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A Study of the Association between the Parameters and Sound Quality of the Designs of Headphone Core

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Abstract

In the current research study, an investigation of the intervention of artificial intelligence in the designs of headphone cores was conducted so that the automated process can be accomplished with the trained network. With the empirical experience in the industry of earphone manufacturing, it can be seen that the design of the headphone was commonly referred to as the culmination of empirical experience, while a large portion of the products was developed based on the modification of diversified and attempts and prototypes. Therefore, the design and production rely on the experience of the senior developers consolidated from the practice, while the associated process is costly and involves extensive wastage. Due to the complexity and the nonlinear association between the selection of the parameters and the resulted sound quality, the intensive involvement of the senior staff and the unpredictable outcomes are commonly seen, while it also limited the rapid development of the products. Thus, the objective of the study is to adopt the machine learning technique to explore the connection between the parameters and the targeted outcome so that a guided and systematic design can result. Practically, the research work characterized the design with the selection of types of divers (dynamic driver/moving coil, balanced armature driver, and planar magnetic driver), magnet (N35, N40, N45, and N50 Grade Neodymium Magnet), voice coils (copper wire, copper-covered aluminium wire, and silver wire), and diaphragm (polyethene terephthalate, polyethene naphtholate, polyetheretherketone, and polyetheretherketone + polyurethane) along with the options of single and double drivers in order to simplify the design problem. Then, the outcome of sound quality was attributed to six parameters, including total harmonic distortion, output power, frequency response, signal-to-noise ratio, speaker impedance, and headroom with seven levels. As a result, the earphone design problem was simplified as 8 inputs and 6 outputs, while the research work was dedicated to finding the black box in connection with the inputs and outputs. The current study adopted the linear regression method, the principal component analysis, and the neural network for the exploration in order to conduct the performance evaluation. After the full investigation of the models, it was found that the neural network provided a promising performance in terms of root mean square error due to its nonlinear nature of it. On the other hand, the limitation of both linear regression and principal component analysis exhibited the limitation in the characterization of the linkage between the independent and dependent variables. Finally, the trained models can be utilized in the design of the earphones for the sake of alleviating human intervention and generating practical impacts on the earphone design process.

Keywords

Earphone Design, Artificial Intelligence, Neural Network, Sound Quality and Computer-aid Design.

Biography

Lui Kwai Hong, Lucas is currently the factory director of Innovative Technology Co. Ltd., dedicated to the research and development of electro-acoustic products for ten years, while he graduated with an Executive Master of Business Administration, University of Hull and a Bachelor of Arts in Information Technology, York University, and presently pursuing a doctorate degree in the Poly University of Hong Kong. Along with his strong technical and practical background, he was heavily involved in different product development projects, including next-generation smart headsets, high-quality acoustic products, etc., while his research interests were the product development process and electro-acoustic product design. Apart from product development, he also keens on the management process of manufacturing and design for production so as to bring the idea to real-life application and the popularization of the new technology for the people.