

# Role of a Unique Innovative Device (HEAR-O-SCOPE) in Prevention of Noise Induced Hearing Loss

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## ABSTRACT

### Introduction

Noise induced hearing loss has great significance in today's world as it comes as an occupational health hazard accompanied with other systemic adverse effects like several neuropsychiatric disorders, cardiovascular diseases, or peptic ulcers. It can be prevented by serial follow up with pure tone audiograms and use of noise protectors like ear muffs or ear plugs. This article demonstrates an easy-to-adopt method of preventing noise induced hearing loss in the form of an electronic device named HEAR-O-SCOPE.

### Device Design

This device is essentially a decibel meter which senses sound intensities above 85 decibel and equates it with permissible time of exposure for that decibel range and if permissible time of exposure is crossed, sends alarm signals in the form of buzzer and display, giving the user adequate time either to move away from the noisy surrounding or put in noise protectors. This device also has provision for real-time graphical plotting facilities.

### Expected Benefits

Expected outcome by using this device in the long run would be early detection and prevention of noise induced hearing loss and other health hazards of noise pollution.

### Conclusion

Regular use of HEAR-O-SCOPE is highly recommendable for prevention of Noise Induced Hearing Loss.

### Keywords

Hearing Loss; Noise-Induced; Prevention; Early Diagnosis; HEAR-O-SCOPE

Ear is one of the most neglected organs of our body which get victimized often unnoticeably by the hazardous effects of noise pollution which is quite inevitable in our daily life. Factory workers, people of music industry, or those regularly attending rock concerts, or using earphones at a stretch, pilots, cabin crews and airport and railway station ground staffs,

bikers and regular long distance travellers are compelled to work or stay in noisy environments for long duration of time. It is generally agreed that, for the human ear, sound levels below 80 decibel (dB) are unlikely to cause hearing damage, no matter how long one is exposed to them.<sup>1</sup> After noise trauma ear may recover within few minutes to few hours even up to two weeks, this being termed as temporary threshold shift (TTS).

It depends on the intensity, frequency and duration of sound, whether continuous or interrupted sound and the susceptibility of the individual to the sound perceived.<sup>2</sup> But when this TTS is surpassed by chronic exposure to noise of harmful decibels for permissible time of exposure (TOE) (Table I), permanent threshold shift (PTS) sets in. Hair cells in the organ of Corti of inner ear tend to get damaged, outer hair cells being affected

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**Table I: The National Institute for Occupational Safety and Health (NIOSH) recommendation for Occupational Safety and Health Administration (OSHA) [US]**

TOLERABLE INTENSITY OF SOUND	MAXIMUM PERMISSIBLE TIME OF EXPOSURE
85 dB	8 hours
88 dB	4 hours
91 dB	2 hours
94 dB	1 hour
97 dB	30 minutes
100 dB and above	15 minutes

before inner hair cells, resulting in permanent hearing loss which could not be reverted unlike in TTS.<sup>2</sup>

For people working in noisy environment, screening should be done with pre-employment pure tone audiograms followed by repeat audiograms usually done annually for early detection of noise induced hearing loss (NIHL). The pure tone audiogram in NIHL will essentially be of sensorineural type. Classically, the audiogram presents a dip or notch at 4000 Hertz (Hz) for both air conduction and bone conduction.<sup>3</sup> The notch in audiogram, common in early and acute cases, may be present anywhere between 3000 Hz and 6000 Hz.<sup>3</sup> In advanced cases of long standing noise assault a steeply sloping audiogram starting from 3000 Hz and gradually increasing in the higher frequencies is found.<sup>3</sup> Noise protectors like ear muffs or ear plugs are in use which may provide noise reduction up to 40 dB (Table II).<sup>2</sup> If NIHL has already occurred the person is rehabilitated as in other forms of sensorineural hearing loss (SNHL) including permanent dependency on hearing aids.

Here we describe an easy to adopt method of preventing NIHL in the form of an electronic device named HEAR-O-SCOPE that senses intensities of sounds of all decibels, and equates it with total TOE. If the permissible TOE is surpassed for the harmful decibel of sound, the device sends an alarm to its user in the form of light, buzzer and gives alert message in its

**Table II: Hearing attenuation provided by different devices**

DEVICE	HEARING ATTENUATION
Cotton wool	5 dB
Ear plug	15-30 dB (mostly in the range of 3 - 5 kilo Hz)
Ear muffs	30-40 dB (mostly in range of 500 hertz – 1 kilo Hz)
Ear plugs + muffs	More than 40 dB

display screen.

### Device Design

The device is essentially a decibel meter. The heart of the device is formed by the microcontroller unit (MCU) having integrated circuit (IC) chip embedded in Arduino Mega or Uno board. It is connected to a microphone which receives and senses sounds of all intensities in the nearby surroundings and converts of sound energy to electrical energy and sends it to the MCU (Fig. 1). The MCU is enabled with such a coding in the Arduino board so that it screens all intensities of sound of and above 85dB, and then equates it with its TOE. If the time crosses the “safe time limit” for that particular decibel range of sound (as in Table I), the MCU sends a signal to the buzzer and to the Organic Light Emitting Diode (OLED) display screen which produces alarm sound and alert message like “DANGER”, respectively, 15 minutes before (Fig. 2).

Over and above this alarm signal, we also have made provision for a real time monitoring of an individual’s daily TOE to the harmful decibels of sound on 24 hours basis in the form of a graphical plotting taking TOE in “X” axis and decibel of sound in “Y” axis (Fig. 3). The entire data of the graph along with being displayed in the liquid-crystal display (LCD) display of the device,

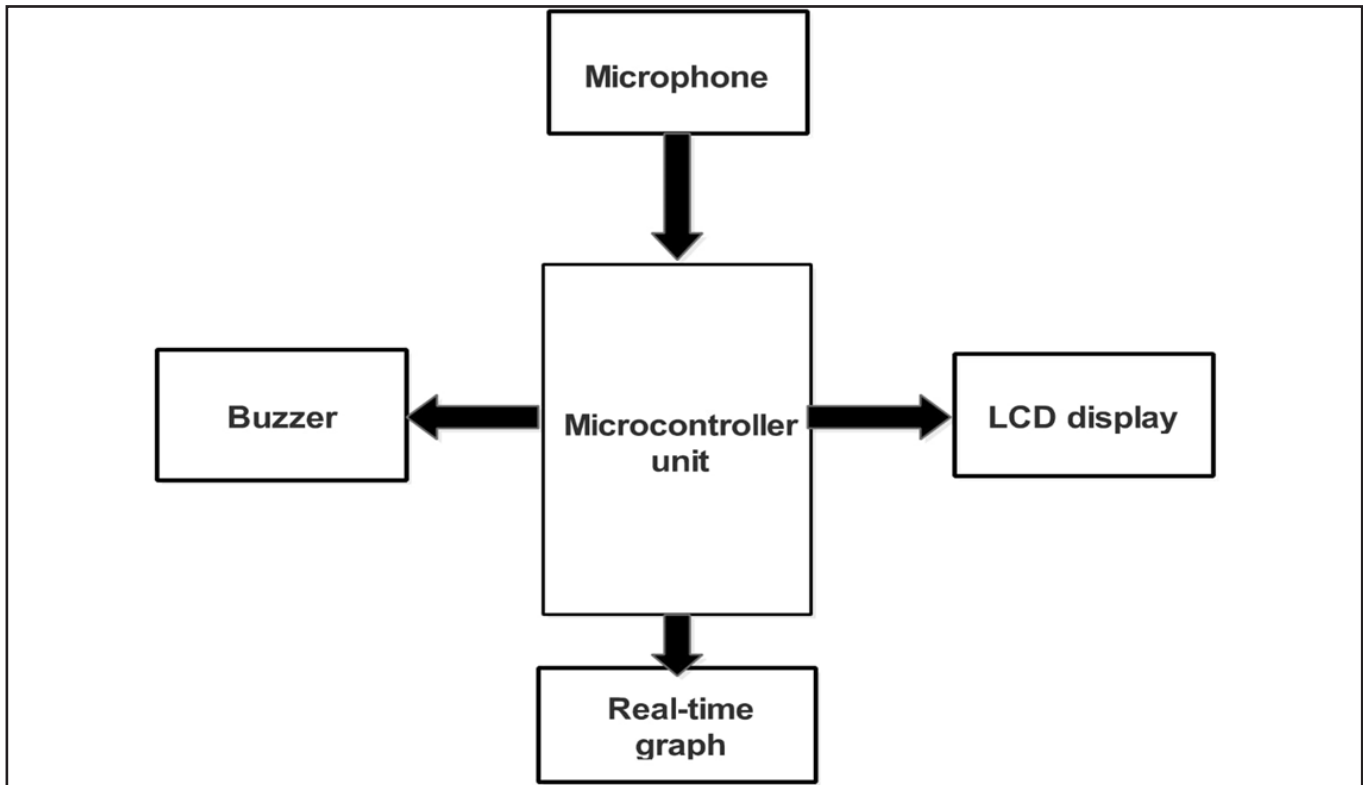


Fig. 1. Device design

also gets stored in a “cloud” in the MCU for later survey and surveillance by the person or his attending clinician, in case any hearing disability is suspected or detected.

The entire electronic device has been made portable with ease of handling and can be embedded in daily usable entities like bluetooth headsets, car dashboards, hearing aids. It can be carried in wallets or pockets. It can be connected to laptop, tablet, mobile phone for alarm signal in the form of text message or alert calls and screen display of the graph.

### Expected Benefits

The actual benefit of an individual from this device in preventing NIHL and other health hazards of noise are still under the scope of research.

The wide range of expected outcomes includes the following.

a) Early detection of SNHL caused by noise

exposure.

b) Easy means of prevention of NIHL.

c) To cut down the systemic adverse effects of noise pollution.

d) To improve an individual’s work productivity.

e) Long term use of HEAR-O-SCOPE is expected to cut down requirement and use of hearing aids.

f) The real time monitored data stored in the device for future reference could lead to better treatment options and outcome when the individual presents later to his attending clinician.

g) Provides the treating clinician an extra edge for choosing treatment modalities by studying the patient’s saved data to give his patient maximally beneficial treatment.

h) The cost effectiveness, portability and easy connectivity of the device to mobiles, laptops, tablets, would enable every individual to afford and use it on regular day-to-day basis as a weapon against noise

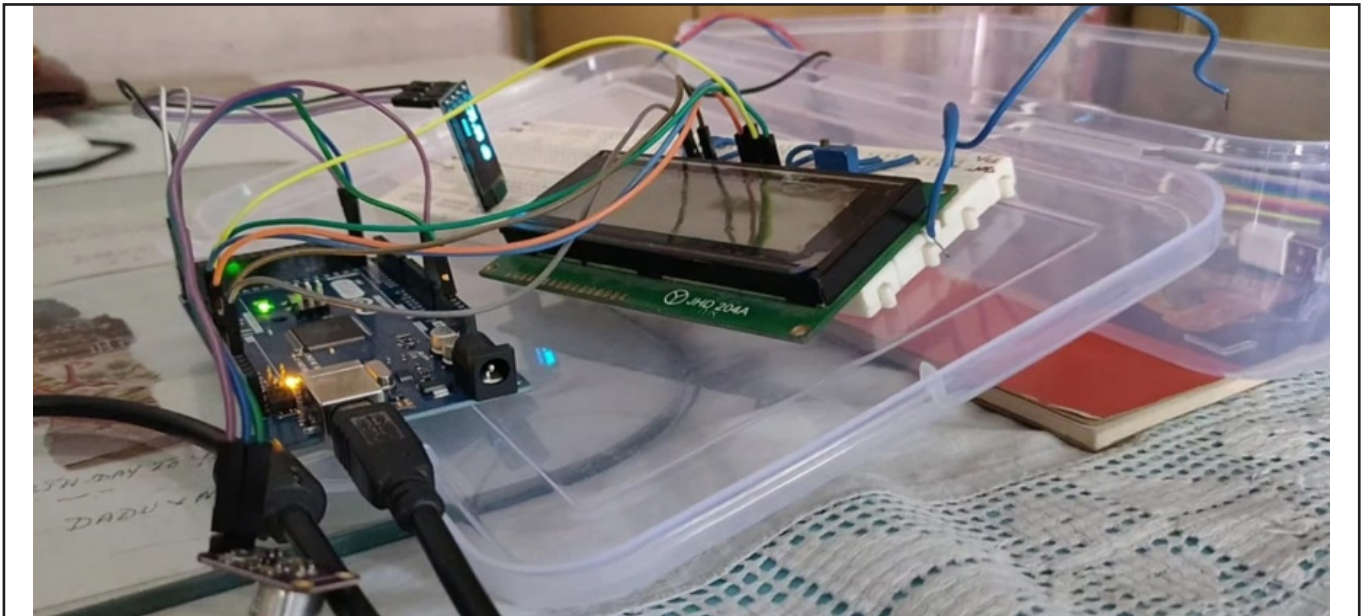


Fig. 2. Microcontroller with microphone, buzzer and OLED display

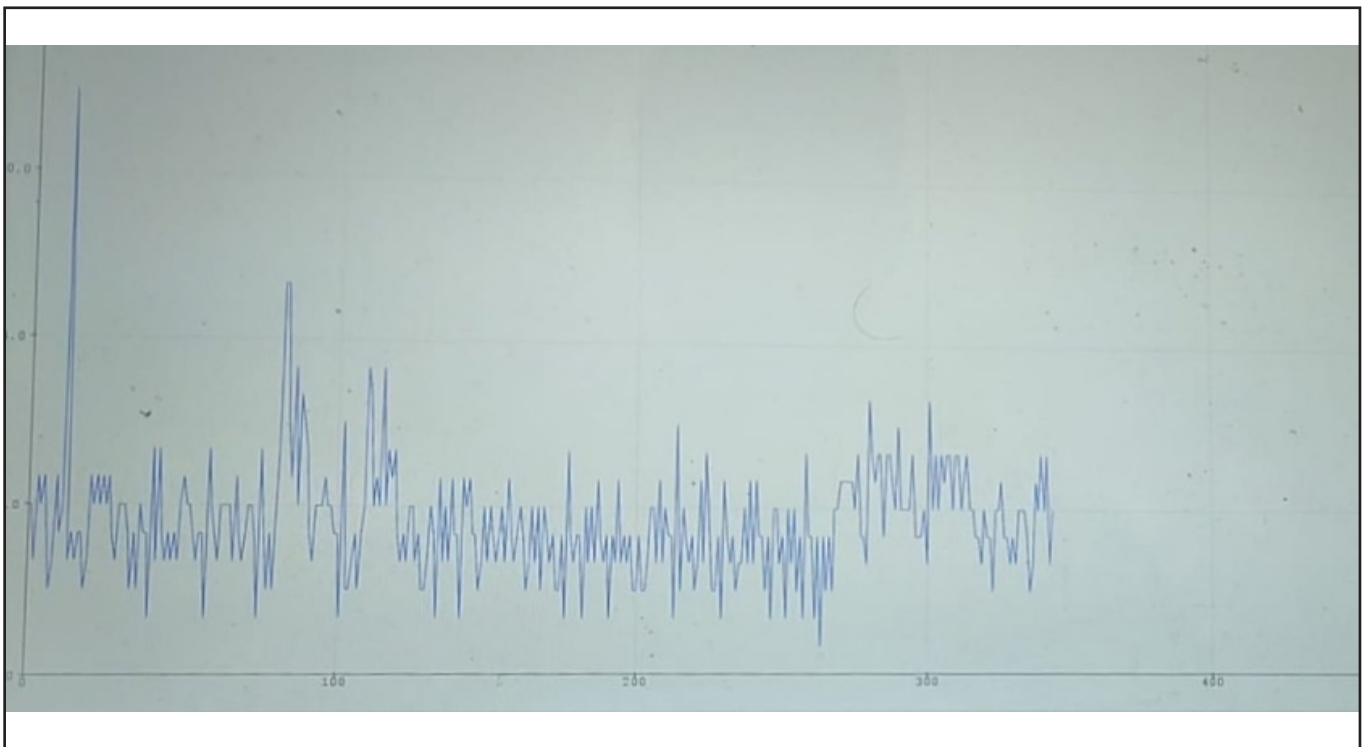


Fig. 3. Graphical plotting

pollution.

i) Last but not the least, this device can be used as a surveillance tool by the government for prolonged surveillance of the noise level in factories or industries with high noise level at minimal cost.

## Discussion

Some forms of noise are practically unavoidable like city-street noises, noises produced by machineries in factories and industries, noises at airports, noises produced in rock concerts and music industry or by constant use of headphones or earphones. Noise pollution not only causes hearing disability in the form of NIHL but other health hazards like mental stress, lack of concentration, anxiety, depression, easy fatigability, insomnia or more serious issues like cardiovascular diseases, hypertension, peptic ulcers and even cardiovascular accident.

Early detection of NIHL is important as measures can be taken to stop its progress, reverse it or start an early rehabilitation programme. Hence the successful implementation of this innovative electronic device (HEAR-O-SCOPE) in day-to-day life for noise decibel monitoring and its unique concept of alarm system being activated 15 minutes before permissible TOE is crossed for that decibel range, allow the individual to either move away from the source of sound or cut down the sound if possible or use noise attenuation devices like ear muffs or ear plugs and provides easy means of prevention of NIHL.

Moreover, the data storage facilities of the 24 hour monitoring of total cumulative TOE of an individual to the obnoxious decibels of noise along with its real time graphical representation would give immense value for future reference of treatment by any clinician and would also allow for surveillance in factories and industrial belts for noise level monitoring,

Its portability, unique design and cost effectiveness is expected to make it suitable for daily use by every individual and aid in prevention of NIHL on mass scale.

## Conclusion

Going by the famous saying “prevention is better than cure”, it would be highly recommendable to use this economic, user friendly, cost effective, easy to use electronic device as a means of preventing NIHL and other health hazards of noise enabling people to increase work productivity and improving quality of life as a whole and helping the society to be triumphant over noise pollution.

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