Sound vibrations perception

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Abstract

In this work we present a set of materials that show the behavior of the human hearing system from the point of view of its Acoustical characteristics. Materials are directed to the teachers, who intend to carry out an educational action about Physiological Acoustics, and other interested people. In a simple form, the ear can be described as a complex system composed by several transducers: a high quality microphone (external ear), a preamplifier (medium ear) and a frequency analyzer (internal ear). In this description, we use electro-acoustics basic principles applied to the different transformations between the original sonorous waves arriving to the ear and the final electrochemical impulses in the brain. We have designed various complementary materials with the objective of improving the learning. We include multiple representations (written, graphic, animated, etc) in order to obtain a better understanding of the phenomena.

Introduction

Communication process involve three systems: the source that emits, the medium that transmits and the receptor that detects. The knowledge of all of them and how they work can be important for people interested in communication as musicians, engineers, architects, etc. Some of them, related to technical world, could better understand the process using materials developed from a technical point of view. With this aim, we have developed a set of materials that describes the human ear using electro-acoustics basic principles. This model explains the operation of the human auditory system in a simple way.

1 The ear

Human ear is a sophisticated device, that converts in-coming air-pressure fluctuations into electrical nerve impulses for processing by the brain. With our approach (figure 1), we can single out the following components:

- Outer ear (Microphone): The eardrum picks up the pressure oscillations of the wave and converts them to mechanical vibrations.
- Middle ear (Preamplifier): The tiny bones act as a lever system to transfer mechanical vibrations from the eardrum to the inner ear. The force increases approximately 1.3 times in this transfer.
- Inner ear (Frequency analyzer): In the cochlea the vibrations are sorted out according to frequency ranges, picked up by receptor cells and converted into electrical nerve impulses.

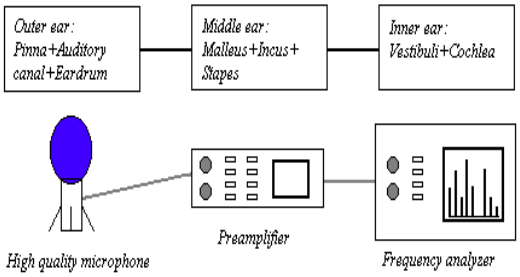

Figure 1. The ear

2 Materials

In order to describe physical processes we use multiple forms of representation: verbal, mathematical, pictorial and physical. Some simulations are included with text, diagrams and formula around. These learning objects allow the observation of the system behavior and facilitate the comprehension of the involved physics concepts.

Conclusions

We have developed didactic materials related to a simplified model of the human ear. They are focused on simplicity, and also on scientific rigor and coherence without an extensive use of the mathematical language.

References

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