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Application of EEG Technology in Kansei Engineering

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Abstract

This paper introduces the theory of EEG technology, operation process and the concept of Kansei Engineering, and discusses how EEG technology can be applied to Kansei Engineering. By recording the EEG signals of participants and analyzing the changes of these signals, EEG technology can help designers to understand the needs and responses of users more deeply, thus optimizing product design and improving user experience and market competitiveness. And the future combination of the two in more aspects is prospected.

Keywords

EEG Technology; Kansei Engineering; Industrial Design.

1. Introduction

The application of EEG technology in sensory engineering is an important technical means to understand an individual's cognitive and emotional feedback on products, services, or designs by recording the electrical activity of the brain. This technology can help researchers gain a deeper understanding of user perception, emotional experience, and attention levels, thereby providing strong support for product design and user experience.

2. Introduction of EEG Technology

2.1. Eeg Technology Principle

EEG technology is a non-invasive neuroscience method, which studies brain function and cognitive process by recording and analyzing the electrical activity of human brain. This technology is based on the measurement principle of Electroencephalogram (EEG), which uses electrodes placed on the scalp to capture weak electrical signals from the brain. According to different frequency bands, EEG can be divided into five frequency bands: α, β, δ, θ and γ, and each frequency band corresponds to different cognitive characteristics [1].

EEG technology provides real-time monitoring and analysis of brain activity, which can record the electrical activity of neurons in the cerebral cortex and convert it into visual brain wave charts. By analyzing these waveforms, researchers can understand the changes of the brain in different tasks, emotions and cognitive States.

EEG technology has great potential in product design and user experience. By analyzing users' EEG signals, designers can obtain information about users' preferences, emotional states and cognitive reactions, so as to better understand users' needs and optimize product design. This personalized design can improve the user experience of products and enhance the advantages of products in market competition.

2.2. EEG Experiment Process

The process of EEG experiment is as follows: First, researchers need to prepare EEG equipment and ensure that all components are well connected. Then, it is necessary to make preparations for the subjects, including explaining the purpose of the experiment, assisting in seating and

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attaching electrodes. Before the experiment begins, it is necessary to deal with any noise and interference that may affect the accuracy of the data. Next, set up experimental tasks, which may involve presenting stimuli or performing specific cognitive tasks.

When you are ready, you can start collecting EEG data. At this stage, EEG signals need to be recorded continuously, and baseline records should be made before and after the experiment. Subsequently, researchers need to preprocess and analyze the data, including noise removal, filtering, spectrum analysis and other steps. After processing the data, the results need to be interpreted and analyzed to answer the research questions and draw conclusions.

At the end of the experiment, it is necessary to turn off the equipment and clean up the experiment site to ensure the integrity of the data. These steps together constitute the operation flow of EEG experiment, which ensures the accuracy and scientificity of data acquisition.

3. Introduction of Kansei Engineering

Kansei Engineering is an interdisciplinary field that focuses on the relationship between human perception, emotional and behavioral responses and product design. It combines the knowledge of psychology, ergonomics, design and other disciplines, aiming at guiding product design to enhance user experience and meet user needs by deeply understanding human perception process and behavior response. Emphasis is placed on considering users' feelings, emotions and behavior habits, as well as the intuitive experience generated when interacting with products. By studying the user's perception, emotion and behavior reaction when using products, designers can better understand the user's needs and preferences, and thus create products that are more in line with the user's expectations. Methods include qualitative and quantitative research techniques, such as observation, interview, focus group discussion and questionnaire survey. These methods help designers obtain data about users' perception, emotion and behavior, and then guide the direction and optimization of product design.

In practical application, Kansei Engineering is widely used in the design process of various products, including electronic products, household goods, automobiles, clothing and so on. By putting users at the core of design, designers can create more attractive, easy-to-use and comfortable products with the help of the principle of Kansei Engineering, thus enhancing the market competitiveness and user satisfaction of products.

Kansei Engineering is committed to integrating people's perception, emotion and behavioral response into the whole process of product design, so as to realize more humanized and user-friendly products. By applying the concepts and methods of Kansei Engineering, designers can create products with more emotional resonance and user-friendliness, and bring more pleasant and meaningful experiences to users.

4. The Combination of EEG Technology and Perceptual Engineering

4.1. Combination Principle

Using EEG technology to identify individual emotions and feelings is a research field that has attracted much attention. By analyzing the characteristics of brain wave shape, we can reveal the physiological response of individuals to different stimuli, and then infer their emotional state. For example, when individuals face pleasant stimuli, certain types of brain wave enhancement may occur; When encountering negative stimuli, different brain wave patterns may be observed. Through the collection and analysis of these EEG signals, researchers can try to establish the correlation model between emotion and EEG shape characteristics, and then infer the individual's emotional state. In the field of perceptual engineering, EEG technology mainly uses EEG and ERP. EEG can reflect five frequency bands of people in different mental

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states, including δ wave, θ wave, α wave, β wave and γ wave. These waveforms can be used to evaluate the user's feelings and emotional state of the product. For example, alpha wave is closely related to creativity and top-down processing [2]. The activity of alpha wave in the left frontal lobe can be used as an indicator of pleasure or liking, while the activity of alpha wave in the right frontal lobe is related to negative emotions. Beta wave appears when the central nervous system is excited or nervous, and it increases with the increase of emotional awakening during the product experience [3]. Therefore, we can use the cognitive characteristics corresponding to the above bands to analyze and evaluate the quality of products.

4.2. Combination Situation

Using EEG technology to evaluate the user experience of products, services or designs is an innovative and potential method. By recording EEG signals, users' cognition and emotional feedback on different design elements, interface layout or product functions can be deeply understood. This method can provide more objective and accurate data, help designers and development teams to understand the user's experience in actual use, and thus improve and optimize products.

By analyzing the characteristics of brain waves, we can reveal the cognitive load, attention concentration and emotional state of users when using products or services. For example, when users encounter an incomprehensible interface layout or functional operation, they may show a high cognitive load, and the brain wave shape characteristics will change accordingly. However, when users have positive emotional feedback on a design element, they may show a specific type of brain wave enhancement. By analyzing and interpreting these EEG signals, the design team can get direct feedback about the user experience, and make corresponding improvements and optimizations accordingly.

This method has a broad application prospect in the study of user experience. In the process of product design, EEG technology can be used to evaluate the user experience effect of different design schemes and help the design team choose the best design direction. In user interface design, users' attention and emotional reactions to different interface elements can be detected, so as to optimize interface layout and interaction design. In addition, this method can also be applied to advertising, games, virtual reality and other fields to help evaluate users' perception and acceptance of different experience elements.

Deng Yaqian and others [4] used EEG technology to explore users' perceptual evaluation and response to different color samples, so as to improve the success rate and efficiency of automobile interior design. By analyzing the implicit perceptual information of users, the perceptual evaluation of automobile interior color samples is studied in order to accurately obtain the evaluation information of users on color sensibility. Yang Cheng et al. [5] adopted the method of combining behavioral experiment and EEG experiment, aiming at analyzing the influence of product appearance characteristics (including shape, color and material) and their familiarity (low, medium and high) on product identification.

5. Current Problems and Future Research Trends

At present, there are still some problems in the application of EEG technology in perceptual engineering, including signal noise interference, diversity and individual differences, complexity of data analysis, ethics and privacy issues. EEG signals are easily influenced by environmental noise and electromagnetic interference, which leads to insufficient stability and accuracy of data acquisition. There are great physiological and cognitive differences among different individuals, such as age, gender and cultural background, which may affect the performance of EEG signals and increase the complexity of data analysis. EEG technology

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involves the collection and processing of a large number of sensitive personal data, and privacy and ethical issues are also important issues in current applications.

The future development direction of EEG technology in the field of perceptual engineering is still full of potential. On the one hand, with the continuous progress of technology and the optimization of algorithms, it can be expected that the collection and analysis of EEG signals will become more accurate and reliable, which is expected to solve the current noise and interference problems. On the other hand, combined with artificial intelligence technologies such as machine learning and deep learning, large-scale EEG data can be automatically processed and emotion recognized, which provides more powerful tools and methods for perceptual engineering research.

The future development direction can be better developed in the following aspects: exploring the method of multimodal data fusion, combining EEG signals with eye movement data, physiological signals and other multi-source data, and comprehensively analyzing the user's perception and emotional experience. Some scholars have put forward an automobile modeling evaluation model combining eye movements and EEG signals, and P300 is one of the evaluation indexes [6].

Promote interdisciplinary cooperation, integrate experts in psychology, neuroscience, computer science and other fields to jointly explore the relationship between EEG signals and perceptual experience, and promote the cross-border development of perceptual engineering. In addition, strengthen the personalized research on user groups, consider the influence of different individual characteristics on EEG signals, and realize more accurate user experience evaluation and personalized design. Pay more attention to ethics and privacy protection, establish a sound data management and security mechanism to ensure that the application of EEG technology in perceptual engineering meets ethical standards and protects users' rights and interests. Through continuous technological innovation and cross-border cooperation, the application of EEG technology in perceptual engineering will usher in a broader development prospect.

6. Conclusion

Overall, the application of EEG technology in the field of sensory engineering provides us with unique insights that can help us better understand user cognition and emotional feedback. Despite facing some challenges in practical applications, such as signal interference, individual differences, and complexity of data analysis, with the continuous advancement of technology and the strengthening of interdisciplinary cooperation, these problems are expected to be solved. In the future, multimodal data fusion, interdisciplinary collaboration, personalized research, and ethical and privacy protection will be important directions for the development of EEG technology. Through continuous efforts and innovation, EEG technology will undoubtedly bring more opportunities and breakthroughs to the development of sensory engineering, and make important contributions to optimizing product design and improving user experience.

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