Testing Method of Bone-conduction Earphone by Attaching Additional Mechanical Component

C.J. Kim[1*], I.P. Kang[1], B.T. Kim[1], S.J.. Kim[1] and J.H.Shon[1]

[1]Department of Mechanical Design Engineering, Pukyong National University, Busan, South Korea

[*]Corresponding author: cjkim@pknu.ac.kr

1. Introduction

The impedance of actuator in bone-conduction module is critical factor in influence on the total performance of responsible device in the transmission of noise information by exciting human bone indirectly [1-2]. The impedance of bone-conduction device is dependent on several design parameters, such as mount module, supporting basement or dynamics of actuator itself. The direct performance of indirect earphone device can be evaluated by subject jury tests from potential people but the test results may be changed according to human feelings. Human feelings are final goal but very sensitive to exposed situation or capability of hearing so that the subjective jury results are not proper consequences to determine the direction of development process. Rather objective design test should be prepared to provide reliable results from the measurable data, such as noise or vibration.

One of conventional test equipment is Artificial Mastoid (Type 4930, B&K) that consists of a mechanical simulation of inertia mass, human head, incorporating a built-in force transducer to monitor the output of the device. That equipment can deliver the impedance of bone-conduction device's actuator by using force data as well as velocity in actuator side. The static force can be possible to generate it with concentrated mass and the human skin was represented with Butyl rubber. However, current test equipment cannot predict the exact dynamics of human head owing to the simplified human head using inertia mass in sensing location. One can find the response errors between real human head and the responsible test equipment by measuring the responding acceleration in actuator side. So it is still required the modification of test equipment for the bone-conduction device to represent the real mechanical situation when human wear the responsible bone-conduction earphone.

Human head consists of several components, such as stiff skull, soft brain, blood supply, nerve supply and organic fluids. In addition, the specific character in each person's head may be different according to age, sex or race. Therefore, human head will show large non-linearity with several kinds of organic fluids as well as skull structures. On the other hand, the actuator's performance was occasionally evaluated with impedance function in a frequency domain for linear system only so that the target system should be modelled with linear mechanical components, such as spring, mass and damper. So the direct model matching between the real human head and equivalent mechanical system is inherently very difficult to achieve it in testing equipment. But it is still required to approximate the real human head with equivalent mechanical components to enhance the reliability of obtained impedance character of bone-conduction's actuator.

In this paper, the enhanced test method of the bone-conductor's actuator was proposed to identify the impedance function in objective manner instead of subjective jury test. Current test equipment, Artificial Mastoid, was modified to enhance the accuracy of dynamics in actuator side by attaching additional mechanical components. The feasibility of the proposed method was compared the acceleration measured at actuator location in both cases, laboratory and real human head.

Acknowledgment

This work was sponsored by National Research Foundation of Korea (Grant No. 2017R1D1A1B03034510).

References

[1] S. Haim, F. Sharon, G.D. Miriam, A. Cathtia, S. Igal, Bone conduction experiments in humans- a fluid pathway from bone to ear, Hearing Research, 146(1-2), pp.81-88, 2000.

[2] R. Dauman, Bone conduction: An explanation for this phenomenon comprising complex mechanism, European Annals of Otorhinolaryngology, Head and Neck Diseases, 130(4), pp.209-213, 2013.