

Visualization Analysis of VR Technology in Medical Education in China in Recent Ten Years

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Abstract

By using CiteSpace visualization software and bibliometric method, this paper makes a correlation analysis on the number of papers, organization distribution, research hotspots, author characteristics and trends of VR technology in the field of medical education research in China. The results show that the combination of VR technology and many research hotspots in the field of medical education provides a new solution for information-based teaching; However, with the further development of 5g and big data, VR and its technology application are more and more extensive and in-depth, and its role will be greater in the future.

Keywords

VR; Medical Education; Virtual Reality; CiteSpace.

1. Introduction

Virtual Reality (VR) is a brand-new practical technology developed in the 20th century. It uses computer technology as the core to enable users to immerse themselves in the virtual environment of multi-source information fusion, interactive three-dimensional dynamic scenes and system simulation of entity behavior. High-tech means with computer technology as the core are used to generate a virtual environment. Through special input or output devices, users can naturally interact with objects in the virtual world and obtain the same feeling as the real world from hearing and vision (Fu Hong, et al., 2017; Li Wei, 2018; Chen Yanchun, 2019).

With the emergence of 5G high-speed transmission, Internet of Things, artificial intelligence, flexible display, mobile high-performance graphics computing card and other technologies, it has laid a foundation for VR technology to enter commercial use. At present, applications and equipment based on virtual reality technology have begun to appear in many fields such as education, media, entertainment, medical treatment, heritage protection and so on. VR technology, as such a computer simulation technology that can create and experience a virtual world, is increasingly applied in our lives, and has been recognized as an important development discipline in the 21st century and one of the important technologies that affect people's lives. This paper mainly focuses on the research and development status of VR technology since 2011, combined with the current environment of higher education, trying to find the fields or directions where VR technology can effectively land (Cao Fan, 2019).

The purpose of this paper is to visually analyze the relevant literature of VR in the field of medical education research through CiteSpace software, so that readers can more intuitively and clearly understand the current situation, hot spots and trends of VR research, thus providing reference for further in-depth research of VR in medical education.

2. Data sources and research methods

2.1. Data Sources

In this paper, China Knowledge Network Infrastructure (CNKI) is used as the data selection source, the retrieval type is "keyword = VR OR virtual reality technology, and subject = medicine", and the category is Chinese journals. The word "VR" in CNKI platform has attracted attention since 1992, with a large number of articles published. In order to study the latest research progress of VR and its technology, this study only sets the retrieval time of documents as 2011-2020. A total of 429 related literatures were retrieved (the database update time was December 31, 2020), and 395 valid literatures were determined by manual screening to eliminate impurity literatures.

2.2. Research methodology

CiteSpace is an information visualization software based on Java platform developed by Professor Chen Chaomei of Dressel University in the United States (Chen Meichao, 2006). It can extract scientific literature, generate corresponding visual maps, and understand the knowledge base, research hotspots, discipline frontiers and new trends in related fields through interpretation of the maps. The author imported the retrieved data into CiteSpace V5.7R4, drew the network knowledge map, combined with bibliometrics methods, mined the data information, and made visual analysis on the application research field of contemporary VR in medical education.

3. Data Result Analysis

3.1. Statistics of Published Volume

VR research has always been the focus of domestic educational technology scholars and is on the rise. In this paper, metrological methods are used to count the number of articles published in VR years, and a column chart of articles published from 2011 to 2020 is drawn as shown in Figure 1. The development of VR research field in China shows a trend of steady growth, re-maintenance and rapid improvement. In 2011, the era of 5G and big data began, and the number of documents in the field of VR research was 16; 2012-2015 is the maintenance stage, then it began to rise significantly in 2016, and reached its peak in 2019-2020, with 72 articles. The arrival of the big data era has brought opportunities to VR research and development. The related research in this field as a whole is developing in depth and has achieved rapid development. 2016 is the first year of VR application in China. In June 2018, the Chinese government issued the "Double Ten Thousand Plan for Implementing First-class Professional Construction", which includes the construction of first-class courses of virtual simulation experiments, so as to further promote the development of VR in medical education industry and deepen its innovative application in medical education.

3.2. Author Characteristics of VR Research

The analysis of the distribution of authors can effectively grasp the development process of scientific research activities in this field, and has positive significance for the current analysis, summary, refinement and forward-looking research of research topics. After the data is imported into CiteSpace, the node is set as the author, and the time is cut into one year from 2011 to 2020. Set the selection criteria (top N=30, select the top 30 levels of each year) to get the visual map. Each node in the figure represents different authors of the articles. The radius of the node represents the amount of articles issued by the authors. The larger the author's name, the more articles issued. The connection between nodes represents the cooperative relationship between the authors. The thicker the connection degree, the more cooperative articles issued. Largest CC is 5 (25%) in the figure, indicating that VR has 5 people with the

largest research cooperation relationship, accounting for 25% (see the most concentrated one in the figure), indicating that researchers are relatively not concentrated enough, team cooperation is relatively small, there are more unrelated researchers, and the number of articles published is mostly between 1 and 2. The number of articles published is headed by Zhang Yejiang, Zhao Feng, Yue Mei and Zhang Xiaohong took second place. In short, the 5G and big data era has brought new technologies and methods to people's understanding and transformation of the world, and has brought great impact on the development direction and application mode of VR in medical education, which is conducive to changing the traditional medical education management concepts and methods that are inconsistent with the times, so that VR can better serve teachers and students in medical colleges.

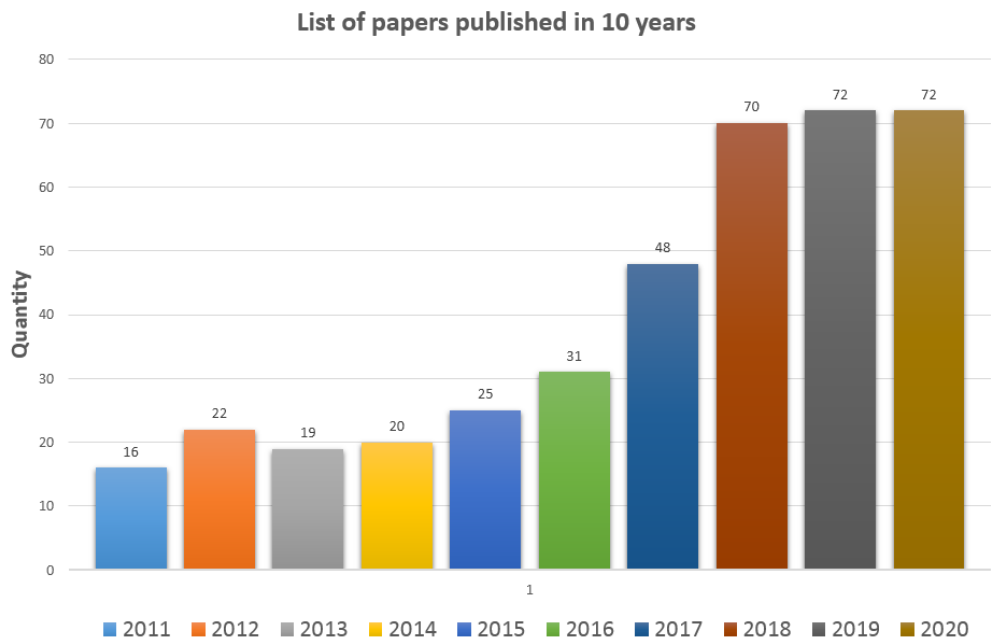


Figure 1. Column chart of articles published from 2011 to 2020

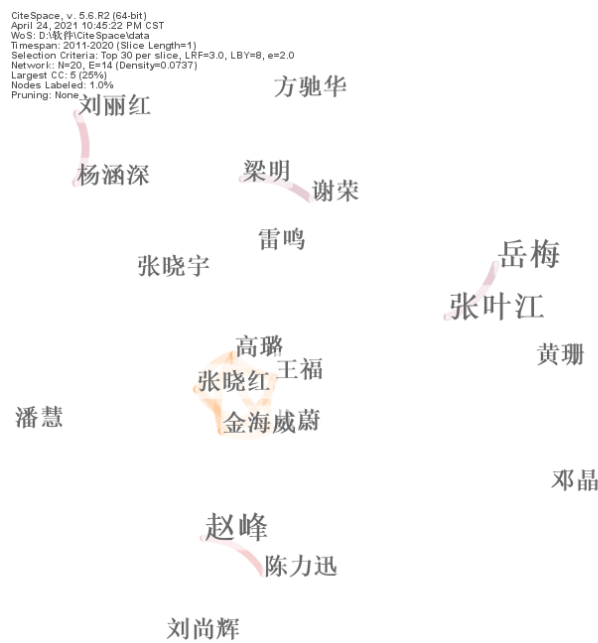


Figure 2. Visualization map of VR research author

3.3. Mechanism Distribution of VR Research

Change the node type to organization, run the software to obtain the visual map of VR research organization as shown in Fig. 3, select the top 10 organizations in the number of articles to draw Table 1, and the year represents that an organization published the most papers in that year. Combined with the chart, we can see that Kunming Medical University, Shandong University of Traditional Chinese Medicine, China Medical University and Chongqing Fuling Central Hospital have the largest number of articles. If the two departments of China Medical University are combined into one unit, the number of articles issued is the largest. Most of these research institutions are related departments of medical colleges. This shows that our medical scholars pay more attention to VR and study it deeply. After investigation, it is found that the researchers in these institutions are not limited to medical colleges and universities, but also come from hospitals of Grade a and above. Their active thinking mode and extensive research perspective have injected new vitality into VR research. In the whole network map, several large nodes with high centrality have no correlation with other nodes, which indicates that universities have poor cooperation in this field.

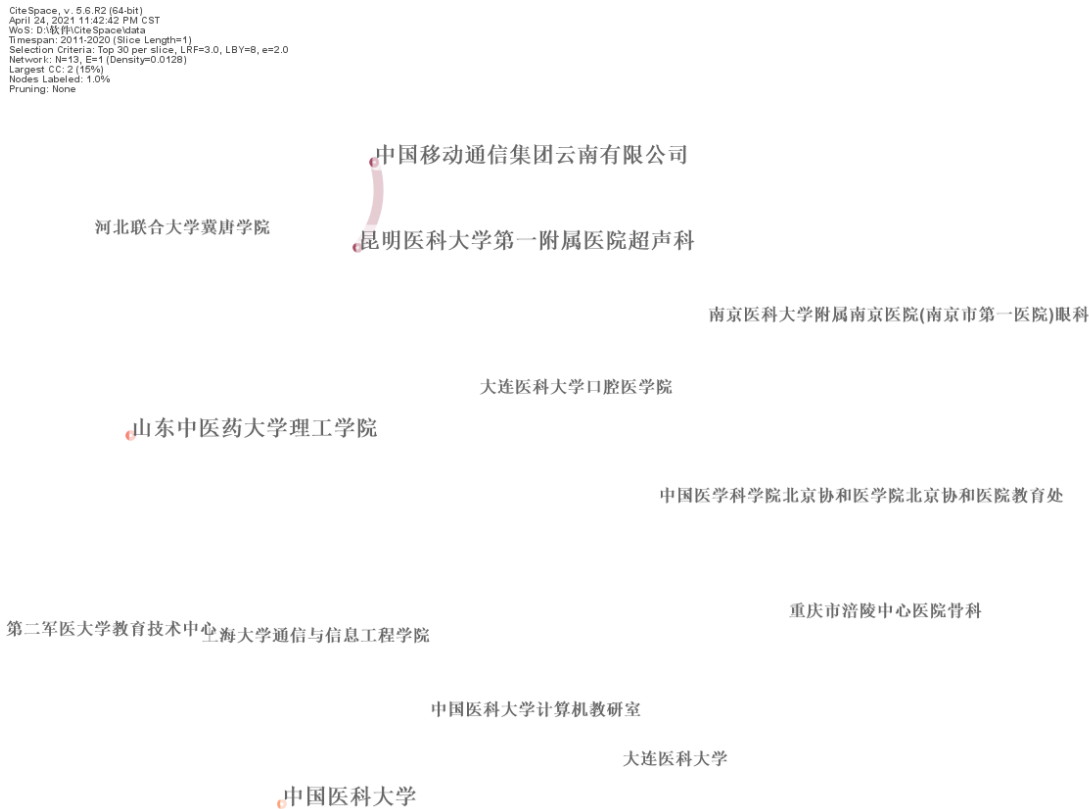


Figure 3. Visualization atlas of VR research institutions

Table 1. Number of articles issued by VR research institutions ranks among the top 10

Number	Name of Organization	Number of Articles	Year
1	Department of Ultrasound, First Affiliated Hospital of Kunming Medical University	3	2020
2	Shandong University of Traditional Chinese Medicine Institute of Technology	3	2017
3	China Medical University	3	2020
4	Department of Orthopedics, Fuling Central Hospital, Chongqing	3	2016
5	Educational Technology Center of Second Military Medical University	2	2012
6	Hebei Union University Jitang College	2	2012
7	Dalian Medical University School of Stomatology	2	2013
8	Dalian Medical University	2	2015
9	Ophthalmology Department of Nanjing Hospital Affiliated to Nanjing Medical University	2	2019
10	Computer Teaching and Research Section of China Medical University	2	2018

3.4. Hotspot Analysis of VR Research

Key words are a high summary of the research topics and contents of literature. Correct analysis of key words can know the basic research contents of this literature, and by measuring the number of keywords appearing, we can clearly know the hot spots of disciplines, institutions and research knowledge base in a certain period of time. The author sets the node as Keywords, the node threshold as Top N=30, takes the "pathfinder" to cut and run the software, and obtains the knowledge map of VR research hotspots (Figure 4). The nodes in the figure represent the keywords of retrieving documents, the size of the cross to which the keywords belong represents the frequency of their occurrence, and the connection lines between nodes represent the co-occurrence relationship between the keywords. Centrality is a measure of the size that plays a connecting role in the knowledge map network. The edge of the circle is purple, indicating that the centrality value of the node is greater than or equal to 0.1. Statistics also show that the research mainly has eight topics (see the blue area in the figure), each of which constitutes the research scope, indicating that the research in the medical field is relatively extensive and enriches medical education and clinical application.



Figure 4. Co-occurrence map of VR research keywords

According to the keyword co-occurrence map and some keyword tables of VR research, It can be seen that the frequency and centrality of "虚拟现实", "虚拟现实技术", "medical education", "medicine", "VR technology" and "VR" are in the front position, The corresponding node area in the figure is relatively large, which shows the accuracy of article data retrieval and topic matching. At the same time, the concepts of this series of keywords in China are basically the same and wide, which can be confirmed from Table 2. From the frequency point of view, after the keyword ranks 10th, its frequency decays rapidly, indicating that the research is relatively scattered; The central display also shows that only the first two keywords reach more than 0.5, and the central concentration of keywords in large parts is not enough.

Table 2. Key words of VR research

NO	keywords	Frequency	Centrality	NO	keywords	Frequency	Centrality
1	“虚拟现实”	199	0.61	16	Artificial intelligence	6	0.01
2	“虚拟现实技术”	155	0.55	17	Experimental teaching	5	0.00
3	Medical education	33	0.28	18	Simulation teaching	4	0.00
4	Application	19	0.15	19	Three-dimensional	4	0.00
5	Medicine	19	0.31	20	Virtual surgery	4	0.01
6	VR technology	19	0.14	21	Telemedicine	4	0.22
7	VR	17	0.17	22	3D printing	4	0.06
8	Augmented reality	15	0.23	23	Training	4	0.07
9	Teaching	11	0.22	24	Medical teaching	4	0.08
10	Clinical teaching	11	0.12	25	Meta analysis	3	0.09
11	Three-dimensional reconstruction	10	0.03	26	Simulated training	3	0.00
12	Rehabilitation	9	0.02	27	Augmented reality technology	3	0.03
13	Stroke in brain	9	0.03	28	Interaction	3	0.00
14	Stomatology	7	0.11	29	Continuing medical education	3	0.05
15	Mixed reality	6	0.00	30	Oral cavity	3	0.00

4. Research and application cases

Virtual reality technology has developed very early in foreign countries. The earliest VR technology can be traced back to Sensorama in 1956. It integrates 3D display, odor generator, stereo speaker and vibrating seat, and has 6 short films built in for people to enjoy. However, its huge volume makes it unable to become a commercial entertainment facility (Li Xiangde, et al., 2004). In 1961, Feige Company developed a head-mounted display Headsight, which integrates head tracking and monitoring functions, but is mainly used to view secret information (Yang Hanshen, et al., 2019). GAF iViewMaster, which came out in 1966, is the prototype of simple VR glasses today. Sword of Damocles, which came out in 1968, is usually regarded as the real beginning of virtual reality equipment. It was developed by Massachusetts Institute of Technology and provided prototype and reference for the later development of VR and even AR equipment. VR technology has gradually swept the world since 2000 and has become the cutting-edge technology of innovation and technology in the global IT field. The product that really brought commercial virtual reality technology to a revival is Oculus Rift, which came out in 2009. In 2013, an early device for developers was introduced at a price of only US \$300, representing that commercial VR devices really entered the consumer electronics market (Chen Yingxuan, et al., 2017).

The development of virtual reality technology in the field of clinical medicine in 2014 is advancing by leaps and bounds, especially in clinical medicine and distance training, showing its incomparable technical advantages and changing the traditional surgeon training and learning mode. Western developed countries have applied VR technology to education and teaching for a long time; The University of California, San Francisco, has established a Virtual Medical Center (VRMC) to study mental and psychological diseases; At the same time, tens of thousands of students use ZSpace's laboratory courseware to learn; On April 14, 2016, Dr. Ahmed S performed a tumor resection operation for a patient in Royal London Hospital. The 360 VR technology adopted enabled netizens all over the world to watch the whole operation process by downloading "VR in OR" (iOS/Android) software and matching the cheap paper Google Cardboard with their mobile phones. This is the world's first live operation through VR technology, which has revolutionary historical significance in the history of medical development (Yang Hanshen, et al., 2019; Tian Jihong, et al., 2017; Cai Xuan, et al., 2019). In February 2017, research on a project funded by the National Health Insurance Commission

(NHS) showed that Blue Room, as a unique immersive virtual reality system, can help autistic children overcome their anxiety and phobia. The first patient has been called VR therapy. The navigation operating system of 3D virtual reality of Surgical Theater Company in the United States has been approved by FDA and CE certification. So far, this 3D virtual reality neurosurgery navigation operating system has been equipped in famous research teaching hospitals in the United States (Bu Xiaofan, et al., 2020; Cao Fan, 2019; Li Jing, 2018).

2016 is the first year of VR in China. In the first half of 2016, VR heat waves are rising one after another. VR technology has been well promoted and erupted in 2016. With the continuous improvement of VR development technology in China, some medical colleges and universities in China have applied VR technology to experimental teaching and have achieved good teaching results, as shown in Figure 5. On October 28, 2016, Tongji Hospital successfully held China's first "VR technology + naked eye 3D technology in clinical medical simulation surgery teaching system new technology and 3DHD high definition-demonstration system class". Panasonic's VR production technology, medical skill network VR + APP technology and KDX naked eye 3D display screen were applied to implement VR technology + naked eye 3D + APP technology simulation surgery trial teaching. Therefore, there is reason to believe that the combination of medical education and VR technology in the future will be the general trend (Cao Fan, 2019; Li Xiangde, et al., 2004; Shen Yuping, 2018).

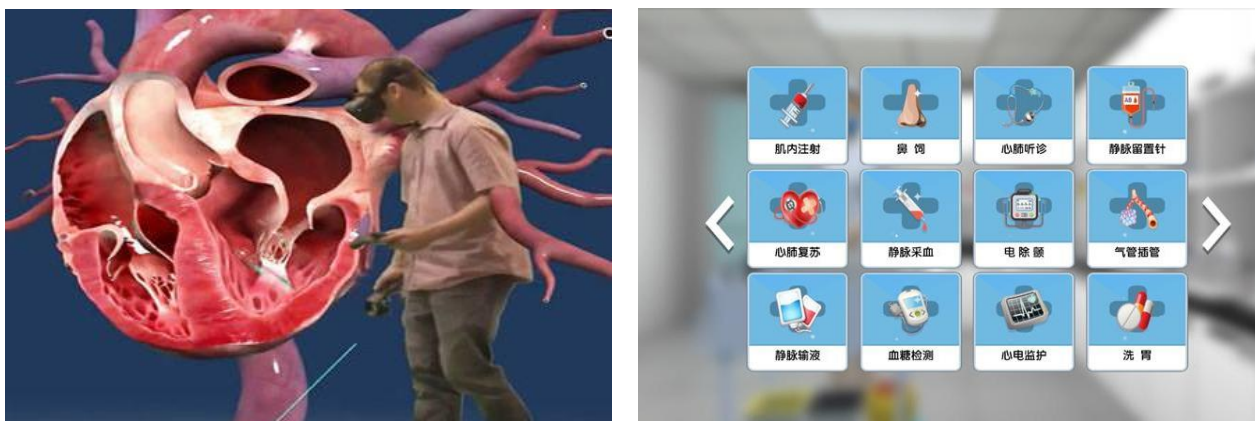


Figure 5. Application of VR in medicine

5. Conclusion and Future Research

Introducing VR into experimental teaching practice of higher education is an effective measure to improve teaching quality. VR technology makes up for the shortcomings of traditional teaching methods, such as the difficulty in building the real environment, the disconnection between theory and practice, the single equipment and the inability to obtain a lot of practical experience. It fully mobilizes students' learning enthusiasm, improves students' learning efficiency, and is conducive to the development of students' innovative thinking, which has a far-reaching impact on cultivating high-level innovative talents in colleges and universities. It is believed that with the further development of computer technology and the continuous research and practice of the vast number of higher education workers, VR technology will become an important part of modern higher education.

In the era of big data, using VR to visualize educational data is of great significance to improve teachers' teaching effect and optimize students' learning process. However, in the process of development, it also faces problems such as high development and design cost and limited application range. It is necessary to strengthen model adaptability and improve VR tool design, which requires in-depth study by scholars.

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