DESIGN OF MICRO-CONTROLLER BASED TINNITUS CONTROLLING DEVICE

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Abstract

The aim of this study is to help people having Tinnitus, which is a symptom. Tinnitus, a buzzing sound in the head can lead to irritation, lack of concentration, sleeplessness and even deafness. As per a study done by an ENT surgeon, it was observed that, performing bhramari pranayama (Bee Breath) regularly, can reduce this significantly. Hence it was essential to design and fabricate a device which can produce similar type of sound and vibration, whose vibrating probe be placed on the person's hard palate and used as per doctor's prescription. This is a pure Microcontroller based device which is battery driven. Its output probe called as piezoelectric speaker generates similar kind of effect as Bhramari Pranayama. Thereby reducing the symptom of tinnitus. It is worth mentioning that at present there is no satisfactory treatment for tinnitus

Keywords: Tinnitus, Bhramari Pranayama, Microcontroller, Piezoelectric speaker

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Introduction

The sensation of noise or ringing in the ears is known as tinnitus. Sometimes hearing loss can be associated with tinnitus in one or both ears that can be continuous or intermittent. Tinnitus, as shown in figure 1, is a common condition that affects 15 to 20% of the population. Tinnitus can be a symptom of an underlying condition such as age-related hearing loss, ear injury, or a circulatory system disorder.

Fig. 1 Representation of Tinnitus

The damage and degradation of the tiny sensory hair cells in the cochlea of the inner ear is the most common cause of tinnitus. This is usually associated with advancing age. Tinnitus can also be caused by repeated exposure to loud noises, temporomandibular joint disorder, chronic neck muscle strain, a tumour that puts a strain on the arteries in the neck and head, earwax build-up or a middle ear infection. Tinnitus is also seen in 90% of the people having noise induced deafness. Otosclerosis, otitis externa, sudden deafness, Meniere's disease and other causes of hearing loss are the other conditions among the otogenic causes of tinnitus.

Tinnitus is extremely common, affecting an estimated 32% of the population in the United States, according to research conducted by the National Centre for Health Statistics. In the hearing-impaired population, the incidence of tinnitus rises to 70-85 percent. More than 80% of people with tinnitus still have a degree of hearing loss, according to this report. Figure 2 depicts the percentage of men and women in various age groups who suffer from tinnitus [1]. The disorder is merely an inconvenience for the majority of citizens. Tinnitus, on the other hand, persists even though the underlying disorder has been addressed.

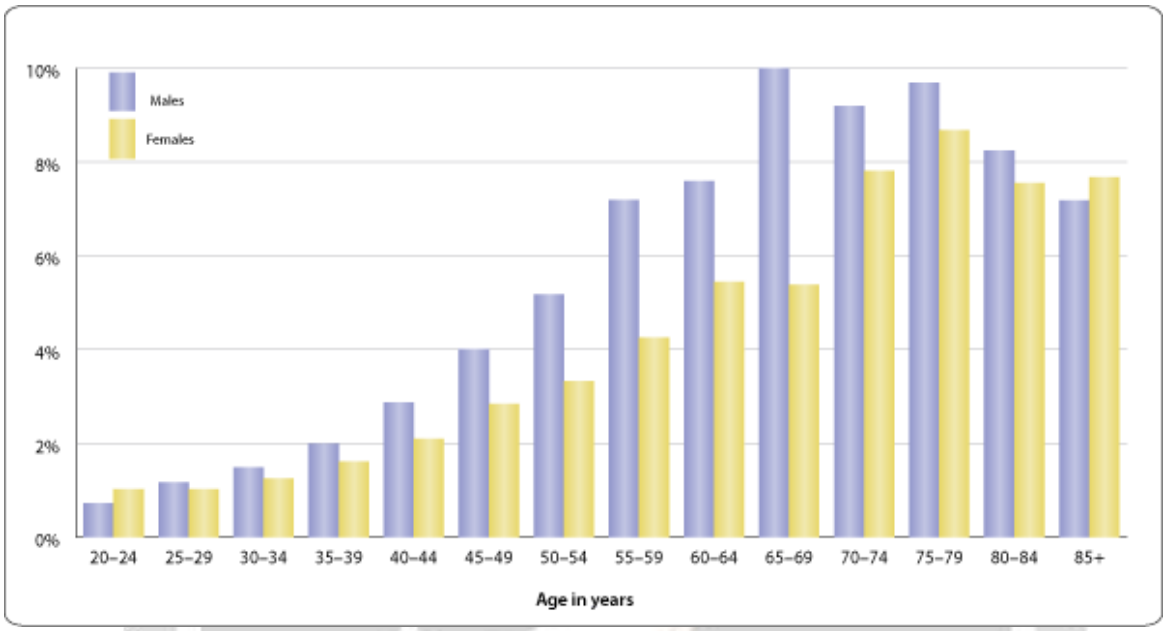

Fig 2. Statistics showing tinnitus affected people

Tinnitus has various types; the most common type of tinnitus is subjective tinnitus. Excessive noise usually causes subjective symptoms that can only be heard by the person who is affected. This type of tinnitus can appear and disappear at any time, and it can last anywhere from 3 to 12 months. It may never stop in some extreme cases. Tinnitus caused by a neurological disorder, such as Meniere's disease, that affects the brain's auditory functions. Tinnitus associated with the sensory system is known as somatic tinnitus. The sensory system causes, worsens, or otherwise affects this form. Tinnitus caused by involuntary muscle contractions is known as objective tinnitus.

Ringing, hissing, static, crickets, screeching, whooshing, crashing, pulsing, ocean waves, humming, dial tones, and even music have all been recorded. A steady, high-pitched ringing is the most common form.

Tinnitus has no known remedy. It may, however, be temporary or permanent, mild or extreme, incremental or immediate. The aim of study is to assist people in reducing their symptoms and how they perceive sound in their heads. Few research papers have been systematically examined in order to achieve this aim.

Literature Survey

B. Langguth [2] in the year 2006 studied about widespread recognition that consistency between research centres in the ways that patients with tinnitus are assessed and outcomes following interventions are measured would facilitate more effective co-operation and more meaningful evaluations and comparisons of outcomes. At the first Tinnitus Research Initiative meeting held in Regensburg in July 2006 an attempt was made through workshops to gain a consensus both for patient assessments and for outcome measurements. It is hoped that this will contribute towards better cooperation between research centres in finding and evaluating treatments for tinnitus by allowing better comparability between studies.

Langreb [3] observed that Tinnitus, the phantom perception of sound, is a frequent disorder that causes significant morbidity and treatment is elusive. A large variety of different treatment options have been proposed and from most of them some patients benefit. However, a particular treatment that helps one patient may fail for others. This suggests that there are different forms of tinnitus which differ in their pathophysiology and their

response to specific treatments. Therefore, it is a major challenge for tinnitus treatment to identify the most promising therapy for a specific patient.

The report of James A. Henry and Mary B. Meikle [4] reviews research from the 1930s to the present that has extended our understanding by investigating the characteristics of tinnitus that can be studied using psychoacoustic techniques. Studies of tinnitus masking and residual inhibition began in the 1970s, leading to the therapeutic use of tinnitus masking and a consequent increase in research devoted to tinnitus measurement. In 1981, the CIBA Foundation symposium on tinnitus advocated general adoption of four tinnitus measures: (1) pitch, (2) loudness, (3) maskability, and (4) residual inhibition. Since then, psychoacoustic research into all four topics has proliferated, yielding many valuable insights and controversies concerning the details of measurement techniques. A consensus has emerged that neither the loudness nor other psychoacoustic measures of tinnitus bear a consistent relation to the severity or perceived loudness of tinnitus. Nevertheless, quantification is needed in clinical trials of proposed treatments and in a variety of other types of tinnitus research. Standardization of techniques for specifying the acoustic parameters of tinnitus thus continues to be an important research goal.

As per Donald M. Casparya and Daniel A. Llano [5] tinnitus is defined as a phantom sound (ringing in the ears), and can significantly reduce the quality of life for those who suffer its effects. Ten to fifteen percent of the general adult population report symptoms of tinnitus with 1–2% reporting that tinnitus negatively impacts their quality of life. Noise exposure is the most common cause of tinnitus and the military environment presents many challenging high-noise situations.

Based on the above literature review, it is found that the tinnitus issue needs to be addressed for the betterment of society. A simple yet effective solution is required.

Project Conceptualization

With the aid of a device called as audiometer, the frequency of the buzzing sound in the tinnitus affected person can be measured. To reduce the intensity of this buzzing and ringing sound (which is involuntarily generated), sound and vibration of similar frequency needs to be intentionally produced. Similar effect has been observed in Bhramari Pranayama.

It is a 'Yogic' technique that involves the combination of a relaxing posture and a process of producing humming sound during exhalation along with simultaneous pressing of the closed eyelids. Fig. 3 shows the correct posture of performing this pranayama.

It was observed and known through various studies (documented and non-documented), that Bhramari has shown very encouraging results in the reduction of degree of discomfort due to tinnitus. It was also observed that a regular practice of this pranayama leads to diminishing symptoms and betterment in quality of life of the tinnitus affected person. It was however also seen that individuals may not be self-disciplined enough to practice the pranayama regularly with the same zeal.

Fig. 3 Posture of Bhramari Pranayama (Bee Breath)

This project was conceptualized along with a Sr. ENT surgeon, who contemplated the need for an electronic device which could generate sounds of different frequencies similar to that generated during Bhramari pranayama. The foundation of this project is based on a battery driven Microcontroller circuit, with a vibrating device to be placed at the palate of the Tinnitus affected person.

Block diagram and Functional description:

The fig. 4 shown below is a simple block diagram of microcontroller based circuit which show all the inputs and outputs of the circuit.

The input side has a push button. When this push button is engaged (pressed) by the user, the circuit starts, i.e. this indicates the onset of frequency and sound through the output device that piezoelectric speaker. This circuit is power driven using a simple battery, but as a microcontroller IC's operating voltage range is between (2.7V-6V), hence to step down the voltage, a voltage regulator IC is used. The heart of this block diagram is the Microcontroller, through which all the input and output operations take place.

The output side has a piezoelectric speaker. This component/device is used for the generation of sound and frequency of a certain range. While the frequency and sound are being generated, an LED glows indicating a particular frequency. For example, When 5 kHz is being generated LED at pin no. 14 of microcontroller glows, when 6 kHz is being generated LED at pin no. 14 and 15 of microcontroller both will glow. At 10 kHz, all LEDs glow. The output device i.e. piezoelectric speaker when mounted/held at person's palate, will generate sound and vibrations, that will get transferred to the entire skull and will reduce the effect of unwanted sound of tinnitus.

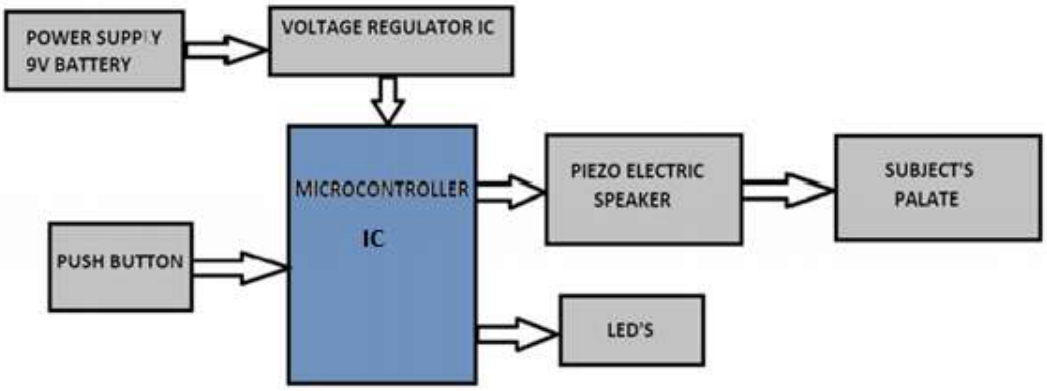

Fig. 4 Block Diagram of Tinnitus Controlling Circuit

Working

The arrangement shown in Fig. 5 below is brought about by the following electronic construction: a simple connection of DC power supply is fed into microcontroller IC. This is connected via a voltage regulator IC where voltage is regulated to ensure correct amount of supply. The circuit caters to frequency from 5 kHz to 10 kHz in increment of 1 kHz. Initially the push button in the reset circuitry is engaged (pressed), to initiate all values of microcontroller to FFH. After this, the push button of microcontroller is engaged (pressed), which will lead to the generation of 5 kHz frequency through the piezoelectric speaker, which is given as an input to the tinnitus affected subject through their mouth's palate. Simultaneously, an LED mounted at pin-no. 14 of the microcontroller IC glows to indicate the onset of 5 kHz sound and vibration. The second instance of engaging the push button at pin-no. 6 fires 6 kHz frequency and sound through piezoelectric speaker and second LED glows along with the first one, signalling the generation of 6 kHz frequency and sound. The same activity continues till the generation of 10 kHz frequency and the feedback of successful generation of the same by virtue of glowing all the 6 LED's. After engaging the 10 kHz frequency and sound, the push button is engaged again to signal the closure of sound, vibrations and switching off of the LED's. This indicates completion of the process. Reinitializing the push button of reset circuitry along with the input push button will start this process again.

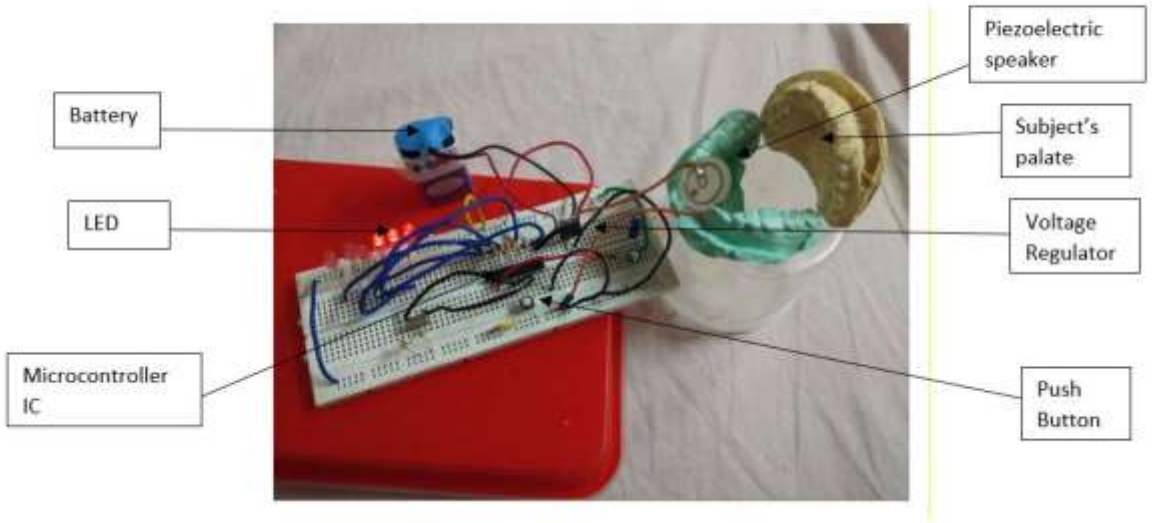

Fig. 5 Final Tinnitus Controlling Device prototype

Result and Conclusion:

It is found that, use of such device, acts as a treatment of tinnitus, heals and gradually reduces the unwanted sounds in the person's ear, provided the person uses the device as per the ENT surgeon's prescription. Using the device developed in this research, the intensity of the tinnitus measured using audiometer, is attenuated. Its advantage being user friendly and cost effective. The disadvantage is it can be uncomfortable for the person to hold it inside the mouth, causing a tingling effect. This device can be customized as per the doctor's prescription and person's requirement.

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