Proposing novel generative artificial intelligence models in the path of Metaverse development

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Abstract

Generative AI is a new artificial intelligence (AI) technology that can automatically generate new content such as text, audio, image, and video using input data. In this research, the applications of generative artificial intelligence in the metaverse with the modeling approach of artificial intelligence in the creation of avatars, the use of chatGPT in the metaverse, have been investigated. Avatars are widely used as digital representatives of people in virtual environments, video games, online education and other industries. Using generative artificial intelligence algorithms and models, avatars with realistic quality can be created. In this paper, an innovative approach to build in the metaverse using image generative networks such as GAN is investigated. These networks can learn new image patterns according to random inputs and produce diverse and realistic images. Using recognition networks, the quality of the generated image is evaluated to improve the training process. Through these artificial intelligence methods, Metaverse can use advanced technology to create beautiful and realistic avatars and improve the user experience. This article is a review of the technologies as well as the future applications of generative artificial intelligence such as ChatGPT in the development of Metaverse technology, which explains the methods used, the results of the review and suggestions for the development of these technologies in different fields and the creation of creative content.

Keywords: artificial intelligence, metaverse, avatar, generative AI, ChatGPT

1. Introduction

Artificial intelligence (AI) systems are classified into differentiated artificial intelligence and generative artificial intelligence. Technological advances in artificial intelligence for content production have led to the emergence of critical technologies such as GPT chat as components of the Metaverse engine layer, which significantly facilitates the process of creating high-quality content in Metaverse. Artificial intelligence has the potential to dramatically improve the functionality of the metaverse by automating intelligent decision making and creating highly customized user experiences. Generative AI technologies such as GPT chat have the capacity to become productivity tools by addressing the problems of digital assets and content creation and filling fundamental gaps in the evolution of the third generation Internet [1]. The third generation of the Internet, with its distributed network architecture, provides consumers with greater privacy and security when conducting online financial transactions. In addition, immutable data storage and transfer mechanisms enabled by blockchain technology ensure data security and integrity. With the emergence of artificial intelligence technologies, such as GPT chat, there has been a wide attention in the industry to its creativity and flexibility. The efficiency and quality of content production and distribution may be greatly improved with the help of JPT Chat based on deep learning models, which can generate content in various contexts and meet a wide range of needs. In addition to these benefits, GPT chat can facilitate the removal of barriers, increase human understanding and creativity, and generate valuable insights and innovations. JPT chat can also use multimodal artificial intelligence technologies to analyze, interpret and generate more detailed information using different perceptual modes[2]. This enables real-time understanding and response to content and provides flexible feedback, ultimately leading to the creation of richer and more diverse forms of content. Technologies such as virtual characters, speech synthesis, and image generation will be integrated into the process of creating reconstructed content. Technological advances in artificial intelligence for content production have led to the emergence of critical technologies such as GPT chat as components of the Metaverse engine layer, which significantly eases the process of creating high-quality content in Metaverse. Currently, the scale of Metaverse content is still demanding. It has not satisfied the users and the cost of building Metaverse spaces is still high and only affordable for a few companies. Moreover, virtual spaces created with significant investments often lack excitement, openness, and refinement. However, if AI can help creators reduce barriers, the price of building metaverse environments can be drastically reduced, such as providing static scenes with basic descriptions. Generative AI will elevate the amount of content in the metaverse to a new level, reviving industries such as virtual reality and augmented reality. This is especially true when it comes to all platforms that produce or plan to produce metaverse spaces, determining whether metaverse can use the power of artificial intelligence to achieve material richness, and thus even attract users who are very It is important. In this article, the technical key of generative artificial intelligence and its application and potential in the metaverse are examined around the topic of technological developments in the metaverse. And the emerging technology based on generative artificial intelligence has been explored to reduce the technical threshold to realize creativity in the global era [3].

2. Theoretical foundations of generative AI

With the advancement of artificial intelligence technology, generative artificial intelligence has become a significant research area. Generative AI is a new artificial intelligence technology that can automatically generate new content using input data. The theoretical framework of generative artificial intelligence includes machine learning, natural language processing (NLP), image processing and computer vision. Machine learning serves as a fundamental foundation for generative artificial intelligence. Machine learning is a field of study that emphasizes how to build effective algorithms using data, enabling computers to gain new knowledge from data. It can facilitate generative artificial intelligence to learn new content from large amounts of data and create diverse content based on different data sets. Machine learning is a critical foundation for artificial intelligence and includes discriminative and generative models. Discriminative models determine a conditional probability to perform classification and decision making given data, while generative models directly predict a distribution and generate new data [4].

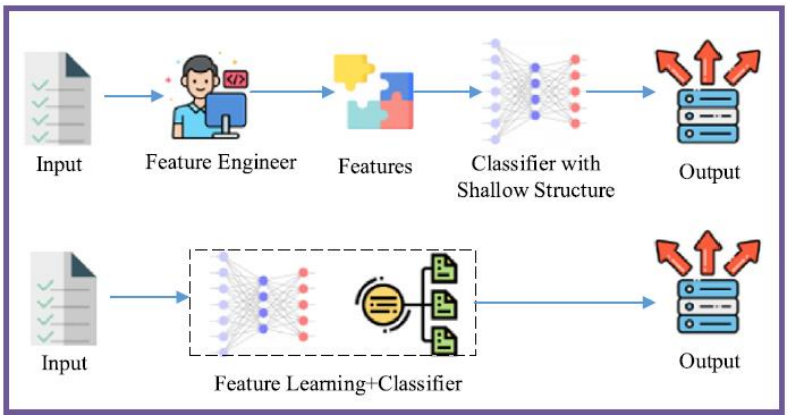

Figure (1) Comparison of workflow between traditional computer vision techniques and deep learning methods in generative AI.

As a result, artificial intelligence systems are classified into differentiated artificial intelligence and generative artificial intelligence. Discriminatory AI has played a vital role in the decade before the current AI era, and its technology is relatively mature.

Based on research, the critical role of natural language processing can be cited as a theoretical basis for generative artificial intelligence. Natural language processing is a field that focuses on human language and facilitates the understanding of human language by generative artificial intelligence and enables the creation of diverse content based on diverse linguistic data. In addition, image processing is another critical foundation for generative artificial intelligence, as it involves analyzing image information to gain new knowledge and generate diverse content from different image collections. Also, computer vision is an important theoretical basis for generative artificial intelligence, because it is related to the processing of image information to acquire new knowledge and generate diverse content from different image collections. Figure 1 compares the workflows between traditional computer vision techniques and deep learning methods.

In summary, machine learning, human language understanding, image processing, and computer vision are all critical theoretical foundations of generative artificial intelligence. These theories can help generative AI to learn new content from large amounts of data and generate different content based on different data sets. In addition, these theories can contribute to the continuous development of productive artificial intelligence and enable its application in various fields [5].

3. Modeling Metaverse parts with generative AI

3-1. Implementation of generative AI

Generative AI works based on learning the probability distribution p(x) and generating new samples from it, in the form of F(•). For example, to generate faces, machine algorithms take into account the constraints of face models,

facial features, and the physical laws of biomechanics, as well as learn from vast amounts of data such as photos, language, and text. This allows the machine to sample and render a subspace associated with the human faces it has learned. Deep neural networks, trained on massive data sets to learn their underlying patterns and probability distributions, are the backbone of generative artificial intelligence. These networks then use generative models to generate new data. Generative artificial intelligence can be obtained through the following two approaches: (1) Autoregression models are generative models based on conditional probability that can generate the next content related to the previously generated content. Common autoregressive models include recurrent neural networks and transformers. (2) Generative Aggressive Network (GAN) are generative models based on adversarial learning that can generate real data such as images and audio. Training a generative adversarial network requires that its generative be pitted against its discriminator in a friendly competition to strengthen the former's capacity to provide realistic data [6].

One of the main algorithms used in generative artificial intelligence is the transformer, which is based on the mechanism of self-attention, as shown in Figure 2 Compared to recurrent neural networks, transformers can simultaneously consider global information and avoid the issue of local incoherence.

The transformer consists of two main components: encoder and decoder. The encoder transforms the input sequence data into a set of feature vectors, while the decoder generates the output sequence based on these feature vectors. In addition to conventional methods, deep learning neural networks are often used in contemporary generative artificial intelligence models. Deep learning uses massive neural networks to learn from data and make predictions. Connected neurons in a neural network transmit messages to each other when stimulated by external stimuli. These methods are used to develop generative artificial intelligence models with capabilities such as image recognition. Generative AI models are also widely used in the production of art, music, and other creative applications. For example, GPT Chat, which is an advanced language model that can generate human-like text from provided prompts, relies on a transformer architecture that efficiently handles large-scale language data. GPT has attracted considerable attention due to its ability to generate coherent and context-relevant text in various applications [7].

Figure (2) Transformer algorithm architecture

3-2. Construction of Metaverse buildings based on generative AI

Castelli & Manzoni (2022) [8] emphasized in their study that generative artificial intelligence is a type of machine learning technology that can generate new output data automatically based on the given input data. The application of this technology in the construction of metaverse buildings can help architects to quickly create complex building structures and improve the efficiency of building design. generative artificial intelligence can help architects to create complex building structures quickly. With generative artificial intelligence, architects can create complex

building structures according to their ideas, such as complex exterior shapes such as arches, circles, triangles, quadrilaterals, and more. In addition, generative AI can help architects rapidly create complex interiors, including interior decoration, layout, and finishing. generative AI can also help architects create complex materials quickly. Architects can use generative AI to create complex materials such as wood, metal, cement, ceramic, steel, rubber, oak, bamboo, aluminum alloy, copper alloy, titanium alloy, etc. Generative AI has the ability to help architects create complex wall decorations, such as murals, carvings, tapestries and other decorations, in a fast and efficient manner. In addition, generative artificial intelligence can assist architects in designing complex performance features [9], such as sound insulation, durability, wind resistance, water resistance, cold resistance, moisture resistance, and resistance. Help against corrosion. In addition, generative AI can also be used to create sophisticated security features that are resistant to theft, water, dust and moisture. Finally, generative AI can be used to quickly create energy efficient features, such as surface water efficiency, wind energy efficiency, geothermal efficiency, photovoltaic energy pool efficiency, groundwater efficiency, etc. In principle, the integration of generative artificial intelligence into the construction of a metaverse building can significantly increase the effectiveness of building design. Lu et al.'s (2022) [10] study shows that generative artificial intelligence can not only help create complex shapes and interior decoration, but also help design complex materials and functional properties, as well as implement energy control methods and energy pool efficiency.

3-3. Modeling Avatar creation based on generative AI

The use of generative AI in Metaverse players is acceptable because it enables developers to produce a wider range of game content. With generative AI, developers can create new maps, monsters, and equipment. Additionally, it can be used to develop distinct metaverse gameplay with unique rules, rewards, and punishment systems [11]. As a result, the gameplay experience can be enhanced, leading to increased player engagement. In their study, generative AI has the potential to enhance players' understanding of game characters and environments, resulting in a more immersive gaming experience. Generative AI can act as an intelligent agent in the game, allowing players to integrate personalized and integrated strategies of various elements. Using generative AI, players can exert more control over game scripts and characters, customize the look of the game, understand characters' emotional states, analyze the game more efficiently, and optimize both game difficulty and the overall player experience. do In addition, developers can use generative artificial intelligence to simulate player behavior and add new content, resulting in an improved gaming experience.

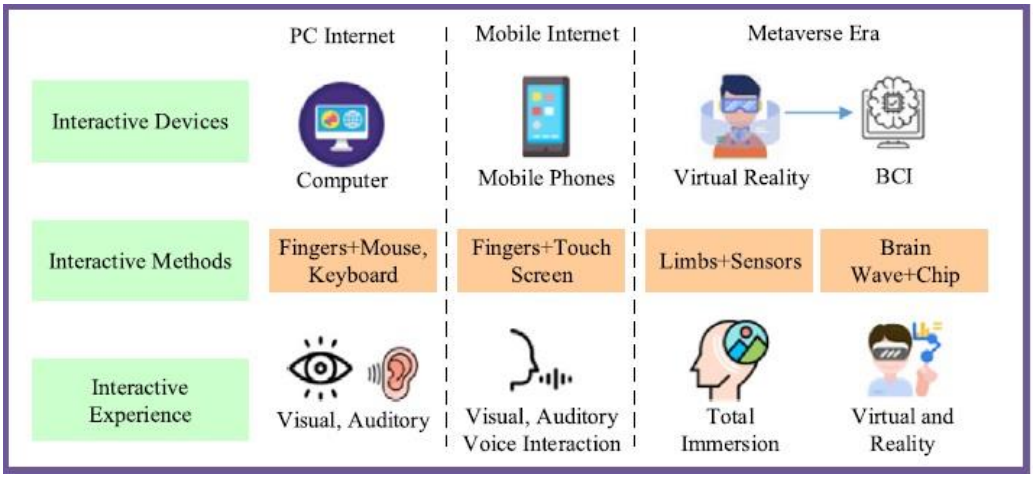

Figure (3) The evolution of interaction methods based on generative AI.

Applying generative AI to player avatars provides exciting opportunities for game developers to create more immersive game worlds and provide players with a more exciting gaming experience. Generative AI has the

potential to enhance the development of more realistic non-player characters (NPCs) for video games. By implementing machine learning techniques, game developers can imbue NPCs with a wider range of behavioral characteristics, enabling them to react differently to different in-game situations. This is in contrast to NPCs with limited, scripted responses. Generative AI can also facilitate the creation of more diverse NPCs by allowing for the inclusion of a wider range of personality traits and behaviors. With such improvements in NPC design, player interaction with NPCs can become more organic and tailored, as NPCs dynamically respond to what players say or do. The use of generative AI in NPCs and dialogue is on the rise, and as developers use machine learning to create diverse and realistic NPCs, players can expect more realistic and varied interactions with their in-game counterparts. Furthermore, advances in brain-computer interfaces could further transform the way users interact with virtual worlds, allowing people to transmit their thoughts directly to in-game agents via brainwaves [12].

This effectively frees users from the constraints of time and space, as virtual worlds manifest themselves directly in the user's mind. Figure 3 shows the evolution of interactive methods that are based on generative artificial intelligence. conversational generative AI is technology that uses artificial intelligence to create natural language conversations. By processing input provided by players, it can generate relevant responses and interpret their intentions, taking into account the context. This technology allows NPCs to express real emotions during conversations and respond differently to player actions. Both conversational artificial intelligence and NPCs are useful technologies that can enhance the immersive experience of games by allowing players to interact with virtual characters. Also, in other fields such as robotics and virtual assistants to facilitate daily communication, these technologies have potential applications.

4. Metaverse content creation based on generative AI

Recent advances in application scenarios and the maturation of underlying interactive technology have given the metaverse a new lease on life. Multi-modal content with immersiveness, low latency, diversity, ubiquity, and clear identity attributes serves as both the fundamental unit and the key pathway to the metaverse. AI will penetrate the entire metaverse ecosystem, playing a role in accelerating content development, increasing content presentation, improving distribution, and maximizing the efficiency of terminal applications. Generational AI, as noted by Zhang et al. (2022) [13] is based on deep learning methods and artificial neural networks that mimic the brain’s structure and function. These systems store, process, and transfer data via interconnected nodes or neurons operating at various levels of a hierarchical structure. NLP activities, including text summarization, machine translation, and dialog systems, have all benefited greatly from the application of generative AI. The Transformer model built on the attention mechanism is one of the most typical and has shown great success in machine translation jobs. generative AI can also be used for image production and image restoration in computer vision. The Deep Convolution Generative Adversarial Network model based on generative adversarial networks is one of the most representative models because of its ability to generate realistic images. In the audio domain, generative AI can be used for tasks such as speech synthesis and music generation.

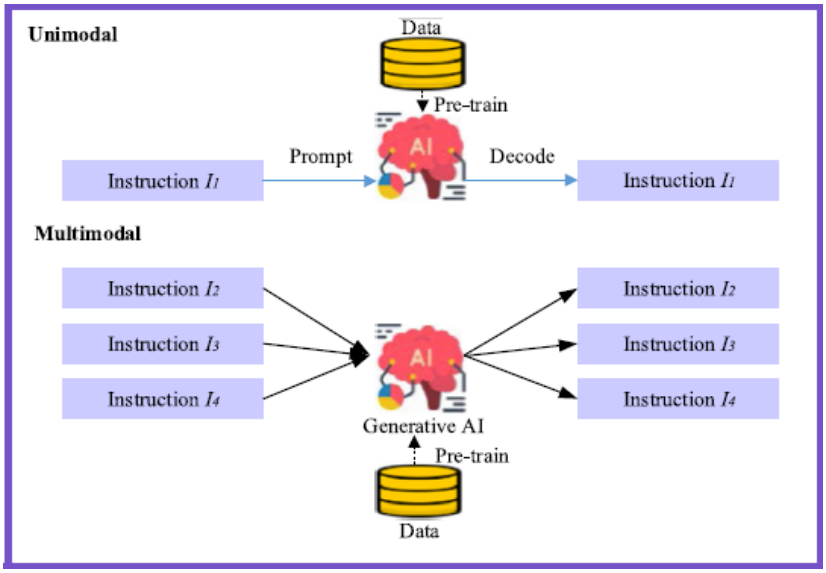

Figure (4) Two types of generative AI models.

The Wavenet model, one of the most prominent examples, can produce convincing synthetic voice and music. There are two main varieties of generative AI models, single-modal and multi-modal, as shown in Figure 4 Single-modal models receive instructions from input types that are the same as their output, while multi-modal models can obtain input from different sources and generate various output forms. Notaro (2022) [14] noted that the emergence of the metaverse is being driven in part by the rapid development of many technolo- gies, one of which is generative artificial intelligence. This technique, based on deep learning neural networks, may generate original conceptual art and other content in response to very straightforward textual instructions. Increased accessibility to AI-generated content interactivity made possible by advances in algorithms and processing power can be achieved through the integration of gen- erative AI with extended reality (XR) and digital twins, among other interactive technologies [85 Production of multi-modal material has become efficient and varied as a result of advancements in AI modeling methodologies, algorithms and computer power.

5. Development and application of ChatGPT in the metaverse era

ChatGPT is an application of generative AI that generates text in response to user inputs in a conversational situation. ChatGPT, driven by the GPT architecture, is a neural network that has been pre-trained using a large

corpus of text. This pre-training enables ChatGPT to generate fluent and coherent high-quality text. Figure 5 depicts the ethical diagnosis framework that is a part of ChatGPT.

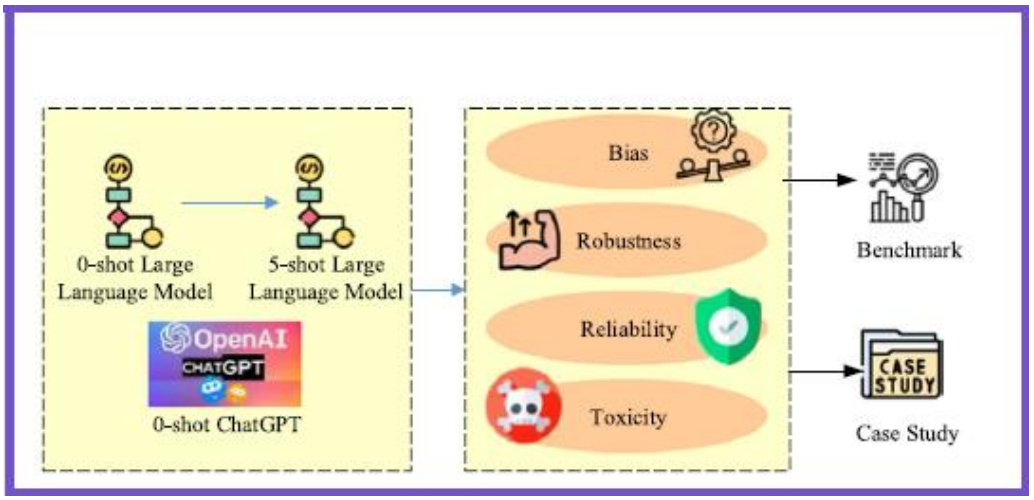

Figure (5) ChatGPT's AI ethical diagnosis framework.

The current focus of metaverse development is on the Professionally-produced Content paradigm to improve the business-to- business (B2B) and business-to-customer (B2C) user experience [15]. The ability of most metaverse products to meet the needs of C2C users is fundamentally hampered, as noted by Guo et al. (2023) [16] , by the research and development capabilities and content production capacity of corporations or platforms. Whether it is a B2B or B2C business model, the ultimate goal is to serve the needs of C2C users, who have diverse demands that can be effectively met by AIGC. As a result of AIGC's content generation approach, everyone and every person in the metaverse has the power to produce material, and everyone benefits from the services produced by this content. This is the essence of Web3.

ChatGPT uses the transformer design, which has been shown to be useful in NLP tasks, as stated by Carnicelli (2023) [17] It is trained on large text datasets such as books and articles and learns to generate text that is similar to its training text. The model processes the input and generates responses when given prompts or context. The model forms words one at a time, which predicts the next word based on the input and the words it has already generated. The model uses an attention mechanism to focus on the most relevant parts of the input and generate consistent and appropriate responses within the given context [18]. Following initial training, the model can be further optimized by feeding it samples from the target task, such as question answering or dialog production. When given language codes or trained on multilingual datasets, it may produce text in a variety of tongues. Dale (2023) [19] pointed out that ChatGPT may continue to enhance its NLP capabilities to better understand and respond to increasingly complex and nuanced queries in the future. There is potential for it to become more individualized as well, learning from users' behaviors and adjusting to meet their own requirements [20]. From a future perspective, there should be no doubt about the potential of ChatGPT to generate "cross-domain" effects, including its specific application scenarios in the metaverse industry. For example, advanced knowledge or experiences from relevant disciplines can be emulated by leveraging the core technologies of ChatGPT, resulting in "integrated innovation". although ChatGPT itself does not have innovative functionality, its deep learning and imitation capabilities which requires further observation may have the potential for "cross-domain" learning and reference.

6. Future Perspective

It is predicted that in the future, generative AI will become smarter, capable of independent learning and decision-making for various tasks, and will provide more intelligent services to users. Furthermore, generative AI technology will become more sophisticated, enabling it to understand human language and behavior, make more precise and

flexible decisions. These advancements will align the generated content more closely with human needs and expectations, facilitating widespread acceptance in various domains such as healthcare, education, finance, and others.

In the realm of education, within the metaverse, leveraging generative AI can facilitate the provision of personalized educational content, assisting individuals in enhancing their skills and knowledge. Similarly, in the domain of entertainment and leisure, this technology can function as an intelligent guide, offering recommendations for engaging content such as games, movies, music, and books tailored to users' preferences. Furthermore, in healthcare, generative AI can play the role of smart assistants, offering solutions to enhance wellness, providing therapeutic guidance, and even aiding in disease diagnosis and prevention.

Additionally, in customer service, tools like ChatGPT powered by generative AI can aid in addressing customers' inquiries and requirements regarding products and services, thereby bolstering customer satisfaction through more accurate responses and appropriate guidance.

In summary, the adoption of generative AI, particularly within metaverse technology, is poised to revolutionize user experience, elevate service quality, boost productivity, and open up new opportunities in this domain.

7. Conclusion

The Metaverse is poised to be a massive and intricate system that will handle an extraordinary volume of simultaneous data. This digital world will also exhibit an exponential increase in the complexity of information due to the expanding dimensions of data, far surpassing the computational constraints of the human brain. This article provides a comprehensive overview of key technologies in the Metaverse and the use of generative AI, highlighting the significant role of Metaverse in various domains such as industry, governance, and scientific research. By integrating core technologies like artificial intelligence, virtual reality, augmented reality, Internet of Things, and blockchain, Metaverse enhances the development of high-quality smart economies. These technologies are becoming the driving force behind future computational power advancements, creating a considerable demand for computational resources and leading to transformations in computational deployment methods.

Artificial intelligence, as a central component of future technology advancement, and its applications such as ChatGPT, along with specialized platforms like Metaverse, have the potential to create a new social and economic space where socio-economic activities can flourish in a closed-loop environment. However, the development and deployment of the Virtual World require deep reflection and study on future prospects. Key issues such as striking a balance between technological advancement and privacy protection, ensuring openness and diversity in spaces like Metaverse, the broad applicability of generative AI, and addressing potential security risks and ethical concerns that may arise with the expansion of users of these technologies need to be carefully examined and deliberated upon.

Therefore, for optimal exploitation of this pioneering digital space, it is imperative that we carefully consider and address ethical, security, and legal issues and provide effective solutions to them.

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