

# The Impact of Metaverse Technology on the Inheritance of Ceramic Craftsmanship

Shiwei Song, Yajun Zhang\*

School of Academy of Arts, Anhui University of Finance and Economics, Bengbu 233030, China

## Abstract

From the perspective of meta-universe technology and combined with some existing technical means, this paper discusses the new inheritance methods of ceramic handicrafts, and believes that the advanced technical means of meta-universe can bring unlimited possibilities for the inheritance of traditional ceramic handicrafts in China. After proposing the countermeasures of combining meta-universe technology and ceramic handicrafts, we do not forget that science and technology is a double-edged sword, analyze the advantages and disadvantages of ceramic handicraft inheritance with meta-universe technology and propose solutions.

## Keywords

Ceramic Handicrafts; Metaverse; Inheritance of Skills; Cultural Preservation.

## 1. Introduction

As one of the four ancient civilizations, China once had very splendid cultural and civilizational achievements, including many excellent traditional handicrafts. Traditional handicrafts are extremely important cultural wealth in China, and with the rapid development of science and technology today, many excellent traditional handicrafts have long disappeared, such as traditional ceramic handicrafts that embody a lot of wisdom of the ancients, which contain great value in culture, practicality and aesthetics. Therefore, how to make good use of contemporary and even possible scientific and technological achievements in the future to continue to inherit traditional ceramic handicrafts has become an urgent problem.

When it comes to future technology, it has to involve the concept of the meta-universe, which represents the latest technology, and about the meta-universe, as early as 2003, some foreign scholars discussed. At this time, the metaverse is considered to be an immersive network collection, where users can freely create and trade[1,2]. At the same time, the emergence of the 3D virtual game Second Life made people regard it as the best interpretation of the metaverse form at that time, and stimulated further thinking about the metaverse, such as the way revenue is created in the metaverse[3], the education model[4], the social form[5], and the possible inflation[6]and moral issues[7]. Throughout China, there are also many studies on the metaverse, such as Guo Yajun, Yuan Yiming, etc. have promoted the efficient sharing and innovation of knowledge in virtual communities by studying the virtual community knowledge sharing model under the metaverse field[8]. Wang Wenxi et al. explored the network and computing technology, management technology, virtual and real object connection, modeling and management technology and virtual and real space integration technology involved in the metaverse, providing reference for researchers and promoting technological innovation to drive product, scenario and application innovation[9]. Xia Cuijuan, Tie Zhong et al. studied digital memory in the metaverse: the concept of digital memory of "virtual digital people"[10]. However, little has been said about the combination of the metaverse with traditional Chinese ceramic craftsmanship, so a bold idea can be put forward, that is, to use the metaverse to inherit China's ceramic craftsmanship, especially some traditional ceramic handicrafts that are about

to be lost. Through the virtual reality function of the meta-universe, allowing users to experience the whole process of ceramic handicrafts, teachers can conduct hands-on teaching through the online virtual model of meta-universe technology, providing more paths for the inheritance of traditional ceramic handicrafts in China and promoting the inheritance of ceramic handicrafts, which has important theoretical value and significance.

## 2. Analysis of the Current Situation of Traditional Ceramic Handicrafts

### 2.1. The Result of a Legacy

Since ancient times, China's ceramic handicrafts have always been at the forefront of the world, and almost all dynasties and dynasties have their own symbolic excellent ceramic varieties, such as the famous Tang Sancai of the Tang Dynasty, the exquisite porcelain fired by the five famous kilns of the Song Dynasty, and the red glaze of the Yuan Dynasty, etc., with brilliant achievements. These excellent ceramic varieties are created by ancient craftsmen in China with diligent and intelligent hands, they master exquisite ceramic hand-making skills, and rely on these ceramic handicrafts to make a living and even obtain a certain amount of fame and fortune. China's ancient ceramic handicraft inheritance method is mainly family inheritance and master-apprentice inheritance, in the traditional society with low production technology level and people's living standards, these two inheritance methods are not much of a problem, and make many ceramic handicrafts in China passed down for thousands of years.

However, today, although there is another school inheritance in the way of inheritance, the inheritance of many ceramic crafts is facing great difficulties, and even lost for a time. This has also caused the state to attach great importance to traditional ceramic handicrafts, issued some protection decrees, and achieved certain results. In 2002, the report of the 16th National Congress of the Communist Party of China for the first time proposed to "support the protection of important cultural heritage and outstanding folk art", clarifying the important position of the protection of intangible cultural heritage[11]. On May 20, 2006, Jingdezhen's handmade porcelain skills were included in the first batch of traditional skills on the National Intangible Cultural Heritage List, item number VIII.-7. In October 2009, "Jingdezhen Traditional Handmade Porcelain Skills" passed the expert evaluation and officially applied for the United Nations 2010 Representative List of Intangible Cultural Heritage on behalf of China[12]. On the morning of August 7, 2022, the atmosphere in the international academic lecture hall of Jingdezhen Ceramic University was enthusiastic, and the establishment of the Ceramic Branch of the China Intangible Cultural Heritage Protection Association was officially announced. It can be seen that the inheritance of traditional ceramic crafts in China is receiving unprecedented attention.

### 2.2. There are Problems

We can see that no matter what kind of inheritance method, most young people are unwilling to learn, and those who are willing to learn are difficult to learn well and refine because there are no good teaching conditions, and naturally there is no motivation to persevere. And those old artists who have insisted on doing traditional ceramic craftsmanship, except for a few "masters" who have gained fame and fortune, most of them are difficult to make a living, with the high-efficiency, low-cost production methods of modern factory machinery and equipment assembly lines, who is willing to order in the old artists.

Therefore, first of all, there are problems in the way of inheritance, and in modern times, these three methods of inheritance have great drawbacks. Although family inheritance is to teach ceramic crafts without reservation, it is generally passed on to men and not women, passed on internally and externally, and has great limitations, once children are not interested in it, or are unwilling to learn, then it will soon be lost. Although the master-apprentice inheritance can

expand the scope of dissemination so that the skills are no longer limited to the clan, because there is no blood relationship, and it is worried that the disciples of the church will starve to death of the master, the master will generally "keep one hand" in the process of teaching the skills, and will not pass on all the skills to the apprentices, which leads to the incompleteness of the inheritance of skills. Although the school inheritance that has risen in modern times has greatly expanded the scope of dissemination, so that students across the country have the opportunity to contact, learn and inherit China's traditional ceramic handicrafts, but the teaching is not perfect, because the ceramics related professional system of these schools is only a short three to four years, and the modern ceramics teaching as the focus, it is difficult for the school to teach a complete set of traditional ceramic handicrafts to students, only to teach some basic skills, and because the learning and practice time is not long enough, Students who graduate from school often rush to find employment after only learning some fur, and it is difficult to truly master a traditional ceramic craft.

Then there are the problems of "change and unchanged" and "how to change" encountered in the process of inheritance of traditional ceramic crafts. Under the impact of the new era, new technologies and new ideas, traditional ceramic handicrafts are still unchanged, so it will be difficult to continue to inherit, and too much change will lose its heart. Today, people do not pay enough attention to traditional ceramic handicrafts, few people are willing to specifically understand it, study it, only care whether it can bring economic benefits now, but are not willing to combine new era, new technology, new ideas to inherit and develop it, such as some places for the inheritance and protection of traditional ceramic handicrafts mostly stay in the previous digital protection methods, the intuitiveness is poor, and can not interact with people, it is difficult to achieve effective inheritance and protection. It ignores the cultural value attached to its inheritance for thousands of years. Cultural value is the core of traditional handicrafts, and the emphasis on interests and culture is the main reason why traditional ceramic handicrafts cannot be well inherited.

### 2.3. Thought-provoking

Inheritance is not the imitation and inheritance of traditional ceramic craftsmanship, but to ensure that the form of this handicraft can be continued in a certain area. In a place with a long history of traditional crafts, there are still people who insist on doing it, maybe the method has changed, maybe the shape has changed, but they can still keep doing it, and they can still do it well. Being able to make money, support a family, have a good social status and living environment, and young people are willing to learn, this is the bottom line and core element of the inheritance of traditional ceramic handicrafts. If you just blindly imitate the traditional form without changing it in combination with the development of the times, this traditional handicraft will lose its market value in the modern sense, and without the market, not many people will naturally be willing to do it, and in the end they can only live in history, which is not called inheritance.

In order to get a better inheritance, ceramic craftsmanship must first break free from geographical restrictions, and people who are interested in and sincerely want to learn from teachers and crafts throughout the country and even around the world should have this opportunity to contact and inherit ceramic craftsmanship. The above three inheritance methods obviously cannot fully meet the necessary conditions for the inheritance of traditional ceramic handicrafts, which requires us to improve the existing inheritance methods, use the power of science and technology to promote the inheritance of ceramic handicrafts, especially the introduction of some advanced concepts and technical means that are likely to be realized, such as meta-universe technology. At the same time, we will use meta-universe technology to increase cultural publicity for ceramic handicrafts, expose more people to the excellent traditional culture of Chinese famous ethnic groups, and enhance our cultural self-confidence.

### 3. Opportunities and Challenges Brought by Metaverse Technology to the Inheritance of Ceramic Craftsmanship

#### 3.1. Introduction to Metaverse Technology

In 1992, American writer Neal Stephenson first proposed the term metaverse in his novel "Snow Crash", in which he wrote: "Put on headphones and eyepieces, find the connection terminal, and you can enter the virtual space simulated by the computer and parallel to the real world in the form of a virtual doppelganger[13]." But the roots of the concept of the metaverse are virtual worlds described by Professor Vernor Vinge in the United States in his 1981 book True Names, which is entered and experienced by real senses through brain-computer interface technology[14]. It can be seen that metaverse technology is different from current virtual reality and other technologies, simply put, metaverse refers to the integration of Internet elements relying on virtual simulation technology, information technology, the Internet, digital technology, etc[15].

Why does the metaverse bring people an immersive experience? This is because metaverse technology involves people's various senses and interactions in the virtual world. In the virtual world built by metaverse technology, users can experience near-real sight, hearing, smell and even touch. With a set of metaverse technology equipment, even if we do not leave home, we can "personally experience" many scenes that are or are not in reality, and even "face-to-face" communication with others.

#### 3.2. Metaverse Technology Brings Opportunities for the Inheritance of Traditional Ceramic Craftsmanship

With the advent of the metaverse era, many of the public's behavior habits will change. First, the way people live and work will change. In life, even if people shop online, they can "try on" or "try on food" first, and even relatives and friends far away can shake hands and hug at any time. At work, whether it's face-to-face meetings or client appointments, people can complete most tasks without leaving home. Second, people's thinking will also change. In the meta-universe era, people's minds will be more open, willing to understand and contact more new things, and most people's horizons will become broader, which will also bring great opportunities for the inheritance of traditional ceramic crafts.

The first is the opportunity of time. We can feel the development history of ceramic handicrafts through meta-universe technology equipment, see the past and present of a ceramic handicraft "with our own eyes", and see the current situation of ceramic handicrafts turning from prosperity to decline for various reasons and few people are willing to inherit them. Then, it simulates the two futures in which ceramic handicrafts may be inherited and those who do not, which arouses people's deep thinking and arouses the public's desire for the inheritance and protection of ceramic handicrafts.

Second, spatial opportunities. The first is the tangible space, meta-universe technology allows the inheritance of ceramic craftsmanship to break through geographical restrictions, through the reproduction of the real world, people can go to any kiln site they want in the virtual world, use local natural resources to make ceramics, and can communicate with local teachers, so that ceramics can get widespread attention while not losing regional characteristics, and the opportunity to inherit is greatly improved. The second is the invisible space, meta-universe technology can build a "cultural corridor" virtual space of a ceramic handicraft, tell the cultural story of a ceramic handicraft, truly display the cultural knowledge involved in this ceramic handicraft to the public, take us to understand the profound cultural heritage of the ceramic handicraft, and let the public deeply understand the importance of China's ceramic handicraft must be inherited.

### 3.3. What are the Technical Challenges of Combining the Metaverse with Ceramic Craftsmanship?

Since network services are needed, then first of all, it is inseparable from the 5G Internet, and at present, only the transmission speed of the 5G Internet can support the meta-universe virtual space, which is the foundation. Secondly, the construction and management of virtual society in the metaverse space, the mapping and connection of virtual and real objects are inseparable from X of X, IoX, identity modeling, social computing, and decentralized management technology, and the massive data generated by it also needs the support of cloud computing.

X-networking includes the Internet of Things (IoT), the Internet of People (IoP), and the Internet of Thinking (IoTk). The Internet of Things builds ubiquitous connections between physical space and the metaverse, mapping ceramic handicraft equipment and natural resources to the virtual world. In addition, the tactile Internet proposed by Fettweis[16] is a new form of Internet of Things in the metaverse, which allows people to grasp the strength of ceramic blanking in real time through the touch of contact with porcelain clay in the process of making ceramics, and then control the type, reaching the most realistic realm of ceramic craftsmanship. The networking of people refers to an interconnection network composed of various human nodes[17], and the interconnection of nodes is inseparable from the social relations with objects as the medium related to ceramic crafts, the social relations between people, and the social relations related to the attributes of time and space. Thinking networking emphasizes the process of thinking creation, so that virtual ceramic making equipment and ceramic blanks in the meta-universe have adaptive perception capabilities to automatically acquire, process, learn and think about knowledge, such as kneading porcelain clay with your hands, adding water to porcelain clay or firing porcelain clay, then the porcelain clay in the meta-universe will make corresponding changes and break through the shackles of time and space[18]. In addition, the interaction of the virtual and real worlds and the unity of vision, hearing, smell and touch are the basis for the integration of virtual and real space in the metaverse, which are inseparable from technologies such as extended reality, video games and brain-computer interfaces.

## 4. Countermeasures for the Inheritance of Ceramic Craftsmanship in the Context of the Metaverse

### 4.1. A New Way of Worshipping

Due to the establishment of the metaverse virtual space, the inheritance of ceramic craftsmanship has broken free from the shackles of time and space. In terms of worshipping teachers, teachers with inheritance intentions can recruit the world's wise men in the meta-universe space, and no longer have to worry about their successors. As long as visitors want to learn, have sincerity and determination, they can directly visit the teacher in the meta-universe space and learn ceramic crafts with the teacher, making the scope of skill inheritance broader. The inheritance method supported by meta-universe technology basically abandons the drawbacks of the existing inheritance method, and there is no limitation of family inheritance and mentor-apprentice inheritance, and teachers and old artists can rely on teaching in the meta-universe virtual space to obtain economic income, so there is no need to "keep a hand". Different from the short-term, rough teaching inherited by schools, the teaching method under metaverse technology can be very detailed and long, and students can learn for many years without delaying normal life until they fully master this traditional ceramic handicraft.

### 4.2. A New Way of Inheritance

Different from the previous face-to-face teaching, the metaverse space adopts the method of online teaching, but this online teaching can also be guided by hand. After visiting the teacher,

the master and the apprentices simultaneously enter the virtual teaching space built by the metaverse, where there are all the equipment and natural resources for handmade ceramics for the master and apprentice to use. The master will guide the apprentices step by step, such as kneading mud and drawing blanks, the master will personally demonstrate and ask the apprentice to do it, and when the apprentice does not do well, the master can pick up the apprentice's hand and let him feel the strength of the hand in contact with the clay, feel the humidity and hardness of the clay, and timely inform what state is most appropriate while feeling it, so as to achieve the purpose of hand-in-hand teaching. After forming, parameters can be set to make the green body quickly dehydrated and dried and then sprayed glaze, the glaze spraying also needs to be operated by the apprentice himself, in the process of glaze spraying the master will observe and guide in real time, telling the apprentice how to control the nozzle and whether the thickness of the glaze is appropriate. Finally, firing, according to the clay material, the absence of gaps in the body, dry humidity, glaze material, thickness, etc., and then through the networking of thinking, the intelligent system in the metaverse will simulate the final firing effect of our handmade ceramics. The master will also give timely feedback to the apprentice's learning according to the effect of firing, inform the apprentice whether a certain step is good or not, and then let him improve and practice continuously. In the long run, apprentices can learn most of the master's craftsmanship, whether in the meta-universe virtual world or in the real world, they can basically master the ceramic handicraft, become the inheritors of the ceramic handicraft, and continue to carry forward the ceramic handicraft in their own way. For example, make or acquire a large number of virtual ceramic items made by traditional handicrafts in the metaverse virtual space, and open your own ceramic shop or exhibition hall in the metaverse space, and make profits and inherit traditional ceramic handicrafts by selling virtual ceramics or exhibition hall tickets.

## 5. The Future of Ceramic Craftsmanship in the Metaverse Era

### 5.1. The Impact of Metaverse Technology on the Future of Ceramic Craftsmanship

Positive aspects:

- (1) Diversify the inheritance methods of ceramic handicrafts, no longer stick to traditions, and lay the foundation for more diverse inheritance methods in the future. At the same time, we will increase cultural export, so that China's traditional culture can be spread more widely and enhance our cultural self-confidence.
- (2) It saves a lot of energy, makes the teaching cost lower, and the existing inheritance method requires a lot of porcelain clay, glaze, hand-made pottery equipment, etc. in the teaching process, and a lot of energy is consumed during firing. In the inheritance teaching supported by meta-universe technology, these are not needed, all are built virtually, and as long as they are built, they can be used all the time without worrying about equipment damage and other issues. Thanks to the simulation of real touch, even small movements can be felt and captured, ensuring accuracy and greatly reducing teaching costs while ensuring teaching quality.
- (3) It has cultivated many excellent inheritors of ceramic handicrafts and spread all over the world, so that more people can contact and learn China's traditional culture while understanding China's ceramic handicrafts, and promote the further development of ceramic handicrafts while enhancing China's cultural self-confidence.
- (4) It enriches the market for ceramic handicrafts. With the increase of inheritors, ceramic handicrafts are no longer confined to traditional forms, inheritors can innovate on the basis of tradition, such as improving some unreasonable production methods, mixing some new materials in porcelain clay or incorporating some modern elements into ceramic handicraft products, etc., to make it more in line with the development of the times. At the same time, more

people will publicize and promote ceramic handicraft products, and more pottery products will appear on the market, followed by more enthusiasts and consumers in the field. This may make ceramic handicrafts industrialized, and inheritors can also use modern marketing methods and teaching methods to inherit ceramic handicrafts and obtain certain benefits from this, not only to make ceramic handicrafts "live", but also to make them "stand".

Negative aspect:

Since ceramic craftsmanship requires many practical exercises to master well, and this inheritance method is carried out in the virtual space, even if it is done well in the meta-universe space, it may not be able to do well when it is actually started, so it also requires a certain amount of practical operation. This may make some inheritors who do not pay attention to practical training lack of craftsmanship, affecting the development of ceramic craftsmanship in a better direction.

## 5.2. The Problems and Solutions that Metaverse Technology May Bring While Promoting the Development of Ceramic Handicrafts

The first is the issue of infringement. Whether the consent of the local government is required to build a virtual space for ceramic handicrafts with regional characteristics is violated, and whether it violates the privacy of local people; With the gradual improvement of people's awareness of rights protection, inheritors use a certain ceramic handicraft learned from the master to sell ceramics for money or charge students to teach students, and whether they infringe the intellectual property rights of the master, etc., with the gradual improvement of people's awareness of rights protection. Therefore, we need to pay attention to copyright and the privacy of others when building a virtual network space, and then build and use the metaverse virtual space in the region with the permission of others.

The second is the issue of ethics and morality. For example, whether learning ceramic crafts from a teacher in the metaverse virtual space is just to learn skills, and whether it violates the traditional Chinese way of respecting teachers from the time of worshipping the teacher to the teacher, from the teacher to the teacher; How much tuition is required for students and teachers to accept after visiting the teacher, and whether they need to give gifts. Moreover, the relationship between master and apprentice, apprentice and apprentice, if the master cannot control the apprentice in the virtual space, the vicious competition between the apprentice and the apprentice and destroy the items in the virtual space, or how to deal with someone committing a crime in the virtual space, etc., with the advent of the meta-universe era, these problems are inevitable. Therefore, teachers need to set their own standards and requirements for accepting disciples under the premise of legality, and if they can accept it, whether they must also follow the master's own wishes. In addition, we need to formulate a set of metaverse virtual space rules, including the handling of various illegal and criminal matters in the virtual space, such as compensation or construction of the same item at their own expense after destroying items in the virtual space, and criminal phenomena such as fights and brawls need to be punished, such as not being allowed to enter the virtual space for several years, or banning the identity of the criminal object in the metaverse virtual space.

## 6. Summary

With the development of the times, the concept of the meta-universe has slowly developed from fantasy to reality, and many things that we did not dare to think about before have a certain scientific basis today. Therefore, we need to prepare for the arrival of the metaverse era, and the most important part of this is to integrate with tradition and develop together. By studying the integration of traditional ceramic handicrafts and metaverse technology, this paper preliminarily explores the inheritance of traditional ceramic handicrafts in the upcoming

metaverse era, and makes positive contributions to the protection of China's cultural heritage and the development of traditional handicrafts. But it is important to know that the metaverse is a double-edged sword, and when enjoying the convenience it brings, we must also consider how to solve the series of problems that follow, only in this way can we seize this opportunity to let our traditional ceramic craftsmanship bloom in the near future.

## Acknowledgments

Funds: 1) Anhui University of Finance and Economics Graduate Research and Innovation Fund Project (ACYC2022254).

2) Key Project of Anhui Province University Research Program(2022AH050574).

## References

- [1] JAYNES C, SEALES W B, CALVERT K, et al. The metaverse: a networked collection of inexpensive, self-configuring, immersive environments[C]Proceedings of the workshop on virtual environments. New York,2003: 115-124.
- [2] ONDREJKA C. Escaping the gilded cage: user created content and building the metaverse[J]. NYLS Law Review, 2005, 49(1): 6.
- [3] TERDIMAN D. The entrepreneur's guide to Second Life: making money in the metaverse[M]. New Jersey: John Wiley & Sons, 2007.
- [4] JENNINGS N, COLLINS C. Virtual or virtually u: educational institutions in Second Life[J]. International Journal of Social Sciences, 2007, 2(3): 180-186.
- [5] KAPLAN A M, HAENLEIN M. The fairyland of Second Life: virtual social worlds and how to use them[J]. Business Horizons, 2009, 52(6): 563-572.
- [6] MAIER M. Can a metaverse have inflation?[J]. Business 2.0, 2003, 4(2): 75-79.
- [7] SALMASI A V, GILLAM L. Machine ethics for gambling in the metaverse: an "EthiCasino"[J]. Journal For Virtual Worlds Research, 2009, 2(3):1-23.
- [8] Yajun GUO, Yiming YUAN, Shuai LI, Weibin HAO. Research on the Knowledge Sharing Mode of Virtual Community in the Metaverse Field[J/OL].Intelligence Theory and Practice:1-14[2022-03-28].<http://kns.cnki.net/kcms/detail/11.1762.G3.20220317.1450.002.html>.
- [9] Wenxi WANG, Fang ZHOU, Yueliang WAN, Huansheng NING. Overview of metaverse technology[J/OL].Chinese Journal of Engineering:1-14[2022-03-28].DOI:10.13374/j.issn2095-9389.2022.01.15.003.
- [10] Cuijuan XIA, Zhong TIE, Wei HUANG. Digital Memory in the Metaverse: The Conceptual Model of Digital Memory of "Virtual Digital Human" and Its Application Scenarios[J/OL].Library Forum:1-9[2022-06-17].<http://kns.cnki.net/kcms/detail/44.1306.g2.20220311.1518.002.html>.
- [11] Ning CHEN, Junjie LIN, Xu ZHANG, Ruiyan DU. Discussion on the "intangible cultural heritage" system of Jingdezhen ceramics since the 21st century[J].Chinese ceramic industry,2019,26(05):19-24.DOI:10.13958/j.cnki.ztcg.2019.05.003.
- [12] Jingdezhen handmade porcelain technique[J].Jingdezhen ceramics,2020(04):18.
- [13] What is the metaverse of the recent fire? [EB/OL].CNR(2021-09-13) [2021-11-18]. <https://baijiahao.baidu.com/s?id=1710776745437385158&wfr=spider&for=pc>.
- [14] What is the metaverse of the recent fire [EB/OL].Mr. Xiong Hongmeng development (2021-11-09) [2021-11-18]. <https://baijiahao.baidu.com/s?id=1715932153689619383&wfr=spider&for=pc>.
- [15] Xiaheng ZHANG, Xiang LI. Research status, hot spots and enlightenment in the field of metaverse abroad[J].Industrial Economy Review,2022(02):199-214.DOI:10.19313/j.cnki.cn10-1223/f.2022.0124.001.
- [16] Fettweis G P. The tactile Internet: Applications and challenges. IEEE Veh Technol Mag,2014,9(1):64.



- [17] Shi F F, Wang W X, Wang H, et al. The Internet of people: A survey and tutorial[J/OL]. arXiv preprint (2021-04-06) [2022-01-15]. <https://arxiv.org/abs/2104.04079>.
- [18] Zhang Z M, Yin R, Ning H S. Internet of brain, thought, thinking, and creation. Chinese J Electron, <http://cje.ejournal.org.cn/article/doi/10.1049/cje.2021.00.236>.