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Original Research Article

The role of AI in optimizing visual design for elderly healthcare users

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Abstract: With the intensification of global agi Brunel University of London ng, the adaptability of elderly healthcare services has become an increasingly pressing issue. As a crucial interactive component in medical systems, visual design significantly influences the operational experience, accessibility, and information acquisition efficiency of elderly users. Starting from the evolution of artificial intelligence (AI) technologies, this paper systematically reviews its core applications in visual design for elderly healthcare—focusing on intelligent interface optimization, personalized visual presentation, and the construction of multimodal interaction systems tailored to the aging population. By analyzing current technological achievements and representative system cases, it explores the potential of AI-based visual systems to improve usability, aging-friendliness, and precision in medical service delivery. At the same time, the study identifies existing technical bottlenecks, ethical risks, and design limitations that hinder widespread adoption. Based on these findings, it proposes a set of recommendations for optimizing aging-friendly visual design and outlines future directions for research and development. The research concludes that AI will play a pivotal role in advancing healthcare systems toward more intelligent, inclusive, and human-centered models—particularly in supporting elderly health, enhancing digital accessibility, and promoting long-term societal well-being.

Keywords*:* Artificial intelligence; Elderly healthcare; Visual design; Interface optimization; Multi-modal interaction

1. Introduction

As global aging accelerates, the proportion of elderly individuals in healthcare continues to grow, making it crucial to improve their experience and health management outcomes. Meanwhile, the rapid advancement of Artificial Intelligence (AI) offers new opportunities for transforming medical services, particularly in visual design and human-computer interface optimization.

Elderly users often face difficulties in using traditional medical systems due to visual, cognitive, and operational decline. To address this, researchers are applying AI technologies—such as intelligent recognition, personalized recommendation, and image analysis—to enhance the usability and human-centeredness of visual interfaces. Vision Attentive Technology, for example, can help tailor interfaces based on elderly users' behaviors and physiological data, improving interaction and coordination[1].

AI is also increasingly integrated into assistive technologies, enabling systems to adapt interface layouts and visual feedback by learning user preferences[2]. This shifts visual design from simple information display to a key factor in service quality and user satisfaction.

However, AI-driven visual design for elderly healthcare is still in its early stages, with underdeveloped frameworks and limited research on personalized, aging-friendly design. This paper explores AI's role in optimizing visual interfaces for elderly users, aiming to improve experience, usability, and service efficiency, and to build a practical design path grounded in AI[3].

2. Literature review

2.1. Overview of visual design in elderly healthcare

With the acceleration of global aging, medical services and health management are continuously evolving toward "aging-friendly" development. The natural decline in cognitive, visual, and auditory functions among the elderly has caused them to face real-world challenges such as complex operations, difficulty in recognizing information, and poor interaction experiences when accessing digital healthcare systems, remote consultation platforms, or self-service medical terminals. As one of the core elements in human-computer interaction, visual design directly affects the user experience and operational efficiency of elderly individuals in healthcare environments. Traditional medical systems often fail to fully consider the visual burden of elderly users in interface design. Common issues include overly small fonts, low color contrast, complex graphics, or excessively long interaction processes.

Researchers have gradually realized that introducing user-centered design into medical visual interfaces—especially strategies focused on the elderly—is key to improving system usability and user satisfaction. For example, Cristiano et al. (2022), in a study on a smart healthcare platform, pointed out that visual interfaces with simplicity, clear structure, and intuitive feedback are more likely to be recognized by both elderly users and clinical practitioners[4]. They emphasized that optimizing visualized information based on user habits and perceptual abilities is fundamental to improving platform efficiency and user engagement.

2.2. Application of artificial intelligence in healthcare design

As a key driving force in current technological innovation, Artificial Intelligence (AI) has been widely applied in the healthcare field and is gradually penetrating areas such as visual interface optimization and interactive experience design. AI not only assists in identifying user behaviors, preferences, and physiological characteristics, but also intelligently optimizes interface layout, content presentation, and interaction logic through algorithmic models, thereby enabling personalized and user-specific design.

Božić (2023) noted that in smart healthcare systems designed for elderly users, AI can be used to automatically adjust the size of interface elements and the contrast of colors, as well as dynamically generate personalized operation paths to improve convenience and safety of use[3]. Additionally, AI can be integrated with graphical user interfaces (GUI) to establish interactive systems with perceptual feedback capabilities. Htet et al. (2024) developed a smart elderly activity monitoring system that integrates AI with GUI technology to create an interaction platform more closely aligned with the usage habits of older adults, significantly enhancing the effectiveness of health monitoring and behavior management[6].

2.3. Design challenges faced by elderly users

Despite the increasing maturity of technological tools, there remain many urgent problems in visual design for elderly healthcare systems. First is the issue of information overload. Many interfaces are designed to be functionally comprehensive but overly complex, requiring elderly users to go through multiple steps to access key information, thereby increasing their operational burden. Secondly, a mismatch between visual decline and cognitive load is also a common problem. Some interfaces fail to sufficiently consider the visual resolution capabilities and information processing speed of elderly individuals, leading to a significantly reduced user experience.

Luo et al. (2024), through research based on the INPD method (Integrated Needs-Perception-Design), found that the key to enhancing elderly interaction experience lies in "de-technologizing" design—making the interface closer to everyday language, using more guided graphics, and ensuring more coherent operations[5]. They

emphasized that the "intelligence" of technology should be reflected in adaptability rather than complexity. A truly excellent AI-based visual design should reduce learning costs while enhancing user confidence.

3. Key application areas of AI in visual design for elderly healthcare

3.1. Intelligent interface optimization technologies

Interface design plays a crucial role in the usability and efficiency of elderly healthcare systems. Common age-related issues such as poor vision, slower response, and cognitive decline often make traditional static interfaces difficult to use. AI addresses this by enabling dynamic optimization of interface structure, layout, and interaction paths. Hmidah et al. (2022) emphasize the importance of data-driven, real-time interface adaptation, which allows systems to respond to user behavior patterns[7]. In elderly healthcare, this enables systems to highlight commonly used functions, simplify steps, and improve overall clarity and responsiveness.

3.2. Personalized visual information presentation

Elderly users have diverse needs depending on their vision, health status, and habits. AI can analyze behavioral data to create personalized visual experiences—adjusting font sizes, contrast, and icon styles for clarity and comfort. Sayed et al. (2023) found that AI-based adaptive content delivery boosts engagement and efficiency[8]. Applied to healthcare, this allows interfaces to adjust content density and presentation order based on user interaction, and further tailor content according to reading preferences, such as text versus visuals.

3.3. Multi-modal interaction design for elderly users

Relying solely on visual output can be limiting for users with sensory decline. AI enables multi-modal systems that incorporate voice, touch, and image recognition to diversify input and output. Pollmann (2021) proposed a "modality card deck" co-created with elderly participants to identify the most intuitive interaction styles[9]. Such systems offer redundancy—e.g., combining voice prompts with graphics—to reduce errors and increase user confidence.

3.4. Case studies of AI-driven elderly healthcare interfaces

Several practical platforms have integrated AI into elderly healthcare interfaces with promising outcomes. Khamaj (2025) introduced an AI-powered chatbot with voice and GUI features to guide consultations and provide personalized tips[10]. It significantly enhanced access and autonomy for elderly users, especially in rural or solitary settings. Other systems using AI in modules like health monitoring, medication reminders, and telehealth have improved usability through simplified visuals and more intuitive interaction flows. These cases demonstrate the real-world effectiveness of AI in creating aging-friendly medical interfaces.

4. Development trends and challenges

4.1. Future trends in AI-based visual design

Artificial intelligence is playing an increasingly important role in advancing medical interfaces, especially visual design. With machine learning, computer vision, and cognitive modeling, AI systems are becoming more adaptive and personalized. Woodman and Mangoni (2023) suggest that AI trained on large-scale health data can support real-time, context-aware interface adjustments based on user behavior[11]. The development of IoT and wearable devices further expands these capabilities into immersive, environment-aware interactions like

voice-guided visuals and AR navigation, enhancing the experience for elderly users.

4.2. Technical and ethical challenges

Despite rapid progress, AI visual systems face technical and ethical challenges. Technically, limited elderly user data affects model training, while device incompatibility and complex algorithms hinder performance. Ethically, continuous data collection raises privacy concerns. Moghadam et al. (2024) note the lack of clear data policies, which weakens user trust[12]. Additionally, low digital literacy among elderly users may lead to anxiety or resistance when using overly complex interfaces.

4.3. Design recommendations

To improve usability, design should shift from technology-driven to user-centered. Interfaces should be simple, with minimal information load and clear layouts. Adaptive features like adjustable fonts and layouts should cater to personal needs. Multi-modal inputs—such as voice, touch, and haptics—can assist those with sensory limitations.

Involving elderly users in early design through co-creation methods ensures better usability. At the policy level, clearer standards, ethical guidelines, and privacy protections are essential for building trustworthy AI-powered healthcare systems.

5. Conclusion

As artificial intelligence continues to evolve, medical systems are shifting from function-oriented to experience-oriented models. In the context of population aging, optimizing visual interfaces for elderly healthcare through AI has become essential for building smart, inclusive medical services. This paper reviews relevant literature and technological trends, highlighting the role of AI in interface optimization, information presentation, and multi-modal interaction, while identifying current challenges and future directions.

AI offers clear advantages in elderly healthcare visual design. It enhances adaptability, personalizes content, and supports intelligent interaction, addressing the varied needs of elderly users more effectively than traditional designs. AI-driven systems can respond to user behavior in real time, adjusting layouts and content to reduce cognitive load and operational errors during medical interactions.

However, several challenges remain. Technically, algorithm complexity, system stability, and cross-platform compatibility require improvement. Ethically, there is a lack of established frameworks for privacy protection, data transparency, and digital rights. Design-wise, many systems still overlook the actual habits and preferences of elderly users, resulting in interfaces that may be intelligent but not user-friendly.

These issues underscore that technological progress does not automatically improve user experience. Truly aging-friendly AI visual design must be grounded in a deep understanding of users, respect for diversity, and the safeguarding of individual rights.

About the author

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