The Simulation work is done on the Multisim Software. It is used as a software tool to analyze the various parameter

related to the acoustic perception. The Hardware implementation is done to provide a stable electronic device which can be used for performing the acoustic experiments. Experiments are performed at various frequencies which give details about the perception of sound by the subjects. The Simulation approach is suitable for verification of circuit built as hardware. The hardware thus built is simple and can be easily used at various frequencies to perform acoustic experiments.

2.1 Multisim Based Simulation

Multisim is a simulation tool which can also be used for implementing the acoustic effects and require skills to implement for a particular application. Multisim simulation and circuit design software gives engineers the advanced analysis and design capabilities to optimize performance, reduce design errors, and shorten time to prototype. Multisim has proven success in a wide range of aerospace and national research applications including avionics equipment for data acquisition, communication applications, and the design of electronics for various applications. It provides domain experts and researchers with an intuitive, yet advanced platform to rapidly prototype regardless of design experience. In Fig 1., Multisim is shown for design of a sound generator using Timer whereas the Hardware circuit of Multisim based Sound generator using Timer can also be designed with various components such as Timer IC, capacitors, various Resistors, supply voltage, transistor, LED's, switches, 8ohm speaker, etc.

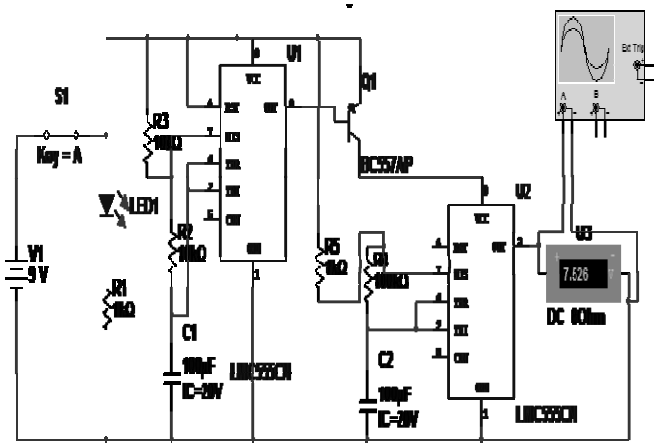

Fig. 1: Multisim Simulation Based Sound Generator

Hardware implementation of the simulation model is done by various electronic components. The hardware setup is built on the bread board and the setup is able to work efficiently. The input source used is a dry battery which provides the efficient power to run the circuit properly. The frequency of the setup can be varied by the external resistors. The external resistors provide variable resistance, when various set of experiment is done on the subjects.The generalized block diagram for the system developed is shown in Fig. 2.

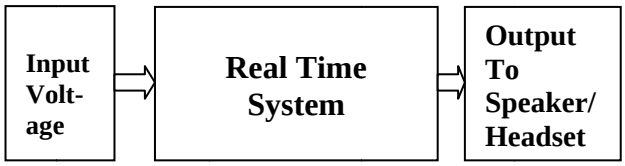

Fig. 2: Generalized Block Diagram for Acoustic Source

The block diagram shows the input voltage module where a dry battery is provide to get the desired input the circuit. The real time system depicts the components and the electronic integrated circuit used for performing the task of generation of acoustic or sound signal. The output is provided to the user with the help of speaker module or headset. The output volume is not in the control of the subject while it can be controlled initially by the task operator.

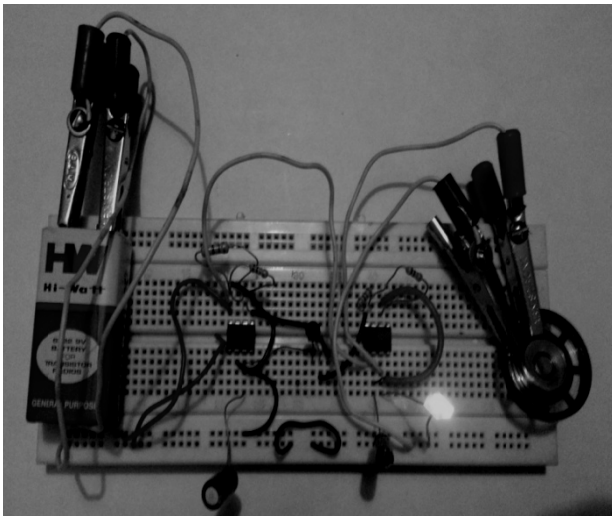

Fig. 3: Hardware Implementation of Simulated Model

The generalized block diagram can be implemented as a hardware module as shown in Fig. 3. The hardware module is built on the bread board with electronic integrated circuits and connecting wires. The output is provided here with the help of the piezo speakers.

2.2 Experimental Methodology

The sound perception experiment is performed on 23 subjects (13 Male, 10 Female, 17subjects aged 22-32, 8 Subjects above 50), all reported normal hearing. None of them had previously participated in this type of experiment. A response or score sheet is provided to all subjects. Subjects are asked to rate the sound perceived on the scale of 0-100. Sample Response sheet is shown in Fig. 4. The sample responses are kept as record for further studies. The sound perception experiment is done in a lab, each subject is advised to not to discuss the experimental procedure with other subject. Subjects are asked to sit and feel relaxed while the experiment is performed. The response is written or filled by the subject under the supervision of the task operator.

Sound Perception Experiment			
Response/Score Sheet (Range: 0-100)			
Subject_Id:	Age:	Sex:	Date &Time
Frequency 12KHz	Frequency 15KHz	Frequency 17.5KHz	Frequency 19.5KHz
Signature			

Fig. 4: Response Sheet for Perception at various Frequencies

3. RESULT

The Results are shown for 12 KHz, 15 KHz, 17.5 KHz and 19.5 KHz frequency. The perception is determined by the response given by the subject on the response sheet. The data is stored in a tabulated form as shown in table 1. 23 (13 Male, 10 Female) subjects are provided subject_id and a separate sheet to give any comment while performing acoustic experiment. Each subject is exposed to the acoustic source for a fixed duration and is asked to provide their response after each acoustic exposure.

The range of response score/ rate is 0-100. The sound perception experiment is performed on 23 subjects (13 Male, 10 Female, 17subjects aged 22-32, 8 Subjects aged above 50), all reported normal hearing. The perception rate of various subjects at 12 KHz Frequency is shown in Fig. 5.

Table 1: Response by subjects at various frequencies

Subject_ID	Perception 12KHz	Perception 15KHz	Perception 17.5 KHz	Perception 19.5 KHz
SUB_1	82	77	65	34
SUB_2	80	75	61	30
SUB_3	79	74	60	31
SUB_4	67	62	45	1
SUB_5	78	73	58	15
SUB_6	77	72	59	24
SUB_7	66	61	44	5
SUB_8	78	73	61	16
SUB_9	80	75	60	28
SUB_10	67	62	46	2
SUB_11	68	63	47	0
SUB_12	75	70	59	14
SUB_13	66	61	47	0
SUB_14	78	73	67	30
SUB_15	82	77	61	19
SUB_16	65	60	42	0
SUB_17	80	75	63	33
SUB_18	79	74	69	22
SUB_19	66	61	50	0
SUB_20	78	73	60	15
SUB_21	77	72	63	17
SUB_22	76	71	68	28
SUB_23	67	62	45	0

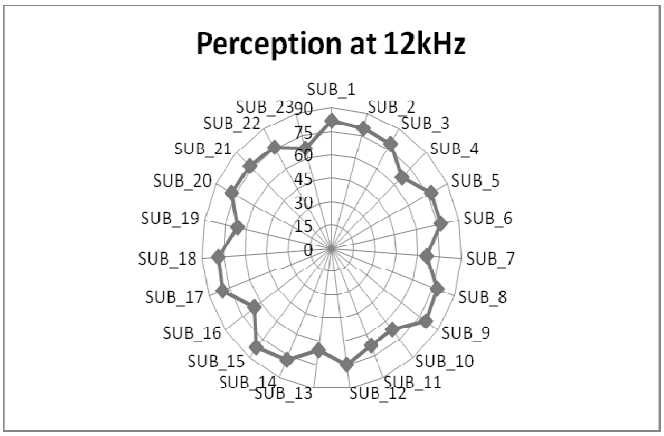

Fig. 5: Perception at 12 KHz Frequency

The result shows that all subjects are able to listen at this frequency and given high response. The perception rate of various subjects at 15 KHz Frequency is shown in Fig. 6. The result shows that all subjects are able to listen at this frequency and given medium response.

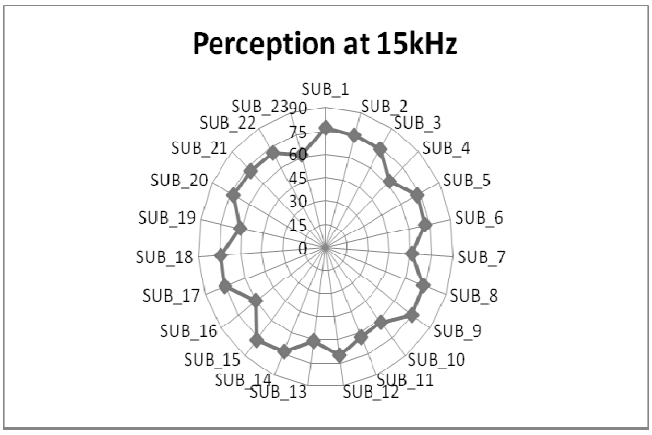

Fig. 6: Perception at 15 KHz Frequency

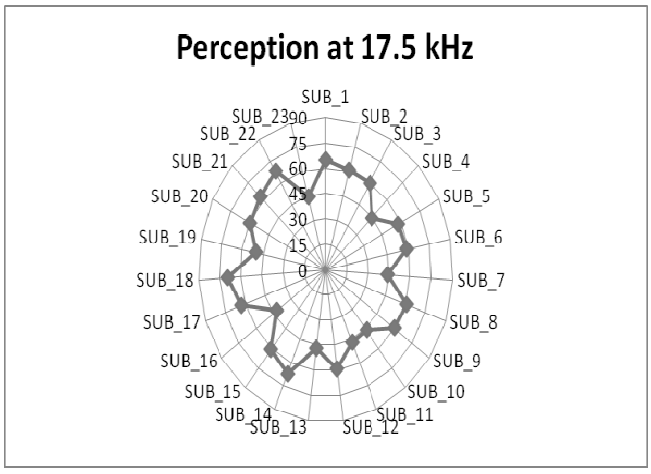

Fig. 7: Perception at 17.5 KHz Frequency

The perception rate of various subjects at 17.5 KHz Frequency is shown in Fig. 7. The result shows that subjects aged 22-32 are able to listen this frequency with low response while subjects aged above 50 are not able to give even low response at this frequency and given very low response.

The perception rate of various subjects at 19.5 KHz Frequency is shown in Fig. 8. The result shows that all subjects are not able to perceive sound and shown no response or very low response and this is the high frequency which is not perceived by the subjects. The high frequency component are thus not in the reach of hearing capability and this may be the reason for the result obtained.

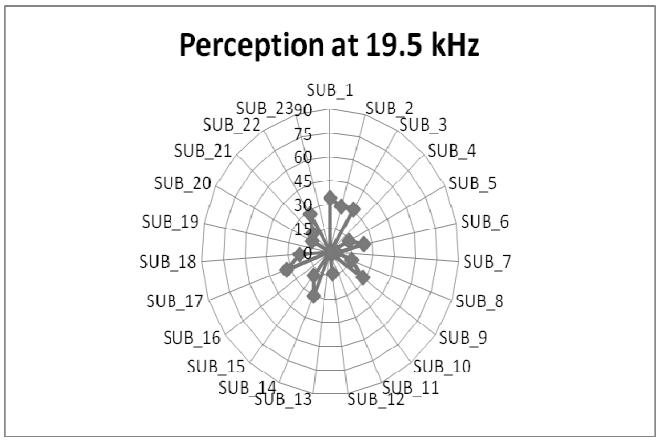

Fig. 8: Perception at 19.5 KHz Frequency

4. DISCUSSION

Acoustic is important and vital experimentation technique in the field of sound perception. The design and implementation of the acoustic source for performing acoustic experiment is conducted by software simulation and hardware implementation respectively. The acoustic experiment done on various subjects provide a data to analyze the perception of sound at different frequencies. The frequencies at which subject are exposed to be 12 KHz, 15 KHz, 17.5 KHz and 19.5 KHz. The tabulated response provided by the various subjects is useful in analyzing the sound perception and also give information about the perception of sound with respect to the age of subject. The analysis shows that age is also a factor which effects the sound perception. This factor may be advantageous in analyzing the effect of acoustic on various human related parameters.

5. CONCLUSION

The simulated model in Multisim gives the desired output. The simulation model is also implemented as hardware acoustic source. The simulated model helps in determining the various parameters such as frequency, time duration, etc. while the hardware model is suitable in absence of the simulation software. The hardware can be used for performing experiments and therefore help the user to design the sound signals as per requirement of the various experiment. The hardware acoustic source can be used for other application related to allied engineering fields. The application is suitable for various fields. Further, various setup of experiments can also be developed for analyzing the response of the human being and it will help in creation of data base for research in this field. Sound perception and localization in human subject can also be analyzed with different set of acoustic experiments. The result obtained thus gives a brief detail about the sound perception in various subjects. The variation in frequency of acoustic source is main parameter which affects the score/ rate of various subjects. It is also analyzed that several other physiological factors may be affecting the listening capabilities of the subject. The obtained result is helpful to analyze the factors affecting the perception of sound.

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