ISSN: 2424-8460(O)
2251-2608(P)

Original Research Article

Research on age-appropriate interface design based on affective computing

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Abstract: With the advent of an aging society, age-appropriate interface design has become the key to improving the quality of life of the elderly. Age-appropriate interface design based on affective computing aims to understand and respond to the emotional needs of the elderly through technical means, thereby providing a more humanized interactive experience. This paper first defines the concept of affective computing and outlines the characteristics of age-appropriate interface design. Then, it discusses in detail key methods such as user emotional need analysis, construction of emotional interaction models, emotional design of interface elements, and design of emotional feedback mechanisms. The research results show that age-appropriate interface design incorporating affective computing can significantly improve the satisfaction and operational convenience of the elderly.

Keywords: Affective computing; Age-appropriate interface design; User emotional needs

1. Introduction

With the intensification of global population aging, how to enable the elderly to better integrate into digital life and enjoy the convenience brought by technology has become the focus of social attention. Age-appropriate interface design not only concerns usability but also involves understanding and responding to the emotional needs of the elderly through technical means. Affective computing, as an emerging interdisciplinary field, its application in age-appropriate interface design provides a new perspective and method to solve this problem. This paper aims to explore the design methods of age-appropriate interfaces based on affective computing, in order to provide references and inspirations for research and practice in related fields.

2. Overview of age-appropriate interface design based on affective computing

2.1. Definition of affective computing

Affective computing is a comprehensive concept covering multiple disciplinary fields including computer science, psychology, and neuroscience. It mainly refers to endowing computers with the functions of recognizing, understanding, expressing, and conforming to human emotions, so as to achieve more natural, intelligent interactions with richer emotional resonances between humans and machines. At the recognition level, affective computing collects human emotional information through various technical means such as speech recognition, facial expression recognition, and physiological signal monitoring. For example, by analyzing the characteristics of speech in terms of tone, speed, and volume, the computer can preliminarily determine whether the speaker's emotional state is excited, depressed, or calm. In facial expression recognition, the computer collects face images with the assistance of a camera and uses advanced image processing algorithms and machine learning models to analyze the movement patterns of facial muscles. A raised corner of the mouth may symbolize happiness, while a frown may imply some kind of confusion or hesitation. In physiological signal monitoring, heart rate and skin conductance data are collected by wearable devices. Since different emotions can trigger different physiological

reactions, such as an accelerated heart rate in a tense state and increased skin conductance in an angry state. To truly understand emotions, on the basis of recognition, we need to further explore the deep meaning and causes behind emotions. Computers need to comprehensively process the collected emotional information and combine it with context, user historical data, and cultural background to accurately grasp user emotional needs. For example, in a conversation scenario, based on the user's previous opinions and current tone and wording, we can understand the emotional tendency contained in the user's speech. To express emotions, computers have many ways. For example, in voice interaction, adjusting the tone, intonation, and speed of speech synthesis can simulate various emotional states. A soft and soothing voice may convey a comforting mood, while a rapid and high-pitched sentence may express urgency or excitement. In the display of graphical interfaces, elements such as colors, icons, and animation effects are used to express emotions. For example, a warm-toned interface may give people a sense of warmth and happiness, while dynamic and vivid animations can create a happy atmosphere. Adapting to people's emotions means that the computer can adjust its behavior and feedback according to the user's emotional state. If the user's emotional state is detected to be unstable, the system can give encouraging words or recommend soothing music and content. In educational software, when students are depressed or confused, the system can adjust teaching strategies to use a more straightforward method to explain. The purpose of affective computing is to break the cold interaction mode between humans and machines and build a bridge full of emotional warmth to provide a more convenient and comfortable experience for people's lives and work.

2.2. Characteristics of age-appropriate interfaces

Age-appropriate interface design mainly targets the special effects generated during the use of digital products and services by the elderly population. It has many significant characteristics. In terms of visual presentation, age-appropriate interfaces generally use large fonts and icons. As the vision of the elderly declines with age, small fonts and tiny icons are difficult for the elderly to recognize. Large fonts are not only easy to read but also reduce visual fatigue. In terms of color matching, high-contrast combinations are more preferred, such as black characters on a white background or white characters on a dark background, which can make information clearer and more eye-catching. At the same time, overly dazzling or complex color combinations are avoided to prevent visual confusion. From the perspective of interface layout, it will use a simple and clear structure. Functional modules are clearly divided, and there is sufficient white space between elements to avoid overcrowding of information. For example, placing commonly used functions in conspicuous and easy-to-operate places and reducing menu levels so that the elderly can quickly find what they need. In terms of interaction operation, age-appropriate interfaces emphasize simple operation and strong fault tolerance. The operation method should be as consistent as possible with the living habits and cognitive abilities of the elderly. For example, using simple gesture operations such as traditional clicking and sliding to reduce complex multi-touch or long-press combination operations. Buttons are designed to be larger, and the tactile feedback is obvious, making it convenient for the elderly to click accurately. At the same time, it has strong fault tolerance. Even if an operation error occurs, it can be easily returned to the previous step or corrected, so that the elderly will not be afraid to operate due to fear of making mistakes. In the interaction process, the procedure is simplified as much as possible, and unnecessary confirmation steps and information input are reduced. For example, voice input and preset options are used to replace manual text input. In terms of content, the information displayed on age-appropriate interfaces is easier to understand. Avoid using professional terms and complex network

buzzwords and use plain and straightforward language to convey information. Provide a large amount of prompt information, help documents, etc., so that the elderly can get timely guidance when they have problems. For example, in the setting function, each step of the operation is accompanied by detailed text descriptions and sample pictures to help the elderly understand and complete the settings. When designing age-appropriate interfaces, the daily life and interests of the elderly are deeply considered. For example, providing relevant sections such as health preservation, latest news, social entertainment, etc., so that they can more easily access and use this information.

3. Design methods of age-appropriate interfaces based on affective computing

3.1. User emotional need analysis

When conducting age-appropriate interface design based on affective computing, analyzing user emotional needs is a very crucial link. Physiologically, due to the decline of physical functions of the elderly, such as decreased vision, hearing loss, and decreased finger flexibility, they have special emotional needs for interface use. They urgently hope that the interface can adapt to their physiological conditions. For example, large fonts and high-contrast displays can reduce their visual burden and make them feel comfortable when browsing information, so as to avoid anxiety and depression due to inability to see clearly. Large operation buttons and clear feedback can enable them to operate accurately and reduce the sense of frustration caused by accidental touches or operation failures. From a psychological perspective, the elderly are more inclined to a sense of security and belonging. In terms of interface design, stable and reliable system performance and a familiar and friendly interface style can give people a sense of security. For example, using a traditional layout and operation mode similar to a device or interface they were familiar with can make them get started quickly and reduce their fear and uneasiness towards new things. At the same time, the addition of social functions also meets their need for belonging. For example, designs that facilitate contact and communication with relatives and friends can make them feel connected with others and increase their emotional satisfaction. At the cognitive ability level, the elderly have relatively slow learning ability and information processing speed. Therefore, the interface requires simplicity, clarity, and logicality. The navigation bar should be clear and the function classification should be clear to avoid complex hierarchical structures and excessive information interference. The way information is presented should be intuitive. For example, using charts, pictures, and other auxiliary text explanations can help them deepen their understanding of the content. Moreover, detailed and patient guidance and prompts for new functions are required to make them gradually familiar with the operation process and meet their emotional expectations when learning new things and overcome the resistance caused by cognitive difficulties. From the perspective of emotional resonance, age-appropriate interfaces should be able to focus on the interests and emotional concerns of the elderly. For example, incorporating design elements based on topics widely concerned by the elderly, such as health preservation and nostalgia. By presenting warm family photos and health tips to stimulate their emotional resonance. And personalized interface elements are designed according to different cultural backgrounds and life experiences. For example, for the elderly with specific regional cultural backgrounds, adding some local characteristic elements can evoke their emotional memories and increase their love and recognition for the interface. In addition, when analyzing user emotional needs, the living scenarios of the elderly should also be considered. For example, interface design in home-based elderly care scenarios should be convenient for querying medical information and controlling smart homes; providing simple-to-operate games

and video playback for leisure and entertainment scenarios. By accurately grasping emotional needs in different situations, designing interfaces that truly meet the psychological expectations and emotional needs of the elderly can enhance the elderly's experience in using digital products and make them feel cared for and respected when interacting with the interface, effectively combining affective computing and age-appropriate interface design.

3.2. Construction of emotional interaction model

Constructing an emotional interaction model is a key link in age-appropriate interface design centered on affective computing. First, an emotional data collection module should be set up. Through various sensors and technical means, various data during the elderly's use of the interface are collected. For example, using a camera to collect facial expressions and analyzing the degree of squinting and the characteristics of the corners of the mouth rising or falling to preliminarily determine the emotional category; collecting voice information with the help of a microphone and analyzing its speed, intonation, volume, and keywords. For example, a fast speech speed and a high pitch may imply an excited or anxious mood. At the same time, physiological data such as heart rate, blood pressure, and skin conductance are collected through wearable devices, and changes in different physiological indicators correspond to different emotional states. Then design the emotional recognition and analysis module. Using machine learning algorithms and combining emotional analysis models, the collected data is processed. Match the facial expression data to the preset expression library and identify the corresponding emotional label; judge the emotional tendency by combining semantic understanding of voice data and analysis of acoustic characteristics; further accurately identify emotions by combining the change laws of physiological data. For example, if the heart rate increases and there is a tense expression on the face and the tone of voice becomes urgent, it can be judged as nervousness. And personalized analysis should be made according to the usage habits and historical interaction data of the elderly to improve the accuracy of emotional recognition. There is also an emotional feedback mechanism module. When the system determines the user's emotional state, it needs to provide relevant feedback. When it is found that the user's emotional state is unstable, the interface will automatically change the color to a warm tone and display encouraging words or suggest relaxing and pleasant content, such as soothing music and interesting stories. From the perspective of interaction methods, if the user shows a confused state, the voice assistant can slow down the speech speed and simplify the language for guidance, and the operation prompts will be more prominent. At the same time, the system can also dynamically adjust the interaction strategy according to the user's emotional changes. For example, when the user becomes gradually familiar with the operation, some personalized recommendation and interaction functions can be appropriately added. For the model optimization and learning module. As the user continues to use the interface, the system continuously collects new data and continuously optimizes the emotional recognition algorithm and interaction strategy. After analyzing and learning a large amount of user data, this model can better meet the emotional needs and usage habits of different elderly people. For example, when the system observes that a user is in a specific emotional state continuously within a specific time period, it is able to prepare corresponding functions or content in advance.

3.3. Emotional design of interface elements

The emotional design of interface elements has an important impact on age-appropriate interfaces based on affective computing. In icon design, simple and highly recognizable graphics are used. For example, for the

communication function, a clear icon of a telephone receiver can be designed to avoid using abstract and difficult signs. At the same time, the icon should be large enough and have bright colors. Given the decline in vision of the elderly, a color combination with a large contrast is adopted, such as a white pattern on a blue background, so that the interface can be clear and easy to understand. Text elements are also very crucial. Easy-to-read fonts should be selected, such as common fonts like Song typeface and Hei typeface. Avoid using overly fancy or artistic fonts. The font size should be larger, and the line spacing and character spacing should be appropriately increased to enhance the readability of the text. Moreover, the expression of words should be plain and easy to understand, kind and friendly, and avoid using rare words and professional terms. In terms of color matching, mainly soft, warm tones such as beige and light blue are used to create a warm and comfortable visual experience for the elderly. At the same time, different functional areas can be distinguished by color, but the color changes should not be too complex. For example, setting the prompt area for important information to warm yellow can not only highlight the information but also not be too dazzling. In addition, the application of animation effects should also be moderate and smooth. For example, after pressing a button, there will be a dynamic effect of slowly enlarging and then shrinking, which can not only provide feedback information for the elderly's operation but also not be distracted by too frequent or complex animations.

3.4. Design of emotional feedback mechanism

In age-appropriate interfaces, the design of emotional feedback mechanisms is crucial for improving user experience. First, establish a multi-channel emotional data collection system. In addition to the information collection through cameras, microphones, and wearable devices mentioned above, the user's dwell time, click frequency, and other operation behaviors on the interface can also be analyzed. For example, if an elder stays on a webpage for too long, it may indicate confusion or interest in understanding the content. Then perform intelligent analysis based on the collected emotional data. This utility model can further improve the interaction experience when the system finds that the user's emotions are more active. For example, when automatically playing happy background music, the interface elements will show some dynamic celebration effects, such as flashing stars or blooming flower animations. When the system detects that the user shows anxiety, such as making frequent mistakes or revealing an urgent mood in the voice, it will automatically provide a detailed operation manual or simplify the current task process. At the same time, in voice feedback, a soft and soothing tone is used. When the user has questions, the voice assistant will answer at a clear and slow speed and provide various solutions for selection. In addition, the emotional feedback mechanism should also have personalized characteristics. Provide customized feedback for different elderly people based on their historical emotional data and preferences. For example, for elders who love traditional culture, some classic patterns or poems are displayed in positive feedback; for elders who love music, play the music types they like as rewards. Through the design of this emotional feedback mechanism, age-appropriate interfaces can better communicate with the emotions of the elderly and improve the user's satisfaction and dependence on the interface.

Conclusion

In summary, age-appropriate interface design based on affective computing can significantly improve the elderly's usage experience by deeply analyzing their emotional needs, constructing emotional interaction models, and designing interface elements with emotional feedback mechanisms. Future research should further refine the

application of affective computing technology in age-appropriate interface design and explore more innovative design methods to meet the diverse usage needs of the elderly and promote their better integration into the digital society.

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References

[1] Ju Yang, Huo Liang. Can emotions be quantified? ——The mechanism and path of metaverse empowering ideological and political teaching evaluation [J]. Journal of Theoretical Guidance, 2024, (10): 120-128.

[2] Wang Yiyan, Zheng Yonghe. The value, dilemma and way out of educational affective computing [J]. Modern Educational Technology, 2024, 34(09): 71-79.

[3] Cui Bowen. Research on psychological early warning of pipeline workers based on multimodal affective computing [D]. Xi'an University of Technology, 2024.

[4] Zhang Yan. Research on movie gender stereotypes based on co-occurrence network and affective computing [D]. Communication University of China, 2024.

[5] Yu Shuzhen, Shan Junhao, Yan Hanbing. Affective computing empowers personalized teaching: logical framework, problem deconstruction and multiple remodeling [J]. Modern Distance Education, 2024, (02): 53-61.