SMART AUDIO TESTING AND HEARING AID DEVICE

A thesis submitted by

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Submitted in the partial fulfillment of the requirements for the degree of Bachelor of Engineering in Telecommunication

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CERTIFICATE

The following students have submitted thesis, entitled, "**SMART AUDIO TESTING AND HEARING AID DEVICE**" under the directions of the *Dr. Fahim Aziz Umrani* (supervisor), *Rizwan Ali Shah* (co-supervisor), and approved by all the members of the thesis committee, has been presented to and accepted by the Chairman, Department of Telecommunication Engineering, in partial fulfillment of the requirements for the degree of Bachelor of Engineering in Telecommunication.

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ABSTRACT

Sound is vibrations that travel through a medium such as air and number of these vibrations produced per second are known as frequency. Humans can hear sounds between 20Hz to 20KHz of frequency. With the passage of time or due to exposure to high noises, the ability of humans to hear sound of higher frequency is decreased until it reaches 8KHz. According to WHO, there are over 1.5 billion people in world that live with hearing impairment. Our "Smart Hearing Aid Audio Testing Device" solves the problem of this hearing impairment by converting the sound of higher frequencies to 8KHz which can be easily heard by everyone. For this purpose, we have developed a hardware device as well as user friendly mobile app. Our device also has a self-diagnosis feature which allows one to generate sound at different frequencies starting from 20KHz going down up to 8KHz, one can check how much their hearing is damaged. Just like humans can hear sound of specific range, there are insects and animals who perceive sound of certain frequencies as annoying. Therefore, in addition to hearing aid and self diagnosis, there are two more features named: "Human Dispersion" and "Animal Dispersion" that allows generation of specific sound frequencies that can be audible only by people of certain age groups and certain animals and insects. The applications of "Smart Audio Testing Hearing Aid" can be implied as a Hearing Aid Device, Insect Repellent Device, Human Dispersion and Animal Dispersion Device. It uses filters and frequency conversion techniques to achieve the desired function of reducing noise, generating specific frequency sounds and converting higher frequency sound to desired hearable frequency

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Human beings can typically listen sounds with frequencies among 20hz to 2000Hz.Despite the fact this range varies substantially with age, occupational hearing damage,and gender.Most of the people can no longer hear 20,000Hz by the time they may be teenagers and gradually lose the potential to hear higher frequencies as they get older.People with impaired hearing abilities have to purchase expensive aids to help them listen properly otherwise they are at disadvantage while communicating with their family, friends and peers.

We are utilizing sound engineering to transform a readily available smart phone into a hearing testing and hearing aid device. Moreover, since most human speech communication takes place between 200 and 8,000 Hz and the human ear is the most sensitive to frequencies round 1,000-3,500 Hz. We intend to use our app to pick up any sound signal from the phones microphone and frequency shift it to 2000 to 8000 KHz as per user requirements so that they can listen better.

Furthermore, as an extension of this work we have made a standalone hardware module that can be used as an insect repellent to repel insects, lizards, mosquitos, rats/mice and cockroaches by emitting high-frequency sounds in the range of 20KHz to 30KHz that are inaudible for humans to hear but are just the right frequency to drive insects away. This device can be attached to the electronics appliances in the compact form placed in kitchen.

1.2 MOTIVATION

Western Canada and lots of towns within the US were efficiently using a excessive frequency sound, which is incredibly nerve-racking and that could be picked up best by teenagers and adolescents. This anti-loitering app will give greater enamel to the anti-graffiti pressure and anti-social behavior in schools and different public places.

The tool, keep the loiterers at bay by means of giving out a really demanding frequency sound that can be heard by means of people winthin the age organization of thirteen to twenty-five years. Those excessive frequency sound waves are sent out from small gadgets which are rarely the scale of vehicle stereo speaker and that the may be without difficulty fitted in school playgrounds, parks, shopping malls or pub exteriors to hold the loiterers in check.

1.3 AIMS & OBJECTIVES

Objective 1: To determine the frequency bands which are audible to different age groups.

Objective 2: To develop a user-friendly app in the Android based cell phone which transform the mobile phone into a hearing aid.

Objective 3: To design an insect repellent and hearing aid module/device

Objective 4: To test the hardware modules, get feedback and perform optimization.

1.4 MAJOR CONTRIBUTIONS

The major part of the thesis consists of a literature review of important background knowledge for developing the device and an android based application capable to produce signals audible to only certain age groups or animals. The detailed model is presented in chapter 3 and 4. Thislow-cost device is useful to keep the loiterers or mosquitoes at bay, and the android-baseduser-friendly application is described and developed by the authors. The thesis provides the complete schematics for the hardware device and algorithms useful to describe the working of software application. The application developed can also be readily used as hear screening device.

1.5 THESIS OUTLINES

The general purpose of this thesis is to study the audio signals which are audible only selected group of people belonging to particular age. In chapter 2, authors gathered some important background knowledge for developing the device and an android based application capable to produce signals audible to only certain age groups or animals. In chapter 3 4 the detailed model is presented which shows how the whole system works. Chapter 5 consists the summary of the results.

CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION TO HEARING AIDS

An electronic hearing aid is a small device placed in or across the ear to enhance the hearing of listening to impaired. The fundamental elements of hearing aid are microphone, signal conditioning, receiver/speaker and a battery. The microphone converts the sound into electric signal.The signal then undergoes conditioning that may be as simple as amplifying all of the sound similarly, to more superior equalization related to a virtual signal processor. The receiver converts electrical signal back to sound, and battery powers the electronics

2.1.1 STYLES

Main Styles of hearing aids now adyas in the market are four and these hey are (1)Behind the ear (BTE),(2)In the ear(ITE),(3)In the canal(ITC), and (4)completely in the canal(CIC).The BTE style sits at the back of the ear with a clean tube progressing to an earmold in the ear to provide the sound. A variety in this style is known as open-in-shape-behind-the-ear (OTE) wherein the earmold is supplanted via a little tip, coming about in a extra open feeling. Different varieties include supplanting the tube with wires and transferring the collector from the BTE to interior the ear. The ITE fashion actions the hearing aid into the external ear, where it receives to be a single unit with the earmold. This fashion fills up most of the external ear and shows up as a strong mass. The ITC fashion actions a some of the listening to help into the ear canal and diminishes the

Figure 2.1: Styles of Hearing Aids

space taken up in the outer ear, however continues to be potentiallly unmistakable. The ComIn the Canal fashion is the littlest of all of them, as it suits totally interior the ear canal, in this way about vanishing from view.

2.1.2 TECHNOLOGY TYPES

Analog and digital are the two basic types of technology. The primary to exist analog hearing aids method electric sound in the analog domain; The extra latest virtual hearing aids technique electric sound into the digital domain. The earliest analog hearing aids simply amplified both speech and noise, and had been ordered after checking out to decide the particular frequency reaction wished by way of affected person. More recent analog hearing aids can be programmed all through the the precise system , and some have couple of listening profiles that the patient can select with a button at the hearing aid. Digital hearing aids are also programmable during the fitting manner, and some have multiple listening profiles that the patient can choose. The digitization of sound lets in more improved flag managing along with clamor diminishment, sifting, and acoustic

enter (ringing) control. The great lion's proportion of listening to allow bought these days are advances because in their mutiplied execution and adaptableness over the analog variations.

2.1.3 COMMON CONDITIONS

The fundamental elements of a hearing aid plan are within the audio-processing way. The only or greater mouthpieces and the recipient are selected together with the pre amplifiers(within the event that requires)and the speakers. Course D intensifiers are utilized in present day hearing helps because of their low-strength operation, moo mutilation, as well as little estimate in comparison to Lesson A along with B enhancer.Even if the sound transmission capacity is twenty kilo hertz restricted to eight kilo hertz,sound codec ought to have a more highest Signal to Noise Ratio for the protection as well as replicate sounds correctly.The heart of the framework is the computerized flag processor (DSP), that is in which all of the advantages of an advanced listening to help are actualized.Digital Signal Processing usage is producer subordinate. In commonplace, it performs condensation/extension by means of band,positive criticism decrease, clamor decrease, and discourse upgrade. It too forms directional data and may give rise to its possess indicators to assist make strides fitting a listening to help to a affected person.

2.2 AUDIBLE AND INAUDIBLE SCIENCE

Sound could be a shape of vitality which is produced by a vibrating body. It requires a medium for its engendering. The transmission medium may be vaporous, strong or fluid. The waves in which the course of proliferation of the wave is the same as the course of vibration of the particles of the medium are known as longitudinal waves. The waves in which the course of engendering of the wave is opposite to the course of vibration of the particles of the medium are known as transverse waves. In arrange for a sound to be produced, a source is required. Fundamentally,based on the Data Almost the Recurrence, Sound Can be Classified into Two Categories.

Audible Sound: All the frequencies dwelling between the restrain of 20Hz and 20KHz can be seen by human creatures. In this manner, these sound waves having frequencies inside the run of 20Hz and 20KHz are known as capable of being heard sounds. But the recurrence that we are able to listen is regularly subordinate on a few other components like our environment. The frequencies within the higher recurrence run get troublesome to see. This regularly happens with ancient age.

Inaudible Sound: The frequencies dwelling underneath 20Hz and those dwelling over 20KHz cannot be seen by the human ears. Consequently, all the frequencies underneath 20Hz which over 20KHz are known as unintelligible sound. Infrasonic sound is the term utilized for the frequencies underneath 20Hz which over 20KHz within the higher extend of frequencies are known as ultrasonic sound. Animals like dogs can perceive frequencies lying above 20KHz.

2.2.1 PERVASIVENESS OF HEARING DAMAGE

Listening misfortune influences 1.57 billion individuals around the world, and projections recommend that 2.45 billion individuals may have listening to misfortune by 2050.1 Hearing misfortune is the 3rd driving cause of a long time lived with inability and the primary driving reason of a long time lived with incapacity among individuals more seasoned than 70 a long time. The World Well being Organization as of late evaluated that unaddressed hearing misfortune speaks to a yearly around the world fetched of 980 billion dollars, counting well being care, instruction, efficiency misfortune, and societal costs.2,3 In expansion to compelling the capacity to communicate, hearing misfortune is related with deferred dialect among children, social confinement, changed quality of life, misery, cognitive decrease, and dementia. Prevalence of hearing loss are rare, determined fundamentally from little and non representative considers, most regularly based on self-reports of hearing misfortune rather than objective audiometric testing, and regularly based on age-restricted cohorts.1,9-14 Existing studies collected information for the most part within the 1990s,15 and the predominance of hearing misfortune has advanced in parallel with the aging of the population.16-18 These restrictions were highlighted within

the 2019 Worldwide Burden of Malady Study1 and in a few other studies.19-21 In spite of the fact that a few broadly agent thinks about have detailed audiometric information on subsamples, such as the National Wellbeing and Nutrition Examination Survey,22,23 agent ponders of huge test sizes are missing within the field, outstandingly in Europe. For occasion, in France, the most recent estimation of hearing misfortune predominance was performed in 2008 and depended on self-reported answers, with gauges of hearing misfortune extending from 8.5 percent to 16.1 percent depending on the question.24 Additionally, looking at quiet characteristics related with hearing misfortune may offer assistance recognize the populaces at most noteworthy hazard of hearing misfortune and advise preventive procedures for hearing loss. Although the affiliation of hearing helps with advancements in a few health-related results are progressively recognized,14,25,26 an underuse of hearing helps has been suggested.Be that as it may, gauges of hearing help utilize are not across the nation and were calculated generally in more seasoned populaces. This consider utilized a expansive, across the nation agent test of the French grown-up populace with full information on audiometric testing to gauge the predominance of hearing misfortune and hearing help utilize within the French populace and to evaluate the characteristics related with hearing misfortune and hearing help utilize.

2.2.2 ACOUSTIC PRODUCTION

Listening to sensitivity lessen with enlarging age among both males and females.A longitudinal look at of hearing thresholds amongst people concealed for noise publicity, otology illness, as well as hereditary listening to loss showed that hearing threshold decline steadily exceeding age 25 years in males, as well as exceeding age 50 years in females(pearson et al).Rejection in listening to thresholds of the males was larger than double as speedy as that of the females,at a sure while. Females indicated the best rejection in listening to sensitivity in the low frequencies, while males indicated the best rejection in listening to the higher frequencies. For unconcealed society, the average thresholds of patriarch, 65 years of age, indicate normal listening to sensitivity within the low frequencies, declining to a mild listening to loss(forty two dB HL) at 3000 cycles per second(Hz)and

above (Robinson). For females the average listening to thresholds at age 65 years indicate a slight hearing loss 916-25 dB HL) from 500 through 4000 Hz, and a mild hearing loss(30dB) at 6000 Hz.

2.2.3 EFFECT OF AGE-RELATED HEARING DAMAGE

Age-related hearing loss presents as a constellation of dysfunctions that influence both the sound-related fringe, the sound-related cortex, and worldwide cortical organization. There is prove for compensatory neural asset assignment, suggestive of cognitive stipend, which may have a critical affect on cognitive working. Restrictions within the strategies utilized for evaluating both age-related hearing misfortune and cognitive decrease may lead to either over- or under-estimation of the affiliation between age-related hearing misfortune and cognitive decrease. Age-related hearing misfortune (ARHL) could be a common issue for more seasoned adults, driving to communication troubles, isolation, and cognitive decrease. As of late, hearing loss has been recognized as possibly the foremost modifiable chance figure for dementia. Tuning in in challenging circumstances, or when the sound-related framework is harmed, strains cortical assets, and this may alter how the brain reacts to cognitively requesting circumstances more by and large. We audit the impacts of ARHL on brain zones included in discourse discernment, from the sound-related cortex, through attentional systems, to the engine framework. We investigate current viewpoints on the conceivable causal relationship between hearing misfortune, neural rearrangement, and cognitive impedance. Through this blend we point to rouse imaginative inquire about and novel intercessions for easing hearing misfortune and cognitive decay.

2.3 SIGNAL PROCESSING FOR HEARING AID

Commonly,listening to aids method sounds in 10-20 frequency channels. The width of channel is increased by increasing the center frequency. Three vast classes of signal processing are given as: 1.Handling to apply frequency along with degree-dependent

amplification to reestablish inaudible also provide ideal loudness,based totally at the hearing description of a character (ordinarily the audiogram but some of the time taking under consideration the comes about to scale the loudness) along with the alternatives of men or women. Frequency bringing down may be taken into consideration as an further approach for reestablishing the audibility of high-frequency sounds. 2. sound cleansing, for case, halfway elimination of motionless noises or drive sounds along with lessening of audible feedback. Noise lessening can be accomplished utilizing both one-microphone as well as multiple microphone calculations,however as it were last mentioned came to be appeared to improve intelligibility. 3.Surroundings class for consequently supervise the settings of a hearing resource completely exceptional tuning in circumstances. It is far decided that present day hearing aids may be compelling in restoring audibility and giving satisfactory loudness and tuning in comfort, however those are still of restricted viability in enhancing the intelligibility of speech in loud circumstances.

2.3.1 EXPLANATION

The essential objective of a hearing aid is to progress the consideration of discourse by a person which has hearing disability, in spite of the fact that the recognition of songs as well as natural sounds is additionally a discussion.An essential processing of signals framework comprises of straight refining following that enhancement, with extra advanced procedures utilized to undertake to make amends for the character of the listening to impedance and to progress discourse comprehensible in noise. The paper begins by a survey of sound-related physiology and the nature of hearing loss. Linear amplification frameworks are at that point talked about in conjunction with hearing-aid plan and the confinements of customary innovation. Criticism dropping, which can make strides hearing-aid framework soundness, is displayed following. Dynamic-range compression is a critical signal-processing approach since the disabled ear includes a diminished energetic extend in comparison with the typical ear, and single-channel and multi-channel compression calculations are portrayed.

2.4 ANDROID APP DEVELOPMENT

The purpose of this section was to investigate the design and implementation process of an Android application which generates different audio signals audible to different age groups and animals. The theoretical part of the thesis discussed the Android platform, its background history and the methods used in this thesis process.

2.4.1 HEAR SCREENING APP

A digital hearing gadget for hearing abilities is called as Hear Screening App.People can use the app and perform screening test at their homes within few minutes through their smart phones. A remote hearing can be performed and the users will be given separate results of their hearing to sensitize the users for their possible hearing problems. Calibrated audiometers are used by the Hear Screenings to identify whether a person has a hearing loss, and his/her possibility the extent of hearing loss by air conduction pure tone threshold testing.

2.4.2 INSECT REPELLENT APP

The threatening, high-pitched cry of a mosquito can instill a spooky sense of foreboding. A few mosses are just a troublesome inconvenience, but in tropical regions they could be carrying evil cargo onboard, such as malaria, dengue and presently the Zika infection. There are applications that are planned to ward off mosquitoes. All the Mosquito repellent applications work on the hypothesis that ultrasonic sounds deliver high frequency that can make mosquitoes hard of hearing or not at all like them. These sounds are undetectable by human but those are tall measurements for the mosquito, insects.

2.4.3 ANIMAL REPELLENT APP

Animal repellent app is designed to repel the animals. Animal repellent may be a free app for Android distributed within the other list of apps, portion of Home Hobby. The company that creates Animal repellent is Blend Mezcla. The most recent form released

by its designer is 2. This app was appraised by 2 clients of our location and has a normal rating of 4.0.

2.4.4 DISPERSE HUMANS

Mosquito named device was invented in Wales long time ago.Since then, forwarding Sound Technologies has been marketing and selling the Mosquito throughout North America. Many cities, municipalities, school, districts and parks boards use the mosquito to combat vandalism. The high frequency can be heard by young people 13 to 25 years old. When it set to seventeen kilo hertz the mosquito can only be heard by teenagers approximately 13 to 25 years age. When set to eight kilo hertz the mosquito can be heard by all ages. After a while the sound will become so annoying that they will have to leave the area. Turning on the high frequencies sounds will make the area around you unattractive to teens without causing discomfort to adults.The sound of the device can almost exclusively be heard by young people till 25 years [3,8].

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this chapter a detailed explanation of methodology/procedure that was followed to complete our project. Numerous procedures or findings from this "Smart Hearing Aid and Audio Testing Device"can be used by different people to take benefits and upgrade as upcoming studies. A procedure is used to get the aim and goal of our project The method is use to achieve the objective of the project that will achieve a perfect result. The methodology comprised of System Development Life Cycle(SDLC) commonly its has three main steps. 1.Planning, 2.Implementing and 3.Analysis.

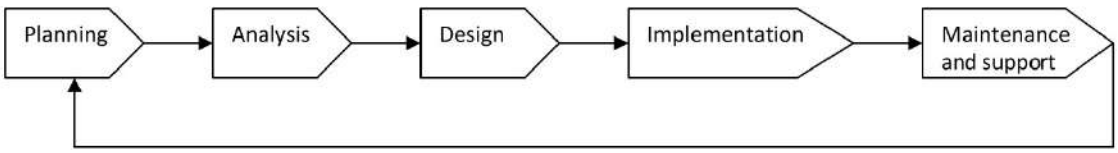

Figure 3.1: System Development Life cycle Phase

3.2 PLANNING

In order to get all the information and know about requirements one should must do a planning in a proper manner. In this stage, we planned what components are required

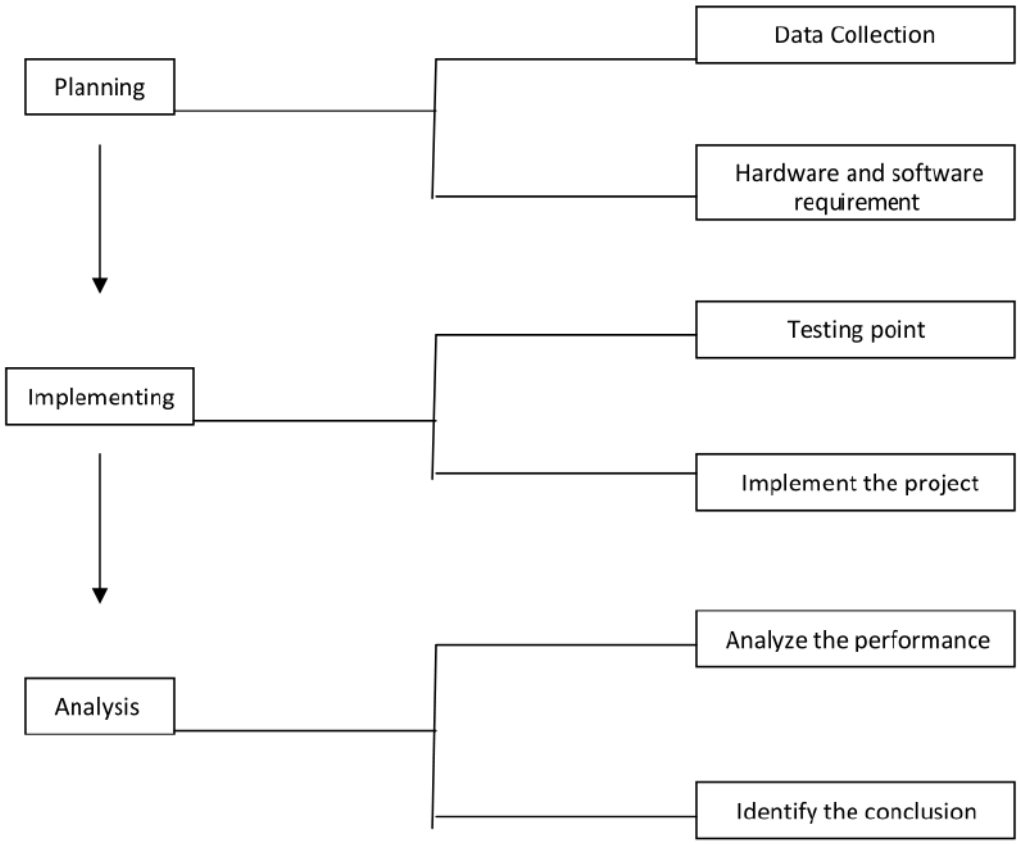

Figure 3.2: Methodolgy steps

for the functions we need from our hardware device and what programming language and IDE we should use for our software app.Two main elements of planning are Data Collection and the hardware/software requirements.

3.2.1 DATA COLLECTION

Project's Resources and requirements were planned in this step.We collected all the information from research papers, internet, and text books. While collecting data we found the design and development of Hearing Aids. Through Project manual we tried to find out the components like electric components, and some other equipment that are to be used.

In planning,we have done all the project related research, in which knowledge about the electric components like as resistors, capacitors, and transistors.The study is not just for the working of the components but the types of small circuit build by each component related.

Figure 3.3 below shows the schematic diagram for sound filtering for hearing aid circuit

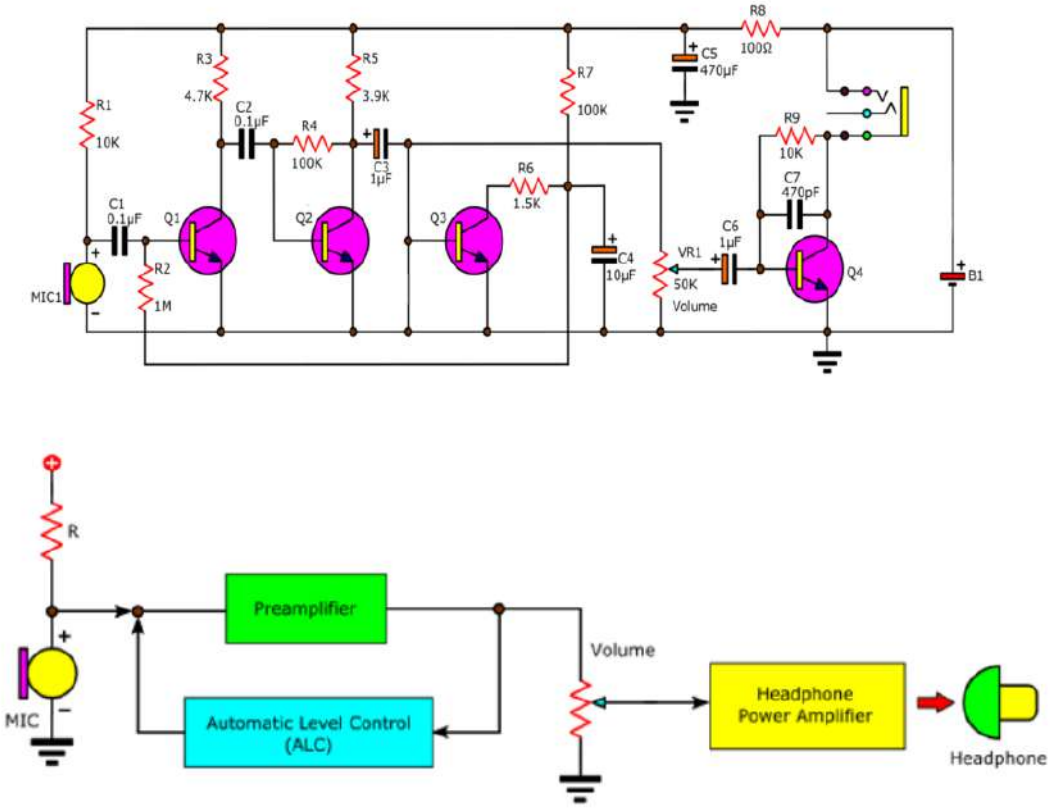

Figure 3.3: Sound Filtering for Hearing Aid schematic Diagram Block Diagram

3.2.2 HARDWARE AND SOFTWARE REQUIREMENTS

3.2.2.1 HARDWARE REQUIREMENTS

The list of components used in this project is given below.

S	Components		Values	Price
1	Transistors	Q1	2N3904	10Rs
2		Q2	2N3904	10Rs
		Q3	2N3904	10Rs
		Q4	2N3904	10Rs
3	Resistors	i.R1,R9	10K Ohms	6Rs
		ii.R2	1M Ohm	3Rs
		iii.R3	4.7K Ohm	5Rs
		iv.R4,R7	100K Ohm	6Rs
		v.R5	3.9K Ohm	3Rs
		vi.R6	1.5K Ohm	3Rs
		vii.R8	100 Ohm	3Rs
4	Capaitors	i.C1,C2	0.1m Farad Ceramic Disc	10Rs
		ii.C3,C6	1m Farad	10Rs
		iii.C4	10m Farad	5Rs
		iv.C5	470m Farad	5Rs
		v.C7	470p Farad	5Rs
5	Semiconductors			
6	Microprocessor	Arduino UNO Boards		
7	OLED Display	SD1306		
8	Headphone Audio Jacks	PJ320D		
9	Microphone			
10	Vero-board for circuit			
11	Buzzer			
12	Soft wires for connections			

Table 3.1: Components and their values

Figure 3.4: Additional parts

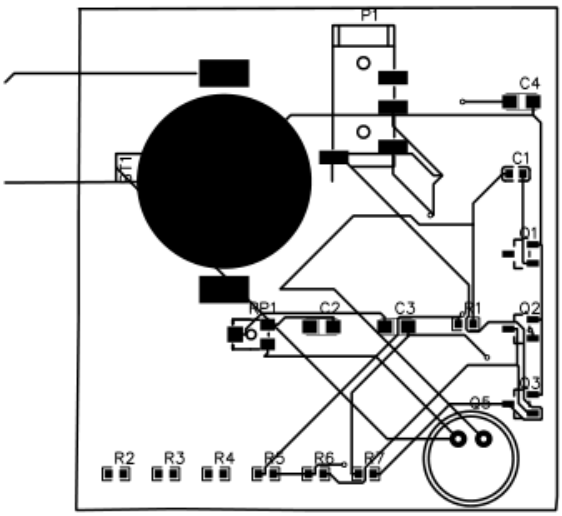

Figure 3.5: Schematic Diagram of Hearing Aid Circuit

Figure below shows the actual design that had been done.

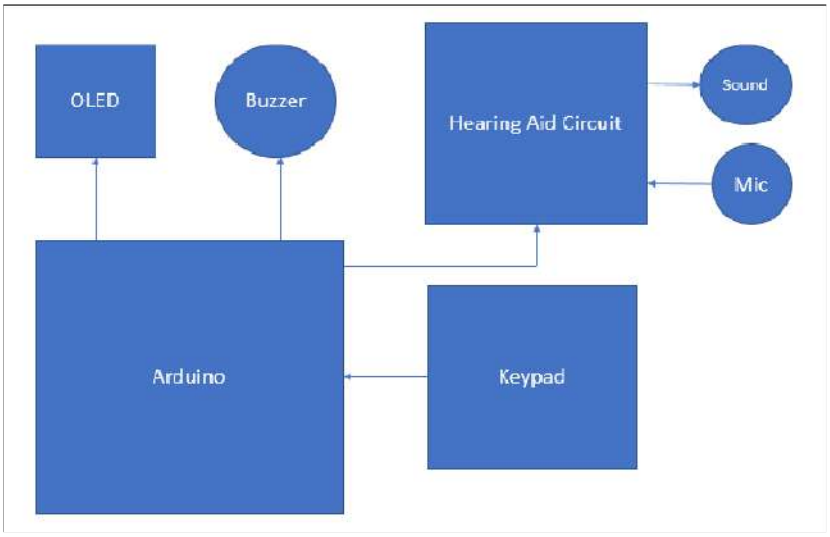

Figure 3.6: Block Diagram of Hardware Device

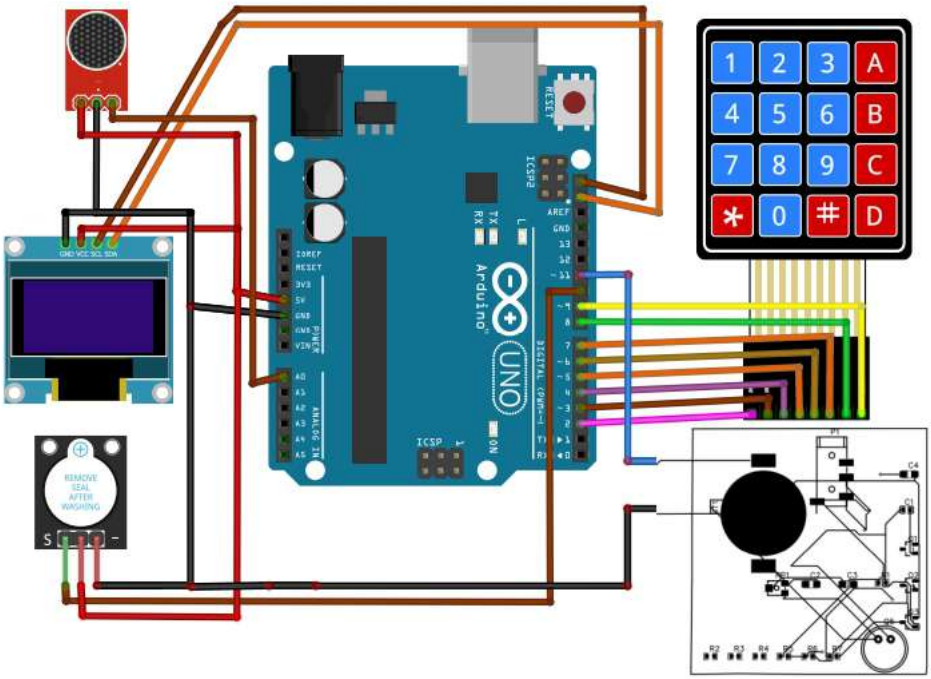

Figure 3.7: Schematic Diagram of Hardware Device of our project

3.2.2.2 SOFTWARE REQUIREMENTS

We have chosen Android Studio Software for app development, MATLAB for simulations of the project and Arduino IDE for coding instruction for hardware device. Android Studio and Arduino software are Integrated Development Environment (IDE) software tools used primarily for specific programming needs. The Android Studio software is used mainly to create android APK file with help of Java and XML programming language and the Arduino IDE is used for programming instructions into the Arduino Microprocessor Development Boards. MATLAB is also an important software; it is abbreviated as MATrix LABoratory. It uses whole matrices and arrays, and it also provides simulation methods in its Simulink feature. After gathering all the related information to our final year project we designed a circuit consists of frequency generation and modulation.The transistor should exhibit high gain, low noise figure, and high performance at the lowest possible current consumption, while preserving relatively easy matching at frequency of operation. After the circuit had been created, it was integrated with the OLED and Buzzer through the Arduino.

CHAPTER 4

PERFORMANCE ANALYSIS AND RESULTS

4.1 SIMULATION IN MATLAB

We designed circuit after that the process of filtering and simulation is done.We used MATLAB software, and obtained results of some simulations. Several simulation characteristics that can be observed and also the characteristics of the project

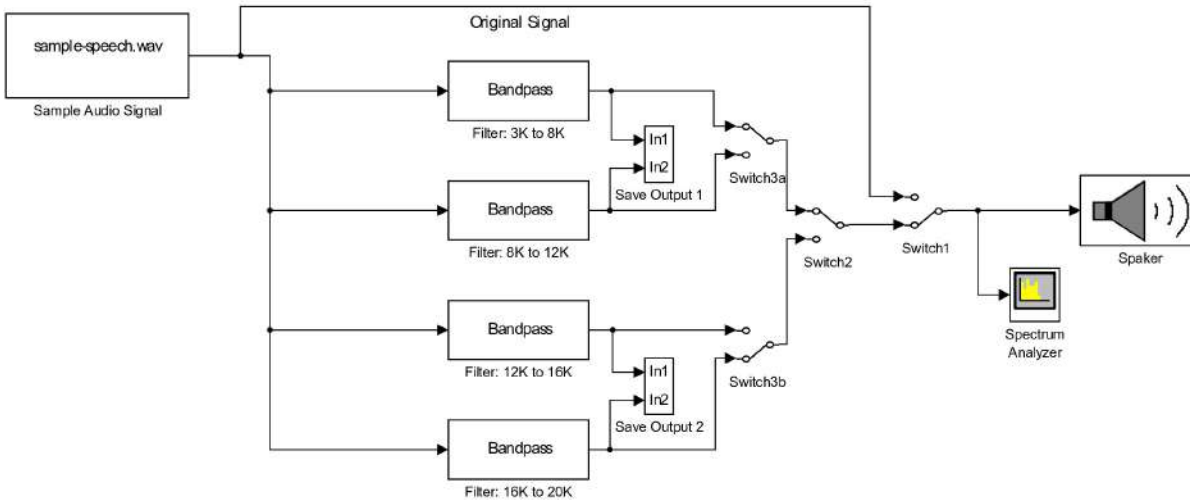

Figure 4.1: Sound filtering Simulation Model 1

Parameters	value	Description
Impulse response	FIR	method or structure of the filter(either FIR or IIR)
Order Mode	Minimum	Choosing minimum will implement a filter with minimum order.
Filter Type	Single-rate	Determines the form of filter and the layout methods as well as systems that can be available to enforce filter.

Table 4.1: Filter Specifications(for all filters)

Parameter	Value	Description
Stopband Frequency 1	2.5KHz	Frequency at edge of end of first stopband
Passband frequency 1	3KHz	Frequency at edge of start of bandpass.
Stopband Frequency 2	8.5KHz	Frequency at edge of start of second stopband
Passband frequency 2	8KHz	Frequency at edge of end of bandpass.
Input Sample Rate(Fs)	18kHz	The sampling frequency at the filter input

Table 4.2: Frequency Specification for bandpass 1(3KHz to 8KHz)

Parameter	Value	Description
Stopband Frequency 1	7.5KHz	Frequency at edge of end of First stopband
Passband frequency 1	8KHz	Frequency at edge of start of bandpass.
Stopband Frequency 2	12.5KHz	Frequency at edge of start of second stopband
Passband frequency 2	12KHz	Frequency at edge of end of bandpass
Input Sample Rate(Fs)	25kHz	The sampling frequency at the filter input

Table 4.3: Frequency Specification for bandpass 2(8KHz to 12KHz)

Parameter	Value	Description
Stopband Frequency 1	11.5KHz	Frequency at edge of end of first stopband
Passband frequency 1	12KHz	Frequency at edge of start of bandpass.
Stopband Frequency 2	16.5KHz	Frequency at edge of start of second stopband
Passband frequency 2	16KHz	Frequency at edge of end of bandpass.
Input Sample Rate(Fs)	33kHz	The sampling frequency at the filter input

Table 4.4: Frequency Specification for bandpass 3(12KHz to 16KHz)

Parameter	Value	Description
Stopband Frequency 1	15.5.5KHz	Frequency at edge of end of first stopband
Passband frequency 1	16KHz	Frequency at edge of start of bandpass.
Stopband Frequency 2	20.5KHz	Frequency at edge of start of second stopband
Passband frequency 2	20KHz	Frequency at edge of end of bandpass.
Input Sample Rate(Fs)	41kHz	The sampling frequency at the filter input

Table 4.5: Frequency Specification for bandpass 4(16KHz to 20KHz)

Parameter	Value	Description
Magnitude Units	dB	Units for magnitude specification
Stopband attenuation 1	60	Filter attenuation in stpband 1
Stopband attenuation 2	60	Filter attenuation in stpband 2
Passband ripple	1	Allowable filter ripple in passband

Table 4.6: Magnitude Specifications (for all filters)

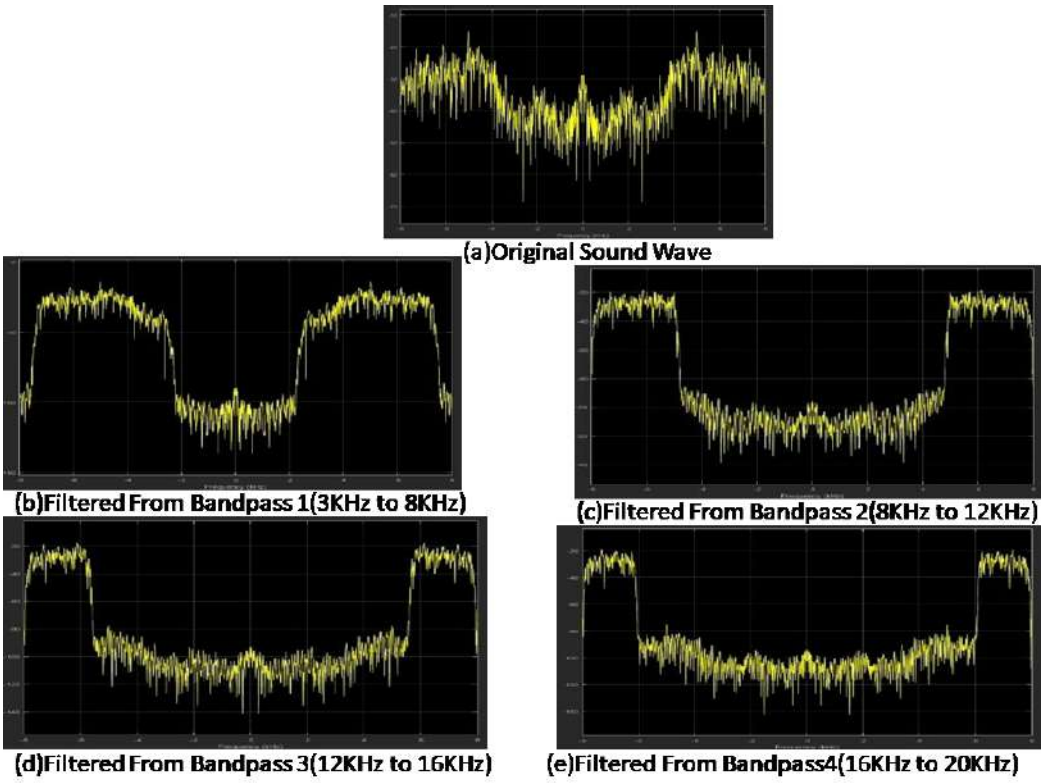

Figure 4.2: Simulink model of designed Filter bank

4.2 DESIGNING THE SOFTWARE APP

We have developed the software app in which there are different features.

4.2.1 LAYOUT DESIGN OF SOFTWARE APP

After all the process of designing hardware and its simulation, the layout for software app was also designed.The designing process of the layout was done in XML programming language as shown below

4.2.2 OPTIONS AND FEATURES OF THE MOBILE APP

Hearing Aid

There are four main features of this app, first is hearing aid which allows hearing impaired people to use their mobile phone as a hearing aid for better hearing with reduced noise in sound, it uses the inbuilt filters, capacitors and other components of the mobile.

Hear Screening

It is a kind of hearing diagnosis tool in which similar to how an ENT doctor checks a person's hearing, anyone can use it the same way to generate sounds of different frequencies to check how much their hearing ability is damaged.

Human Dispersion

There are different frequency sounds according to the age factor of humans, one can generate these sounds to interact with different age groups of people, one such application of this can be disperse the loiterers that are usually of age 24 and younger thereby, generating an annoying sound that is only hearable to them.

Animal Dispersion

Fourth option is of "Animal Dispersion" in this feature, there are different sounds with frequencies hearable to specific animals or insects such that one can use it as an insect, cockroach and mosquito repellent or get rid of lizards and rats.

Figure 4.3: Screen of the Mobile Application

(a)First Screen (b)Option Selection Screen

•Table shows the frequency ranges for human and animal dispersion that we have selected.

Human dispersion	
Aged 24 and Younger	17KHz
Aged 39 and Younger	15KHz
Aged 49 and Younger	14KHz
Aged 59 and Younger	12KHz
For Everyone	8KHz
Animal dispersion	
Lizards	52KHz
Pet Animals	22KHz
Insects(Mosquitoes,Flies,Cockroaches etc	38KHz
Rats	60KHz

Table 4.7: Frequency Ranges

Figure 4.4: Available options in the Mobile Applications are given below

(a) Screening Test

(b) Dispersion Frequencies for Different Age Groups

(c) Dispersion Frequencis For Different Animals

How these frequencies help get rid of insects can be understood by the example of mosquitoes. According to studies, only the female mosquitoes bite and suck blood because they need it to lay eggs. On the other hand, the males do not bite and females avoid them by sensing their frequency. These male mosquitoes generate a specific frequency which announces their presence to the females. Our insect dispersion option generates that same frequency so when female mosquitoes sense this frequency in an area, they avoid it.

- The layout design for this software app is performed and it is shown below.

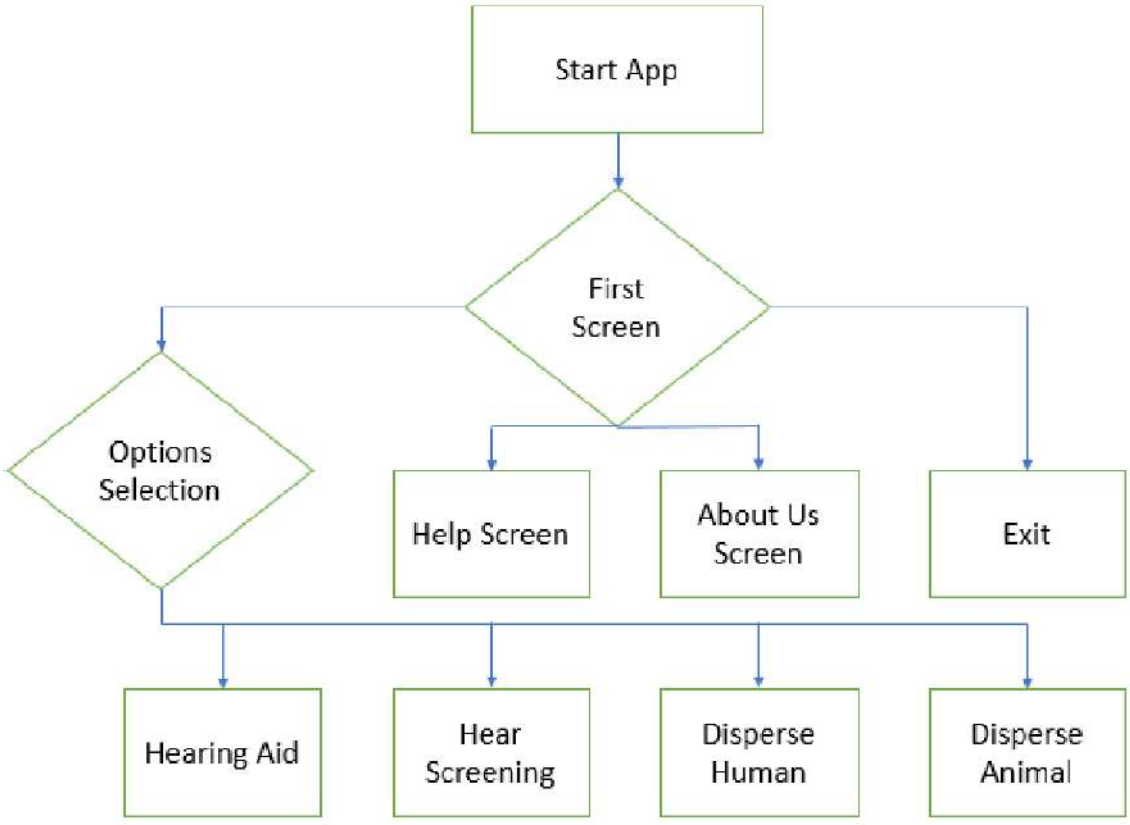

Figure 4.5: Layout Design Of Software Application

Mobile Application is uploaded on Playstore

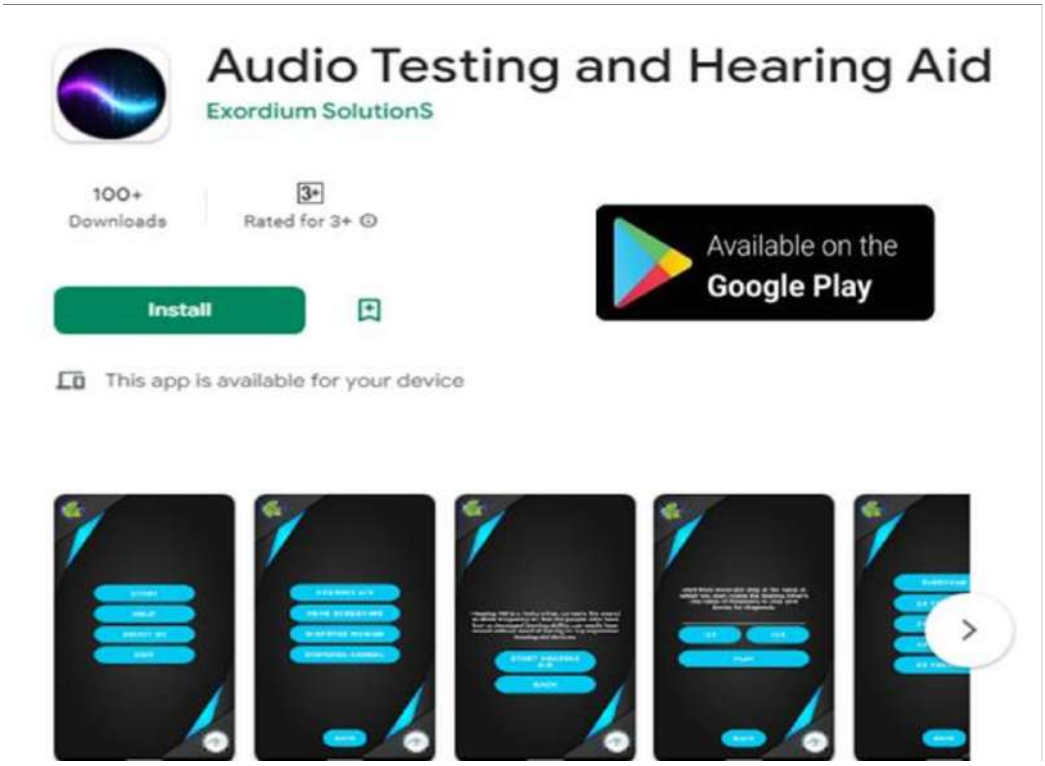

Figure 4.6: Application Available on Playstore

4.3 IMPLEMENTATION

4.3.1 CREATING THE HARDWARE DEVICE

When MATLAB software provided us with results of simulations, the process of connecting the components in a physical circuit is followed. The components were first placed on a breadboard to form a temporary circuit in order to check if its working or not. Afterwards the components were permanently connected on a Veroboard to form the circuit with help of Soldering Iron.

4.3.2 COMPONENTS

Based on circuit diagram the components for our project have been purchased from local electronic shop as well as some components were orderes online.

4.3.3 CONSTRUCTION

i. First the Hearing Aid circuit is created using the diagram with the components as mentioned previously.

ii. Resistors, capacitors and transistors are soldered; the components are small and takes very few spaces on the Vero board.

iii. The next step is to connect the headphone jack for audio output. In this part of we attached 2 wires with the jack for easy mounting.

iv. Then the circuit is interfaced with the Arduino board through the selected port for operation.

v. The input voltage for the circuit is provided from the Arduino as the instruction for starting hearing aid are processed.

vi. OLED, Keypad and Buzzer are also connected with Arduino for frequency generation related features.

vii. The whole circuit is placed in a small rectangular box for protecting it and easy operation.

Figure 4.7: Hardware device in working

(a)

(b)

4.4 CHECKING

We did checking of the continuity tune of the circuit after organizing the components at veroboard.This step was done for the ensurity that the operation of circuit will run smoothly. The gear associated with checking components is multimeter and the factor of soldering.It will alert the failed continuity by means of buzzer multimeter.The failed continuity will recover with the solder again the lake of components related.

4.5 TESTING AND TUNNING

The process of testing is beginning with the testing of mobile app's frequency generation feature for dispersion of insects such as cockroaches and animal dispersion for Cats and Dogs etc.We also tested the hardware device's hearing aid feature on people with hearing impairment.

We obtained feedback from people who tested the hearing aid and desirable results were obtained. We also adjusted the device according to the feedback received to integrate the features with better performance.

4.6 ANALYSIS

This is the final stage of methodology.The evaluation is primarily based on the overall performance of circuit associated in which the output need to be performed nicely as well as successful and second one is to identify the conclusion.

4.6.1 ANALYZED THE CIRCUIT

The circuit of Smart Hearing Aid and Audio Testing device is a combination of a small electronic circuit with the microprocessor development board i.e., Arduino, where in the working of small electronic circuit will perform the good result of filtering the sound, reducing the noise and amplifying the sound frequency at suitable levels. The microprocessor acts as storage of instructions and executor of those instructions, it shows options on the small oled, these options are selected with help of the keypad and the buzzer

attached is responsible for frequency generation for features of Human and Animal Dispersion

4.6.2 CIRCUIT DESCRIPTION

While the connection has been done at different stages, the power used by it, is very low at only 3.3 to 5volts. It is a small and compact circuit built for easy handheld device.

Transistors Q1 to Q4, resistors R1 to R9 and capacitors C1 and C7, form a Hearing Aid. This is the part of the project that takes in sound from microphone and does operations on it to reduce noise, filter and amplify sound. The output sound that is generated is very low as it has to be transmitted through the headphones connected at the headphone jack.

The buzzer connected with microprocessor is responsible for generation of various sound frequencies. It is a piezoelectric buzzer, the piezoelectric material in it, vibrates at the frequency provided through the instructions.

Printed Circuit Board(PCB) is designed on Easyeda.com website and the "gerber" file is generated then that gerber file was uploaded on Jlcpcb website. They printed pcb for 2 dollars and shipping from china took 1.5 month.

websites : Easyeda.com and jlcpcb.com

4.6.3 IDENTIFY THE CONCLUSION

Identifying the conclusion of circuit is the very last step.

4.7 CONCLUSION OF METHODOLOGY

Commonly the methodologies have three different parts.It includes planning, implementing and analysis. Planning step have reading activity and some sort of hardware and software requirements that are to be used.

Reading phase includes the research through many sources like journals, paper references, internet , text books and various other sources to get the knowledge related to the

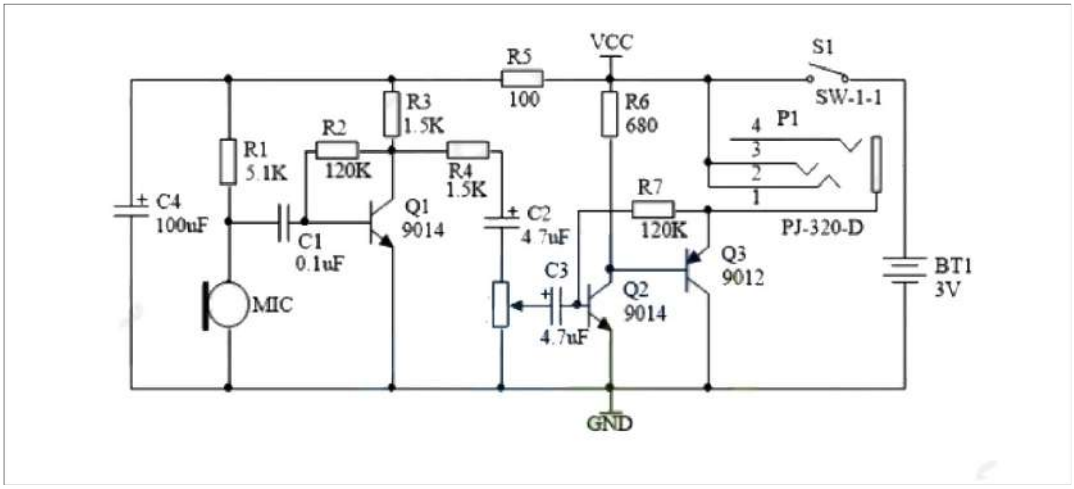

Figure 4.8: PCB Schematic Circuit Diagram For Sound Filtering

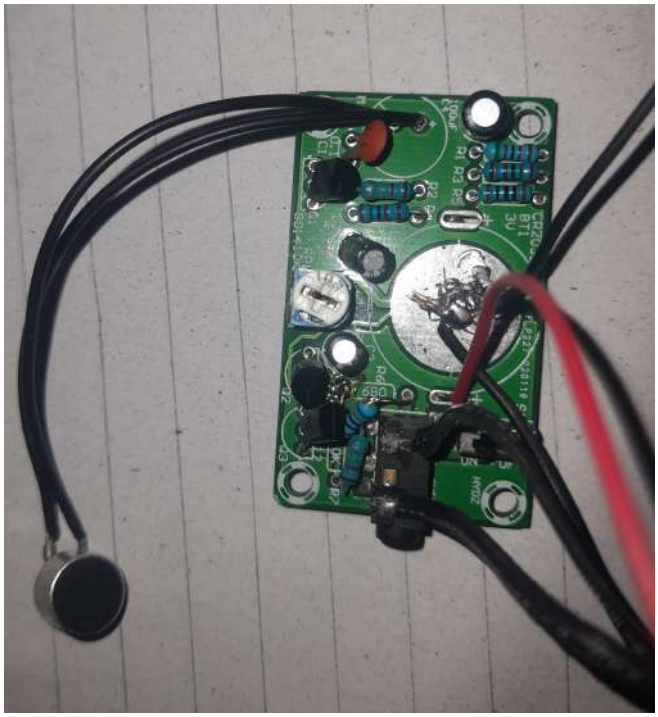

Figure 4.9: PCB Circuit Diagram For Sound Filtering

project.Where as Requirement phase includes the hardware and software requirements that are found through the research. Second step is implementing phase in which the first and temporary circuit is created physically on breadboard for checking and after that on veroboard for the permanent connections, The procedure of circuit construction is followed.The procedure of checking, testing and tuning are followed due to complete a part of implementing.

Finally, Analysis phase includes that the project was come out with the operations of Hearing Aid and Frequency Generation. It was looking at the combination of electronic circuit with the microprocessor for instructions.

CHAPTER 5

CONCLUSION

5.1 CONCLUSION

This final year project aimed to develop a digital hearing aid in the form of mobile application, which we successfully created but in addition, we also implemented the same on a hardware device. This project can help the hearing-impaired people to get a better hearing as there are over 2 billion hearing impaired people around the world and 10 million hearing impaired people in Pakistan. The main achievement of objectives for this project were as follows:

1. Develop the mobile application that was created by previous batch to integrate the feature of Hearing Aid.

2. Removing redundancy and outdated code from the app for making it up to date.

3. Implementing the Google's latest design guidelines for better user interface and easy to use app.

4. Presenting the results and evidence of the performance of Hearing Aid.

The method used for completion and evaluation of the project is Systems Development Life Cycle (SDLC) which is a project management model that defines the stages involved in bringing a project from inception to completion. Using the stages of SDLC of planning, implementing and analysis, we started our working on the project.

In the planning phase, we collected data about hearing aids' working mechanism, components and processes involved. Then the implementation phase included simulation, testing and physically developing the circuit. Lastly, in the final phase of analysis, the

project was tested by people and their feedback was collected.

The components used in this project are very low cost and easily available at any local shop which makes it a cheap, user-friendly and easy to use device. Moreover, if someone can not get the device, our mobile application is freely available on the play store which also implements all these features in software form.

5.2 APPLICATIONS OF THE PROJECT

There are many features of this project which can be beneficial in a lot of applications. In rural areas, this device can used as an insect repellent, in urban areas it be used to keep loiterers at bay and the main application being a low-cost and easy to use hearing aid. The applications of this project are mentioned in detail below:

• The Hearing Aid feature is not only useful for reducing noise and amplifying sound to suitable levels for hearing impaired people however, it also helps those with good hearing to hear low sounds more clearly

• Self-Diagnosis Device is also one of the applications of this device, it can be used for Hearing Treatment by testing up to which frequency one can hear sounds and telling this frequency to the ENT doctor will save time and expedite the process of treatment.

• It can also be used as an Insect Repellent, it has a feature of generating frequency that is only heard by insects however this frequency is annoying for the insects such as mosquitoes, cockroaches and flies.

• Avoiding Loiterers and Annoying People by generating the frequency in the age group of 24 and below which is most common age group of loiterers, this frequency can only be heard by the said age group it causes irritation to them.

• Another feature of this device is that the device human feature can also be useful in case if someone want to check the age of a person, it may not give exact information but one can estimate the age group of a person.

5.3 LIMITATIONS OF THE PROJECT

• Hearing aids do NOT restore normal hearing. In contrast, eyeglasses can restore 20/20 vision.

• When you begin to use hearing aids, many sounds, including your own voice, might seem too loud if the device is not properly calibrated.

• The use of disperse human feature as age checker will only provide an estimation of a person's age group however it will not be useful if that person's hearing is damaged beyond the average damage in that age group.

• The device and android can work efficiently in certain environment conditions.

• The android app uses components of the mobile in which it is installed so if the mobile's components such as speaker or filters are not of good quality, the results would not be as good as expected.

5.4 FUTURE WORK RECOMMENDATIONS

It is imperative that with future developments the device and android app can be further improved in future by implementing more efficient noise reducing, filtration and frequency translation techniques.

Further study can be applied to the hearing range of humans, one such improvement of the device can also be to convert it into a device which plays sounds or music at specific frequency.

With more enhancement, the device can also be used specific probe tips to make it work as a lithotripsy device. The lithotripsy is a process used for clearing kidney stone by use of directional frequency generation in the range of 23000Hz to 27000Hz, the probe tip can be useful for converting the isotropic generation of frequency into directional frequency.

[2] [4] [8] [10] [13] [3] [1] [5] [6] [7] [9] [11] [12] [14] [15] [18] [17] [16]

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