Design of a Universal Audiometric Device for Hearing Loss People

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Abstract: The design of a universal audiometric device as testing instrument for hearing loss people by using Atmega16 microcontroller that has the capability to apply an audio sound to the patients' ear with a frequency range of (250Hz to 8KHz) with an intensity ranging from (-10 to 110 dB), and recording the patients' response through an input device. Mainly in Middle income countries the diagnosis and treatment against Hearing loss is still very poor due to the poor of patient to doctor ratio so main motive behind designed this project is to provide a way of detecting hearing loss in order to improve patient care so The instrument hardware will be implemented by using a push button switch, headphone circuit, power supplies, output units using 2 X 16 LCD display and microcontrollers programmer with its program.

Keywords – **Audiometer, ATmega16, Audio Player**

I. INTRODUCTION

Audiometry measure the affectability and the range of an individual's sense of hearing, this gadget uses a progression of unadulterated tones presented at chosen frequencies in the scope of hearing, important to understand the discourse so as to build up a profile of auditory acuity. Hearing disability tests can be accomplished for the beneath principle reasons: As a routine part of a baby's or young child's developmental checks. To check the hearing of someone who is experiencing hearing problem or has a hearing impairment. To get a qualitative and quantitative analysis of the patients hearing. Hearing impairment occurs if any part of our ear has a problem, such as blockage in ear canal or infection of outer ear (Otitis external) or middle ear (Otitis media). This sort of outer or middle ear hearing weakness is known as conductive hearing loss, in which the sounds can't achieve the inner ear hearing organ despite the fact that it is working typically. Hearing impairment of this sort might be transient and alterable.

II. DIAGNOSTIC

This section describes the measurement technique to measure hearing loss and it's important in normal human life.

2.1 Study of Audiometer

The process of measurement of hearing capabilities of one's ear for the sake of diagnosis a hearing loss is known as an audiometer, it is used to measure the ability of a patient to hear at specific frequencies. Fundamental to this measurement is pure tone measurement. The audiometer is used to generate pure tone signals at specific frequencies within the 250 Hz to 10 kHz range. For each frequency the level of loudness is incremented from soft to loud. The patient is asked at which point he/she starts to hear the sound, which will then represent the patient's hearing threshold at that frequency. The final result is plotted as an audiogram that will be interpreted by medical professionals to determine proper treatments.

The weakest sound heard at a selected frequency is the hearing level in decibels (dB HL) for that particular frequency. This is a relative value; the intensity reference is 0 dB HL, or audiometric 0, which corresponds to the average threshold response (for a normal intensity range of -10 to +25 dB HL) of age group of 18- to 25-years-old with no otology pathology. The sensitivity of the normal ear varies with frequency; therefore, 0 dB HL represents different levels of sound pressure at different frequencies.
(Minus dB HL readings indicate that hearing sensitivity is greater for that particular frequency than for the average value)

III. LITERATURE SURVEY

Based on the literature survey, In the paper entitled "The Acoustic test environment for hearing test", written by Robert Margolis published in the Journal of the American academy of Audiology in 2015, the author was mostly studying different environmental conditions, how they can affect the result of the audiology test [1].

In the paper entitled: "Validated Smartphone-Based Apps for Ear and Hearing Assessments", published by Tess Bright in "JMIR Rehabil Assist Technol conference" in 2016, the author focused on multiple apps that are present for ear hearing assessment and found out that even though few of them have got validation to test and detect hearing conditions, the evolution of smartphone applications are providing an alternative tests that present low-cost solutions [2].

In the Journal of International Advanced Otology of 2008, Ykhlef Fayçal, Benzaba Wahiba, Bendaouia Lotfi, Boutaleb Ratiba and Abdel Rahmane Benia have published paper entitled "Computer Audiometer for hearing testing test in this paper, a prototype of an audiometer for hearing testing purposes named CAUM; "Computer Audiometer" the software developed under windows in order to provide a virtual instrument of a standard audiometer on computer, the result was accurate but the designed device presented some noise from the sound card of the computer[3].

A comparative study of smartphone based app with free field hearing for possible use as a screening test written by Himanshu Swami, Sabarigirish K, Aditya Bhargava, and published in International Journal of Otorhinolaryngology and Head and Neck Surgery (2017), was talking about investigation of validity and reproducibility using application based hearing assessment and free

field hearing using clinical pure tone audiometry. Found out that using the smart phone apps can be validated and efficient, hearing it is most preferable and precise. It's cheap, easy to conduct and there is no need of added premises or qualified care taker as compared to free field [4].

PC based audiometer generating audiogram to assess acoustic threshold written by Mahalakshmi.A, Christila.S, Mohanavalli.M, Raja, Sankari.V.M, Shobha and published in International Journal of Pure and Applied Mathematics (12 /2018), the authors highlighted about the implementation of a software application in the LabVIEW programming which recreates the functions and features of a standard audiometer. It was successfully implemented and this diagnostic can be done almost wherever there is availability of a PC [5].

A Survey of Hearing loss and Hearing Aids written by Sureewan Jangjit and Mahasak Ketcham , published in Int'l Conference on Advanced Computational Technologies & Creative Media (07/ 2014) talked about study of the hearing loss, hearing aids with hearing impairments, and bring to use the data of the study to design new algorithm for hearing aids in the future, concluded that the main improve digital signal processing strategies of hearing aids include noise reduction and acoustic feedback reduction generate to provide amplification and good out sound quality [6].

The paper of Pure-tone audiometer written by A Kapul and V. V. Drobchik published in Conference Series in 2017 in this journal the authors explain how there was high issues of auditory analyzer in older people and children, it's why they thought how they could design a new audiometer to find out the improvement and cost -effective compared to the recent audiometers [7].

IV. HARDWARE DESCRIPTION

This section specifies the various components used to the implementation of the device. The bloc diagram of the proposed equipment which comprises of five fundamental parts:

1. Power supply
2. Atmega16.
3. Sound card.
4. Headphone
5. LCD

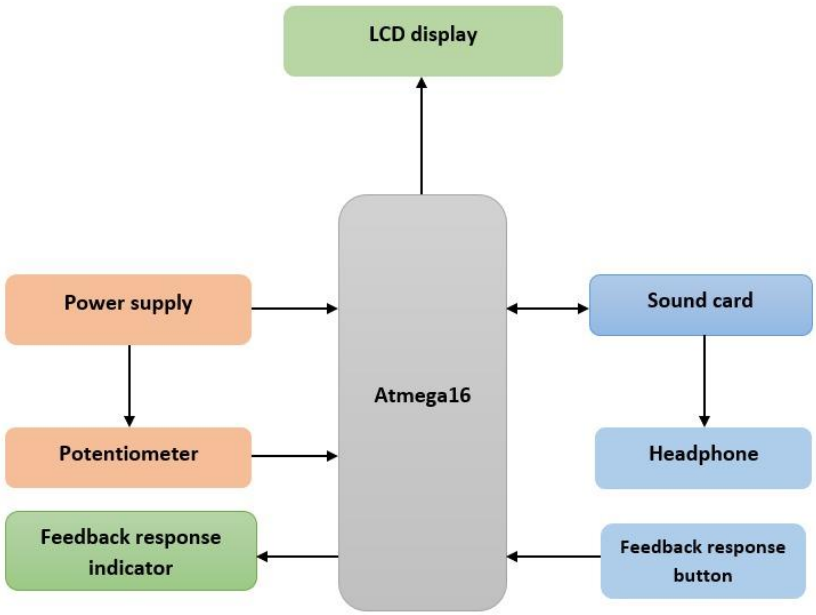

Figure 1. Block diagram of universal audiometric device

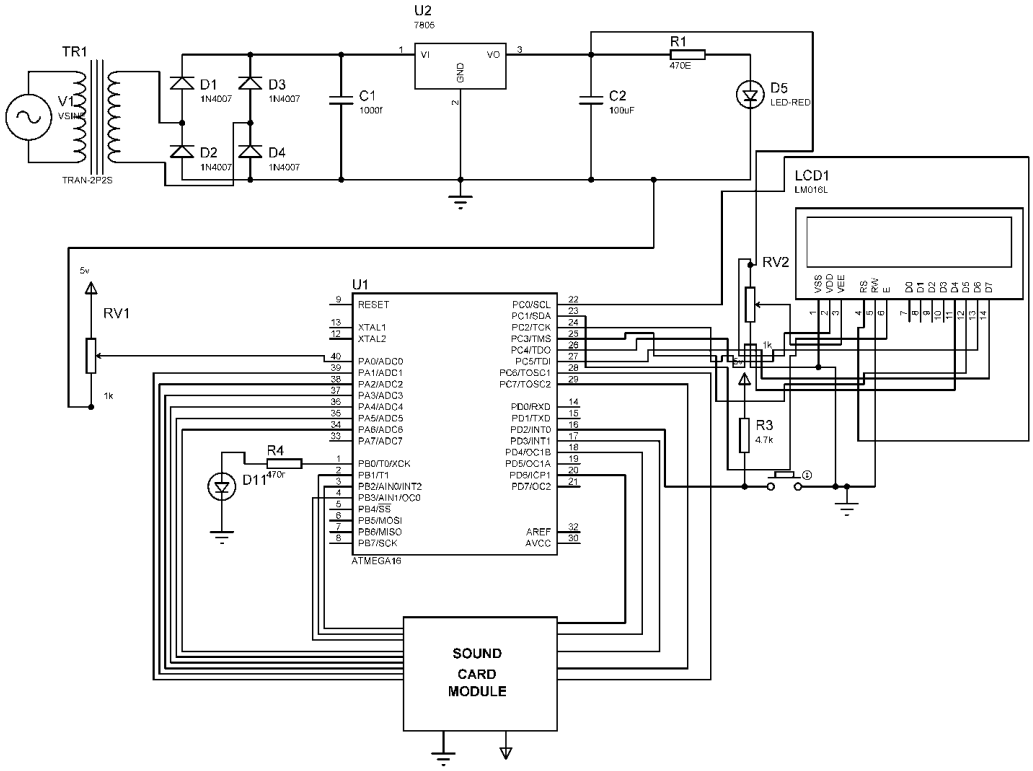

Figure 2. Electronic circuit of universal audiometer

4.1 Frequency Circuit Selector

It consists of potentiometer which is voltage divider used for measuring electrical potential, it obtains the input voltage then gives the output divided depend on voltage selected. We have 14 sounds of different frequencies from the sound card on the memory card which has been downloaded from the official website for sound check and hearing analysis www.audiocheck.net/testtones these downloaded tones when applied to the patient's ear the reaction of the test is seen.

As we have 14 sounds, and by varying the potentiometer which is fed by 5v, it means 0.35 V per each frequency, once + 0.35 V is applied to the microcontroller through the potentiometer the controller gives command to the sound card to change to the next frequency,
The range of frequencies used in this project are 250Hz, 500Hz, 1000Hz, 2000Hz, 3000Hz, 4000Hz, 4500Hz, 5000Hz, 5500Hz, 6000Hz, 6500Hz, 7000Hz, 7500Hz and 8000Hz.
The Intensity in decibel used is from 23.9dB to 39.03dB. The output this circuit is connected to pin 40 (PA0/ADC0) of Atmega16.

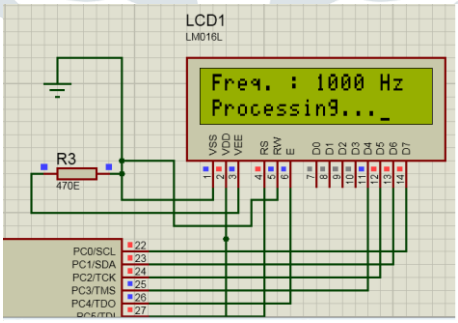

Figure 3. The output display on LCD

The LCD will display contents regarding to the input frequency variation from the potentiometer, we started from 250Hz to 10000 Hz while testing the patient, when the patient heard the tone at 10 KHz he has given the feedback by pushing the push button then the "**is hearing**" message displayed on the LCD.

V. SOFTWARE DESCRIPTION

Software design captivate different programs used to execute the program, we have chosen the program based on the one which are easy programmable and error checking, the software tool is as needed as hardware tools for nice design.

The software development tool used is: "Bascom-AVR software" for coding the controller as per the idea of the project, the Bascom is easy to interface with different devices, easy to understand, reduces program length, reduces the complexity and is flexible as it can be worked with other controllers for making some easy changes. Another software used is "Robokits" for loading the program to the controller, with all of these software we can include the "Proteus 8.0 professional" design suit software that used for electronic circuit design of schematics ready to print for manufacturing circuit.

VI. TESTING AND RESULTS

When the examiner varies the resistance through the potentiometer to certain frequency from Min – Max slot our device applies a sound wave of corresponding frequency to the patient's ears through the headphone. At the same time the frequency quantity is seen on the LCD. The patient press the push button when hears the tone, causing a blue LED to light simultaneously display a message as **"Is Hearing"** on the LCD screen.The values of frequencies are seen on the LCD screen as you can see from below figures:

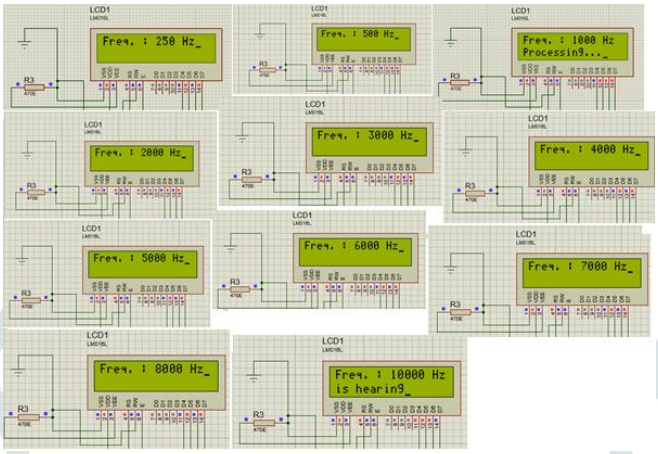

Figure 4. Different threshold values when potentiometer is varied

Here we propose a unique testing technology that allows the audiologists to perform a wide range of hearing tests for identifying the type of hearing loss in patient.

This project will give the level of hearing loss by using the patient's feedback to different frequencies applied to his/her ear. The frequency of the audio signals is controlled by a microcontroller which randomly choses different frequencies to be generated.The output of the audiometer result is displayed in an LCD display where the audiologist can know the hearing ability of the tested person.

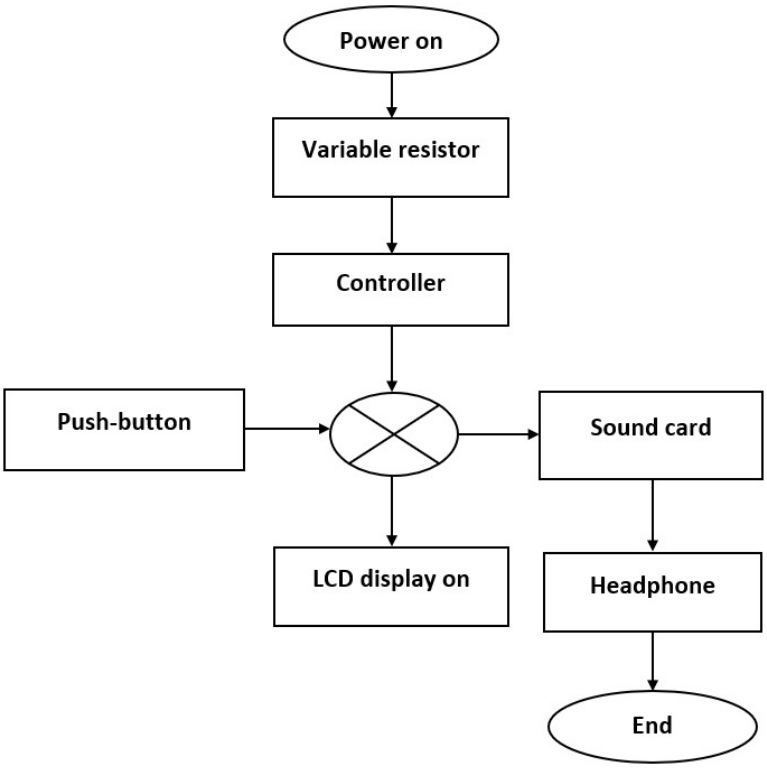

Figure 5. The flow chart of the proposed system

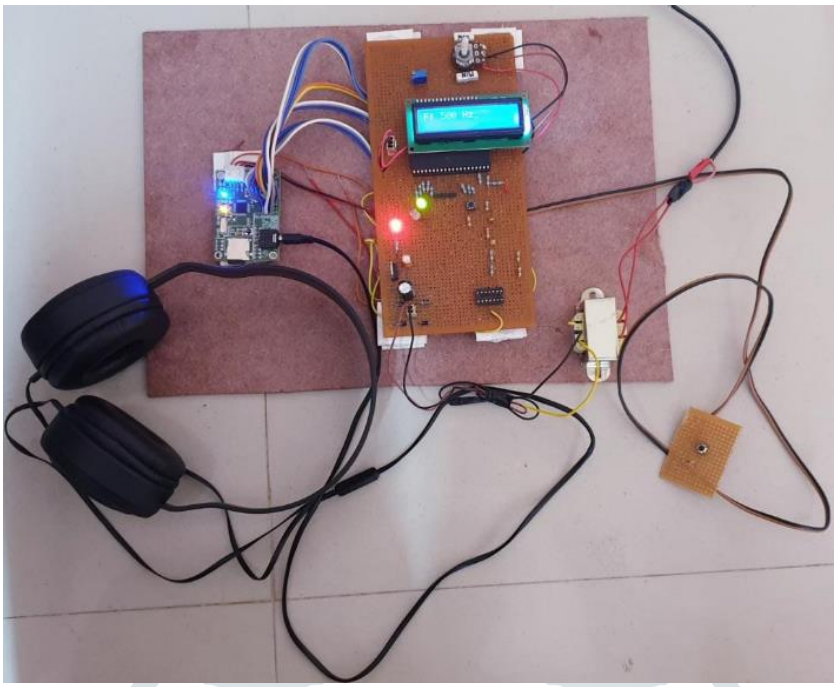

Figure 6. Hardware module of proposed system

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