EAR FREE LISTENING USING BONE CONDUCTION TECHNOLOGY

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ABSTRACT
Audio Bone is an advancement in listening technology that enables to hear even though the ear drum is damaged. The main aim of this project is to implement the hearing aid using bone conduction technology. The conduction device (headphones) performs the role of eardrums in bone conduction listening. The device decrypts sound wave and converts it into vibrations, thus excludes the eardrums and bypasses directly to the Cochlea. The vibrations through the bones of skull and skin, reaches the ear as sound.

Keywords – auditory nerve; hearing impairment; eardrum; cochlea cells; bone conduction

1. INTRODUCTION

Current radio communication interfaces rely on air conduction (AC) of sound and require the use of boom microphones and headphones, earplugs, or telephone handsets. AC systems transmit sound through the air to the listener’s ears. These interfaces are very efficient in quiet and undemanding acoustic environments and are supported by well-established and mature technology.

An alternative method to AC for auditory communication is bone conduction (BC). Acoustic signals can be heard when transmitted through bones of the listener’s skull. In addition, skull vibrations produced in the talker’s head during speech production can be picked up by a contact microphone and transmitted over wired or wireless networks to listeners. BC interfaces that include both transmitters and receivers can take advantage of available headgear and hearing protectors without adversely affecting their functionality. Such interfaces can be used in a wide variety of applications demanding enhanced situation awareness and can be visually inconspicuous for stealth operations. Therefore, BC interfaces are of great interest to both police officers and fire fighters. To date, however, BC interfaces are not commonly used by the US military due to their potential susceptibility to noise, limited signal quality, and potential interference from body vibration.[1]

2. BACKGROUND STUDY

Tomasz Letowski have described about the bone conduction communication in noise. In this he has done two kind of experiments to evaluate the results. First experiment was such that a group of 10 individuals with normal hearing used boneconducted and air-conducted interfaces to communicate by radio silently and in a 85 decibel noise. Final outcome of this experiment indicated that available bone conduction interfaces permit 85% speech intelligibility in 85 dB (A) white noise when the talker and the listener wore no hearing protection. Adding hearing protection raised the tolerable noise level to above 100 dB (A). Further increases in operational noise levels may be obtained with improved head coupling. In the second experiment a group of 14 listeners compared the speech quality and listening comfort of six earphones and bone conduction transmitters (bone vibrators). Both the sound quality and the listening comfort of bone conduction interfaces were comparable to those of typical earphones. Further improvements in suspension systems used for bone conduction transducers are needed for wide applications. Results of both experiments demonstrated the potential of bone conduction interfaces for human communication in various environments [2].

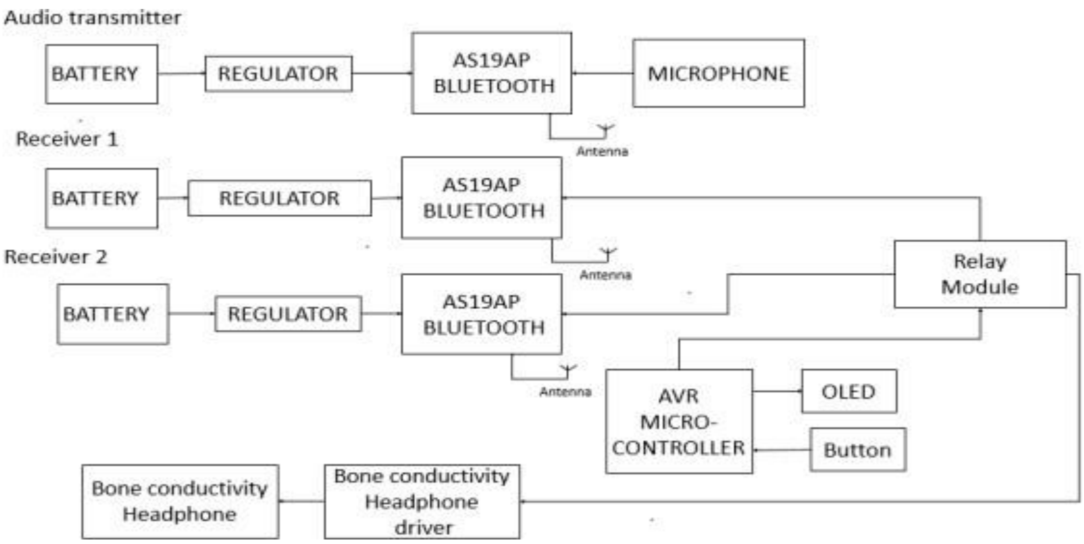
Tomasz Letowski and Phuong Tran have done an elaborated research on bone conduction communication using optimum vibrator. In it the signal's detectability, and the military's requirement for producing gadgets for communication utilizing bone conduction technology. Although, it's effectiveness varies in some respects. The perceptibility of signal that is obtained through BC is affected by the vibrator's position on the bones of the head. Based on hearing threshold levels for multiple signals this work mainly was conducted to spot ideal II Locations for the positioning of BC vibrators. Eleven signals of 12 volunteers to 11 skull locations were transmitted via bone conduction. Results suggested that the condyle is probably highly effective position as the minimum level of threshold was recorded [3].

3. SYSTEM DESIGN

To assess a recording's clarity of speech and quality with a BC microphone situated at numerous spots of the speaker's head. At 8 varied locations a BC microphone was attached to the speaker's head and it recorded 10 words said by speaker’s of both gender in a silent place. The sound levels of the recorded signals were normalized, using an acoustic and cinema Equipment K240DF earphones it was presented to 33 listeners .The clarity of speech and quality of sound of every word was evaluated by a group of volunteers in 2 alternate listening sessions. During every session each volunteer was given about six hundred and forty signals (4 repetitions x 2 talkers x 8 placements x 10 words). Outcome suggested the maximum efficiency of the recordings and quality of it was achieved at the positioning of forehead and temple and clarity ranked highest than most positions of the BCM .One major drawback is the sound quality of the headphones. The audio's quality can still be further enhanced.

Microphone is an audio transmitter. Bluetooth 4.2 audio transmitter is used to send audio to the listener. Each microphone has a Bluetooth 4.2 audio transmitter in it. 48 microphones can be connected with this device. Bluetooth transmitter sends the audio recorded in microphone to the Bluetooth audio receiver 4.2 .Listener has a Bone conduction earphone for listening to the audio. The earphone has an Audio channel switcher which is used for switching channels between various microphones.AVR Microcontroller with Liquid crystal display (LCD) is used.

The characteristic of the earphones is freeing the ear canal from immediate noise even if used noisy environment. The main reason for the increasing demand of BC earphones is it does not involve ear bud and thus preventing further damage to the eardrum. The technology of BC is deemed as safe as it protects the eardrum from noise considered to be very safe to use and also helps in safeguarding the ear from noise, which in turn directly leads to hearing loss also irrevocably damages the human cochlea. The research on BC earphones suggested that it generates enough power to listen to music as in a range of about 20 to 20,000 Hertz frequency. Although, the buyers demand more quality of sound the improvements are done gradually. The difference between a regular earphones and that of BC is it requires a power supply for the ones that are wired and hence to overcome it has to have an additional battery supply. Although this cannot be immediate implemented in the new wireless versions of the BC earphones.



4. IMPLEMENTATION OF DESIGN

Small vibrations are sound waves that travel in air and reach our eardrums. The waves of sound are decrypted into various vibrational types and is sent to the cochlea, also known as the inner ear. Our auditory nerve receives the sound sent to brain by cochlea. The eardrums are circumvented using Bone Conduction .The role of eardrums is performed by device (such as headphones). The bone conduction devices decrypts the sound waves and changes them into vibrations thus excludes the eardrums sent directly to cochlea. Vibrations through the bones of skull and skin is received by the ear in the form of sound.

Most hearing impairment cases are due to the damages pertaining to eardrums and would be able to hear clearly again with bone conduction while having a healthy and a normally functioning cochlea. Generally, hearing impairment can be classified into three categories, namely conductive impairment, mixed impairment and perceptive impairment. The conductive impairment is due to damages to the eardrums that is associated with faulty transmission of sound. A conduction hearing loss can be aided using bone conduction as it acts as a replacement of eardrums. The struggle of auditory nerves in sensing the cochlear vibrations by the auditory nerves is known as perceptive impairment. Therefore, for perceptive hearing loss, bone conduction is less efficacious. As for mixed hearing loss, since it differs among individuals, a trial is suggested in identifying the need and effect of the technology if BC might prove beneficial.

5. CONCLUSION

This study demonstrated that position on the speaker’s head of the BC headphones impacts the clarity of speech and whether is received as a clean audio. The bone conduction location's impact was practically independent despite the placement ratings varied for both talkers of the specific speech item. This is a due to the shape of the speaker’s head, quantity of hair at the estimated locations, and variations in voice generation by male and female speaker's. Highly beneficial placements for these devices are the forehead and the bone above the temple on the speaker’s head. These placements were ideal for both male and female talkers participating in the study. Poor ratings were obtained at the area covering the head with hair and the headphones and skin must be in proper contact. Likewise, to maintain stable contact with a BCM, further jaw area should be neglected so as to avoid strain while communicating. Therefore if the placement of BCM is accurate it overcomes its drawbacks. Nonetheless, reported results need to be acknowledged by the Magnetic Resonance Tomography and Northwestern University Auditory Test Number Six, speech recognition tests. Further, for betterment many other positioning of BC microphones has to be carried out for future advancements.

6. REFERENCES

[1] T. Letowski, P. Henry, and T. Mermagen, “Use of bone conduction transmission for communication with mounted and dismounted soldiers”, Proceedings of the ASNE Human System Integration Symposium on “Enhancing Combat Effectiveness through Warfighter Performance”, Arlington VA, June 20-22, 2005.

[2] T. Letowski , T. Mermagen, N. Vause, and P. Henry, “Bone conduction communication in noise: A preliminary study”, Proceedings of the 11th International Congress on Sound and Vibration, International Institute of Acoustics and Vibrations (IIAV), St. Petersburg, Russia, pp. 3037-3044,July 5- 9, 2004.

[3] M. McBride, T. Letowski, and P. Tran, “Search for the optimum vibrator location for bone conduction communication”, Proceedings of the HFES 49th Annual Meeting, CD ROM, Orlando, FL, September 26-30, 2005.

[4] F. Kuk, B. Crose, P. Korhonen, T.Kyhn, M. Mørkebjerg, M.L. Rank, P. Kidmose, M.H. Jensen,S.M. Larsen, M. Ungstrup. ―Digital wireless hearing aids, Part 1: A primer.‖Hearing Review. 2010, 17(3), pp. 54-67.

[5] R. Herbig, R. Barthel, E. Branda, ―A history of e2e wireless technology‖,Hearing Review. 2014, 21(2), pp. 34-37.

[6] P. Henry and T. Letowski, “Bone Conduction: Anatomy, Physiology, and Communication”, ARL Technical Report ARL-TR-4138, U.S. Army Research Laboratory, Aberdeen, MD, May 2007.

[7] B.Allen, D.A.Berkeley, and J.Blauert,"Multi microphone signal-processing technique to remove room reverberation from speech signals,"J.Acoust. Soc. Am., 1977, vol. 62, pp. 912-915.

[8] Y. Wang, A. Narayanan, and D. L. Wang, ―On training targets for supervised speech separation,‖ IEEE/ACM Transactions on Audio, Speech, and Language Processing, vol. 22, pp. 1849–1858, 2014.

[9] Y. Dong, D. Li, S. Frank, "The Deep Tensor Neural Network with Applications to Large Vocabulary Speech Recognition", IEEE Transactions on Audio, Speech, and Language Processing, vol. 21, no. 2, pp. 388-396, Feb, 2013.

[10] [10] S. Theodoridis, Machine Learning: A Bayesian and Optimization Perspective, Academic Press; 1st edition, April 10, 2015