

Innovation and Strategic Path of AI Live-streaming Sales in the Digital Economy Era

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Abstract. Against the backdrop of the vigorous development of the digital economy, traditional e-commerce live streaming is confronted with predicaments such as high costs, lack of innovation, and loss of trust. Enterprises urgently need technology-driven transformation. This article delves deeply into the AI live-streaming e-commerce model in the era of digital economy. AI live-streaming sales rely on multimodal interaction and deep learning to achieve "7× 24-hour" precise live-streaming by virtual hosts. It generates personalized interactive content based on semantic understanding to activate the depth of user participation. Meanwhile, blockchain technology builds a transparent trust mechanism to ensure the authenticity and reliability of transactions. This model not only meets the diversified and personalized demands of consumers, reduces the operating costs of enterprises and enhances efficiency, but also promotes the innovative development of the industry and reshapes the relationship among "people, goods and places". This article also proposes practical strategies such as improving technical facilities, establishing a talent training system, and standardizing management processes to help the e-commerce industry effectively utilize virtual anchors and achieve digital transformation, providing a reference for the global e-commerce technology-driven transformation.

Keywords: Digital E-commerce; AI-powered Product Promotion; Technology Empowerment.

1. Introduction

Against the backdrop of the in-depth development of the digital economy, traditional e-commerce live-streaming entities are facing three structural predicaments: First, the "high-cost dependence" of real live-streamers is becoming increasingly prominent. The rising cost of human resource training and the restrictions on live-streaming duration have led to a marginal decline in operational efficiency, and the industry is at risk of labor disputes and the loss of live-streamers. Secondly, the "exhaustion of innovation" in content creation intensifies users' aesthetic fatigue, and the excessive reliance on scripted scripts and promotional tactics leads to a continuous weakening of user stickiness. Thirdly, the "trust deficit" in the live-streaming ecosystem is constantly accumulating, with frequent false advertising and after-sales shirking, which harms consumers' rights and interests and the foundation for the sustainable development of the industry. To break through the efficiency bottleneck of the traditional model, enterprises have an urgent need for technology-driven transformation. By integrating multimodal interaction technology and dynamic deep learning algorithms, enterprises can not only achieve the "intelligent evolution" of virtual anchors, that is, break through the limitations of time and space to complete 7× 24-hour precise live streaming, but also generate personalized interaction content based on semantic understanding and sentiment computing, effectively activating the depth of user participation. The introduction of blockchain technology, A transparent and traceable trust mechanism can be established through transaction evidence preservation and smart contracts. Based on this, this article analyzes the necessity of introducing virtual digital humans into the live-streaming e-commerce industry in the digital economy era, and explores the practical strategies for live-streaming sales with virtual digital humans in e-commerce under the background

of the digital economy. The aim is to help the e-commerce industry make more effective use of virtual digital human hosts and achieve digital transformation.

2. Connotation and Characteristics of Digital Virtual Person

Although the professional term "virtual digital human"[1] was proposed by scholars or research institutions in related fields as early as the 1980s, due to the limitations of the technological development level and social awareness at that time, it did not attract widespread social attention or in-depth discussion. It was not until the full advent of the digital economy era, along with the rapid development of information technology and the accelerated advancement of social digitalization, that "virtual digital humans" truly came into the public eye and became a hot topic of discussion in all sectors of society, especially drawing extensive attention and high regard from the e-commerce industry[2]. The e-commerce industry has keenly perceived the huge potential of virtual digital humans in enhancing user experience and expanding business models, and has been actively engaged in the research and application exploration of related technologies.

At present, in both the academic research field and the industrial practice level, the industry has not yet formed a unified and precise understanding of the definition of virtual digital humans. Different scholars, research institutions and enterprises have provided diverse explanations for virtual digital humans based on their own research perspectives, technical backgrounds and application requirements. Overall, however, most definitions start from the technical principles, notable features and practical application scenarios of virtual digital humans, conduct in-depth analysis and comprehensive consideration, and thereby draw corresponding and targeted explanations[3].

Based on the viewpoints of numerous scholars and relevant authoritative organizations, it can be found that virtual digital humans generally refer to digital images with highly anthropomorphic features created with the aid of a series of advanced digital technologies such as computer graphics, artificial intelligence, and motion capture[4]. This type of digital image not only has an appearance extremely similar to that of humans, including facial features, body proportions, etc. It also has a rich variety of expressions and can vividly display various emotions such as joy, anger, sorrow and happiness. At the same time, its voice is highly anthropomorphic, with aspects such as pitch, timbre, and speaking speed all as close as possible to the real human voice[5]. In addition, in terms of behavioral performance, virtual digital humans can also simulate various human actions and postures, achieving a high degree of similarity with humans at the behavioral level.

The realization of these virtual digital humans mainly relies on the comprehensive application of technologies from multiple fields such as computer graphics, speech synthesis, natural language processing, deep learning, artificial intelligence, and biotechnology. Computer graphics provides fundamental support for the construction of virtual digital human images, enabling them to present realistic visual effects. Speech synthesis technology endows virtual digital humans with the ability to speak, enabling the output of voice. Natural language processing technology enables virtual digital humans to understand human language input and conduct corresponding semantic analysis and processing. Deep learning technology provides a powerful learning ability for the behavioral simulation and intelligent interaction of virtual digital humans[6], enabling them to continuously optimize their performance. Artificial intelligence technology runs through the entire construction and operation process of virtual digital humans, enabling their intelligent decision-making and interaction. Biotechnology offers new ideas and methods for shaping the anthropomorphic features of virtual digital humans. For instance, by simulating human biological characteristics and behavioral patterns, the realism and credibility of virtual digital humans can be further enhanced.

In practical applications, virtual digital humans simulate human behavior and communication methods through large-scale models and can conduct real-time and efficient voice and visual interactions with humans[7]. They not only have the ability to understand and generate natural language, but also can accurately understand human language intentions and generate responses that are in line with the context and logic. It can also express emotions, display corresponding emotional

states according to different scenarios and interaction contents, and enhance emotional resonance with humans. Meanwhile, virtual digital humans also possess a certain logical reasoning ability, enabling them to analyze and judge complex problems and provide reasonable solutions. Essentially, they are entities existing in virtual Spaces. Although they do not have a real physical form, they can interact with humans in all aspects and at a deep level in the digital world, bringing brand-new experiences and changes to people's lives and work.

3. The Necessity of Introducing Virtual Digital Humans to the Live-Streaming E-Commerce Industry under the Background of the Digital Economy

3.1 Meet the Diversified Demand

The application of virtual digital human technology provides an innovative solution to meet consumers' increasingly diverse demands. In the era of digital economy, consumers' demands are characterized by fragmentation, personalization and contextualization, making it difficult for traditional live-streaming models to effectively cope with them. Virtual digital humans can activate and meet various long-tail consumption demands through scene fission technology[8]. Specifically, enterprises can build multi-dimensional interaction matrices and, based on user profiling and behavioral data analysis, provide precise content supply for different consumer groups. Firstly, through advanced clone technology, enterprises can achieve synchronous operation of multi-theme live streaming rooms, and each virtual host can optimize content for specific audience groups. This model can enhance the efficiency of user selection, thereby significantly reducing the cost of information acquisition for consumers. Secondly, with the help of cross-cultural adaptation algorithms, virtual digital humans can automatically adjust content elements such as language style and product display methods, breaking through geographical and cultural limitations. In addition, virtual digital humans can dynamically adjust the live streaming content based on real-time interaction data, achieving a true "thousands of people, thousands of broadcasts" effect. This intelligent supply system not only enhances consumers' shopping experience but also promotes the process of consumption democratization, ensuring that all kinds of niche demands receive equal attention and satisfaction.

3.2 Improve and Optimize Enterprise Operating Costs and Efficiency

Virtual digital human technology offers live-streaming e-commerce enterprises a brand-new path for cost reduction and efficiency improvement. Under the traditional live streaming model, problems such as high labor costs and low operational efficiency have long restricted the development of the industry. However, virtual digital humans have restructured the cost structure of the industry through automated processes. By integrating virtual anchors into the entire operation chain, enterprises can significantly optimize resource allocation. The saved costs will eventually be transformed into more competitive price advantages to benefit consumers. Specifically, the efficiency advantages of virtual digital humans are mainly reflected in two aspects. Firstly, there is a significant reduction in labor costs. Virtual streamers can achieve 7×24-hour non-stop live streaming while maintaining a stable quality of content output. In conjunction with the intelligent product scheduling algorithm, the system can dynamically adjust the product display strategy based on real-time sales data, effectively reducing the risk of inventory overstock. Secondly, there is the continuous optimization of operational efficiency. The virtual digital human system will form a complete data loop, recording and analyzing key indicators such as user interaction and conversion rate for each live stream, and constantly optimizing the live streaming strategy through machine learning algorithms. Finally, the virtual digital human system has a significant learning curve effect. As the usage time increases, its operational efficiency will continue to improve. This efficiency revolution is driving the entire industry towards lean operation, enabling enterprises to achieve fundamental optimization of their cost structure while maintaining service quality [9].

3.3 Promote the Innovative Development of the Industry

The introduction of virtual digital human technology is not only an efficiency optimization tool for the live-streaming e-commerce industry, but also a key driving force for promoting the innovative development of the industry. Against the backdrop of the rapid iteration of the digital economy, technological innovation and business model innovation complement each other. Virtual digital humans, with their high intelligence, scalability and cross-domain integration capabilities, are reshaping the ecosystem of live-streaming e-commerce and giving rise to new growth points[10]. First of all, technological innovation drives industry upgrading. Virtual digital humans integrate cutting-edge technologies such as artificial intelligence, computer vision, natural language processing, and augmented reality, enabling live-streaming e-commerce to evolve from the traditional "people, goods, and place" model to an "intelligent interactive ecosystem". For instance, based on generative artificial intelligence technology, virtual digital humans can generate dynamic content, adjust live streaming scripts according to real-time user feedback, and even create personalized marketing content, such as automatically generating product reviews and user-customized advertisements. This technological breakthrough not only enhances the intelligence level of live streaming but also provides the possibility for the industry to explore a new model of "AI+ e-commerce". Secondly, business model innovation expands the profit space. The application of virtual digital humans has given rise to diverse business models and brought new growth opportunities to the industry. Enterprises can transform virtual digital humans into brand-exclusive IPs and achieve diversified monetization through cross-industry collaborations, digital peripheral sales, and other means. For instance, L'Oréal's virtual spokesperson "M Sister" not only participates in live-streaming sales but also appears in brand advertisements and social media, forming a full-chain marketing strategy. The user behavior data accumulated by virtual digital humans during live streaming can help enterprises optimize their supply chains, predict consumption trends, and even provide precise marketing support for third parties, forming a data-driven business closed loop.

4. Practical Strategies for Live-Streaming Sales by Virtual Digital Humans in E-Commerce under the Background of the Digital Economy

4.1 Improve the Equipment and Facilities Required for Virtual Digital Humans

The technical infrastructure for virtual digital human live streaming is a prerequisite for the implementation of business models, and it is necessary to build a technical ecosystem that integrates software and hardware. To break through the perception and interaction bottlenecks and computing power constraints of virtual anchors, enterprises should integrate AIGC, digital twin and blockchain technologies to create end-to-end technical solutions. Specifically, first, deploy multimodal interaction devices, including high-precision motion capture systems, 3D scanning devices, and real-time rendering engines and other hardware equipment. These devices can ensure that the expressions, movements, and voices of virtual digital humans achieve a natural and smooth interaction experience. Second, build a distributed computing power network by deploying edge computing nodes to reduce the latency issue of real-time rendering and enhance the smoothness and user experience of the live streaming process. Thirdly, embed a blockchain evidence storage module to utilize the immutability of blockchain technology to ensure the intellectual property protection of virtual avatars and the authenticity and reliability of transaction data. Fourth, enterprises also need to establish a continuous technological iteration mechanism, regularly update hardware equipment and optimize software algorithms to adapt to the rapidly developing market demands. By building such a complete technical infrastructure system, enterprises can provide solid technical support for virtual digital human live-streaming sales, ensuring the smooth implementation and sustainable development of the business model.

4.2 Build a Virtual Digital Professional and Technical Personnel Training System

The technical complexity of virtual digital human live streaming requires the industry to establish a professional talent team to support technological innovation and commercial application. To address the industry pain point of "disconnection between technology development and operational practice", enterprises need to collaborate with universities and research institutions to build a training system that integrates industry and education, and at the same time improve the standards for professional ability certification. Specifically, first, develop an interdisciplinary curriculum system. Universities can collaborate with enterprises to offer a dual-mentor master's program in "AIGC and Digital Marketing", covering courses in natural language processing and consumer behavior analysis, achieving a deep integration of academic theories and business scenarios. Second, establish industry-university-research cooperation training bases to provide students with real project practice opportunities, enabling them to gain practical experience throughout the entire process of virtual digital human development, operation and optimization. Third, implement a vocational skills certification system, formulate relevant vocational ability standards for virtual digital humans, and provide the industry with professional talents with practical capabilities. Fourth, enterprises should also establish internal training mechanisms, regularly organize technical exchanges and business training, and help employees continuously improve their professional skills. By establishing such a comprehensive talent cultivation system, the problem of talent shortage in the industry can be effectively solved, providing continuous talent support for the innovative development of virtual digital human live streaming.

4.3 Establishing Virtual Digital People Carry Standardized Management Process

The compliance risk control of virtual digital human live streaming is the core guarantee for the sustainable development of the business model. To avoid legal disputes and ethical controversies, enterprises need to establish standardized processes covering copyright management, algorithm auditing and crisis response [4]. First, clearly define the intellectual property rights of virtual avatars. At the very beginning of the development of virtual digital humans, sign a complete copyright agreement, stipulating key terms such as the ownership, usage rights, and income distribution of the image, to avoid copyright disputes in the future. Second, establish an algorithm transparency mechanism, conduct regular audits on recommendation algorithms, interaction algorithms, etc., to ensure the fairness and interpretability of algorithm decisions and prevent problems such as algorithm discrimination. Third, formulate an emergency response plan for public opinion, establish a 7×24-hour public opinion monitoring system, and respond and handle possible negative public opinions promptly. Fourth, establish a content review mechanism to conduct real-time monitoring of the live-streaming content of virtual digital humans and ensure compliance with relevant laws, regulations, and platform norms. By establishing such a standardized management process, operational risks can be effectively reduced and the healthy and sustainable development of the virtual digital human live streaming business can be guaranteed.

4.4 Strengthen the Multi-Scene Application and Multi-Platform Collaboration of Virtual Digital Human

To maximize the value of virtual digital humans, it is necessary to break through the limitations of a single scenario and build a cross-platform and cross-industry collaborative ecosystem. To expand the business boundaries of virtual anchors, enterprises should promote the reuse of technology and data sharing. Specific measures include: First, develop a multi-scenario clone system to enable the same virtual digital person to adapt to the needs of different scenarios such as e-commerce live streaming, brand endorsement, and customer service, and achieve multi-scenario value extension through a unified image IP. Second, build a cross-platform account system to achieve account intercommunication and data sharing of virtual digital humans on different platforms such as Douyin, Taobao, and WeChat, and expand the scope of influence. Third, build an industrial collaboration network, establish in-depth cooperative relationships with MCN institutions, content creators,

technology suppliers, etc., and form a complete industrial ecosystem; Fourth, explore the application of virtual digital humans in emerging scenarios such as the metaverse and continuously expand business boundaries through technological innovation. By implementing these strategies, the commercial potential of virtual digital humans can be fully exploited, achieving economies of scale and synergy, and creating greater commercial value for enterprises.

4.5 Construct the Transparent Interaction Mechanism between Virtual Digital People and Users

Users' technical trust and emotional identification with virtual streamers are the key barriers to commercial conversion, which need to achieve mental breakthroughs through experience upgrades and value co-creation. To allay consumers' concerns, enterprises should establish transparent interaction mechanisms and enhance value perception. First, design an interpretable interactive interface. Virtual streamers can simultaneously display AI decision-making basis when recommending products, such as "Recommend low-sugar formulas based on the oat milk you browse", to enhance the transparency of recommendations. Second, embed an emotional feedback system. Virtual streamers can capture users' micro-expressions through emotion recognition algorithms, dynamically adjust the rhythm of their scripts and recommendation strategies, and extend the duration of user interaction. Third, launch a user co-creation program. By inviting consumers to participate in the design of live streaming scripts through virtual ips and generating exclusive plans through UGC content voting, the repurchase rate of fans can be increased. Through the above measures, enterprises can achieve a synergy between the construction of technological credibility and the empowerment of user sovereignty, promoting the evolution of virtual anchors from marketing tools to brand value communities.

5. Summary

In the current era when the digital economy is booming and profoundly reshaping the business landscape, the virtual digital human live-streaming sales model has emerged as a new force in the e-commerce field, attracting widespread attention. This article conducts an in-depth exploration of it. From a technical logic perspective, the technical architecture constructed with AIGC and digital twins breaks the physical constraints of traditional live streaming. AIGC automatically generates diverse content based on massive data, while digital twins achieve precise virtual mapping of real scenes. Combined with dynamic character modeling and multi-modal interaction, it realizes "thousands of people, thousands of broadcasts" precise marketing. Meet diverse marketing demands. In terms of commercial value, compared with traditional live streaming, it has lower costs, can be operated for a long time and avoids the risk of human error. The marketing effect is better. It can optimize strategies in real time based on big data and user feedback, attract young people and enhance brand influence. It has strong scalability and replicability, which is conducive to multi-platform promotion. Meanwhile, virtual digital humans play a significant role in reconstructing the relationships among people, objects, and places. They not only break through physical boundaries to create diverse scenarios and images but also ensure the authenticity and integrity of transaction data through blockchain evidence storage, achieve transaction automation through smart contracts, and build a new trust mechanism, laying a solid foundation for the sustainable development of the industry. This innovative model offers a feasible path for the integration of the digital economy and the real economy, helping real enterprises expand their markets and enhance their competitiveness. It also provides a useful reference for the technology-driven transformation of the global e-commerce industry, promoting the industry to move towards a new stage of intelligence, digitalization and personalization.

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