Research Hotspot and Trend of Digital Clothing Based on Bibliometric Map

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Abstract. Objective: To explore the research status of digital technology in the field of clothing, analyze research hotspots and frontier trends, and provide ideas and references for subsequent research topics. Methods: CNKI database was used as the data source of Chinese literature, Web of Science core database as the data source of English literature, and CiteSpace 6.2.R5 visual tool software was used. This paper visually analyzes the research status of digital technology in the field of clothing from the aspects of cooperation between authors and institutions, keyword co-occurrence, keyword clustering and emergence analysis, and draws correlation maps for comparative study. Results: A total of 118 Chinese literatures and 1418 English literatures were included. The analysis shows that the total number of papers published by Chinese and foreign institutions is on the rise, but there are great differences in research hotspots. The data sources of Chinese literature are mainly digital technology, intelligent clothing, intelligent manufacturing, etc. The data sources of English literature are mainly reflected in the continuous research of social media, clothing industry and purchase intention. Conclusion: Researchers and institutions should grasp the hot spots and trends in the field of digital clothing, strengthen exchanges and cooperation between China and foreign countries, provide theoretical support and practical guidance for academia and industry, promote the effective integration of digital technology and clothing industry, and inject new vitality and innovation.

Keywords: Clothing design; digital technology; Bibliometric; Visual analysis; Hotspot research; Chinese and foreign comparison.

With the increasingly popular application of digital technology in the field of fashion, it has brought many new possibilities for the clothing industry, and the digitalization rate of China's textile industry equipment has reached 55.6% in 2022, and the digital production equipment network rate has reached 49%. Garment computer-aided design (CAD), enterprise resource planning (ERP) and other information systems are centrally deployed in textile enterprises [1], and digital technology also promotes the digital transformation of the entire garment industry chain. The Ministry of Industry and Information Technology of China proposed in the Notice on carrying out "Joint action" to promote the integration and innovation of large, small and medium-sized enterprises (2022-2025) that pilot construction will be organized around key industries such as textile and apparel, in order to accelerate the digital transformation and upgrading of the industry, and achieve green, low-carbon and high-quality development of data-driven industrial clusters. However, relevant data show that the specific application of digital technology in the clothing industry chain needs to be further explored, for example, many enterprises and practitioners are still facing challenges such as technology application, cost control, and personnel training. The dilemma between practical application and theoretical research makes the in-depth study of digital technology in the field of clothing become particularly important. Therefore, promoting the research and transformation of digital technology in the field of clothing will bring broader space and opportunities for the entire clothing industry chain.

Document metrology analysis takes document system as the research object and document metrology as the research method, which can accurately analyze massive document samples and capture research hotspots and frontier trends in specific disciplines, and has been widely used in various disciplines [2]. This method has produced relatively rich research results in the field of clothing. For example, Li Wanjun et al. [3] used the bibliometric atlas method to search the
databases of CNKI and Web of Science(WOS). The research status and trends of smart fibers at home and abroad are visually analyzed from four aspects: smart clothing, health monitoring, conductive sensing, and Internet of Things access. Wei Yijun and Zhao Hengyu [4] took the papers on ethnic minority clothing collected by CNKI as the research object, and adopted the bibliometric analysis methods such as word frequency statistics, co-word analysis, cluster analysis and topic analysis to make statistics on 2,552 research results on ethnic minority clothing in China from 1955 to 2022, and constructed a visual knowledge map. Wang Baolu and Wu Yilin [5] used word frequency analysis, cluster analysis and other bibliometric analysis methods to carry out visual research on five hot research trends of big data in the textile and garment field, so as to promote the application of big data technology in all aspects of the textile and garment industry. Tang Bei and Xia Qiuju [6] took the subject-specific literature included in SCI as the analysis object, and used the methods of information visualization and bibliometrics to investigate the subject-specific characteristics of clothing and the rules of literature utilization from an international perspective. However, the above research reflects two problems: First, although the bibliometric analysis of digital clothing has been involved, few scholars have compared the research content, hot spots and frontier trends at home and abroad, and there is still a lack of comprehensive grasp and comparison of the overall research status and development trend at home and abroad. Second, the evaluation of the current research conclusions is more positive, and the application of digital technology in the field of clothing is affirmed. However, the results of bibliometric analysis show that from 2022 to now, the number of published papers at home and abroad has shown a downward trend. This phenomenon indicates that the application, effect and influence of digital technology in the field of clothing need further discussion.

1. Data sources and research methods

1.1 Data source

In order to comprehensively understand the domestic research status of digital technology in the field of clothing, this study uses bibliometric analysis method and scientific knowledge graph CiteSpace software to summarize the literature research results published at home and abroad, and uses visual analysis methods to present the research status, summarize research hotspots, and grasp the frontier trends. The data in this paper are from two databases: Web of Science (WOS) and China National Knowledge Network (CNKI).

Use advanced search in CNKI, "Source category" check "Chinese Core Journals (Peking University Core)", "Chinese Social Sciences Citation Index (CSSCI)", "China Science Citation Database (CSCD)" are set as "digital" and contain "clothing" or "fashion" or "clothing" or "fashion" respectively according to the theme. The literature type was selected as "academic journals", and a total of 118 Chinese literatures were obtained after further refining. The search time was December 2023, and the publication year was "2003-2023". Foreign data are reflected in English literature, and "Web of Science Core Collection" is selected in WOS. Advanced search with Science Citation Index Expanded (SCI-EXPANDED) and Social Science Citation Index(SSCI) as search scopes, If the theme is "digital" or "digitization" AND contains "fashion" or "clothes" or "clothing" or "garment" or "apparel", the theme is set in the cross-search to select "AND method". Mainly based on the extensive research of foreign journals on clothing digitization and fashion digitization, there are a lot of combined literatures, the literature types are selected Article and Review, and the countries and regions are not limited. A total of 1418 English literatures were obtained, the search time is December 2023, and the publication year is 2005-2023.

After the search was completed, the above literature was reviewed to confirm that there were no irrelevant and duplicate literatures, and to determine the main research results that could cover the application of digital technology in the field of clothing. The specific literature retrieval process and methods are shown in Table 1.
Table 1. Process and method of literature searching

<table>
<thead>
<tr>
<th>[count] search strategy</th>
<th>CNKI</th>
<th>WOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archive</td>
<td>Peking University core、CSSCI、CSCD</td>
<td>SCI-EXPANDED、SSCI</td>
</tr>
<tr>
<td>Search mode</td>
<td>&quot;Digital&quot; and include &quot;clothing&quot; or &quot;fashion&quot; or &quot;clothing&quot; or &quot;fashion&quot;</td>
<td>&quot;digital&quot; or &quot;digitization&quot; and &quot;fashion&quot; or &quot;clothes&quot; or &quot;clothing&quot; or &quot;garment&quot; or &quot;apparel&quot;</td>
</tr>
<tr>
<td>Publication year</td>
<td>2003-2023</td>
<td>2003-2023</td>
</tr>
<tr>
<td>Document type</td>
<td>learned periodical</td>
<td>article or review</td>
</tr>
<tr>
<td>Retrieval time</td>
<td>On December 4,2023</td>
<td>On December 4,2023</td>
</tr>
<tr>
<td>Search result</td>
<td>118 Articles</td>
<td>1418 Articles</td>
</tr>
</tbody>
</table>

1.2 Study Methods

The CiteSpace software was used to analyze and study the relevant literature of domestic and foreign digital clothing. Integrated use of CiteSpace 6.2.R5 visualization tools of the author cooperation map, organization cooperation map, keyword co-occurrence map, keyword clustering map, keyword sudden map function [6], through qualitative induction and quantitative analysis, using the way of information visualization of these data, comprehensive comparison and analysis of domestic and foreign two dimensions published research results and basic situation, analysis found and understand the key author in the academic field, important literature and cooperation, step by step and parsing digital research hotspot in the field of clothing, finally to the future development trend.

2. Study the basic situation, hot spots and trend analysis

2.1 Number of publications

The number of published literatures is an important indicator to judge research achievements. In order to clearly reflect the number of relevant research achievements of institutions, the literature samples obtained after literature retrieval and screening were statistically sorted by using Excel software according to the time series from 2003 to 2023, and the changes of research trends in this field were intuitively reflected by graphs. As shown in Figure 1-2, the trend of the first publication of Chinese and English literature can be divided into three stages. In the first stage, there are not many literatures on digital clothing, the number of publications in foreign journals is significantly higher than that in domestic journals, and the scholars and institutions carrying out extensive research are also earlier. The number of Chinese literatures has risen sharply since 2016, and in the second stage, the number of domestic and foreign literatures has risen rapidly. Both reached a peak in 2022, with 37 articles in Chinese and 223 in English, but the increase in Chinese papers was still far smaller than that in English during the same period, which may be related to the fact that WOS is a database covering the whole world, and researchers and research institutions have more diversified research types on digitalization and clothing. However, in the third stage of 2022-2023, the number of Chinese and foreign papers has declined, which may be related to the development of the field of artificial intelligence worldwide, and the definition of traditional digital technology and artificial intelligence needs to be further clarified, but the specific reasons need to be further dug.
2.2 Researcher Analysis

2.2.1 Analysis of researchers' published papers

In the CNKI database, Zhu Weiming and Wei Yanghong of Zhejiang University of Science and Technology published "Research on Internet + Clothing Digital Personalized Customization Operation Mode" in Silk in 2018, which was cited 62 times and downloaded 2255 times, making it the most downloaded article in CNKI database. This study puts forward two operating models of digital personalized clothing customization, which provides effective paths and relevant marketing suggestions for the transformation and upgrading of the traditional clothing industry. Ko Eunju of Yonsei University in South Korea is the most prolific author of the WOS database on digital fashion. His team's Modeling consumer adoption of mobile shopping for fashion products in Korea, published in PSYCHOLOGY & MARKETING in 2009, With 473 citations, this study used a structural equation model to describe the relationship between perceived value and consumers' willingness to shop online fashion products through 511 questionnaires.
2.2.2 Analysis of researcher cooperation network

Through the analysis of researcher cooperation network, we can clarify the academic cooperation between researchers.

It helps to discover the core cooperative team and explore the degree of its connection. In this study, CiteSpace 6.2.R5 software was used to visually analyze the cooperation between researchers. Node Types were set as Author, the time range was 2003-2023, and the time slice was 1 year. "Pathfinder" and "Pruning" are used sliced networks and "Pruning the merged network" were cut, and other items were set as default. Combined with the data from the statistical table of the number of published papers, multiple core author groups were formed in Chinese literature. Researchers have formed a relatively stable cooperative ecosystem, but the co-occurrence relationship is mainly concentrated among researchers within the same unit, and is generally loose. At the same time, the cooperation of English literature researchers is more close, forming a core group of authors represented by Ko Eunju, Tiggemann Marika, Zeng xianyi and other scholars. The node connection overlap among researchers is dense, and the degree of cooperation is high.

2.3 Mechanism Analysis

2.3.1 Statistics of the number of issued documents

To some extent, the total number of published documents can reflect the research ability and academic exchange level of the institution. According to the literature samples, a statistical table was formed for the number of documents issued by high-yield institutions, as shown in Table 2. Inter-agency cooperation can directly explain the outcomes of innovation exchange, academic cooperation, technology sharing and other behaviors at the institutional level. CiteSpace 6.2.R5 software was used to generate the cooperation network maps of Chinese and English donors respectively, as shown in Table 2. Each circular node in the institutional cooperation network map represents an institution, and there is an institution name corresponding to it. The size of the institution name is positively correlated with the occurrence frequency of the institution. The larger the institution name indicates the greater the number of publications. More and tighter connections mean closer cooperation.

<table>
<thead>
<tr>
<th>Ranking</th>
<th>The institution</th>
<th>Number of posts / articles</th>
<th>Ranking</th>
<th>The institution</th>
<th>Number of posts / articles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>School of Fashion and Art and Design, Donghua University</td>
<td>9</td>
<td></td>
<td>University of London</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Key Laboratory of Modern Fashion Design and Technology, Ministry of Education, Donghua University</td>
<td>5</td>
<td></td>
<td>University of North Texas Denton</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Wuhan Textile University</td>
<td>5</td>
<td></td>
<td>University of North Texas System</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Donghua University</td>
<td>4</td>
<td></td>
<td>University of Arts London</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>School of Fashion Technology, Zhejiang Sci-Tech University</td>
<td>3</td>
<td></td>
<td>Yonsei University</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>School of Fashion College, Wuhan Textile University</td>
<td>3</td>
<td></td>
<td>Pennsylvania Commonwealth System of Higher Education</td>
<td>16</td>
</tr>
</tbody>
</table>
2.3.2 Institutional cooperative network analysis

Chinese literature, the number of ranking Top10 institutions a total of 38, donghua university, Wuhan textile university, Zhejiang university, Beijing institute of garment technology is the main unit of the field published Chinese literature, the three institutions have absolute advantage in the literature, post more than two-thirds, prove that it has been committed to digital research in the field of clothing. English literature is more closely than Chinese literature, Overlapping dense node connections are formed between University of London, University of North Texas Denton and University of Arts London, For ten different but institutions, And mainly in Britain and the United States, It can be seen that the cooperation of English literature countries is very close, See Figure 3-4, It is suggested that Chinese research teams should enhance communication with different institutions and disciplines, and embrace digital research hotspots and trends in multiple fields, Research attitude of strengthening international academic cooperation.

![Figure 3. Cooperative Network Map of Chinese literature institutions](image-url)
2.4 Analysis of keyword co-occurrence

Keyword co-occurrence analysis is an analysis and statistics for the number of pairs of keywords appearing in a literature, so as to gain insight into the affinity relationship between keywords. Run CiteSpace 6.2.R5 software, set Node Types to Keyword, time, slice set, cut mode, and other items as in "2.2.2". Based on the running statistics results, The co-occurrence analysis of Chinese literature keywords contains 392 keywords, With 840 connecting lines, The co-occurrence network density was 0.011, Keywords ranking Top 5 are clothing design, intelligent clothing, textile and clothing, artificial intelligence, intelligent manufacturing. Research hotspots mainly focus on the intelligent design of clothing, This is related to China's manufacturing capacity, long textile and garment industry accumulation, can provide a research basis for digital technology in the field of clothing research; The keyword analysis of English literature contains 448 keywords, 773 wire lines, The co-occurrence network density was 0.0052, The Top 5 ranking of keywords are social media (social media), technology (technology), impact (influence), consumption (consumption), fashion (fashion), In terms of international research hotspots, Not just limited to technical research, Also focused on cross-sectional areas such as social media, clothing management, and apparel consumption, Pay more attention to the practical research of digital technology in commercial applications, See Table 3 for the high-frequency keyword statistics.

<table>
<thead>
<tr>
<th>ranking</th>
<th>Chinese literature</th>
<th>word frequency</th>
<th>English literature</th>
<th>word frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>costume designing</td>
<td>32</td>
<td>1</td>
<td>social media</td>
</tr>
<tr>
<td>2</td>
<td>Smart clothing</td>
<td>11</td>
<td>2</td>
<td>technology</td>
</tr>
<tr>
<td>3</td>
<td>Textile clothing</td>
<td>4</td>
<td>3</td>
<td>impact</td>
</tr>
<tr>
<td>4</td>
<td>artificial intelligence</td>
<td>4</td>
<td>4</td>
<td>consumption</td>
</tr>
<tr>
<td>5</td>
<td>intelligent manufacturing</td>
<td>4</td>
<td>5</td>
<td>fashion</td>
</tr>
<tr>
<td>6</td>
<td>costume</td>
<td>4</td>
<td>6</td>
<td>management</td>
</tr>
<tr>
<td>7</td>
<td>Appliance</td>
<td>3</td>
<td>7</td>
<td>fashion industry</td>
</tr>
<tr>
<td>8</td>
<td>Clothing style</td>
<td>3</td>
<td>8</td>
<td>design</td>
</tr>
<tr>
<td>9</td>
<td>Costume matching</td>
<td>2</td>
<td>9</td>
<td>information</td>
</tr>
</tbody>
</table>
2.5 **Keyword cluster analysis**

Keyword cluster analysis can help researchers understand the correlation between keywords in literature and the distribution of research topics. Based on the results of keyword co-occurrence analysis, keyword cluster analysis is carried out to judge and identify research frontiers [7]. The author uses the log-likelihood ratio method to cluster the keywords and form the map.
2.5.1 Chinese literature keyword cluster analysis

In terms of Chinese literature, 14 clusters were obtained, with a modular value of Modularity $Q=0.943$ ($Q$ value $>0.3$ indicates a significant cluster structure). Average cluster profile value Weighted Mean Silhouette=0.9919 (average cluster profile value $S>0.7$ indicates reasonable clustering reliability) indicates that the cluster structure is significant and credible. The resulting map display results are shown in Figure 6 (K=10). The corresponding cluster and keyword examples are #0 digital representation; #1 Smart clothing; #2 Clothing matching; #3 Image interpretation; #4 Transformation of traditional industries; #5 Clothing structure design; #6 Textile and clothing; #7 Smart fiber; # 8 Machine vision; # 9 Women's design.

![Figure 7. Cluster map of keywords in Chinese literature](image)

2.5.2 Cluster analysis of keywords in English literature

In English literature, 19 clusters were obtained, with a modular value of Modularity $Q=0.836$ ($Q$ value $>0.3$ indicates a significant cluster structure). Weighted Mean Silhouette=0.9123. The weighted mean silhouette value $S>0.7$ indicates reasonable clustering reliability. This indicates that the cluster structure is significant and credible. See Figure 7 (K=10). The corresponding cluster and keyword examples are #0 Fashion Industry; #1 Purchase intention; #2 Digital transformation; #3 Social media; #4 Sharing economy; #5 Supply chain; #6 Digital platform; #7 Digital media; # 8 Fashion blogs; # 9 Digital fashion; # 10 Fashion designer.
2.6 Keyword breakout Analysis

Keyword emergence refers to the comprehensive analysis of the frequency and time information of keywords, and the detection of keywords with a high frequency change rate within a certain period of time, so as to reveal the development dynamics and frontier trends of the research field. According to the mutation detection algorithm, the list of mutation words in Chinese literature and English literature is obtained, as shown in Table 5-6. The results show that the hot spots of Chinese literature research are relatively dispersed from 2003 to 2020, and the hot spots of Chinese literature research are relatively dispersed from 2003 to 2020, which are divided into two obvious intervals, including digital technology, design method, trend prediction, supply chain, etc. From 2021, the research focus will be mainly on smart clothing and industrial sustainable development. The research focus of English literature is divided into three distinct sections. Before 2014, from 2014 to 2021, it mainly focuses on the research of clothing communication empowered by digital technologies such as media, data and network. After 2022, it is developing in the direction of brand, supply chain and fashion. Therefore, the results of keyword co-occurrence and keyword cluster analysis in Chinese and English literatures differ greatly. The research focus of Chinese literatures tends to be on technology and manufacturing, while that of English literatures focuses on industrial development, social media and brand communication.
3. Digital clothing research trends

Through the bibliometric analysis, it can be seen that the hot spots of digital research in the field of clothing in Chinese literature mainly focus on design methods, digital transformation, intelligent manufacturing, and personalized customization. English literature pays more attention to the deep integration of digital technology and mass communication, and researchers more discuss the role and influence of digital technology in the fashion industry value chain, such as the impact of user
experience and consumer behavior. Research at home and abroad shows that both have gradually shifted their attention from the early application of technology to the whole fashion industry.

The future research direction of digital technology in the field of clothing can include the following aspects:

3.1 Artificial intelligence and intelligent manufacturing

Study how to use artificial intelligence technology to improve the efficiency of clothing design, production and sales, including intelligent design system, intelligent cutting and sewing system, so as to achieve customization, personalization and rapid response to market demand. For example, research on how to use virtual reality technology and body scanning technology to achieve a more real and accurate virtual fitting experience to further enhance consumers' shopping experience and satisfaction. Research and improve the 3D printing technology of clothing materials to achieve higher printing accuracy, wider material applicability and faster printing speed, while exploring sustainable and environmentally friendly material applications to achieve the digital transformation of the clothing industry.

3.2 Sustainable development of clothing production and consumption

In future research, digital technology can also be combined with sustainable development, environmental protection and other issues to explore how to use digital technology to reduce resource waste and environmental pollution, while improving social, economic and environmental sustainability.

3.3 Consumer behavior analysis and big data application

Study how to use big data technology to analyze consumers' shopping behaviors, preferences and needs to guide clothing design, production and marketing strategies to achieve precision marketing and personalized customization. In future studies, digital technology can also be combined with sustainable development, environmental protection and other issues to explore how to use digital technology to achieve sustainable development of clothing production and consumption, reduce resource waste and environmental pollution, and improve social, economic and environmental sustainability.

3.4 Focus on user experience

Simplify user interface and operation process, make complex technology intuitive and easy to understand, user interface friendly, operation logic clear, reduce user cognitive load; Provide easy-to-understand training courses, tutorial videos, how-to guides, etc., to teach users methods and techniques to use technology, and enhance their ability and confidence. Pay attention to the actual use of users, analyze the needs, reduce the cost and risk of users trying new technologies, and enhance the willingness of users to accept. Continue to improve the technology, provide new features and better user experience, and continue to promote the development and popularization of technology.

These research directions require interdisciplinary and cross-industry cooperation, combining knowledge and technology in the fields of clothing design, material science, computer science, human-computer interaction, marketing, and brand management, to promote the innovation and development of digital technology in the clothing field.

4. Conclusion

In the past decade, the total number of articles published by Chinese and foreign institutions has continued to rise, and scientific and technological achievements have emerged continuously, mainly combining the inspection and testing business and related needs. The major Chinese journals published include Silk, Textile Journal and Journal of Donghua University, among which Donghua
University and University of London have the largest number of articles. It plays a leading role in digital clothing research, is an important force to promote the development of digital technology and clothing industry, and also supports the disciplinary background, research foundation and scientific research platform. According to the visual analysis results, the current Chinese literature mainly aims at realizing intelligent manufacturing in the textile and garment industry, emphasizes the application of digital and intelligent technology in the industrial chain and supply chain, and discusses the apparel enterprises and design education. English literature pays more attention to the consumers and market at the end of the industrial chain, and studies digitalization and information technology in fashion communication, social media, user research and other fields with the academic background of multidisciplinary integration. In the future scientific research, it is hoped that Chinese researchers will combine their own national conditions and research advantages, closely follow the international frontier research hot spots to carry out diversified exploration and research, and strengthen cross-institutional, cross-regional and cross-national academic cooperation, so as to provide strong intellectual support for digital technology, digital communication and transformation in the field of clothing.

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Reference


