China's Metaverse Serves Traditional Chinese Medicine

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Abstract. The Metaverse has been contributing to the long-term development of Traditional Chinese Medicine (TCM) medical services. The layout of a wide variety of regions in China in the new track of "Metaverse" has been initiated. China has been subjected to a high incidence of cancer and other diseases, and the aging tends to be increasingly serious. Moreover, the prevalence of chronic diseases and the demand for rehabilitation are rising rapidly. People have always hoped to tackle down the problems of medical resource shortage and patient treatment through technology empowerment. Numerous cutting-edge technologies (e.g., virtual/augmented reality, blockchain and cloud computing) have technically underpinned the Metaverse from concept to reality, and they also serve as the cornerstone of driving the landing of application scenarios in TCM.

Keywords: Metaverse · Traditional Chinese Medicine (TCM) · cloud computing

1 Introduction

The year 2021 is recognized as the first year of the Metaverse. The Metaverse will usher in a new round of rapid exploration, and related technological progress and business model innovation will emerge in an endless stream. The Metaverse is an artificial virtual space running parallel to the real world, in which there is a real design and economic environment. Users exhibit special virtual identity and digital assets in the Metaverse, and they are allowed to interact freely in the virtual world, engage in production and operation activities, and create cost value. Interaction technology, blockchain technology, artificial intelligence technology, electronic game technology, network technology and Internet of Things technology significantly expedite the realization of decentralized economic system [1–5], low latency, improving user immersion, thus satisfying diversified access needs and virtual symbiosis in the Metaverse. Since it is an attractive and typical immersive experience, the universe will first land in the form of games [6–10]. In the future, a huge space will be created for imagination in the industrial ecology of medical and other fields. VR virtual reality, AR augmented reality, MR hybrid reality and other technologies take on certain significance in medical imaging, surgical assistance, medical education, telemedicine, rehabilitation training, drug research and

development. Besides, they can contribute to the optimization of the traditional medical process, increase the therapeutic effect, while reducing the workload of medical staff. The brain-computer interface technology supporting the development of the Metaverse is the first and most important application field in the medical health field. The brain-computer interface technology refers to one of the underlying application technologies of the Metaverse [11–15]. The medical health field has been confirmed as the first and critical application field of the brain-computer interface technology, as well as the closest application field to commercialization at present [16–18]. Significant progresses have been made in the research of TCM services. With technological progress, brain-computer interaction will help the medical field to achieve greater development in the future.

2 Metaverse

2.1 Definition of Metaverse

Metaverse - The word originates from the science fiction "Avalanche" by Neal Stephenson, describing a world where people interact with different types of software in three-dimensional space with virtual images. Meta represents transcendence, and verse represents universe. Together, metaverse means "beyond the universe", which can be recognized as an artificial virtual space running parallel to the real world. The Metaverse connects virtual and reality. To be specific, there is a real design and economic environment. It refers to a 3D virtual world that is capable of connecting all people. Users exhibit special virtual identity and digital assets in the Metaverse, and they are allowed to interact freely in the virtual world, engage in production and business activities, and create value.

From the functional perspective, Metaverse refers to a platform that carries virtual activities. Users are enabled to conduct social and spiritual activities (e.g., social, entertainment, creation, display, education, as well as trading). The universe provides users with rich consumption content, fair creation platform, reliable economic system and immersive interactive experience. It is capable of reposing people's feelings and giving users a psychological sense of belonging. It can make friends in the digital world, create their own works, conduct transactions, educational meetings and other social activities.

Technically, the Metaverse has raised more rigorous requirements in terms of immersion, participation and sustainability on the basis of the traditional Internet, such that it will be supported by numerous independent tools, platforms, infrastructure, protocols, and so forth. With the increasing maturity of AR, VR, 5G, cloud computing and other technologies, the Metaverse is expected to move from concept to reality progressively (Fig. 1).

2.2 Main Characteristics of the Metaverse

The sense of real experience provides users with an immersive experience that ignores everything in accordance with sufficient real sensory effects. The strong sociality breaks the boundaries of physical space, and provides online social experience with high interaction, sharing, and high sense of participation. The virtual identity in the Metaverse
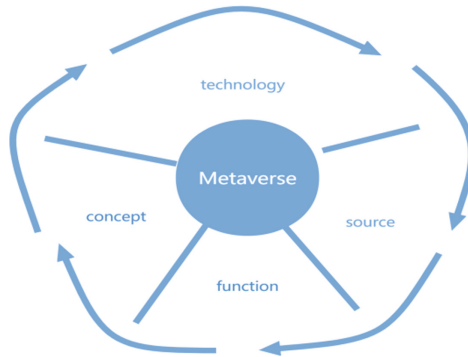
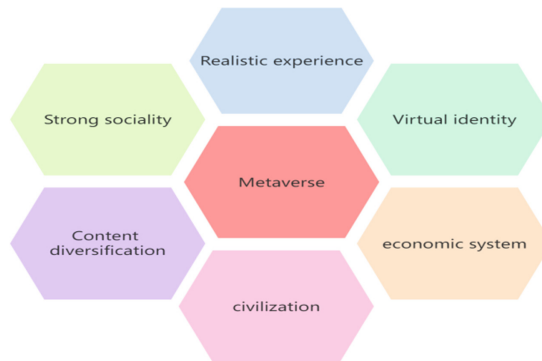**Fig. 1.** Definition of Metaverse

Fig. 2. Main characteristics of the Metaverse

is characterized by consistency and strong sense of substitution. The user carries out the planned activities in the Metaverse with the virtual identity. Content diversification accommodates considerable second and third party (UGC) content while supporting the expansion of self-made content in different manners. The Metaverse displays an independent economic system, and it has a correlation with the real economic system. Since a growing number of people live in the Metaverse, the Metaverse will serve as the carrier of human civilization (Fig. 2).

3   Metacosmic Medicine

Some pain points have been revealed in the medical and health industry (e.g., the simple and crude conventional equipment, the lack of medical resources, the significant geographical gap, and the lack of professional talents). The virtual imaging technology represented by VR/AR/MR breaks the boundary between the digital virtual world and the physical real world. Relevant information and corresponding solutions can be given timely and accurately based on specific scenarios through intelligent wearable interactive

Fig. 3. Medical imaging application

devices, which is conducive to optimizing the traditional medical process, increasing the medical effect, and reducing the workload of medical staff.

Traditional medical image analysis is complicated and requires considerable energy from doctors, with a high misdiagnosis rate of patients. Through MR technology, the computer virtual model is mapped to the real world scene that users see and mixed with the real environment, which opens the holographic vision without affecting the perception of the real environment. With the help of the imaging data displayed by holographic/virtual reality, the details of the lesions can be comprehensively observed, the image information can be deeply mined, doctors can be supported to shorten the time of reading the film, reduce the probability of misdiagnosis. Besides, patients can gain more intuitive insights into the situation of the lesions and the treatment plan and boost the communication between doctors and patients:

3.1 Medical Imaging

Foreign medical workers have employed virtual reality helmets combined with motion controllers to browse and find lesions in 3D CT images. Compared with the traditional reconstruction technology, Cinematic VRT real image rendering technology can obtain a clearer anatomical level, provide clinicians and patients with clear image diagnosis information, and assist in clinical treatment planning. VR is adopted to illustrate pathology and bring patients and family members images and videos that are easier to understand than words (Fig. 3).

3.2 Drivers

In 2020, the number of new cancer cases in China will reach 4.56 million, taking up nearly 25% of the global cancer incidence. This data is expected to be elevated to 5.20 million cases in 2025. The huge and growing group of cancer patients generates huge demand for cancer treatment market while creating a favorable clinical trial environment for the rapid development of the new treatment market. For instance, the form of the Metaverse virtual medical room brings medical care into the virtual world, where patients can undergo physical therapy, occupational therapy and pain management treatment, and patients are enabled to discuss their conditions with medical experts in real time while discussing the necessary adjustment of the treatment process when necessary.

The demand for chronic diseases and rehabilitation will grow rapidly with the intensification of population aging. With the use of immersive XR technology, doctors and

patients are connected via the data analysis platform to provide comprehensive treatment and nursing solutions, such that patients can even be subjected to treatment without leaving their homes, and their treatment rate can be increased.

3.3 Development Trend

Clinical medicine has been confirmed as the main field of brain-computer interface research, which is capable of investigating and evaluating the brain activity and behavioral cognition of subjects. Besides, brain-computer interface assisted clinical medical system can provide assistance in the treatment of epilepsy, language disorders, Parkinson's disease, rehabilitation treatment and other aspects. Cognitive neuroscience is capable of laying a theoretical basis for brain-computer interface research. Moreover, cognitive neuroscience explores the psychological and computational neural mechanisms obtained in the cognitive process, which can serve as vital guide for the design of brain-computer interface paradigm and the evaluation of subjects. Neurorecording technology is adopted to acquire nerve signals from the brain. The neural recording technology of high-density electronic, high spatiotemporal resolution and long-term stable recording can serve as excellent tools for the research on brain-computer interface for large-scale monitoring of neural activity. Neural signal processing can extract information from neural signals and interpret brain signals as instructions to drive external devices. Signal processing comprises neural signal denoising and transformation, neural information coding and decoding, feature extraction, as well as neural circuit dynamics.

Zhejiang University has made significant progress in the treatment of epilepsy by developing China's first closed-loop brain-computer interface nerve stimulator. This study can help intractable epilepsy patients monitor the EEG activity status and pre-disease characteristics in real time while automatically activating the pulse generator to inhibit the occurrence of abnormal EEG. The School of Mechanical Engineering of Xi'an Jiaotong University successfully made a high paraplegic aphasia patient say "Hello" using brain-computer interface technology. The brain-computer interface system can be adopted to recover the hands of patients with severe spinal cord injury (Fig. 4), as reported by The Battelle Institute of the United States and the Wexner Medical Center of Ohio State University.

4   Traditional Chinese Medicine

TCM has developed for over 2000 years since its birth, and is an important sub-track of the medical and health service industry. In 2019, China's TCM big health industry achieved the market scale of 920 billion yuan, and it is expected to reach 2.97 trillion

Fig. 4. Application overview

yuan in 2030, with a CAGR of 11.3% in 2019 to 2030. The scale of the Chinese medicine diagnosis and treatment service track reached nearly 290 billion yuan in 2019, and it is expected to reach 1.8 trillion yuan in 2030, with a CAGR of 17%. TCM hospitals serve as the main component of TCM hospitals. In 2020, there were 4426 hospitals, with 1.1274 million employees, 72.3% of hospital beds, and 518 million people for diagnosis and treatment, which were concentrated in East China. The development of TCM hospitals in municipal areas is better than that in county-level areas, with a larger volume.

4.1 Medical Needs

In 2020, China's population aged 65 years and above will reach 190 million, accounting for 13.5% of the total population. The irreversible trend of population aging will emerge. The incidence rate of chronic diseases among the population aged 65 and above is 54%, and the demand for chronic diseases and prevention of diseases is expanding. TCM (TCM), with its unique concept of periodization, course of treatment, and personalization, continues to comprehensively and deeply recuperate patients while providing personalized Chinese medicine prescriptions for patients through unique means (i.e., seeing, hearing, and asking questions), such that it has become a novel trend of health management. The national development plan for TCM has been in place for a long time. On December 30, 2021, the State Health Insurance Bureau and the Administration of TCM issued the guidance on medical insurance supporting the inheritance and innovation of TCM, providing clear support for the development of the TCM industry.

4.2 Metacosmic Resource Scheduling

The cloud computing technology under the Metaverse refers to a further extension of distributed processing, parallel processing and grid computing on the basis of Internet technology and advanced information processing technology, which can be regarded as the commercial realization of the above scientific concepts. Inconsistent with the above-mentioned concepts, the main features of cloud computing are that virtual characters are capable of renting resources in a transparent way of pay-as-you-go and realizing on-demand allocation of resources and global sharing of large-scale resources by distributing computing tasks in geographically dispersed data centers.

4.3 Mathematical Model

The resource usage allocated to the calculation task is adjusted, while the resources allocated to the calculation task is adjusted. A good resource scheduling scheme should comprehensively consider a considerable number of factors (e.g., load balance, resource utilization, running time, and cost). The existing research on resource scheduling is mostly focused on the optimization of a single target. The constraints considered are difficult to satisfy the actual operating environment of cloud computing, resulting in a large bottleneck in the application process. The mathematical model is illustrated as follows (Table 1):

$$\sum_{p \in P} y_{tp} = 1 \quad \forall_t \in T \tag{1}$$

Table 1. Symbols involved

Symbol	
character	*definition*
t	assignment
p	natural resources
y_{tp}	Each t is assigned to p
w_{tp}	Execution time of each t on each p
T	Total tasks
P	Total resources

$$m \geq \sum_{t \in T} w_{tp} y_{tp} \quad \forall_p \in P \tag{2}$$

The Eq. (1) indicates that the respective task can only be assigned to one machine; Eq. (2) suggests that the goal of problem solving is to minimize makespan, that is, to minimize the end time of the entire task set.

5 Conclusions

VR virtual reality, AR augmented reality, MR hybrid reality and other technologies take on certain significance in medical imaging, surgical assistance, medical education, telemedicine, rehabilitation training, drug research and development, and they are conducive to optimizing traditional medical processes, increasing medical effects, and reducing the burden of medical staff. With the help of the imaging data displayed by holographic/virtual reality, the details of the lesions can be comprehensively observed, and the image information can be deeply mined, which will help doctors reduce the time of reading the film and reduce the probability of misdiagnosis. Moreover, patients can gain more intuitive insights into the situation of the lesions and the treatment plan, and promote the communication between doctors and patients. The number of TCM clinics is increasing on a year-on-year basis, and the work of doctors' face-to-face diagnosis is considerable. The efficiency of surgery can be increased using VR/AR/MR and other technologies. For instance, holographic imaging technology can achieve holographic display effect, and panoramic display can make up for problems such as limited long-distance consultation, reduce door-to-door queuing, and increase efficiency. The layout of various regions in China in the new track of the "Metaverse" has begun. The deep integration of the digital economy and the real economy will be achieved with the support of policy. Besides facilitating the diversification of application scenarios, it will also boost the development of relevant enterprises, form a virtuous circle, and achieve the comprehensive upgrading of the real economy.

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