

Bibliometric Analysis of Human-Computer Interaction

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ABSTRACT

Human-Computer Interaction (HCI) has emerged as a multidisciplinary field that bridges computer science, artificial intelligence, psychology, and design to improve the interaction between humans and digital technologies. This study aims to analyze the intellectual structure, research trends, collaboration patterns, and emerging themes within the HCI literature through a bibliometric approach. Data were collected from the Scopus database using the keyword "Human-Computer Interaction" and related terms. Bibliometric analysis and visualization were conducted using VOSviewer to examine publication networks, keyword co-occurrences, citation structures, co-authorship relationships, institutional collaborations, and country-level research partnerships. The findings reveal that HCI research is centered on themes such as user interfaces, user experience, artificial intelligence, machine learning, computer vision, gesture recognition, virtual reality, and augmented reality. Overlay visualization indicates a recent shift toward advanced technologies, particularly deep learning, emotion recognition, convolutional neural networks, and intelligent interaction systems. Citation analysis identifies several highly influential publications that have shaped the theoretical and methodological foundations of the field, while collaboration analyses highlight the significant roles of the United States, China, and India, alongside leading institutions such as Carnegie Mellon University and the University of Washington. The results demonstrate that HCI research is increasingly interdisciplinary and globally collaborative, reflecting the growing demand for intelligent, adaptive, and user-centered technologies. This study provides a comprehensive overview of the evolution of HCI research and offers insights into future directions, particularly in the areas of AI-driven interaction, multimodal recognition, immersive environments, and personalized digital experiences.

Keywords: Human-Computer Interaction, Bibliometric Analysis, VOSviewer, Artificial Intelligence, User Experience

1. INTRODUCTION

Human-Computer Interaction (HCI) is undoubtedly one of the most important interdisciplinary areas in today's digital world. It involves designing, evaluating, and implementing interactive computing systems to be used by people. From the inception of computer systems in the last century until now, people have been making attempts to enhance the interaction between computers and people through usability, accessibility, efficiency, and satisfaction [1]. In addition, the use of technology in various sectors including education, health care, business, transportation, and communication has led to an expansion of the area under HCI. This means that today, HCI is more than just the interaction between humans and computers since it is not only concerned with computer science and interface design but also includes other disciplines like psychology, cognitive science, sociology, design, and artificial intelligence. Some of the notable theories in this regard include those by [1]-[3].

Apart from being driven by the fast-paced development of technology, research on human-computer interactions has been fueled by the growing number of scholarly studies in the field. Modern developments such as virtual reality, augmented reality, wearable technology, machine learning, and artificial conversation intelligence have presented numerous opportunities and difficulties for the interaction of people and computers. Therefore, an increased number of researchers worldwide has become interested in the interaction of humans and intelligent technologies within different settings. Consequently, the HCI body of knowledge has expanded significantly during the past 20 years. The expansion can be explained by the need for user-oriented

designs aimed at ensuring that technologies will serve users' interests and requirements. In addition, increased availability of internet and mobile computing has prompted specialists from various backgrounds and geographical locations to become involved in HCI research [4], [5].

Though a significant amount of research in HCI has already been conducted, the growth of scholarly publications presents difficulties for scientists in terms of comprehending the general architecture of the domain. The usual literature review techniques turn out to be insufficient for detecting the tendencies in publication, finding important authors, institutions' collaboration, etc., especially when dealing with a great deal of data [6]. It is at this point that bibliometric analysis turns out to be a helpful method for assessing scientific literature in a more detailed manner. With the help of bibliometric analysis, the researcher is able to analyze the structure of publications, citation networks, co-authoring practices, keywords used in studies, and even scientific productivity of certain organizations or individual scientists in the selected domain of research. Using bibliometric mapping, the scholar finds what topic is dominating, which journal is considered influential, what countries take the lead, and where research gaps lie.

In recent times, many bibliometric studies have been conducted in various fields of science like artificial intelligence, information systems, health informatics, and educational technology. Nonetheless, there are very few extensive bibliometric research studies dedicated to the study of HCI despite the tremendous growth that the field has undergone. These studies often focus on specific aspects such as usability engineering, user experience, and mobile interaction without providing an overall view of the development of HCI research. Considering the multidisciplinary nature of HCI, it becomes important to conduct bibliometric research to understand the role of various fields of research in creating knowledge networks in this area. Knowledge about this would help identify upcoming trends and technology shifts in the area of HCI [5].

One more crucial reason why bibliometric analysis should be conducted in the realm of HCI is the emerging importance of innovation and human-centered development of technologies in the context of digital transformation. Nowadays, governments, businesses, and educational organizations pay a lot of attention to such factors as user experience and accessibility. This makes HCI an especially important area of study from the perspective of sustainable technological advancement and improving the quality of people's lives. Bibliometric analysis will allow policymakers, educators, and scholars to better understand the current state of research on this topic and identify those areas which need further research and investigation. Moreover, results of bibliometric research can be used as a basis for further collaboration and policy-making related to innovations in HCI.

Despite substantial progress and diversification in the domain of Human-Computer Interaction in recent decades, there has been a relatively small amount of systematic research that aims at gaining comprehensive knowledge concerning its development process, intellectual structure, and research tendencies. The extensive and ever-growing number of articles published within the scope of HCI renders it almost impossible for scholars to detect the most relevant articles, thematic trends, collaborations, and innovations without using advanced bibliometric techniques. The interdisciplinary nature of HCI poses additional challenges related to tracing connections between disciplines, authors, organizations, and countries involved in the research field. The absence of thorough analysis of patterns within the body of HCI literature might result in missing certain crucial insights, which could otherwise be used to conduct future research successfully. This study

From the visual representation of co-occurrence network, it can be observed that Human-Computer Interaction (HCI) is the focal point of research, depicted as the biggest node appearing right in the middle of the entire network. Since human computer interaction is the dominant keyword in terms of frequency within the database, its significance as a research stream lies in the fact that it forms the nucleus around which all other research domains revolve. The close knit network of connections around this core denotes the interdisciplinary character of Human Computer Interaction that combines theories from computer sciences, artificial intelligence, psychology, education, and user centered design. The red cluster shows that HCI is applied to educational technology and artificial intelligence. The presence of terms like students, teaching, e-learning, learning systems, and artificial intelligence show the large amount of research that is being conducted to improve learning experience by implementing interactive technologies. The occurrence of machine learning and humans in this cluster means that the researchers are getting more interested in creating smart systems of education which will respond to the activities and learning preferences of users.

The blue cluster, however, deals mostly with computing intelligence and recognition capabilities. The keywords "deep learning," "speech recognition," "emotion recognition," "convolutional neural networks," and "computer vision" fit into a theme-based cluster of keywords related to computer perception and interactions. Since these keywords are closely associated with each other, it can be said that recent HCI research tends to take advantage of deep learning methods to implement machine capability to recognize speech, emotions, gestures, and visual information. These developments are indicative of new modes of computing, which are no longer limited to graphical user interfaces. The green cluster is based on user-oriented design and interactive design. Words like computer interaction, user interface, user experience, behavioral studies, virtual reality, and augmented reality denote the importance of researching the interaction process between the user and digital technology. There are numerous connections between user interface and immersion techniques, denoting that more research will be devoted to the development of comfortable environments for users. Usability, satisfaction, cognitive processes, and behavior may be explored in this research direction.

Yellow and Purple clusters reflect particular types of interaction mechanisms and research directions. Yellow cluster includes such words as gesture recognition, computer vision, and palmprint recognition, demonstrating the works that make use of biometric interfaces and gesture interactions to enhance the communication between human and computer. The purple cluster includes such terms as eye tracking, eye movements, and their associations with VR/AR technologies.

3.1 Overlay Visualization

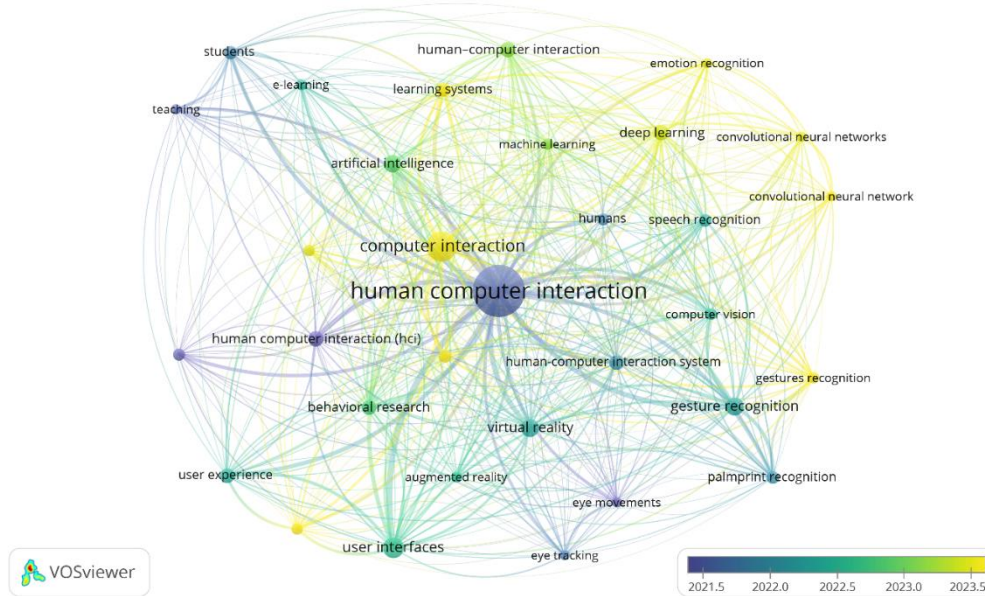


Figure 2. Overlay Visualization

Source: Data Analysis Result, 2026

This overlay visualization depicts the timeline showing the development of studies related to Human-Computer Interaction (HCI) from 2021 through 2024. Terms in dark blue hues show the themes researched in the past, while green and yellow terms show more recent themes in scholarship. The core term human computer interaction continues to be the major and persistent theme in this research area. This is because it is the cornerstone of many other research streams. Dense connections between various terms show that this area of inquiry is evolving into an interdisciplinary field incorporating AI, education, computer vision, and user design.

The early researches, which have blue and blue-green nodes, have been more focused towards the following areas: students, teaching, speech recognition, gesture recognition, human-computer interaction system, eye tracking, and palmprint recognition. These research areas show that the initial efforts made by scientists to develop human-computer interactions were mainly aimed at building communication interfaces, recognition techniques, and other interactive technologies that would increase the level of cooperation between human beings and computers. As can be seen in yellow-colored nodes, newer research trends in HCI have emerged, which are centered on AI technologies like deep learning, machine learning, emotion recognition, convolutional neural networks, and computer vision. The appearance of these subjects reveals the current trend of developing AI-based technologies that are able to understand intricate human interactions such as gestures and emotions. It is clear from the above analysis that the trend in the study of HCI is shifting from traditional interface design to interaction design that is context-sensitive and based on artificial intelligence technologies. From these results, it is obvious that the next step in HCI studies is using deep learning in multimodal recognition systems.

3.2 Citation Analysis

Table 1. The Most Impactful Literatures

Citations	Authors and year	Title
13029	[7]	Haploview: Analysis and visualization of LD and haplotype maps
7216	[8]	From game design elements to gamefulness: Defining gamification
4009	[9]	An empirical evaluation of the system usability scale

Citations	Authors and year	Title
3795	[10]	The GeneMANIA prediction server: Biological network integration for gene prioritization and predicting gene function
3643	[11]	Recognizing human actions: A local SVM approach
3219	[12]	A model for types and levels of human interaction with automation
3090	[13]	On Seeing Human: A Three-Factor Theory of Anthropomorphism
2817	[14]	Detecting faces in images: A survey
2624	[15]	A survey of socially interactive robots
2614	[16]	ROCR: Visualizing classifier performance in R

Source: Scopus, 2026

Table 1 shows that the most impactful literature in Human–Computer Interaction is highly interdisciplinary. The most cited work is [7] with 13,029 citations, followed by [8] on gamification and [9] on the System Usability Scale. The list shows that influential HCI research is not limited to interface design, but also covers visualization tools, usability measurement, gamification, automation, anthropomorphism, face detection, human action recognition, classifier performance, and socially interactive robots. This indicates that HCI has developed as a broad research field connecting technical system development with human behavior, user experience, automation, and intelligent interaction.

3.3 Density Visualization

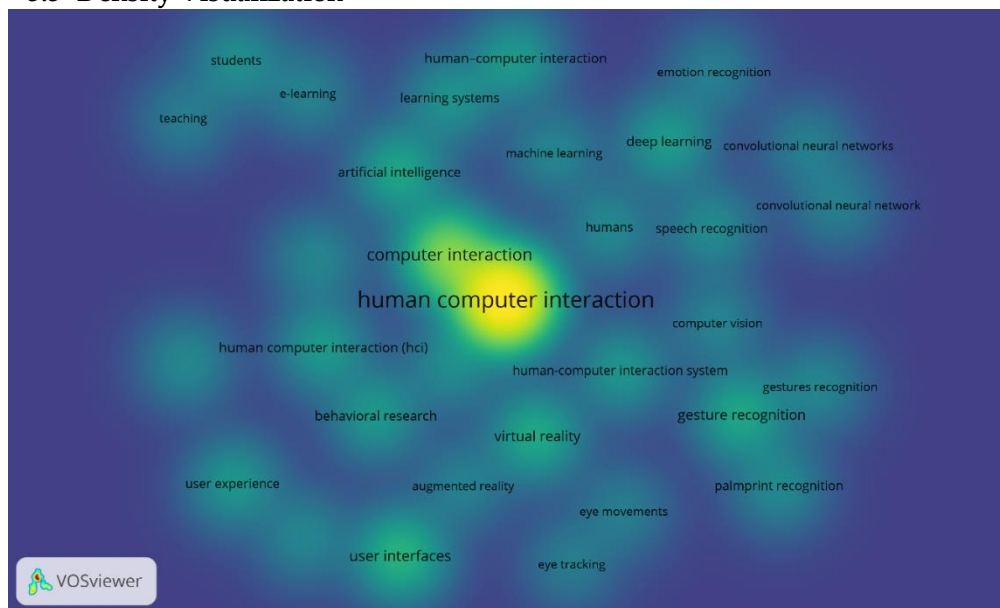


Figure 3. Density Visualization

Source: Data Analysis Result, 2026

The density chart reveals the topics that have received the greatest attention and have the highest interconnection frequency in the HCI research field. Topics in bright yellow and green are those that have the highest density, whereas topics in blue color are less researched. Human computer interaction is one of the dominant hotspots, reflecting its importance in the HCI domain. Computer interaction, artificial intelligence, machine learning, human, and human-computer interaction system topics are positioned at the center, signifying their importance as key components of the current HCI field. These keywords have strong links, which reflect the increased use of computational intelligence integrated with human-centric methods to enhance interactions. In

addition to the primary topics, other secondary focal areas also provide some insight into possible future research directions in the field of HCI. Some of the keywords that have an average density include user interfaces, user experience, virtual reality, augmented reality, gesture recognition, speech recognition, computer vision, and deep learning. Other emerging terms are eye tracking, eye movements, emotion recognition, and palmprint recognition.

3.4 Author Visualization

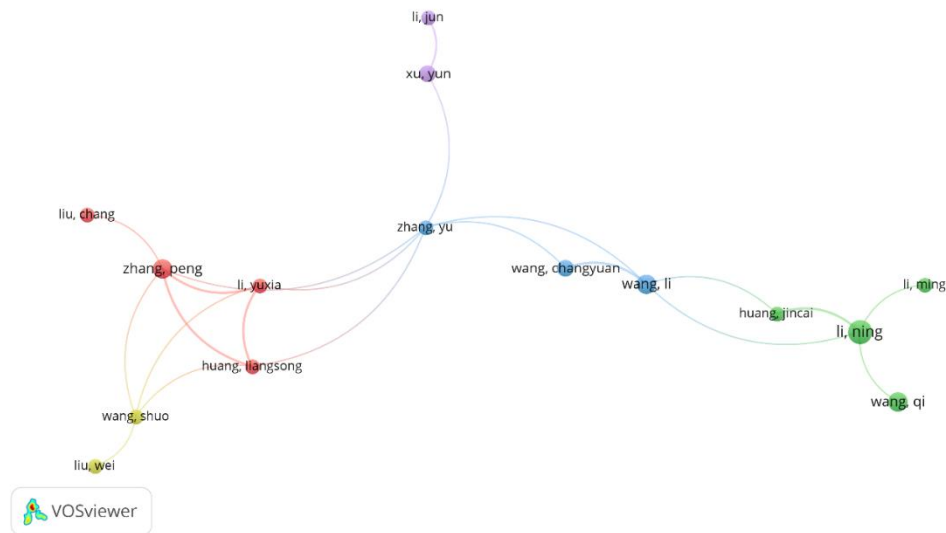


Figure 4. Author Visualization

Source: Data Analysis Result, 2026

Figure 4 reveals a relatively concentrated collaboration structure within the Human-Computer Interaction research domain. Several author clusters can be identified, with researchers connected through collaborative publications. The network is centered around authors such as Zhang Yu, Li Yuxia, Zhang Peng, Wang Li, and Li Ning, who serve as important bridges linking different research groups. Among them, Zhang Yu appears to play a particularly significant role by connecting multiple clusters, indicating a high level of collaboration and influence within the network. Similarly, Li Ning functions as a central node within another cluster, linking authors such as Wang Qi, Li Ming, and Huang Jincai. The existence of these bridging authors suggests that knowledge exchange within the field is facilitated by a limited number of highly connected researchers. The visualization also demonstrates that HCI research collaborations tend to occur within relatively small and specialized groups rather than through a single large international network. Distinct clusters can be observed, including the Zhang Peng-Li Yuxia group, the Zhang Yu-Wang Li group, the Li Ning group, and the Xu Yun-Li Jun group. The varying node sizes indicate differences in publication productivity or collaborative influence, while the links represent co-authorship relationships among researchers.

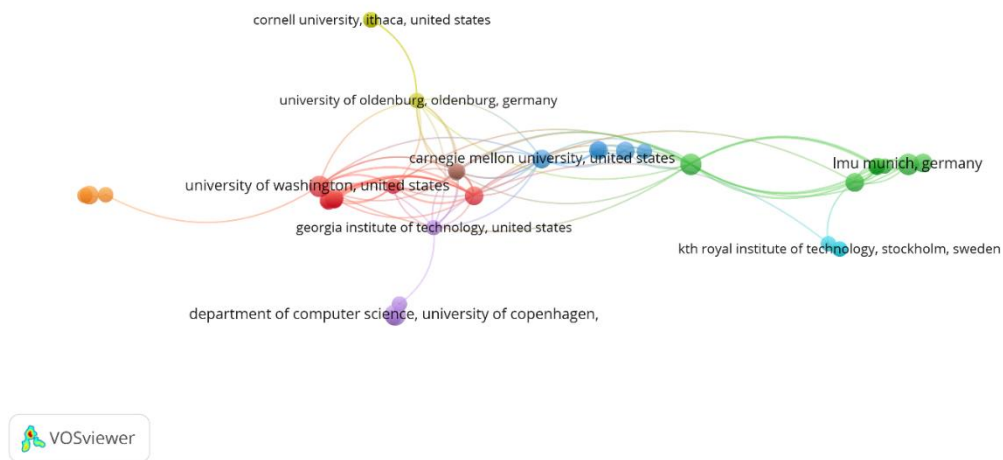


Figure 5. Institution Visualization

Source: *Data Analysis Result, 2026*

Figure 5 indicates that Human–Computer Interaction (HCI) research is supported by a number of highly connected universities and research institutions across North America and Europe. The visualization shows that institutions such as Carnegie Mellon University, University of Washington, and LMU Munich occupy central positions within the network, suggesting their significant influence and active participation in collaborative research. The larger node sizes of these institutions indicate higher publication output or stronger collaborative engagement compared to other organizations. Their central locations and multiple connections further demonstrate their role as major hubs facilitating knowledge exchange and scientific cooperation in the HCI field. The network also reveals extensive international collaboration among leading institutions. Several universities from the United States, including Carnegie Mellon University, University of Washington, Georgia Institute of Technology, and Cornell University, are interconnected with European institutions such as LMU Munich, University of Oldenburg, KTH Royal Institute of Technology, and the University of Copenhagen. This pattern suggests that HCI research benefits from cross-border partnerships that combine expertise from diverse academic and technological environments.

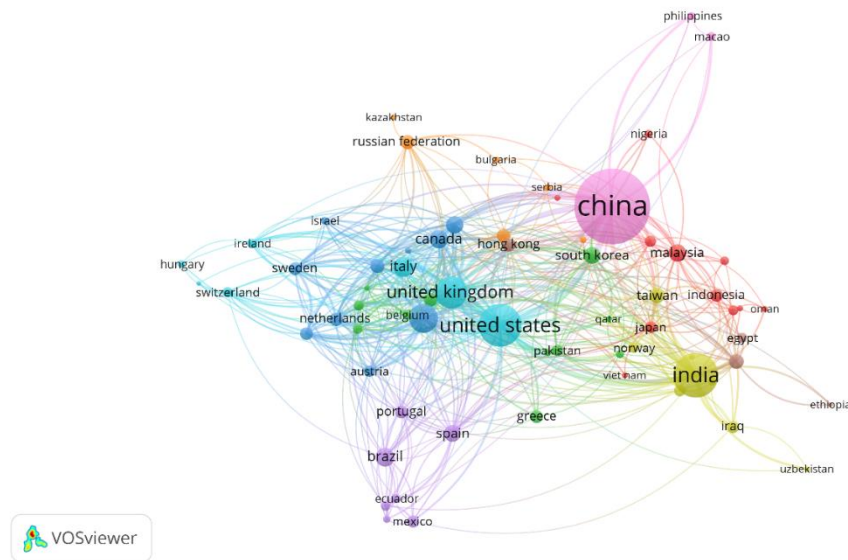


Figure 6. Country Visualization

Source: Data Analysis Result, 2026

Figure 6 demonstrates that Human–Computer Interaction (HCI) research is characterized by extensive international cooperation, with several countries serving as major hubs within the global knowledge network. The United States, China, and India appear as the largest and most influential nodes, indicating their dominant contribution to HCI publications and collaborative activities. Among these, China occupies a particularly prominent position, reflecting its growing research productivity and strong connections with both developed and developing countries. The United States acts as another central hub, maintaining extensive collaborative relationships with European countries such as the United Kingdom, Italy, Sweden, the Netherlands, and Canada. The large node sizes and dense interconnections among these countries suggest that they play a leading role in shaping the direction of HCI research worldwide. The visualization also reveals the presence of several regional collaboration clusters. European countries, including the United Kingdom, Italy, Spain, Portugal, Sweden, Switzerland, and the Netherlands, form a closely connected network that facilitates the exchange of scientific knowledge and technological innovation. Meanwhile, Asian countries such as China, South Korea, Taiwan, Malaysia, Indonesia, and Japan exhibit strong collaborative ties, reflecting the increasing importance of Asia as a center for HCI research. Emerging contributors such as Pakistan, Vietnam, Qatar, Nigeria, Egypt, Iraq, and Ethiopia are also integrated into the network, indicating the growing globalization of HCI scholarship.

CONCLUSION

As shown by this bibliometric analysis, the field of Human-Computer Interaction (HCI) has developed into a very interdisciplinary and fast-growing research area that brings together disciplines including computer science, artificial intelligence, psychology, education, and user-centered design. In terms of co-occurrence, one can note that human computer interaction is the central theme, with close links to emerging themes such as artificial intelligence, machine learning, deep learning, computer vision, gesture recognition, virtual reality, and user experience. Meanwhile, overlay and density visualization also point to a changing trend within HCI studies from classic areas of research such as usability and interface design to modern technologies related to intelligent, adaptive, and immersive interaction. As for citation analysis, this allows us to identify some seminal works on usability, gamification, automation, anthropomorphism, and socially interactive systems. Finally, co-authorship, institutional, and country collaborations suggest that research in this field relies on international collaboration, with the key countries being the US, China, and India and

prominent academic organizations being Carnegie Mellon University, the University of Washington, and LMU Munich.

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