

Research on the Development of Immersive Communication Industry Driven by AIGC in Metaverse Scenarios

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Abstract. In the current digital age, the concept of the metaverse is rapidly becoming the new frontier in internet development. The metaverse integrates technologies such as Augmented Reality (AR), Virtual Reality (VR), and Artificial Intelligence (AI), with the aim of creating an entirely new virtual space that offers users an unparalleled immersive experience. Within the metaverse's development wave, Artificial Intelligence Generated Content (AIGC) technology plays a pivotal role in the immersive communication industry. This paper aims to explore the application of AIGC in metaverse scenarios and analyze its driving force in the development of the immersive communication industry. Through a review and analysis of existing literature, this study reveals that AIGC technology not only generates highly personalized and interactive content for users but also enables more efficient content production and distribution, bringing about a qualitative leap in the communication industry. The study also addresses the challenges brought about by AIGC technology, including issues related to content copyright, ethical considerations, and user privacy protection. This paper proposes a series of recommendations for future research and practice, with the hope of providing reference for the sustainable development of the metaverse.

1 Introduction

With the rapid advancement of technology, particularly the breakthroughs in Artificial Intelligence (AI) and Virtual Reality (VR) technologies, the concept of the metaverse is gradually becoming a reality. The metaverse is a network composed of various virtual worlds, aiming to simulate real-world social interactions, economic activities, and cultural experiences through highly interactive and immersive virtual environments. In this context, Artificial Intelligence Generated Content (AIGC), as an emerging content creation model, is driving a revolution in the communication industry.

This paper aims to analyze the current application status and future trends of AIGC technology in the metaverse, exploring how it is shaping the communication industry and guiding the industry's development trajectory. The article first introduces the concept of the metaverse and its intersection with AIGC, analyzes the opportunities and challenges of AIGC in immersive communication, and discusses its impact on content creation methods, communication models, user experience, and industry structure. The study also delves into the ethical, legal, and social issues involved, as well as their potential impact on industry development and user experience. Through in-depth research on AIGC technology and its application in metaverse scenarios, this paper aims to provide theoretical and practical guidance for understanding and grasping the future of the immersive communication industry.

2 Overview of the Metaverse and AIGC Technology

2.1 Analysis of the Metaverse Concept

The term "Metaverse" originated from Neal Stephenson's 1992 science fiction novel *Snow Crash*, where it referred to a digital universe constructed via virtual reality technology, running parallel to the real world. Over time, this concept has evolved to encompass a richer and more tangible meaning. The metaverse can now be understood as a persistent, 3D-simulated, interactive virtual space that integrates numerous technologies such as Augmented Reality (AR), Virtual Reality (VR), blockchain, and social networks [1]. Within this space, users can engage in social interactions, entertainment, economic transactions, and other activities similar to those in the real world, using digital identities—commonly known as "avatars."

The metaverse is centered on providing an immersive experience, allowing individuals to transcend the limitations of physical space and engage in a simulated world from entirely new perspectives. Its vision is to create an ever-expanding digital universe where the virtual and the real converge, collectively shaping human lifestyles and communication methods. This holds immense growth potential, particularly in industries like gaming, social networking, education, work, and creative content creation.

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2.2 Introduction to AIGC Technology

AIGC refers to the use of AI systems, particularly machine learning and deep learning algorithms, to automatically or semi-automatically generate creative content. AIGC technology works by analyzing large volumes of data, learning the specific formats and styles of particular content, and then creating entirely new text, images, music, videos, game elements, and more [2]. These outputs can be applied in a wide range of sectors,

including news reporting, social media, advertising, and the entertainment industry.

AIGC represents a significant breakthrough in content creation, as it offers the ability to generate high-quality materials at scale, without the need for traditional human input. This makes it a highly efficient tool in content production, providing new avenues for creative expression and industry innovation. As shown in Figure 1:

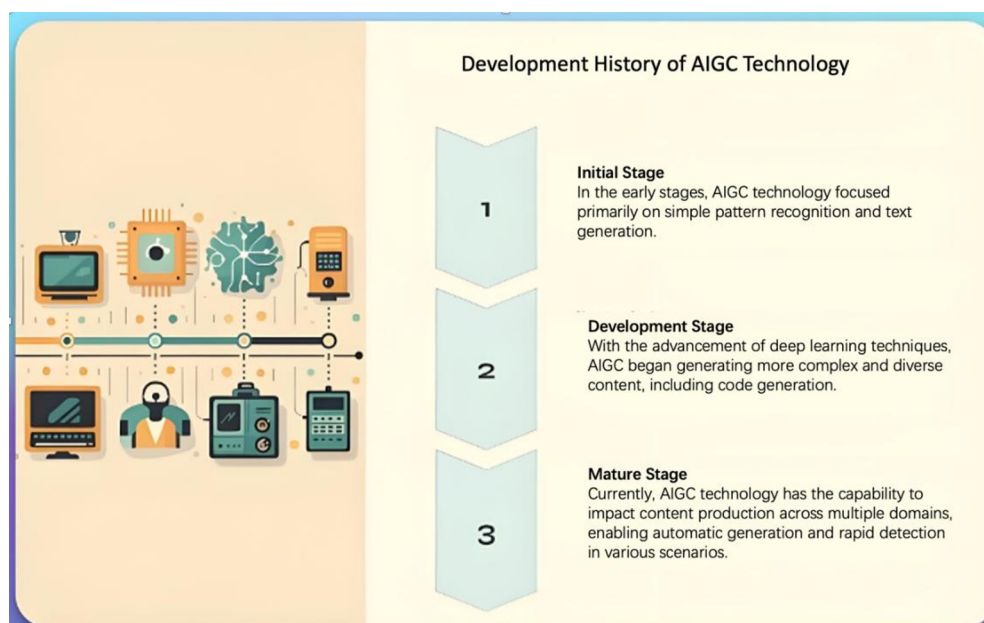


Fig. 1. Development History of AIGC Technology

The core of AIGC technology lies in algorithmic models, which are trained to understand and imitate human creative processes. For example, Natural Language Processing (NLP) algorithms can generate grammatically correct and contextually relevant text, neural networks can create visual artwork, and Generative Adversarial Networks (GANs) are capable of producing realistic images and sounds [3]. These technological advancements enable AIGC to not only efficiently produce content but also ensure diversity and personalization, catering to the needs of different user groups.

With the enhancement of computational power and optimization of algorithms, the accuracy and applicability of AIGC continue to improve. This allows AIGC to offer users a more dynamic and interactive content generation experience. Particularly in metaverse scenarios, AIGC can interact with users in real time, adjusting content output based on user behavior and preferences, thereby driving the development of the immersive communication industry.

However, AIGC technology also presents new challenges, particularly in the areas of content authenticity verification, intellectual property protection, and addressing algorithmic biases, all of which require further research and regulatory development. As the technology evolves, AIGC is expected to transform traditional methods of content creation, distribution, and consumption, while bringing unprecedented opportunities to the communication industry.

3 Current Applications of AIGC in the Metaverse Immersive Communication Industry

3.1 Case Studies of AIGC Technology in Metaverse Scenarios

The metaverse provides an ideal platform for the application of AIGC technology, as it not only requires vast amounts of content to populate its virtual worlds but also demands that this content dynamically adapts and responds to user interactions. Below are examples of AIGC technology applications in metaverse scenarios:

Virtual Characters and Interactive Assistants: In the metaverse, AIGC can generate virtual assistants or characters with personalities and emotions, capable of interacting with users in real time and offering personalized services. For instance, they can serve as non-player characters (NPCs) in games, engaging in dialogue, providing task guidance, or narrating stories. AIGC technology can generate the appearance and personality traits of virtual characters based on simple textual descriptions from users. For example, users can input descriptions such as "a female character in a red dress with long hair and a smile," and utilize GANs to generate a corresponding 3D virtual character. This technology not only enhances design efficiency but also enables rapid adjustments to the character's appearance

and behavior patterns according to users' personalized needs. AIGC technology extends beyond generating virtual characters' appearances, as it can also imbue them with intelligent behavior and interaction capabilities. Through Reinforcement Learning (RL), virtual characters can be trained in simulated environments to learn how to interact with users. For example, virtual characters may respond to user inputs by smiling, nodding, or dancing, significantly enhancing the immersive user experience.

AIGC's Natural Language Processing (NLP) Technology enables virtual characters to understand users' natural language inputs and generate context-appropriate dialogue. Pretrained language models such as GPT-3 and GPT-4 provide virtual characters with powerful conversational abilities, allowing them to answer user questions, engage in casual conversations, and even generate humorous or emotionally nuanced responses based on context. This technology has been applied in virtual museum tour guide scenarios, where users can ask the virtual guide for information about exhibits, and the guide responds accurately and in detail, even recommending other relevant exhibits based on users' interests. The application of AIGC technology in the metaverse is not limited to virtual character creation but also extends to the creation and optimization of virtual environments. For instance, AIGC can update the content and layout of virtual scenes in real time based on user behaviors and feedback, providing a richer and more personalized experience. AIGC also supports social interactions between virtual characters in the metaverse, enabling them to generate appropriate dialogue content based on users' emotions and contexts.

Custom Content Creation: AIGC empowers users to create unique content in the metaverse, such as clothing designs and architectural layouts, without requiring professional skills. With the help of AIGC technology, users' initial designs can be automatically refined into high-quality works.

Event and Story Generation: AIGC enables metaverse games and social platforms to generate new storylines and events, keeping the virtual world dynamic and changing, thereby enhancing players' sense of immersion and belonging. For example, the game company Cyber Manufacture Co. released a preview of its latest AIGC technology, Quantum Engine, which allows users to interact with NPCs using natural language, and the AI generates storyline interactions based on users' expressions in real time. This technology application allows the story in games to no longer be fixed scripts but to be dynamically generated based on players' choices and actions, significantly enriching the gaming experience. Another example is AI Dungeon, a game that uses AI technology to generate personalized adventure stories. Based on players' inputs and choices, the AI provides different narrative directions, offering a unique gaming experience. This dynamically generated storyline not only increases the game's playability but also allows players to experience novelty and challenge in each session.

AIGC technology is being used to create a continuous, self-evolving virtual environment that can change based on user behavior and preferences, offering

users a unique experience. However, the accuracy and creativity of AIGC-generated content still require continuous improvement to ensure it aligns with user expectations while maintaining the coherence and logic of the metaverse world. As shown in Figure 2:



Fig. 2. AIGC Technology in Metaverse Scenarios

3.2 Current Development of the Immersive Communication Industry Driven by AIGC

The emergence of AIGC has reinforced multiple aspects of the immersive communication industry, particularly in content creation, user interaction, and the provision of personalized experiences. This technology has transformed the traditional model of content generation, with the current situation as follows:

Provision of Personalized Experiences: By integrating user data analysis, AIGC can generate highly personalized content, thus attracting and retaining user attention. Whether for personalized news, educational materials, or advertisements, AIGC ensures that the content aligns with users' needs and interests.

Efficiency and Cost-Effectiveness: AIGC technology can rapidly and continuously produce large amounts of high-quality content, reducing the time and cost associated with traditional content production. This is particularly crucial for providing continuous updates for large-scale metaverse platforms.

Interactive Storytelling: In a metaverse environment, AIGC can enable dynamic, interactive storytelling, adjusting the storyline based on user decisions and behavioral patterns. By offering multiple narrative paths, it significantly enhances the immersion of the story and the user's sense of participation. Although AIGC technology is still developing and improving, it has already shown tremendous potential in the immersive communication industry. However, as this industry grows, deeper research and regulatory measures will be necessary to address issues such as privacy, copyright, and content moderation, ensuring the healthy and sustainable development of the sector.

4 Challenges and Opportunities for the Immersive Communication Industry Driven by AIGC

4.1 Challenges Faced

4.1.1 Technological Challenges

Despite offering significant advantages in efficiency and innovation potential, AIGC technology still faces several challenges. First, there is the issue of content authenticity and accuracy. AIGC must ensure that the generated information is factual and reliable, avoiding the spread of false information or inaccuracies. Additionally, the limitations of the technology lie in its difficulty to fully replicate the complexity of human creativity, especially in understanding the subtle differences in culture, emotion, and context. Furthermore, for large-scale metaverse environments, the technology must handle a vast number of concurrent user interactions while maintaining content coherence and logical consistency, all while ensuring system stability and security. Algorithmic bias is also a key issue—if the training data contains biases, the content generated by AIGC could also reflect those biases, leading to unfair or discriminatory outcomes.

4.1.2 Regulatory Challenges

With the widespread application of AIGC technology, there is increasing pressure to update legal and regulatory frameworks. Copyright is a major concern, as AIGC-generated content may involve issues such as plagiarism and intellectual property infringement. To address this, it is necessary to clearly define what constitutes original content and how the copyright of AI-created works should be allocated. Privacy protection also needs to be strengthened, as AIGC systems often require the collection and analysis of user data to personalize content generation, increasing the risk of personal information misuse or leakage. Regulations governing the distribution of AIGC-generated content must be established to prevent the spread of harmful information and protect the public interest.

4.1.3 Social Challenges

The development of AIGC technology has also raised social-level challenges. One prominent issue is the impact on employment, as AIGC may replace creative jobs and content production positions in certain industries, sparking concerns about future job prospects. There is also public skepticism about the credibility of AI-generated content, particularly regarding whether AIGC can truly understand and reflect human emotions and cultural values. Increased social acceptance requires education and transparency to help people understand both the potential and limitations of AIGC. It is essential to ensure that technological development does not exacerbate social inequalities by promoting digital literacy training, ensuring that all social groups can benefit from the transformative potential of AIGC.

Despite these challenges, the application of AIGC technology in the metaverse presents numerous future opportunities, including the creation of new types of professions, improved content creation efficiency and

quality, and unprecedented immersive interactive experiences for users. To seize these opportunities, interdisciplinary collaboration is needed to address the challenges mentioned above.

4.2 Opportunities Faced

4.2.1 New Application Scenarios Driven by Technological Innovation

AIGC technology continues to innovate, expanding its application scenarios within the metaverse and bringing new opportunities to the immersive communication industry. With advancements in algorithms and computational capabilities, AIGC is increasingly able to create highly realistic and refined content, offering users more authentic and dynamic interactive experiences. New application scenarios include highly interactive educational platforms where AIGC can generate real-time educational content tailored to various age groups and learning levels; personalized healthcare consultations where AI assistants provide health advice and treatment plans customized to users' health data; and more enriched entertainment experiences such as virtual concerts and art exhibitions that can adjust content based on audience reactions and interactions. Technological innovation has made these once-imagined scenarios possible, significantly expanding the boundaries of immersive communication and entertainment.

4.2.2 Commercial Opportunities Driven by Market Demand Growth

Having witnessed the transformation brought about by the internet and mobile internet, businesses and investors are optimistic about the metaverse as the next growth point. The surge in user demand in areas such as social networking, gaming, and education is driving the commercialization of AIGC technology. The market's desire for personalized and immersive experiences will undoubtedly drive further innovation in business models, including but not limited to subscription-based personalized content services, event-based virtual experience marketing, and commercialization of advertising and user-generated content. The advancements in AIGC make it a powerful tool for creating differentiation and increasing user engagement. As a result, both startups and large companies can find new growth and profit opportunities in this rapidly expanding market.

4.2.3 Policy Support and Financial Investment

As governments and policymakers gradually recognize the importance of technological advancements for the economy and society, more policies are being implemented to support high-tech sectors, including artificial intelligence and the metaverse industry. National-level research grants, innovation competitions, tax incentives, and entrepreneurial support policies provide strong backing for technological research, development, and application. Venture capital and

private investment are injecting substantial funds into early-stage projects, providing ample financial resources for the research and commercial application of AIGC technology. This policy and capital-driven momentum not only accelerates technological development but also helps the industry navigate through the "valley of death," fostering the growth of startups and the exploration and practice of new technologies in broader fields.

5 Strategies and Recommendations for Promoting the Development of the Immersive Communication Industry Driven by AIGC

5.1 Technological Innovation and Development Path

To promote the application of AIGC in the immersive communication industry, it is essential to continue driving technological innovation and optimizing development paths [4]. Key steps include:

Strengthening Core Algorithm Research and Development: Focus on the research and development of core AI technologies such as machine learning, deep learning, and natural language processing to enhance the content generation quality and innovation capabilities of AIGC [5].

Interdisciplinary Collaboration: Encourage collaboration across disciplines such as computer science, humanities and social sciences, and art and design to enrich the diversity of AIGC content and enhance its cultural and emotional sensitivity.

Achieving Technological Standardization: Formulate and promote industry standards for AIGC technologies to ensure compatibility and transferability of content across different platforms.

Open Platforms and APIs: Establish open AIGC platforms and provide API interfaces to enable researchers and developers to more easily access and utilize these capabilities, thereby promoting the prosperous development of the ecosystem.

5.2 Regulations, Policies, and Standards Formulation

With the increasing prevalence of AIGC technology, it is particularly important to develop supporting regulations, policies, and standards. The following recommendations are proposed:

Clarifying Copyright Ownership: Formulate detailed regulations to clarify the intellectual property ownership of AI-generated content, ensuring the protection of creators' rights.

Protecting User Privacy: Strengthen data security regulations to safeguard users' personal data security and privacy when using AIGC services, and strictly supervise data collection and usage.

Establishing Content Supervision Frameworks: Build transparent content review mechanisms and regulatory frameworks to prevent the generation of

harmful content by AIGC and ensure the safety of public information.

5.3 Social Awareness and Ethical Guidance

To ensure the widespread societal acceptance and proper ethical use of AIGC technology, it is necessary to strengthen public education and ethical guidance.

Popularizing AI Education: Promote foundational knowledge of artificial intelligence at various levels of schools and communities to improve public understanding and awareness of AIGC technology [6].

Discussing and Establishing AI Ethics: Engage in discussions on AIGC ethical issues between governments, industry associations, and academia, and jointly develop and implement ethical guidelines.

Transparent Operations: Encourage operators of AIGC platforms to implement transparent management practices, publicly disclose algorithms and data processing policies, and enhance public trust in AI systems.

6 Conclusion

With the rapid advancement of artificial intelligence (AI) technology, the AIGC-driven immersive communication industry has shown tremendous development potential in the metaverse. It has not only transformed content creation methods by providing personalized, dynamic, and interactive experiences but has also introduced new business models and growth opportunities for the industry. This study systematically reviews the current applications of AIGC in the metaverse immersive communication industry, explores the challenges and opportunities it faces, and proposes corresponding development strategies and recommendations. Technological innovation is key to driving industry growth, while interdisciplinary collaboration, technological standardization, and open platforms can further accelerate the integration and application of AIGC in the metaverse. In addressing regulatory challenges such as copyright, privacy, and content regulation, a clear legal framework and standardized system are crucial. Enhancing public awareness of AIGC technology and establishing comprehensive AI ethical guidelines are prerequisites for gaining widespread societal acceptance.

The future of AIGC technology requires cautious optimism. On the technological front, continuous efforts are needed to tackle issues such as algorithm accuracy, authenticity, and algorithmic bias. On the regulatory front, balancing innovation support with risk management is essential. On the societal front, strengthening education and public communication, as well as enhancing public participation and trust, are necessary [7]. By effectively addressing and leveraging these challenges, the AIGC-driven immersive communication industry is poised for leapfrog development on the vast stage of the metaverse.

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