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Analysis on Research Hotspots and Trends of The Application of VR in Archives Management Based on CiteSpace

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Abstract: **Virtual reality technology(VR) and products are getting more and more convenience and intelligence with the support of big data and artificial intelligence technology, Introducing VR into archives management can provide users with immersive, interactive, and imaginative experiences. This article uses CiteSpace software to analyze 791 journal articles with VR and archives as keywords from the Web of Science international literature database obtained from 2000 to 2022. Based on visual analysis, it combines keywords co-occurrence, classification, and burstness to analyze research trends, hotspots, and frontiers. Finally, we propose several suggestions for the application of VR in the field of archives management,in hope of providing reference for future studies.**

Keywords: CiteSpace; Virtual Reality; Archives; Visual Analysis

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1. Introduction

Virtual reality technology(VR) is a simulation system that can bring personal feelings to users. It can fully collects data and information from the real world, and ultimately transforms the technology into environments and phenomena that can be realistically felt by users through output devices. These phenomena are represented through three-dimensional models, which can be known objects in the brain or unknown objects. Because these phenomena require computer technology to simulate, they are called virtual reality technology. It is used to simulate virtual environment to bring immersive and interactive experience to people [1]. So it is is also known as Lingjing Technology. In recent years, it has gradually emerged and been used domestically in medical,aerospace and aviation, education and other aspects[2]. Virtual reality system is divided into five parts: virtual environment, software system, computer, input device and output device. The virtual world it constitutes can be regarded as a digital representation of the real world [3]. With the development and progress of science and technology, this technology has brought satisfactory experiences to many people.

The application of VR brings new challenges and opportunities to archives management. It can provide users with a powerful visual impact, which can help them review historical scenes, and imagine the future. In 2016, the Canadian Association of Archivists identified the theme of the annual meeting as "Archives and Innovation" to explore the challenges faced by archival work in a technology driven society; United States and Australia have also launched exploration and research on new technologies for archives management,indicating that the international archival community also attaches great importance to the application of new technologies in archival management.The application of VR in archives management has become the focus of theoretical research and practical work.With the continuous advancement of digitization of archives management, the advantages of VR are becoming more and more important. The application of it can strengthen the organized and logical archives management, improve management efficiency and quality. And so save manpower and material resources, improve the level of archives management.

2. Research methods and data sources

2.1. Research methods

CiteSpace software is used to visually analyze the data in this study. CiteSpace is an information visualization software ,which is developed by Professor Chen Chaomei in the Java language. It is mainly based on the theory of communal factor analysis and pathfinder network scaling to measure domain-specific literature to explore the critical paths of scientific domain evolution and its intellectual turning points[4]. This software can draw a series of knowledge maps, and provide a basis for researchers to carry out knowledge management or make scientific decisions by analyzing the map information to interpret the research status and explore the frontiers of disciplines. It is used more and more widely in various research fields.

2.2. data sources

The data used in this paper were obtained from the Web of Science Core Collection (WoS).The WoS Core Collection is the most commonly used and authoritative search engine for research literature, providing comprehensive coverage of major research results worldwide, including articles, meeting abstracts, books, and published projects[5].the search topics are set as “VR” and “archives” , “virtual reality” and “archives”,”AR” and “archives”,”Augmented reality “ and “archives”.The time span is from 2000 to 2022 and the document type is article,excluding the proceedings papers,

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editorial material, book reviews and reviews.A total of 791 related documents are obtained.The search results in this study including full records and references are downloaded and handled by CiteSpace.

3. Research Status

3.1. Overview of VR in Archinves from WOS

The annual quantity of published articles is an important value for evaluating the development of scientific research.To some extent, it reflects the growth of knowledge quantity in this field. Figure 1 shows the annual quantity of this study.From 2000 to 2022 ,the number of publications increased gradually. Between 2000 to 2012, the number of documents issued has increased slowly.It growed steadily since 2013. In 2021, the value reached its peak.In general,the amount of knowledge in the field of the application of VR in archives management has shown a steady growth trend, reflecting the research heat is getting higher and higher.

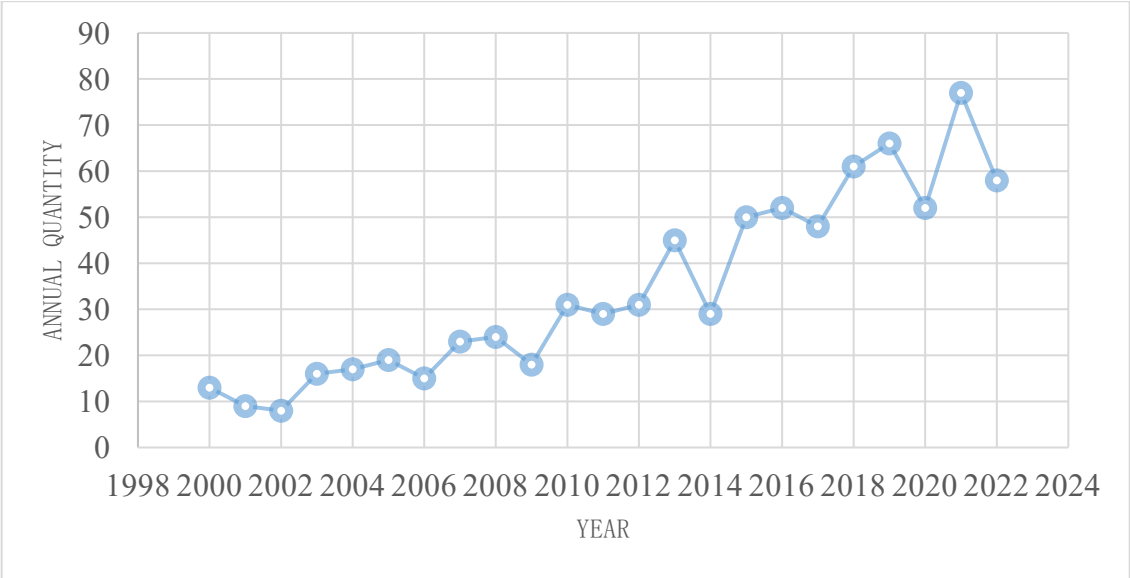

Figure 1. The Annual Quantity of Published Articles

3.2. analysis of scholar collaboration

In order to further reveal the influence and importance of researchers, grasp the breadth and depth of research in this field,we analyze the co-occurrence mapping of authors.According to CiteSpace software analysis, A collaborative network of scholars is conducted in the figure 2.The size of the author's name in the diagram is directly proportional to the quantity of published articles. The larger the name font size, the greater the quantity. The cooperative relationship between scholars is represented by the lines between nodes. The color of the lines is used to indicate the cooperation time, while the dark color indicates the early cooperation time, and the light color indicates the late cooperation time.

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Fig. 2. The network of scholar collaboration

In the collaborative network of scholars there are 678 nodes and 1055 connections, with a density of 0.0049. Table 1 lists the top 10 authors with the largest number of publications. Zolitschka and Bernd are the researchers who have published the most journal literature in this field. The second is Andersen, Steven Arild Wuyts, who has published 8 articles; The count of authors ranking third is large, such as Acharya, B SChitnis, Maksimovic, etc., with a total of 7 articles published.Several prominent author subnetwork structures have been formed in the atlas, reflecting closer collaboration among scholars.

Table 1. Top 10 authors with citations

Authors	Count	Year
Zolitschka, Bernd	9	2013
Andersen, Steven Arild Wuyts	8	2018
Acharya, B S	7	2008
Chitnis, V R	7	2015
Maksimovic, Vesna R	7	2007
Zolitschka, B	7	2013
Adolphi, Florian	6	2015
Ohlendorf, Christian	6	2013
Shukla, A	6	2015

3.3. analysis of Research Institutions

We selects "Institution" as the network node to analysis, and the data extraction object is "Top50".CiteSpace software performs data screening to obtain a graph of institutional cooperation networks, as shown in Figure 3.Table 2 lists the top 9 institutions in the volume of VR and archives management research publications. there are 763 nodes and 2702 connections. The overall density of institutional cooperation mapping is only 0.0093,indicating that the international connection between research institutions is strong. University of California System,University of Bern,United States Department of Energy (DOE) and Stockholm University have cooperated relatively closely, forming research network with these three units as the core. Stockholm University,Uppsala University,Helmholtz Association,University of California System,Centre National de la Recherche Scientifique (CNRS) are research institutions with a large number of publications.They are from

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Sweden,Germany,United States and French.Among them Stokholm University contributed the most to VR and archives research with 57 publications.

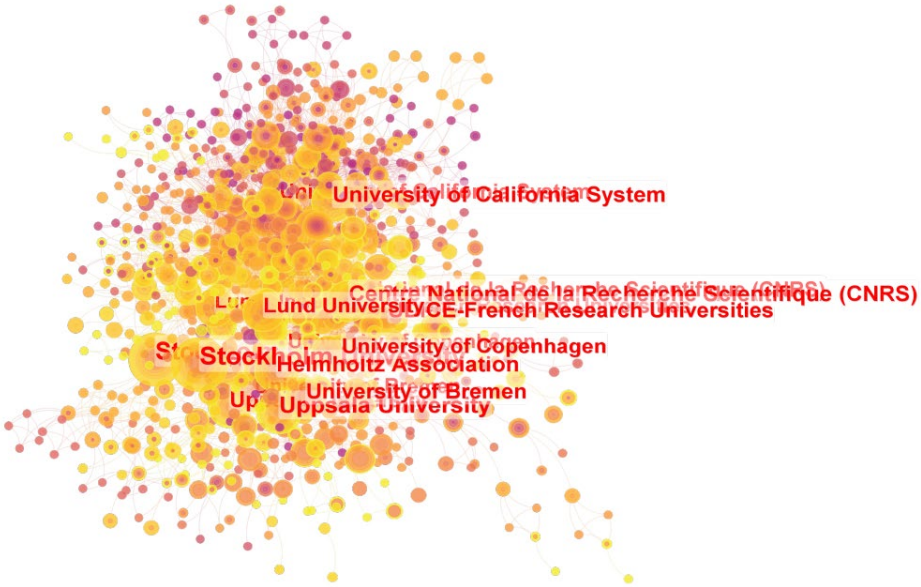

Figure 3. Collaboration network of institutions

Table 2 Top 9 Institutions with most publications

Institutions	Count	Year
Stockholm University	57	2009
Uppsala University	35	2008
Helmholtz Association	33	2000
University of California System	32	2007
Centre National de la Recherche Scientifique (CNRS)	31	2011
UDICE-French Research Universities	29	2011
University of Bremen	29	2011
Lund University	26	2009
University of Copenhagen	26	2010

4. Research Hotspots and Trends

4.1. Keyword Co-occurrence Analysis

Research hotspots are the topics discussed in a large amount of literature with inner link in a period of time[6]. Keywords are the core words that can reflect the topic and content of literature research. By extracting keywords from a large number of literature, the co-ccurrence times of different keywords and their correlation are statistically analyzed to reflect the research status in this field [7].Word frequency refers to the number of words appearing in the analyzed literature, and word frequency analysis is to extract the frequency distribution of key words or theme words that can express the core content of the literature.

Using CiteSpace software,the visualized graph of keywords is shown in Figure 4. The nodes represent keywords, and font size represents the occurrence frequency of keywords. The line between nodes represents the co-occurrence of keywords. The circle size represents the frequency of keywords, and the higher the frequency, the larger the circle[8]. Removing the research keywords which has nothing to do with this study, the high frequency keywords shown in Table 3 are retained. From the

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table, we can have a preliminary understanding of the research hotspots of VR used in archinves management,especially the keywords that appear frequently, such as performance,evaluation,impact,variability,model, etc.

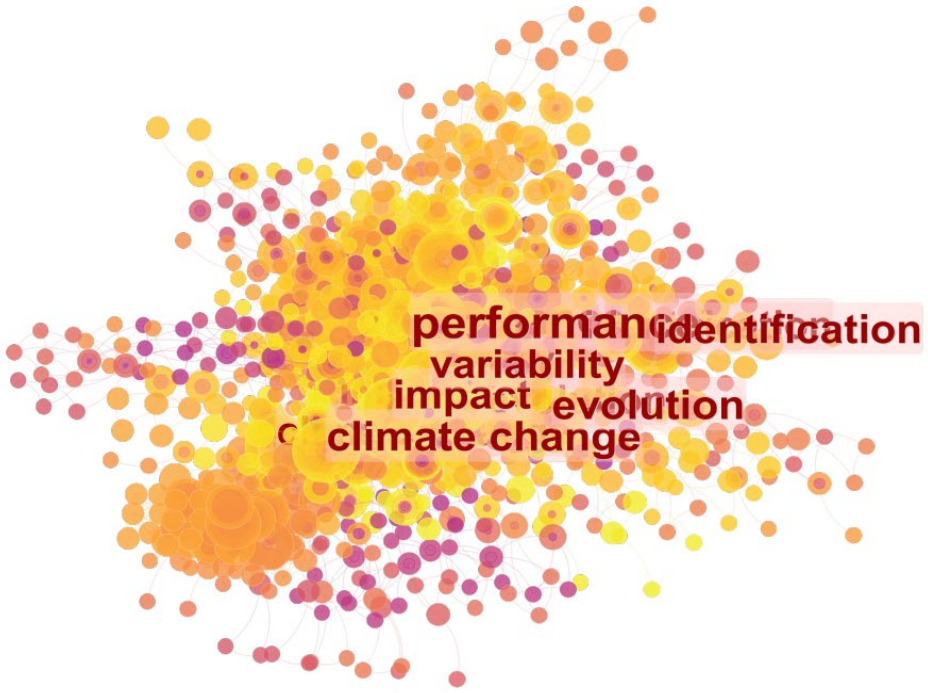

Figure 4. Co-ccurrence network of institutions

Table 2 Top 10 most frequently used keywords

Keywords	Count	Year
performance	27	2005
evolution	19	2000
Climate change	19	2006
identification	18	2008
impact	17	2015
variability	16	2011
model	15	2013
lacustrine record	12	2013
quality of life	11	2009
rehabilitation	10	2005

4.2. Keyword Cluster Analysis

Clustering represents the overlap and connection of relevant literature in terms of research subjects and content, and to a certain extent represents the direction and focus of the research field. Keyword clustering graph can indicate different concerns in the field of research. By using CiteSpace software to conduct keyword clustering analysis on the literature, a clustering graph is obtained (Figure 5). CiteSpace evaluated the clustering effect based on two indicators, Q (Modularity) and S (Silhouette), where Q corresponds to the network structure and S represents the definition of clustering. It is generally believed that when Q>0.3, it means that the cluster structure is significant; When S>0.5, clustering is reasonable, and S>0.7 means that clustering is convincing[8] The cluster module of generated cluster view in figure 5 has a Q value of 0.819 and a contour S value of 0.9133,indicating that the graph structure is significant and the cluster structure is reasonable. The research on VR in

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archives management can be divided into five major topics: virtual reality,mental health,identification,climate change,durable medical.

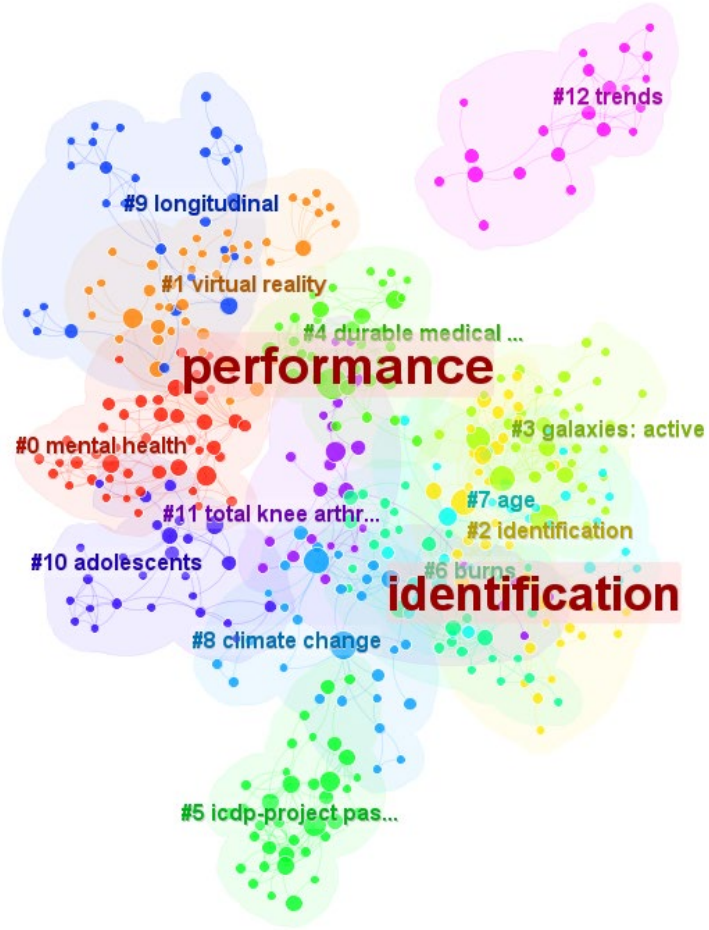

Figure 5. Keyword clustering network

4.3. Keyword Burst Analysis

The burst of keywords concerns those that have increased significantly in their frequency of use in a short period and are used further to explore the cutting-edge dynamics of the research field, reflecting the sudden impact on the research field of new concepts formed by policies or public events from a particular moment onward [9,10]. The network knowledge map of keyword burst from 2000 to 2022 is obtained by using Citespace software and selecting keywords as node, as shown in Figure 6. It shows that the keywords started to burst from 2008 onwards. The earliest burst keyword was “Identification” (starting in 2008 and ending in 2012). The research during this period mainly focuses on the most fundamental research in the application of virtual technology.The keyword with the longest sustained burst was “model”(start in 2013 and end in 2018), while the keywords with the shortest sustained burst were “impact”.

We can see that the VR applications in the field of archive management involves various aspects such as warehouse management, online exhibition of physical archives, and exhibition of special collections of archives. On the whole, it has entered the application exploration stage.

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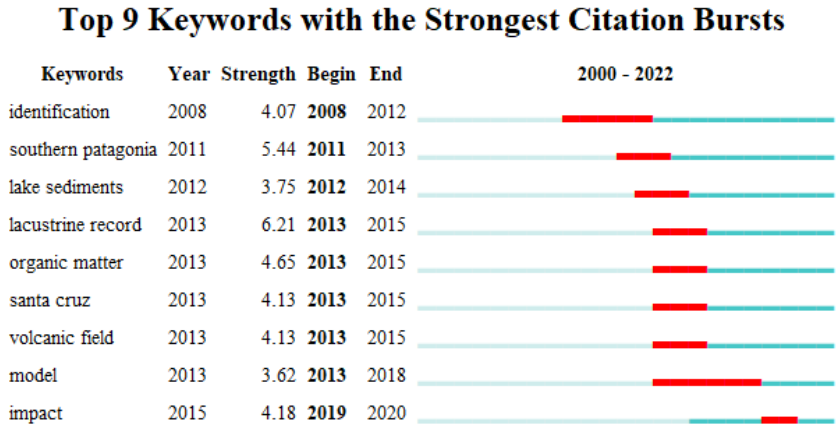

Figure 6. Keyword burst list

5. Discussion and Conclusions

5.1. The application of VR should be highly valued

Currently, VR gets more and more attention,and the integration of VR and archives management has broad application prospects.However,compared to other new generation information technologies such as artificial intelligence, VR has a relatively insufficient role in the planning and construction of the field of archives management, so it is necessary to establish and improve policies related to the application of VR in archives management.In addition, the archives management department should collaborate with other departments to develop more detailed application guidelines, providing more targeted guidance for archives management practices.

5.2. Promoting the integrated application of VR

Ensuring the authenticity, integrity, availability,and security of archive information in a virtual reality environment is very important. It is necessary to pay more attention to the issue of digital continuity and continuously promote the integrated application of VR. The principle of digital continuity emphasizes that information management in a digital environment should ensure the integration of information,systems,and management processes[11].Its requirements include ensuring the authenticity and reliability of information, digital management methods, and the ability to continuously preserve, protect, and manage information.Although VR affects the archives management process, it can truly integrate into the entire lifecycle of the covered archives, thereby maximizing their value,as long as it is deeply integrated into the infrastructure for the construction of digital archives or smart archives.

5.3. Enhance the integration of VR and management theory

When applying VR in archives management, it is necessary to clarify the basic theories and principles. Archives management activity is a highly operational activity, and the application of information technology such as virtual reality is only a means to serve archives management activities. It can't contradict the theories, principles, and methods of archives management. The archives management under VR should follow the basic theories and principles of archives management, and apply virtual reality technology to archives management without damaging the principles and methods of archives management.

5.4. Conclusions

Virtual reality technology can be applied in various archive service fields such as digital archive display, increasing the user's sense of interaction and improving the experience when using archives.

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Users can achieve deep interaction with archival entities and virtual reality models in various ways, utilizing various interaction methods combined with sensing technology to achieve a better experience and interactive effect. Archives management should make full use of new technologies, enrich the practical effects of archive utilization, deeply explore the connotation of archives, and achieve digitalization, interactivity, and intelligence of archives management,

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