RESEARCH ARTICLE OPEN ACCESS

Study and Implementation of Neonatal Hearing Screening Device

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ABSTRACT

Hearing impairment in neonates is caused due to various reasons. This condition is identified based on the OAEs (Otoacoustic Emissions) that are emitted as a bi-product of Outer Hair Cells mechanism. Over the years, significant study has been done showing the benefits of early identification of hearing impairment and its effect on children in developing speech and language abilities, which have an impression on educational, economic, and social capabilities. Infants are unable to access their hearing loss. Therefore non-supportive assessments are used based on Otoacoustic emissions. The principle is to deliver an acoustic stimulus to the new-born and evaluate the biological reaction to this stimulus. TEOAEs (Transient Evoked Otoacoustic Emissions) are evaluated when a temporary stimulus is applied to the cochlea and "*response*" of cochlea is determined. If the response exists even after the application of stimulus, the result is passing else refer to doctor. In this work, a prototype has been developed to determine the hearing capability of new-borns and help them to overcome the difficulty.

Keywords :— *Cochlear Anatomy; Cochlear Mechanics; Cochlear Amplifier; Hearing losses; Otoacoustic emissions; MAICO ero scan device*

I. INTRODUCTION

.About 500,000 hearing impaired infants are born every year in the world; of this 100,000 are in India. Unnoticed hearing loss causes an inability to learn, process spoken language, and speak. 26 million infants are born in India every year. Just 47% of these births are in hospitals. The Causes for hearing impairment in new-borns are Persistent involuntary ventilation, Medicine infection, Small natal weight, Jaundice, Viral infection in the course of pregnancy, Gene transformation in the course of fetal growth. The RISK FACTORS are an Ancestral history of hearing loss, Low birth weight and SIGNS OF HEARING LOSS are do not perturb in return to a rapid deep sound, do not react to sounds, music, or voices, Neonatal Hearing Screening Device.

The main purpose of this paper is to implement Neonatal Hearing Screening Device to recognize hearing impairment in kids that might disturb Health development, Communication, Education and helps in the early recognition of hearing loss and Child can be trained to communicate in different ways with its family and teachers.

The MAICO to scan device has been used to screen hearing-impaired subjects. The device costs around $5612. The device which has been implemented in this paper is a low-cost device. As stated by the World Health Organization (WHO), Over 5% of the world's population – 360 million people – has an immobilizing hearing impairment (328 million adults and 32 million children). This problem exists worldwide and in each and every country. So, the opportunity of marketing this device is vast. The number of hearing loss kids in India alone is 100,000 per year as of 2011. Therefore India can be a vast aimed market. As the device is low-cost and simple, the key target is the rural population which is almost 65% of the Indian population. Consumers will be government and also private hospitals. The end users are new-borns and kids below 3 years of age. There are existing devices by GE Healthcare and Siemens Healthcare which can be used for the analyzing purpose. But they cannot be deliberated as challengers since those devices are very expensive. Therefore this device has a vast market and we can mostly aim at the rural population. The loud sound or voice doesn't affect the baby while it is sleeping in a silent room. After two months, the baby doesn't make sounds like "oh". The baby doesn't respond to well-known voices.

In this paper implemented Neonatal Hearing Screening Device measure hearing capability of new-borns. The device developed is compact, affordable and easy to use. It can be used in hospitals by trained people to screen babies to avoid hearing disability and thereby to reduce no. of children being deaf by birth. The device developed can be used: In hospitals and By health workers to screen neonates. Android application can also be implemented for easy access to common people.

II. MATERIALS AND METHODS

The MATERIALS for hardware requirements are Condenser Microphone, Speaker, Head phone, LM358(Op-Amp), Microcontroller, Resistors, Capacitors and Display. The software requirements are Arduino and Operating System: Windows 8.

The proposed block diagram has been outlined in Figure 1

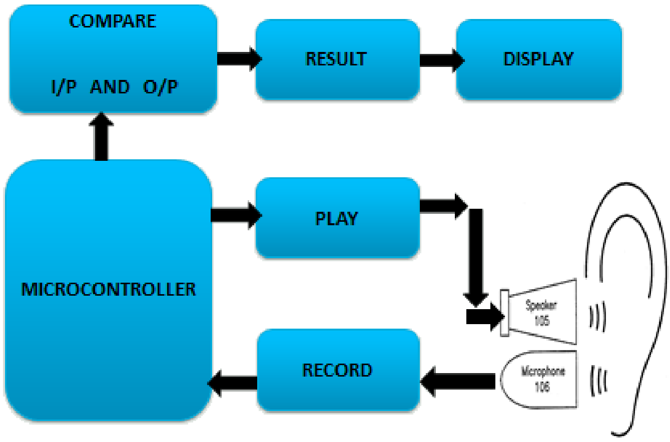

Figure 1: Block diagram

A. Condenser Microphone

Condenser means capacitor, an electronic part which stores vitality as an electrostatic field. The term condenser is really out of date yet has cling as the name for this sort of mouthpiece, which utilizes a capacitor to change over auditory vitality into electrical vitality.

Condenser receivers oblige energy from a battery or outer origin. The subsequent sound sign is more grounded sign than that from an element. Condensers additionally have a tendency to be more delicate and answerable than elements, making them appropriate to catching unpretentious subtleties in a sound. They are not perfect for high-volume performance, as their affectability makes them inclined to bend.

The working of a capacitor has two plates with a voltage between them. In the condenser mic, one of these plates is made of light matter and as a diaphragm. The diaphragm shivers when struck by stable waves, altering the separation between the two plates and along these lines altering the capacitance. In particular, when the plates are closer together, has been depicted in Figure 2, capacitance increments and a charge current happens. At the point when the plates are encourage separated, capacitance abatements and a release current happens. A voltage is needed over the capacitor for this to work. This voltage is provided either by a battery in the mic or by exterior phantom power.

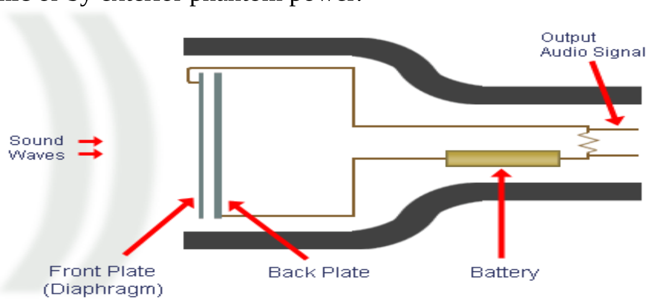

Figure 2: Cross-Section of a Typical Condenser Microphone

B. Speaker

It is an electroacoustic transducer which changes an electrical audio signal to an equivalent sound. At the point when a rotating current electrical sound sign information is connected through the voice curl, a loop of wire suspended in a round crevice between the shafts of a perpetual magnet, the loop is compelled to propel quickly and backward because of Faraday's law of prompting, which causes a stomach (as a rule narrowly formed) appended to the curl to advance and backward, pushing reporting in real time to make sound waves.

C. Headphones

Here headphones are used as a noise cancellation tool. Speaker and a microphone are mounted within a headphone.

D. LM358 (Op-Amp)

Figure 3: LM358 IC

This is a dual operation amp components low power deplete, a typical mode data voltage extent stretching out to ground/VEE, and single supply or part supply operation. The LM358 arrangement is comparable to one-a large portion of a LM324. These enhancers have a few particular preferences over standard operational intensifier sorts in single supply applications. They can work at supply voltages as low as 3.0 V or as high as 32 V, with quiet streams around one-fifth of those connected with the MC1741 (on a for each speaker premise). The regular mode data extent incorporates the negative supply, along these lines dispensing with the need for outside biasing parts in numerous applications. The yield voltage run likewise incorporates the negative power supply voltage. Figure 3 represents the outer view of the IC.

The features of LM358IC are

- Short circuit Protected Outputs
- True differential Input Stage
- Single supply Operation:3.0 to 32v
- Low Input Bias Currents
- Internally Compensated
- Common mode Range Extends to Negative Supply
- Single and Split Supply Operation

- Large DC voltage gain:100 dB

E. Microcontroller

The Arduino Uno is a microcontroller used for acquiring and processing signals.

The technical features of Arduino Uno:

- Microcontroller - ATmega328
- Operating Voltage - 5V
- Input Voltage (recommended) 7-12V I
- Input Voltage (limits) - 6-20V
- Digital I/O Pins - 14
- Analog Input Pins - 6
- DC Current per I/O Pin - 40 mA
- DC Current for 3.3V Pin - 50 mA
- Flash Memory - 32 KB
- SRAM - 2 KB
- EEPROM - 1 KB
- Clock Speed - 16 MHz

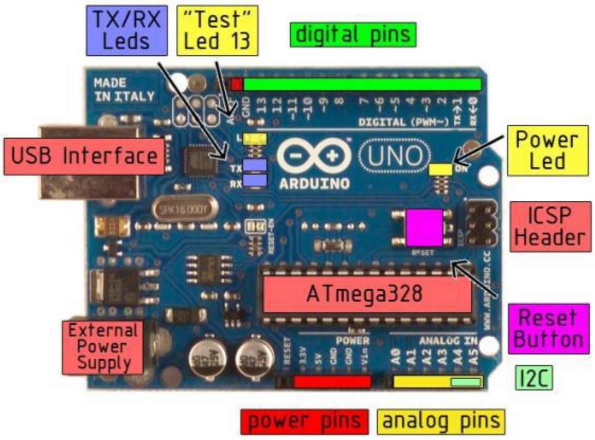

Figure 4: Arduino Uno

The ATMEGA328P chip contains six analog inputs namely as A0 to A5 on the Arduino board. The chip has a single 10-bit ADC (Analog-Digital Converter). The ATMEGA328P can measure only one analog input at once. It contains multiplexer, the six inputs are connected to ADC through multiplexer. This multiplexer allows automatic connection of input to the ADC depending on the program used. The board can be powered through USB, power jack or other regulated power supply. The communication of Arduino Uno with computer can be done through serial communication over USB. Figure 4 represents microcontroller used in the proposed system. The Arduino Uno is programmed with Arduino software, which includes serial monitor. Figure 5 represents the outer view of ATMEGA328P IC.

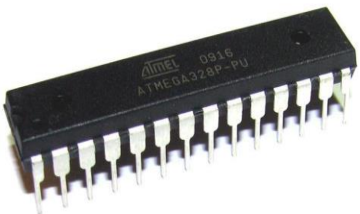

Figure 5: ATMEGA328P IC

F. Display

In this work 16X4 LCD display is used to display the results. Figure 6 represents the LCD display used in the proposed system.

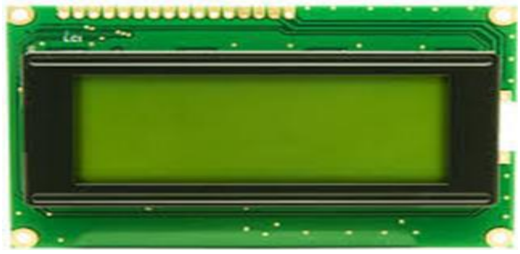

Figure 6: LCD Display

G. Protocols

OAEs.

• Limited

• TEOAE: One level (e.g., 80dB SPL) click stimulus should be finished.

• Comprehensive

• TEOAE: Two levels (e.g., 80 dB SPL and a lower level) may be finished and/or one level utilizing snap and numerous frequencies for stimuli. The TEOAE is a superior indicator of low-recurrence listening to affectability.

III. IMPLEMENTATION

Different frequencies click stimuli in the range 0.4Hz to 4.5 KHz has been sent to newborn's ear one after the other through tiny speakers mounted within a headphone. The sound signals travel through different parts of ear; Outer hair cells react to these signals and emit otoacoustic emissions for respective frequencies. These unique responses have been recorded by the condenser microphone. The recorded signals are compared with sent signals. And then analysed by the controller. The compared output is displayed on the serial monitor as well as the LCD display. System flow has been outlined in Figure 7.

Requirements for the proposed system have been outlined in Table 1.

TASKS	REQUIREMENTS
PLAY(stimuli)	Type- click Duration- 80 micro second pulse Delay between two clicks- 20 ms
RECORD(response)	Bandwidth- able to record between 1000 to 5000hz Data collection/analysis window- start 4ms, end 10 to 12.5ms Maximum recording time- 6 minutes

Table 1: Requirements table

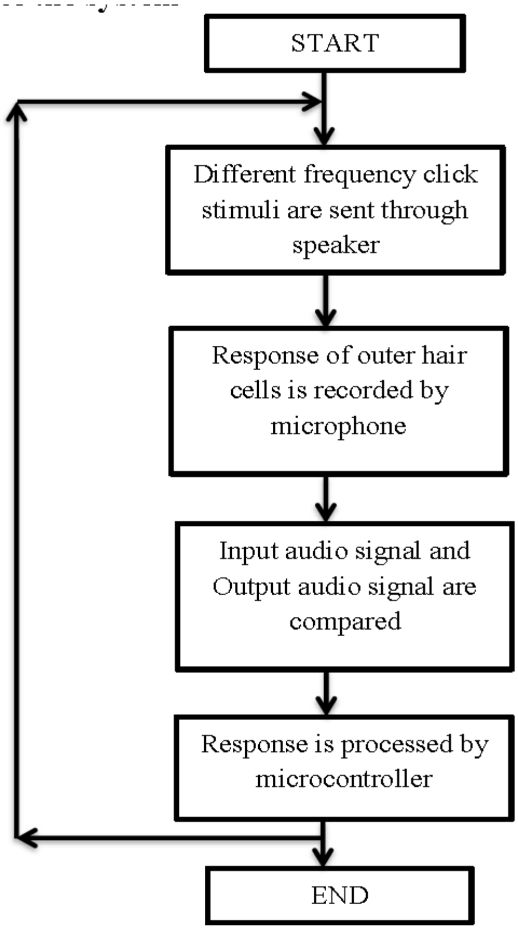

Figure 7: System Flowchart

Stimulus Intensity Level

Stimulus intensity level is a critical determinant for the presence or absence of TEOAEs. The graph in Figure 8 represents nonlinear paradigm for TEOAE stimulation. Each click stimulus should be of 80 µs width and the delay between two stimuli should be 20 ms.

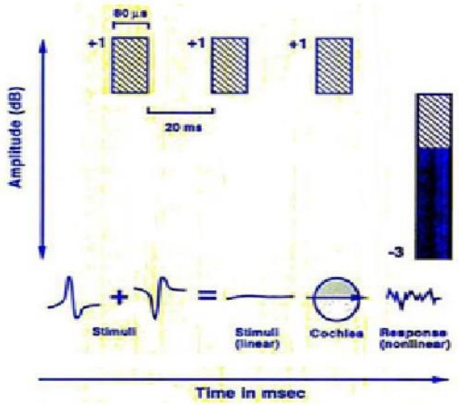

Figure 8: Nonlinear paradigm for TEOAE stimulation

IV. RESULTS AND ANALYSIS

Click stimuli of 6 different frequencies from the range 0.4 Hz to 4.5 KHz has been sent through the speaker into the ears. The corresponding response of the OHC of ears in terms of frequencies has been recorded and displayed on LCD display as depicted in Figure 9 and displayed serially as depicted in Figure 10.

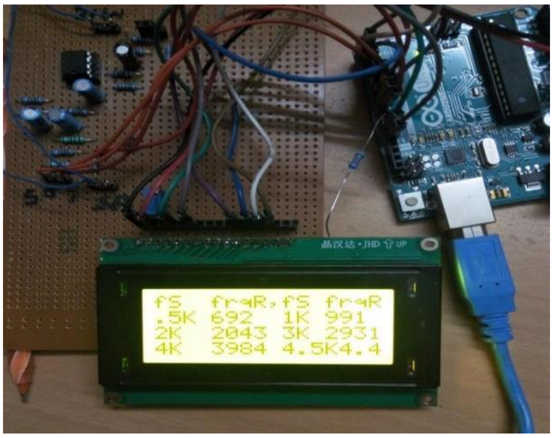

Figure 9: LCD display of result

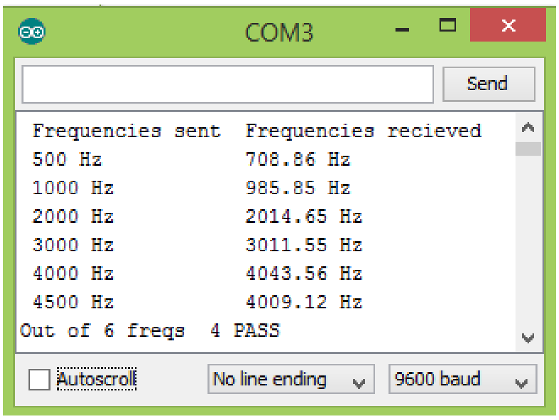

Figure 10: Serial port display of result

Validation of the prototype has been done with standard Audiometer. As the ears of both neonates and adults respond to the frequencies which have been selected, the prototype was tested on adults itself. Due to ethical issues, the prototype cannot be used to test on neonates. Firstly few selected people underwent audiometer test for certain different frequencies and the corresponding result was noted down. Later for the same set of frequencies they were checked with the prototype and response was measured. The result of both the methods correlated as shown in Table 2.

Test Conducted (Subjects)	Prototype Result	Reference Device Result
1	Pass	Pass
2	Pass	Pass
3	Pass	Pass
4	Pass	Pass
5	Pass	Pass

Table 2: Results of both prototype and Reference device tabulated

V. CONCLUSION

A device has designed and developed to measure hearing capability of new-borns. The device developed is compact, affordable and easy to use. It can be used in hospitals by trained people to screen babies to avoid hearing disability and thereby to reduce no. of children being deaf by birth. The device developed can be used: In hospitals, By health workers to screen neonates. In this work, only ambient noise has been considered for analysis, in future noise created within the ear also need be cancelled out for accurate results. Android application can also be developed for easy access to common people.

ACKNOWLEDGMENT

I sincerely thank Mrs Meghanna for their guidance and encouragement in carrying out this project work.

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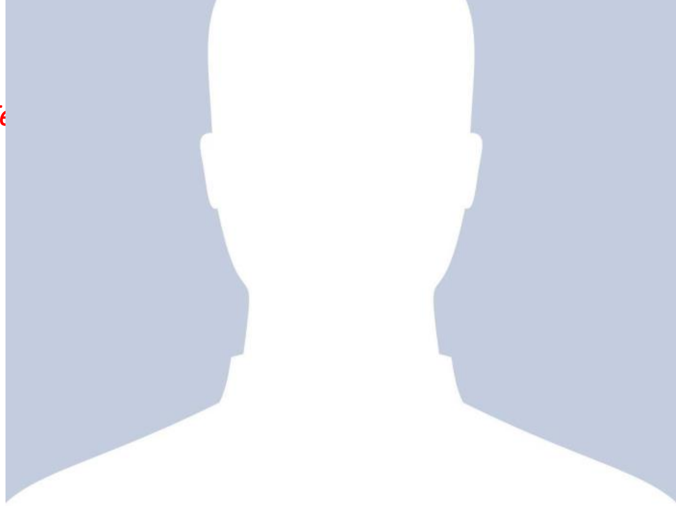

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