OPINION

AI-Driven Horizons; Transforming Assistive Technology for Inclusive Healthcare: An opinion Article

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ABSTRACT

Background: Assistive technology (AT) has grown from a specialized field into a major source of mainstream innovation, while also benefiting from rapid advances in everyday consumer technology. Artificial Intelligence (AI) refers to computer systems capable of tasks requiring human intelligence, such as speech recognition, visual processing, and object identification. Forms of AI relevant to AT include generative AI, transfer learning, human-in-the-loop AI, and embodied AI. AI is integral in developing adaptive aid, autonomous wheelchairs, guidance systems, facial recognition tools, and smart home platforms, facilitating communication, mobility, and independence. **Objective**: This opinion article examines the role of artificial intelligence in assistive technology, exploring how AI-driven innovations can optimize health outcomes for individuals with functional impairments by enhancing accuracy, personalization, and scalability of assistive solutions, while addressing inherent limitations and challenges specific to AI applications in this field. **Key Points**: AI-powered AT systems offer extraordinary accuracy, personalization, and scalability through machine learning algorithms, speech recognition, smart prosthetics, and autonomous guidance systems. However, these systems face challenges including data bias, limited generalizability, privacy concerns, and short real-world evaluation. Despite these challenges, AI continues to transform assistive healthcare by enabling more adaptive, responsive, and user-centered technologies that promote greater autonomy and quality of life for people with disabilities. Continued advancements and rigorous real-world testing are imperative to address these limitations and fully realize AI's potential in assistive technology. Additionally, the validation of these systems through more extensive and long-term real-world testing is crucial to ensure consistent safety and effectiveness. Current AT development remains in its infancy, with persistent limitations in speech recognition for dysarthria and safety detection in smart wheelchairs. **Conclusion**: AI-powered assistive technology (AT) offers remarkable accuracy, personalization, and scalability through machine learning, speech recognition, smart prosthetics, and autonomous navigation. These systems significantly improve independence and quality of life for individual with functional impairments by adapting to individual needs. While ongoing challenges include addressing data bias, enhancing model generalizability, ensuring privacy, and validating long-term safety, continued innovation is driving rapid progress. Limitations remain in areas like speech

recognition for dysarthria and hazard detection in smart wheelchairs, but these spur further research and refinement, promising smarter, more responsive, and accessible AT solutions in the near future.

KEYWORDS
Assistive Technology; Artificial Intelligence; Functional Impairment; Healthcare Technology

INTRODUCTION

Assistive technology (AT) encompasses any commercially purchased, altered, or customized system, piece of equipment, or device intended to preserve, enhance, or improve the functional abilities of people with functional impairments. It includes goods and services designed to improve autonomy, involvement, and wellbeing in all facets of daily life, from mobility and communication to self-care and mental health (1). As we stand at a pivotal moment in technological evolution, artificial intelligence (AI) presents extraordinary opportunities and complex challenges for the assistive technology (AT) landscape.

The Evolution of Assistive Technology: A Two-Way Street

Assistive technology has continuously taken the lead in the development of new technologies. Historically, many innovations that are now widely used were initially created to meet the needs of people with functional impairments. Many technologies we use today such as word prediction software, environmental control systems, audiobooks, text-to-speech apps, and even early virtual assistants were originally developed as solutions for people with functional impairments before becoming mainstream (2). However, the opposite trend has also emerged. Ordinary technologies have become necessary for people with functional impairments as they fully adopt accessibility and universal design principles. Technologies like smartphones, smart home appliances, and voice-activated platforms not only promote independence and involvement but also enable meaningful engagement with environments and communities. This bidirectional relationship between AT and mainstream technology continuously promotes inclusivity and stimulates innovation (2).

Understanding Artificial Intelligence in the AT Context

The capability of computer systems to carry out tasks like speech recognition, visual processing, and object identification that typically need human intelligence. Generative AI, known for creating text, images, and audio, is one of the most familiar forms of artificial intelligence but it's just one branch of a broader field. Other important types include transfer learning AI, which helps machines understand and translate language; human-in-the-loop AI, used in areas such as facial recognition and medical diagnosis; and embodied AI, which brings intelligence to physical systems like robots, drones, and self-driving vehicles.

Every type of AI has potential applications, and many types of AT are now digitally connected. AI contributes to the development of autonomous wheelchairs, assistive devices, and guide systems for the blind and visually impaired. (3). Research has explored using facial recognition technology as a tool to help people who struggle with social interaction (4). Numerous AI-based solutions have already gained extensive acceptance. For example, AI has transformed speech recognition technology, making it more accurate and useful in assistive applications. Similarly, AI-driven smart home systems have shown remarkable benefits, enhancing user's mental well-being, overall quality of life, and independence in daily living. (5,8). AI-powered wearable devices offer real-time health monitoring for people with chronic illnesses or disabilities, enabling early intervention or personalized care through continuous data analysis. Communication aids, such as those that interpret sign language, eye movement, or augmentative input, allow individuals with severe speech or motor impairments to interact with their environment and others more effectively.

The Irreplaceable Role of Natural Intelligence

The term "natural intelligence" describes the innate emotional, cognitive, and adaptive capacities of biological beings, particularly humans. Unlike artificial intelligence, which is created using algorithms and data, NI results from evolution, genetics, experience, and environmental interaction [6]. It includes perception, learning, memory, reasoning, creativity, problem-solving, and emotional control.

NI's adaptability represents one of its main features. Humans can apply common sense to new situations, transfer knowledge across contexts, and learn from limited data. Additionally, NI combines intuition, ethical judgment, and abstract thought to facilitate decision-making in challenging, uncertain situations. In contrast to machine intelligence, which frequently depends on clear programming or vast amounts of data, NI is strong, context-aware, and capable of balancing empathy, moral principles, and logical reasoning [7]. When it comes to assistive technology, NI is essential for directing ethical design, human oversight, and ensuring that technologies meet actual human needs.

Table 1: Artificial Intelligence (AI) Characteristics in Assistive Technology Contexts

Characteristic	Description
Algorithmic processing	Data-driven and pattern recognition
Task-specific	Designed for focused applications
Scalability	Enables wide deployment
Personalization	Adapts to individual user needs
Automation	Handles repetitive tasks efficiently
Lack of self-awareness	Operates based on code and data

The Collaborative Framework: AI and NI in Practice

Artificial intelligence plays a crucial role in assistive technology by providing computational power to analyse vast datasets, detect patterns, and deliver personalized support through tools such as smart home systems, advanced prosthetics, and speech recognition applications. AI excels at automating repetitive tasks and scaling solutions that improve the effectiveness, accessibility, and customization of assistive devices. These AI-driven technologies adapt to individual needs, learning and evolving with user behavior to provide more intuitive assistance. While AI operates based on pre-established models and algorithms, its ability to process real-time data enables more responsive and tailored support for people with disabilities. The integration of AI in assistive technology creates highly effective, inclusive, and adaptive tools that empower users to achieve greater independence and improved quality of life (7).

Impact on Health Outcomes

AI-powered AT systems provide accuracy, flexibility, and customization. For example, AI-powered prosthetics improve mobility and rehabilitation outcomes by adjusting to users' movement patterns using machine learning algorithms (3). People with speech or motor impairments can communicate more successfully thanks to AI-based speech recognition and generative tools, restoring their independence and social engagement. AI-powered smart home systems help people with physical or cognitive impairments live more independently, become less dependent on caregivers, and experience improved psychological wellbeing (5). AI-enabled wearables also monitor health in real time, detecting early complications and supporting tailored rehabilitation plans. AI-based speech recognition and generative tools assist individuals with speech or motor impairments by enabling more effective communication, thereby restoring independence and enhancing social participation. Such technologies translate speech or limited motor inputs into

clear, understandable communication, empowering users to interact confidently in various social and professional contexts (13). Collectively, AI-powered assistive technologies represent a significant leap forward in enhancing autonomy, participation, and quality of life for individuals with disabilities by providing tailored, intelligent support across mobility, communication, and health management domains.

Challenges and Limitations

AI-powered assistive technology systems face several challenges in their development and deployment. These include issues related to data bias, where training data might not represent all user groups equally, potentially resulting in unfair or less effective assistance. Limited generalizability is another concern, as AI models trained in specific contexts may not perform well across diverse real-world environments. Transparency issues arise because some AI systems operate as "black boxes," making it difficult to understand or explain their decisions. Safety considerations are also raised by malfunction hazards in critical health settings. Since many AI assistive devices handle sensitive behavioural and health data, privacy is crucial, and careful adherence to data protection laws is necessary. Many AI-based AT solutions are still in early stages and exhibit shortcomings, such as speech recognition challenges for users with dysarthria and smart wheelchairs lacking reliable hazard detection like stair recognition. Despite AI's long presence in AT, its full potential and long-term impacts remain to be realized, necessitating continued cautious development and improvement. Many assistive technologies remain in early developmental stages with significant drawbacks. For example, speech recognition systems frequently fail to reliably interpret the voices of people with dysarthria (9). Similarly, smart wheelchairs continue to lack accurate recognition of hazards like descending stairs a crucial safety requirement despite increasingly incorporating features like obstacle detection (10). Even though AI has long been incorporated into assistive technology, the field is still primarily regarded as being in its beginning. Since its full potential, optimal uses, and long-term effects remain unknown, careful application and ongoing improvement are required.

The Path Forward: Collaboration and Ethical Development

Even though technology is rarely neutral or equally accessible, assistive technology continues to play a crucial role in furthering the objectives of the UN Convention on the Rights of Persons with Disabilities (UNCRPD) (11). A fair digital transition in line with the Sustainable Development Goals requires cooperation between industry, government, private providers, and civil society to guarantee that the advantages of artificial intelligence in AT are shared equitably (12). Healthcare professionals and assistive technology (AT) users must be meaningfully involved in the development process to address the challenges posed by emerging technologies. Their involvement is essential not only for influencing the design of these technologies but also for directing their ethical application and affecting the laws, rules, and guidelines that administrate them. A strategy focused solely on artificial intelligence (AI) is required, where AI offers scalability, accuracy, and adaptive capabilities to effectively meet the diverse needs of individuals with functional impairments. Meaningful stakeholder engagement ensures that AI-driven AT solutions are user-centered, ethical, and accessible, thereby promoting greater autonomy and improving quality of life. As AI continues to evolve, its integration into assistive technologies will create more intelligent, personalized, and inclusive systems that empower users and foster equitable access.

CONCLUSION

The future of assistive technology lies in leveraging the complementary strengths of artificial intelligence (AI) and other cutting-edge technologies to create more adaptive, personalized, and effective solutions.

Continued commitment to expansive research and innovation is crucial to advancing the field. Active involvement of assistive technology users in all stages of research and development from designing and evaluating products to addressing ethical considerations and shaping policy will ensure that advancements meet the genuine needs of individuals with functional impairments. Adopting this collaborative, human-centered approach is key to realizing the full potential of assistive technology to enhance autonomy, participation, and wellbeing for all.

Authors Contribution

Suman Badhal and Ravinder Singh conceptualized the study, provided the core idea of the manuscript, and contributed to the overall writing and guidance of the work. Arvind Vashist and Kajal Hans were primarily responsible for drafting the manuscript, data interpretation, final review, and carrying out all necessary revisions and amendments. All authors have contributed equally to this work and approved the final version of the manuscript.

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Conflict of Interest

There are no conflicts of interest.

Declaration Of Generative AI And AI Assisted Technologies In The Writing Process

The authors haven't used any generative AI/AI assisted technologies in the writing process.

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