Seventeen Years of the ACM Transactions on Multimedia Computing, Communications and Applications: A Bibliometric Overview

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ACM Transactions on Multimedia Computing, Communications, and Applications has been dedicated to advancing multimedia research, fostering discoveries, innovations, and practical applications since 2005. The journal consistently publishes top-notch, original research in emerging fields through open submissions, calls for articles, special issues, rigorous review processes, and diverse research topics. This study aims to delve into an extensive bibliometric analysis of the journal, utilising various bibliometric indicators. The article seeks to unveil the latent implications within the journal's scholarly landscape from 2005 to 2022. The data primarily draws from the Web of Science Core Collection database. The analysis encompasses diverse viewpoints, including yearly publication rates and citations, identifying highly cited articles, and assessing the most prolific authors, institutions, and countries. The article employs VOSviewer-generated graphical maps, effectively illustrating networks of co-citations, keyword co-occurrences, and institutional and national bibliographic couplings. Furthermore, the study conducts a comprehensive global and temporal examination of co-occurrences of the author's keywords. This investigation reveals the emergence of numerous novel keywords over the past decades.

CCS Concepts: • **Information systems → Multimedia databases;**

Additional Key Words and Phrases: Bibliometric, transactions on multimedia computing, communication and applications, citation analysis, Web of Science, VOS viewer

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1 Introduction

Over the years, rapid advancements in the multimedia field have led to the evolution of multimedia from traditional media such as audio, video, text, images, graphics, and animation to the inclusion of new media types, including virtual reality, holography, haptics, and others [1]. The field is further expanded by embracing emerging technologies, fostering interdisciplinary collaboration, addressing emerging application domains, tackling research challenges, promoting real-world impact, and driving standardisation efforts. While this trend offers numerous benefits, it also presents challenges and opportunities for research [2]. It was much needed to have a platform where researchers, scientists, and academics could share their findings and contribute to evolving the development of multimedia computing, communication, and applications. To address the issue, **ACM Transaction on Multimedia Computing, Communication, and Applications (TOMM)** emerges to disseminate timely information on the latest development in multimedia computing, communication, and related applications. TOMM is a scholarly journal focusing on multimedia computing (input/output devices, media coding and processing), multimedia communications (real-time protocols, resource allocation, multicast protocol), and multimedia applications (database, distributed collaboration, 3D virtual environments). Nicholas D. Georganas, the journal's founding **editor-in-chief (EIC)**, published the inaugural issue in February 2005 [3], having two editorials and five revised best articles of the first ACM Multimedia Conference held in 1993. In addition, that issue included the ACM SIGMM retreat report on future directions in multimedia research.

During its first year, in 2005, the journal published four issues, in February, May, August and November. Today, under the leadership of Abdulmotaleb El Saddik, the current EIC of the journal and a co-author of this article, the journal is recognised as a reputable and influential publication venue in multimedia computing, communications, and applications. The journal ensures that it remains at the forefront of disseminating the latest advancements and discoveries in the ever-evolving field of multimedia research. According to data extracted from the CrossRef database on the journal's website, each article averages 514 downloads, showcasing a notable impact. Additionally, the average number of citations per article is 14, further highlighting the influence of the journal [4]. As per the Journal Citation Reports from Web of Science, the journal achieved an impressive impact factor of 5.1 in 2022. The journal holds notable positions in various categories based on **Journal Impact Factor (JIF)** ranks and percentiles. In the computer science and software engineering category, for the year 2022, the journal holds a place of 16 out of 108, placing it in the **first quartile (Q1)**. The journal continues its Q1 place for the seventh consecutive year since 2016. The corresponding JIF percentile is 85.6. In the second category—computer science, and information systems, the journal holds a place of 52 out of 158, with a JIF percentile of 67.4, placing it in the second quartile. In the third category, computer science, theory, & methods, the journal is in position 21 of 111, placing it in Q1 and with a JIF percentile of 81.5. The journal has been in Q1 in this category since 2018. In terms of the **Journal citation indicator (JCI)**, in computer science, information systems and computer science, and software engineering categories, the journal is placed in Q1 in all three categories, with rankings of 49/250, 17/131, and 19/144, respectively. Due to the increasing importance of the journal, it is imperative to analyse hundreds of publications and reveal the top influential publications, leading authors, institutions, and countries through bibliometric analysis. The bibliometric study in the journal unveils influential articles, authors, countries, and important key terms. The study enables one to understand the existing trend and predict the future direction in a certain domain.

The bibliometric analysis is a quantitative statistical method that measures all aspects of the publications in a specific domain. This is one of the most effective ways to highlight the most significant aspect of the journal in terms of the topic trend, highly cited articles, leading authors, and

most influential and productive institutions and countries. The study enables one to understand historical development, appraise the existing trend, and predict the future in a particular field [5]. The bibliometric analysis act as an objective measuring scale for researchers and organisations. By assessing the individual's or institution's research output, one can better understand the improvement and productivity of an organisation in a specific domain [6]. Researchers better understand the diffusion and impact of articles published in a journal, which assist in selecting a journal for its article submission. Organisations better understand the quality of research, researchers or research groups to assist in decision-making regarding promotions and funding.

Acknowledging the importance and effectiveness of the bibliometric study, there are many examples of bibliometric analysis across different disciplines. Some of the examples where the authors did a bibliometric analysis of the journals are the Journal of Networks and Computer Applications [7], European Journal of Marketing [8], Journal of Business & Industrial Marketing [9], Information Systems [10], International Journal of Intelligent Systems [11], Group Decision and Negotiation [12], Journal of Business Research [13], and Safety Science [14]. In addition, multiple research discussed bibliometric analysis of different topics such as Fuzzy Decision Making [15], Fuzzy Sciences [6, 16], Computer Science [17], Accounting Research [18], topic-based bibliometric analysis [19], and influential and productive universities across the world [20].

Motivated by the growing interests of the researcher in the journal and the increasing trend of annual citations, the article develops a bibliometric analysis of the TOMM. The article analyses the bibliometric indicators in terms of quantity, quality and relationship. The article aims to analyse the number of articles published, the most cited articles, highly influential and productive authors, institutions and countries. Moreover, the article presents interactive graphical maps to analyse the bibliographic linking among different indicators. These maps present a bibliographic coupling, co-citations, co-occurrences of the author's keywords, and institutions and countries coupling. To achieve the objective, the article uses the **Web of Science (WoS)** database and analyses articles published between 2005 and 2021.

The rest of the article is organised as follows: Section 2 discusses the methodology followed in the article. Section 3 describes the analysis results. The results discuss annual citation structure, highly cited articles of the journal, most influential authors, institutions, and countries. Section 4 presents a graphical mapping of bibliometric indicators using **Visualization of Similarities (VOS)** Viewer software. Section 5 discusses the findings and concludes the article.

2 Bibliometric Methods

Bibliometrics is the statistical method to analyse books, journals, and articles and generate insightful information to assist researchers in evaluating scientific activity [21, 22]. The bibliometric analysis evaluates the developments in a particular field and provides a general overview of leading trends. For a couple of years, there has been a growing trend of bibliometric analysis in a wide range of knowledge and data engineering topics, including knowledge management [23], data analytics [24], big data [25], data mining [26], data management [27], machine learning techniques [28], support vector machine [29], and text mining [30]. Generally, there are bibliometric studies from different areas, such as business and marketing [31], physics [32], computer science [33], and mathematics [34].

The bibliometric analysis is expressed through different indicators such as quantitative, qualitative and relationship indicators [35]. The quantitative indicators measure the productivity of researchers in the form of several publications. The qualitative indicators measure the impact or quality of the work by the number of citations, and the structural indicator measures the relationship between various scientific actors, such as the connection between publications, authors, and respective research domains [36, 37]. In this work, we used the Web of Science Core Collection

Table 1. Annual Evolution of the TOMM

Year	2022	2021	2020	2019	2018	2017	2016	2015	2014
TP	154	140	122	116	89	62	58	60	52
Year	2013	2012	2011	2010	2009	2008	2007	2006	2005
TP	61	56	31	37	14	45	27	18	20

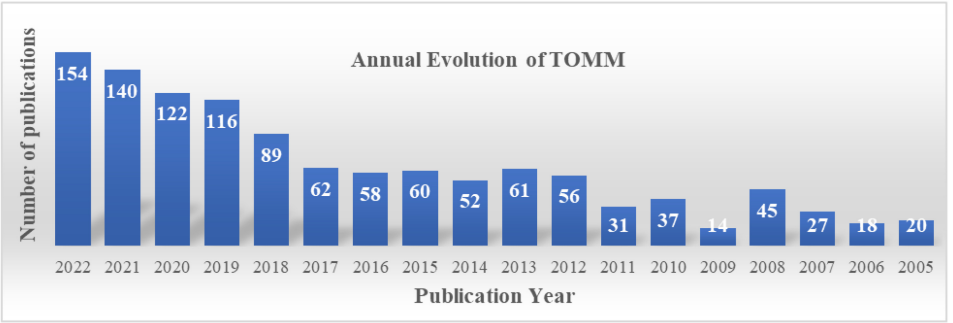

Fig. 1. Annual number of articles published in TOMM.

database and considered all the articles published between 2005 to 2021 to measure productivity, influence and relationship. To further analyse the co-occurrences of authors and quantify individual scientific research output with different co-authorship patterns, the article considers the citation per article ratio, citations threshold, and the H-index [38].

3 Results

This section presents the bibliometric analysis results of the journal from 2005 to 2021. The analysis results are categorised into three sections. The first section presents the publication and citation structure of the journal. The second section presents influential articles in terms of the most cited documents. The third section discusses the leading authors, institutions and countries regarding productivity.

3.1 Publication and Citation Structure of TOMM

The journal displays intriguing trends over the years. As depicted in Table 1 and Figure 1, extracted from the journal website, there have been fluctuations in the number of publications during the initial decades of its existence. Nevertheless, there has been a discernible upward trend in publications since 2016.

During the first year of publications, the journal published 20 documents, including three editorials and 17 articles, in four issues that appeared in February, May, August, and November 2005.The journal kept publishing four issues per year for the next two years, 2006 and 2007. In 2008 the journal produced two volumes—Volumes 4 and 5 with six issues total, consisting of 45 documents. In 2009 the journal produced only two issues in Volume 5, which appeared in August and October 2009. Therefore, we see the number of publications is smaller, with 14 publications in that year. Since 2016 there has been a growing trend in several publications. It is worth noting that in 2022, the journal experienced a significant increase in a number of publications, reaching a record-high of 154 documents published. This substantial growth could be indicative of the expanding research interest in multimedia computing and communications. Particularly after the COVID-19 pandemic,

Table 2. Annual Citation Structure of the TOMM

Year	2022	2021	2020	2019	2018	2017	2016	2015	2014
TP	2,910	2,224	1,557	1,387	1,150	861	831	637	569
Year	2013	2012	2011	2010	2009	2008	2007	2006	2005
TP	442	366	271	247	167	158	60	6	5

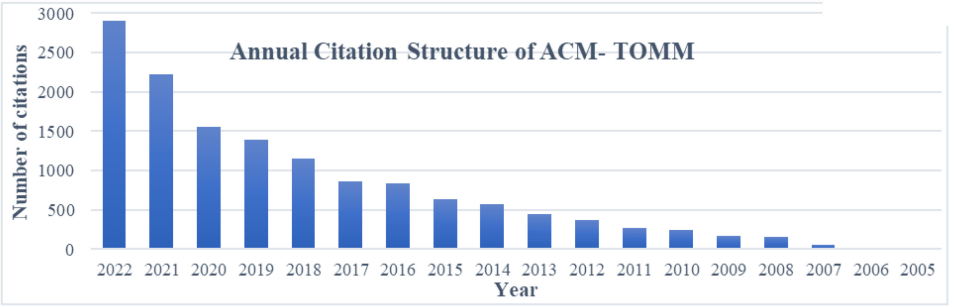

Fig. 2. Annual citation structure of TOMM.

there are many dependencies on online communication and its emergent issues, such as security, privacy, and integrity. The journal published a total of 1,162 documents from 2005 to 2022.

To enhance the examination of the document quality within the journal across various years, the article introduces the annual citation structure of the journal, as delineated in Table 2.

The citation structure in Figure 2 shows that the journal has significantly boosted its citations over the past decade. This shows the quality of the articles that appeared as a regular or part of the special issues discussed on cutting-edge technologies and rigorous peer-review processes. The journal achieved the highest citation of 2,910 in 2022, which is approximately seven times higher than 2012.

To further deepen the quality of published article, the Table 3 provides an overview of documents published in each specific year, along with the citations. The article retrieves the citation count as of January 2024 from the WoS. To conduct a more nuanced analysis of the influential and impactful articles from each year, the study undertakes a comparative assessment of citations using distinct benchmarks. These benchmarks include categorisations based on the number of citations received, specifically those exceeding 800, 500, 100, 50, 20, 5, and 1 citation, thereby facilitating a comprehensive evaluation of the journal's citation landscape. It is important to highlight that the citation figures provided in this study are derived from data extracted from the journal website for the publication count and utilise the Web of Science (WOS) for citation counts, as of early 2023. It is acknowledged that these figures may vary at the time of publication, with the most current data available, considering that other articles in 2024 might have cited those articles.

Furthermore, the analysis reveals that over 84% of documents received at least one citation, while 54% of documents achieved more than five citations, underscoring the journal's commitment to high-quality publications. Noteworthy is the fact that 13 documents received more than 100 citations, and 2 documents surpassed 500 citations. Specifically, the article "Content-based Multimedia Information Retrieval: State of the Art and Challenges" by Lew et al., published in 2016, boasts an impressive 889 citations. Similarly, "A Discriminatively Learned CNN Embedding for Person Reidentification" by Zheng, Zheng, and Yang, published in 2018, has garnered 508 citations. The cumulative analysis results demonstrate that the journal accumulated 15,057 citations from 2005 to 2022, affirming its enduring scholarly impact.

Table 3. Annual Citation Structure of TOMM

Publication of a particular year attracted citations till 2022										
Year	**≥800**	**≥500**	**≥100**	**≥50**	**≥20**	**≥10**	**≥5**	**≥1**	**TP**	**TC**
2022	0	0	0	1	4	6	16	79	154	2,912
2021	0	0	1	5	19	41	63	127	140	2,231
2020	0	0	2	5	12	29	54	84	122	1,556
2019	0	0	2	4	14	32	66	102	116	1,387
2018	0	1	2	5	13	41	61	80	89	1,150
2017	0	0	1	4	15	32	40	56	62	861
2016	0	0	1	5	16	25	43	56	58	831
2015	0	0	0	2	11	25	35	47	60	637
2014	0	0	1	3	12	28	45	57	52	569
2013	0	0	0	4	12	25	33	56	61	442
2012	0	0	0	3	6	16	31	46	56	366
2011	0	0	0	1	10	16	27	33	31	271
2010	0	0	0	2	6	13	18	27	37	247
2009	0	0	0	0	4	7	10	13	14	167
2008	0	0	1	2	12	26	36	42	45	158
2007	0	0	1	2	9	16	23	27	27	60
2006	1	1	1	3	5	9	16	17	18	6
2005	0	0	0	1	5	6	9	16	20	5
Total	1	2	13	52	185	393	626	965	1,162	13,856
%	0.09%	0.17%	1.13%	4.53%	16.13%	34.26%	54.58%	84.13%	100.00%	

To further deepen the analysis, Table 4 presents the citation structure of computer science journals that have cited articles of the AMC TOMM published in different years. The temporal analysis results show that the journal Multimedia Tools and Applications is at the top of the list and has been contributing from its inception. The journal has cited a total of 624 AMC TOMM documents. The journal covers the same research topics as ACM-TOMM, such as computer vision, multimedia applications, digital games, games, biometrics and multimedia systems. The second-highest citing journal is IEEE Access, which cites 493 documents. The reason for high citation by IEEE Access is that this publication is a multidisciplinary open-access journal published by the IEEE covering all IEEE fields, including multimedia computing and communications. The next most highly cited venue is Lecture Notes in Computer Science, which is a leading conference proceeding series that covers different topics in all areas of computer science. The venue has cited a total of 438 documents, and the highest citing venue during the first decade cited 95 documents. The journal itself ranked fourth in terms of self-citations. The list of top-25 high-citing journals and the number of documents cited annually is presented in Table 3.

3.2 Influential Articles in TOMM

The second aspect of the analysis results is determining the most cited documents in TOMM. Table 5 presents the top 40 most cited documents published by the journal. The details include rank, total citations, title, author/s, publication year, and average citation per year. The article "Content-based multimedia information retrieval: State of the art and challenges," published in 2006 by Lew, Sebe, Djeraba, and Jain, is the most cited article with 820 citations. This work, with an annual citation rate of 48.24, has evidently made a significant impact in the field of multimedia information retrieval. The second most cited article, "Video abstraction: A systematic review

Table 4. Citation Structure of Journal Articles That Cited TOMM Articles Published in Different Years

R	Journal name	TDC	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	RY
1	Multimedia Tools and Applications	624	75	48	82	59	62	46	53	31	36	13	54
2	IEEE Access	493	69	97	109	115	43	23	7	1	0	0	0
3	Lecture Notes in Computer Science	438	89	24	24	44	56	25	18	23	13	8	95
4	ACM Transactions on Multimedia Computing Communications and Applications	437	83	60	32	62	33	22	24	11	27	14	44
5	IEEE Transactions on Multimedia	311	53	33	23	14	20	12	7	11	3	6	14
6	Neurocomputing	243	46	38	32	13	13	15	36	17	7	14	3
7	IEEE Transactions on Circuits and Systems for Video Technology	207	53	33	23	14	20	12	7	11	3	6	14
8	Sensors	184	56	44	23	8	6	2	7	3	2	1	2
9	IEEE Transactions on Image Processing	175	31	32	34	15	15	7	7	7	6	7	5
10	Applied Sciences Basel	118	39	21	13	10	5	1	2	0	0	0	0
11	Pattern Recognition	113	22	21	16	8	9	6	3	2	2	8	8
12	Multimedia Systems	103	15	16	5	2	3	3	14	6	4	3	24
13	Journal of Visual Communication and Image Representation	101	19	16	6	8	5	6	6	5	3	4	10
14	IEEE Conference on Computer Vision and Pattern Recognition	90	17	11	9	8	16	7	5	6	4	1	6
15	Wireless Communications Mobile Computing	89	41	24	13	1	8	2	0	0	0	0	0
16	Information Sciences	85	13	15	11	5	6	1	2	3	14	2	5
17	Neural Computing Applications	81	29	19	9	2	8	0	0	0	0	0	0
18	Knowledge-based Systems	79	35	22	6	2	1	1	0	1	0	2	2
19	IEEE International Conference on Image Processing	77	0	4	11	5	9	6	5	12	11	2	12
20	IEEE International Conference on Multimedia and Expo	77	0	0	4	6	8	7	5	4	7	8	28
21	IEEE Transactions On Neural Networks And Learning Systems	77	17	22	10	5	7	1	2	1	0	1	0
22	Electronics	74	21	24	9	2	0	0	0	0	0	0	0
23	Applied Intelligence	68	39	14	6	2	1	1	0	0	0	0	0
24	Proceedings of Spie	68	4	6	3	4	7	5	1	3	5	6	24
25	IEEE Transactions on Pattern Analysis and Machine Intelligence	64	17	6	7	2	3	2	1	1	2	1	9

and classification" by Truong and Venkatesh, has accumulated 480 citations since 2007, with a yearly citation rate of 28.24. This article provided a comprehensive overview of video abstraction techniques, which has been a useful resource for multimedia researchers.

Despite being relatively recent, another article that stands out is "A Discriminatively Learned CNN Embedding for Person Reidentification" by Zheng, Zheng, and Yang, published in 2018. It has attracted 394 citations with an annual citation rate of 23.18, highlighting its influence in the realm of person reidentification using convolutional neural networks. The fourth most cited article, "Unsupervised Person Reidentification: Clustering and Fine-tuning," also from Fan, Zheng, Yan, and Yang, published in 2018, has received 277 citations. The annual citation rate of the article is 16.29. This article further deepens the field of person reidentification by introducing an unsupervised approach to the problem. The fifth article on the list, "Multimodal Hand and Foot Gesture Interaction for Handheld Devices" by Lv, Halawani, Feng, Li, and Rehman, was published in 2014.

Table 5. Fifty Most-cited Documents in TOMM

R	TC	Title	Author/s	Year	C/Y
1	820	Content-based multimedia information retrieval: State of the art and challenges	Lew, Michael S.; Sebe, Nicu; Djeraba, Chabane; Jain, Ramesh	2006	48.24
2	480	Video abstraction: A systematic review and classification	Truong, Ba Tu; Venkatesh, Svetha	2007	28.24
3	394	A Discriminatively Learned CNN Embedding for Person Reidentification	Zheng, Zhedong; Zheng, Liang; Yang, Yi	2018	23.18
4	277	Unsupervised Person Reidentification: Clustering and Fine-tuning	Fan, Hehe; Zheng, Liang; Yan, Chenggang; Yang, Yi	2018	16.29
5	152	Multimodal Hand and Foot Gesture Interaction for Handheld Devices	Lv, Zhihan; Halawani, Alaa; Feng, Shengzhong; Li, Haibo; Rehman, Shafiq U. R.	2014	8.94
6	143	On-chip communication architecture exploration: A quantitative evaluation of point-to-point, bus, and network-on-chip approaches	Lee, Hyung Gyu; Chang, Naehyuck; Ogras, Umit Y.; Marculescu, Radu	2007	8.41
7	100	Multimedia streaming via TCP: An analytic performance study	Hossain, M. Shamim; Amin, Syed Umar; Alsulaiman, Mansour; Muhammad, Ghulam	2019	5.88
8	94	Content-based retrieval of 3D models	Peng, Yuxin; Qi, Jinwei	2019	5.53
9	91	Semi-Supervised Distance Metric Learning for Collaborative Image Retrieval and Clustering	Tanveer, M.; Richhariya, B.; Khan, R. U.; Rashid, A. H.; Khanna, P.; Prasad, M.; Lin, C. T.	2020	5.35
10	83	Mulsemedia: State of the Art, Perspectives, and Challenges	Zheng, Zhedong; Zheng, Liang; Garrett, Michael; Yang, Yi; Xu, Mingliang; Shen, Yi-Dong	2020	4.88
11	80	Applying Deep Learning for Epilepsy Seizure Detection and Brain Mapping Visualization	Tang, Jinhui; Shu, Xiangbo; Li, Zechao; Qi, Guo-Jun; Wang, Jingdong	2016	4.71
12	76	Deep Learning for Mobile Multimedia: A Survey	Wang, Bing; Kurose, Jim; Shenoy, Prashant; Towsley, Don	2008	4.47
13	76	Video Streaming Using a Location-based Bandwidth-Lookup Service for Bitrate Planning	Hoi, Steven C. H.; Liu, Wei; Chang, Shih-Fu	2010	4.47
14	76	SA-EAST: Security-Aware Efficient Data Transmission for ITS in Mobile Heterogeneous Cloud Computing	Yan, Chenggang; Li, Zhisheng; Zhang, Yongbing; Liu, Yutao; Ji, Xiangyang; Zhang, Yongdong	2021	4.47
15	74	Visual Query Suggestion: Towards Capturing User Intent in Internet Image Search	Ota, Kaoru; Minh Son Dao; Mezaris, Vasileios; De Natale, Francesco G. B.	2017	4.35
16	73	CM-GANs: Cross-modal Generative Adversarial Networks for Common Representation Learning	Del Bimbo, Alberto; Pala, Pietro	2006	4.29
17	73	GamingAnywhere: The First Open Source Cloud Gaming System	Ghinea, Gheorghita; Timmerer, Christian; Lin, Weisi; Gulliver, Stephen R.	2014	4.29
18	72	Generalised Deep Transfer Networks for Knowledge Propagation in Heterogeneous Domains	Wang, Shui-Hua; Zhang, Yu-Dong	2020	4.24
19	72	Learning from Collective Intelligence: Feature Learning Using Social Images and Tags	Huang, Chun-Ying; Chen, Kuan-Ta; Chen, De-Yu; Hsu, Hwai-Jung; Hsu, Cheng-Hsin	2014	4.24
20	69	Re-Cinematography: Improving the Camerawork of Casual Video	Riiser, Haakon; Endestad, Tore; Vigmostad, Paul; Griwodz, Carsten; Halvorsen, Pal	2012	4.06
21	69	Two Decades of Internet Video Streaming: A Retrospective View	Lv, Zhihan; Song, Houbing	2021	4.06
22	63	Adaptive Fractional-Pixel Motion Estimation Skipped Algorithm for Efficient HEVC Motion Estimation	Gai, Keke; Qiu, Longfei; Chen, Min; Zhao, Hui; Qiu, Meikang	2017	3.71
23	59	Machine Learning Techniques for the Diagnosis of Alzheimer's Disease: A Review	Gleicher, Michael L.; Liu, Feng	2008	3.47
24	59	QoE-Driven Rate Adaptation Heuristic for Fair Adaptive Video Streaming	Zhang, Hanwang; Shang, Xindi; Luan, Huanbo; Wang, Meng; Chua, Tat-Seng	2017	3.47
25	54	Depth Image Denoising Using Nuclear Norm and Learning Graph Model	Gao, Zan; Li, Yinming; Wan, Shaohua	2020	3.18
26	54	Sparse Transfer Learning for Interactive Video Search Reranking	Zha, Zheng-Jun; Yang, Linjun; Mei, Tao; Wang, Meng; Wang, Zengfu; Chua, Tat-Seng; Hua, Xian-Sheng	2010	3.18
27	52	A Survey of Music Similarity and Recommendation from Music Context Data	Ding, Yuhang; Fan, Hehe; Xu, Mingliang; Yang, Yi	2020	3.06
28	52	Effective Transfer Tagging from Image to Video	Li, Baochun; Wang, Zhi; Liu, Jiangchuan; Zhu, Wenwu	2013	3.06
29	51	Exploring Deep Learning for View-based 3D Model Retrieval	Pan, Zhaoqing; Lei, Jianjun; Zhang, Yajuan; Wang, Fu Lee	2018	3.00
30	51	Foveated gaze-contingent displays for peripheral LOD management, 3D visualisation, and stereo Imaging	Petrangeli, Stefano; Famaey, Jeroen; Claeys, Maxim; Latre, Steven; De Turck, Filip	2016	3.00

(Continued)

Table 5. Continued

R	TC	Title	Author/s	Year	C/Y
31	51	Intercrossed Access Controls for Secure Financial Services on Multimedia Big Data in Cloud Systems	Cornia, Marcella; Baraldi, Lorenzo; Serra, Giuseppe; Cucchiara, Rita	2018	3.00
32	51	Mobile Device-to-Device Video Distribution: Theory and Application	Villanueva, Arantxa; Ponz, Victoria; Sesma-Sanchez, Laura; Ariz, Mikel; Porta, Sonia; Cabeza, Rafael	2013	3.00
33	51	ACM SIGMM Retreat Report on Future Directions in Multimedia Research	Knees, Peter; Schedl, Markus	2013	3.00
34	50	Hybrid Method Based on Topography for Robust Detection of Iris Center and Eye Corners	Duchowski, Andrew T.; Cotekin, Arzu	2007	2.94
35	49	Performance Modelling and Analysis of Software-Defined Networking under Bursty Multimedia Traffic	Tian, Xinmei; Tao, Dacheng; Rui, Yong	2012	2.88
36	48	Defining user perception of distributed multimedia quality	Yang, Xun; Wang, Meng; Hong, Richang; Tian, Qi; Rui, Yong	2017	2.82
37	47	The Sweet Smell of Success: Enhancing Multimedia Applications with Olfaction	Li, Yibin; Gai, Keke; Ming, Zhong; Zhao, Hui; Qiu, Meikang	2016	2.76
38	44	Image Captioning with Deep Bidirectional LSTMs and Multi-Task Learning	Liang, Wei; Long, Jing; Li, Kuan-Ching; Xu, Jianbo; Ma, Nanjun; Lei, Xia	2021	2.59
39	44	Multi-Camera Coordination and Control in Surveillance Systems: A Survey	Miao, Wang; Min, Geyong; Wu, Yulei; Wang, Haozhe; Hu, Jia	2016	2.59
40	43	Crowd Scene Understanding from Video: A Survey	Ghinea, Georghita; Ademoye, Oluwakemi	2012	2.53

The article has earned 152 citations, with a citation rate of 8.94 per year. This research has brought novel perspectives into the interaction methods for handheld devices.

3.3 Leading Authors, Institutions, and Countries

In this section, the article discusses the most productive authors that have contributed the maximum number of articles to the journal. Table 6 presents the 30 most productive authors who contributed to the journal. The authors are at any positions in the article. The comparison is performed based on—total publication, total citations, H-index, average citation per article, affiliation, and country. The H-index here refers to the authors H-index with reference to TOMM articles. The analysis results show that C. S. Xu from the Chinese Academy of Sciences is at the top of the list with 24 publications and 206 citations. The H-index of the author is 9, with an average of 8.58 citations per TOMM article. The second highly productive authors in the list have contributed 17 articles toward the journal. There are three authors listed on the second, third, and fourth rows in Table 6 that have each contributed 17 articles. All three authors are the second most productive authors. T. S. Chua, listed in the second row, is from the National University of Singapore, Singapore. The H-index of the author is 10, and the contributed documents have received 344 citations, with an average of 20 citations per article. M. Wang, in the third row from Hefei University of Technology in China, contributed 17 articles. The author has an H-index of 10, and the documents have received 339 citations. The last author in second place is S. C. Yan from the National University of Singapore, having an H-index of 8 and has received 202 citations from 17 articles. T. Mei of Yonsei University, South Korea, features prominently with 15 articles, an H-index of 7, and an average of 12.40 citations per article. The author is placed as the third most productive author in the journal. Meanwhile, A. El Saddik from the University of Ottawa in Canada and M. Hefeeda from Simon Fraser University in Canada have authored 14 articles, demonstrating a robust Canadian contribution to the field. Both authors are in fourth place on the list. C. H. Hsu from the National Tsing Husa University, Taiwan, is also in fourth place with 14 publications that have received 106 citations.

Table 7 presents the most productive and influential institutions related to their contributions to TOMM. Several factors were taken into account in this analysis, including the total number of

Table 6. Top 30 Most Productive Authors in TOMM

Rank	AUTHOR	TP	TC	H	TC/TP	UNIVERSITY	COUNTRY
1st	Xu CS	24	206	9	8.58	Chinese Academy of Sciences	China
2nd	Chua TS	17	344	10	20.24	National University of Singapore	Singapore
2nd	Wang M	17	339	10	19.94	Hefei University of Technology	China
2nd	Yan SC	17	202	8	11.88	National University of Singapore	Singapore
3rd	Mei T	15	186	7	12.40	Yonsei University	South Korea
4th	El Saddik A	14	123	8	8.79	University of Ottawa	Canada
4th	Hefeeda M	14	74	4	5.29	Simon Fraser University	Canada
4th	Hsu CH	14	106	4	7.57	National Tsing Hua University	Taiwan
5th	Hu HF	13	31	5	2.38	Sun Yat Sen University	China
5th	Li HQ	13	97	4	7.46	University of Science & Technology of China	China
5th	Ooi WT	13	72	6	5.54	National University of Singapore	Singapore
5th	Rui Y	13	257	9	19.77	Hefei Institutes of Physical Science	China
5th	Steinmetz R	13	26	3	2.00	Technical University of Darmstadt	Germany
5th	Yang Y	13	843	9	64.85	University of Technology Sydney	Australia
5th	Zimmermann R	13	72	7	5.54	National University of Singapore	Singapore
6th	Ghinea G	12	310	8	25.83	Brunel University	United Kingdom
6th	Kankanhalli MS	12	70	5	5.83	National University of Singapore	Singapore
6th	She J	12	60	4	5.00	Hamad Bin Khalifa University-Qatar	Qatar
7th	Nahrstedt K	11	89	6	8.09	University of Illinois Urbana-Champaign	United States
8th	Li Y	10	69	4	6.90	Shanghai University	China
8th	Shirmohammadi S	10	83	6	8.30	University of Ottawa	Canada
8th	Tian Q	10	182	6	18.20	University of Texas at San Antonio (UTSA)	United States
8th	Zha ZJ	10	200	6	20.00	University of Science & Technology of China, CAS	China
8th	Zhou WG	10	93	4	9.30	Civil Aviation Flight University of China	China
9th	Atrey PK	9	160	6	17.78	State University of New York (SUNY) Albany	United States
9th	Jain R	9	929	5	103.22	University of California Irvine	United States
10th	Chen KT	8	122	4	15.25	Academia Sinica-Taiwan	Taiwan
10th	Griwodz C	8	172	6	21.50	University of Oslo	Norway
10th	Hua XS	8	159	6	19.88	Zhejiang University	China
10th	Zhang L	8	39	4	4.88	Microsoft	United States

articles, total citations, H-index of the institutions, and citations per article. To further analyse the ranking of each institution, the **QS World University Ranking (QS)** and the **Academic Ranking of World Universities (ARWU)** 2023 are also presented for each university. The analysis results show that the Chinese Academy of Sciences, China, leads the list with an impressive 110 articles that attracted 1,469 total citations, boasting an H-index of 21 and a commendable average citation per article of 13. Here the H-index refers to author's contribution with reference to the TOMM articles. The organisation is ranked among 51–100 top institutions in a recent QS ranking. The second most productive institution is the National University of Singapore, which exhibits a notable performance with 75 articles that attracted 732 total citations. The average citation per article of the organisation is ten citations. The university's 26th rank in ARWU reflects its strong academic performance globally. The third leading institution is the University of Science, Technology of China, which has contributed 40 articles that have received 458 citations, with an average citation per document of 11. The analysis results show that Chinese Universities dominate the list, with 18 institutions in the top 50 productive institutions, including the top-ranked universities such as Peking University, QS ranked 12, Tsinghua University, QS ranked 14, and Zhejiang University QS, ranked 42. The second most dominant universities are from the USA, with 13 institutions in the top 50 most productive institutions list. Some of the top American universities, such as the University of California Berkeley, QS ranked 8, and Columbia University, QS ranked 22 contributed significantly to the journal. Moreover, one of the top universities in Singapore–Nanyang Technological University, QS, ranked 19 in the list that has contributed 15 articles to the journal that has received 267 citations.

Table 7. Fifty Most Productive and Influential Institution's Contributions to TOMM

R	Institution	Country	TP	TC	H	TC/TP	ARWU	QS
1	Chinese Academy of Sciences	China	110	1,469	21	13	—	51–100
2	National University of Singapore	Singapore	75	732	15	10	26	—
3	University of Science Technology of China	China	40	458	13	11	—	94
4	University of California System	USA	35	1,086	10	31	—	27
5	Institute of Automation CAS	China	30	236	10	8	—	51–100
6	Microsoft	USA	30	450	13	15	—	—
7	Sun Yat-sen University	China	28	153	10	5	79	267
8	University of Chinese Academy of Sciences CAS	China	27	119	8	4	—	51–100
9	University of Ottawa	Canada	27	217	11	8	—	237
10	Indian Institute of Technology System IIT System	India	25	184	10	7	—	270
11	City University of Hong Kong	Hong Kong	24	168	10	7	99	54
12	Simon Fraser University	Canada	22	194	9	9	201–250	328
13	Tsinghua University	China	22	400	10	18	—	14
14	University of Texas System	USA	22	235	10	11	—	72
15	Hefei University of Technology	China	21	246	9	12	594	351–400
16	Microsoft Research Asia	China	21	373	10	18	—	—
17	Zhejiang University	China	21	135	7	6	36	42
18	Hong Kong University of Science Technology	Hong Kong	20	171	7	9	—	40
19	State University of New York SUNY System	USA	19	171	8	9	—	206
20	University of Technology Sydney	Australia	19	908	10	48	—	137
21	Peking University	China	16	111	6	7	—	12
22	Technical University of Darmstadt	Germany	16	33	4	2	—	275
23	Beihang University	China	15	93	6	6	151–200	443
24	Nanyang Technological University	Singapore	15	267	8	18	88	19
25	Nanyang Technological University National Institute of Education NIE Singapore	Singapore	15	267	8	18	88	19
26	Shandong University	China	15	92	5	6	151–200	396
27	State University System of Florida	USA	15	148	7	10	—	—
28	University of Illinois System	USA	15	161	8	11	—	85
29	Academia Sinica Taiwan	Taiwan	14	176	7	13	—	77
30	Columbia University	USA	14	230	8	16	—	22
31	Tianjin University	China	14	89	5	6	—	307
32	University of California Berkeley	USA	14	125	6	9	—	8
33	University of Illinois Urbana Champaign	USA	14	159	8	11	—	85
34	Agency for Science Technology Research A*STAR	Singapore	13	126	5	10	—	—
35	Arizona State University	USA	13	67	5	5	—	219
36	Arizona State University Tempe	USA	13	67	5	5	—	219
37	Harbin Institute of Technology	China	13	49	5	4	151	217
38	Huazhong University of Science Technology	China	13	134	6	10	96	306
39	University of Florence	Italy	13	171	6	13	—	401–500
40	University of Massachusetts System	USA	13	245	7	19	—	253
41	A*STAR Institute for Infocomm Research I2R	Singapore	12	110	5	9	—	—
42	Brunel University	United Kingdom	12	325	9	27	—	412
43	Peng Cheng Laboratory	China	12	14	5	1	—	—
44	Shenzhen University	China	12	33	4	3	201	581–590
45	Aalto University	Finland	11	89	6	8	—	116
46	National Taiwan University	Taiwan	11	82	5	7	—	77
47	Shanghai Jiao Tong University	China	11	57	6	5	59	46
48	Udice French Research Universities	France	11	69	5	6	—	—
49	University of Massachusetts Amherst	USA	11	217	5	20	151–200	253
50	Delft University of Technology	Netherlands	10	78	6	8	42	61

This article delves into the leading countries in terms of productivity and influence in the journal. The data is outlined in Table 8, evaluating the top fifteen countries based on total publications, total citations, H-index, and citations rate per article. The H-index score is associated with publications in TOMM. In addition, the article further analyses articles that have received more than equal to 10, 30, and 50 citations. The analysis results show that China is leading with 532 publications that attracted 6,789 citations, with an H-index of 37. It is worth mentioning that seven documents have received more than 100 citations, one article has received more than 500 citations, and 169 articles have received more than ten citations. The USA trails in second place with 279 publications, attracting 4,159 citations and an H-index of 32. Impressively one article has attracted more than 800 citations. Fifteen documents have received more than 50 citations, and 101 articles

Table 8. Most Productive and Influential Countries in TOMM

R	COUNTRY	TP	TC	H	C/P	≥10	≥50	≥100	≥300	≥500	≥800
1	CHINA	532	6,789	37	13	169	26	7	2	1	0
2	USA	279	4,159	32	14	101	15	3	1	1	1
3	SINGAPORE	110	1,318	18	12	39	5	0	0	0	0
4	CANADA	93	995	18	11	38	1	0	0	0	0
5	ENGLAND	70	976	17	14	30	5	0	0	0	0
6	AUSTRALIA	68	2,435	18	36	28	8	5	3	1	0
7	INDIA	67	758	15	11	29	1	1	0	0	0
8	ITALY	58	649	12	11	20	3	0	0	0	0
9	TAIWAN	57	635	14	11	18	2	0	0	0	0
10	GERMANY	42	367	10	9	11	1	0	0	0	0
11	France	36	269	10	7	10	0	0	0	0	0
12	Japan	35	409	10	12	11	3	0	0	0	0
13	Netherlands	30	1,150	11	38	12	1	1	1	1	1
14	Saudi Arabia	21	386	9	18	9	1	1	0	0	0
15	South Korea	19	166	8	9	6	0	0	0	0	0

have received more than ten citations. Singapore and Canada are, respectively, in the third and fourth positions. Singapore contributed 110 publications that received 1,318 citations. Canada contributed 93 publications that have received 995 citations. England and Australia are next, with 70 and 68 publications, respectively. It is noteworthy that Australia has contributed to very impactful publications. Australia's three documents have received more than 300 citations, five received more than 100 citations, and eight have received more than 50 citations. The country stands out with the second-highest citation rate per article of 36 citations. In the seventh and eighth positions are India and Taiwan, with 67 and 58 publications that received 758 and 649 citations, respectively. It is worth mentioning that the Netherlands has recently contributed very impactful publications. The country has contributed 30 articles to the journal that have received 1150 citations, with the highest citation rate of 38. Nine documents have received more than ten citations.

To further dig out the trend of articles published annually by different countries, the article presents annual publications of each country published in TOMM, as presented in Table 9. Overall, there has been an apparent increase in the number of publications in almost every country since 2019. This surge is due to multiple factors, such as multimedia for remote working and learning, particularly during and after COVID-19, multimedia communication and content understanding using AI technologies, multimedia analytics, multimedia in healthcare and several other factors. The analysis results show a gradual increase in publications by China during the last decades. During the past five years (2018–2022), the country has published 384 documents, representing about 72% of China's total publications in TOMM. In contrast, the USA has been contributing to the journal in a consistent way from its inception. In the first year of the journal, the country has contributed 15 articles, the highest contribution by any country. A similar trend can be seen in Singaporean and Canadian institutions, which have contributed consistently to the journal from its inception. Some countries, like India, Australia, Japan, and Saudi Arabia, have contributed significantly since 2020. For three years (2020–2022), India has contributed 46 documents, about 69% of its all-time publications. This shows a growing interest of researchers toward the journal. The detailed distribution of countries is presented in Table 9.

Upon analysing the yearly evolution of articles published in TOMM by various countries, distinct patterns become evident, as depicted in Table 9. Notably, China's contributions, initially

Table 9. Number of Articles Per Country: Annual Evolution of Countries

R	COUNTRY	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
1	CHINA	1	0	2	7	0	4	8	15	18	24	14	37	18	36	74	58	117	99
2	USA	15	9	13	18	7	13	8	17	25	12	16	14	15	28	28	13	15	13
3	SINGAPORE	1	3	5	1	3	5	7	9	12	16	7	5	2	7	7	4	10	6
4	CANADA	2	0	2	10	2	4	7	9	8	4	4	7	7	3	5	5	8	6
5	ENGLAND	0	1	4	1	2	1	1	2	2	7	2	5	1	3	10	8	11	9
6	AUSTRALIA	1	1	1	4	0	2	2	2	1	4	0	2	2	5	5	9	20	6
7	INDIA	0	0	0	1	1	0	1	0	4	1	0	4	4	1	4	13	23	10
8	ITALY	0	3	1	1	1	0	2	1	0	2	3	4	7	9	6	2	5	11
9	TAIWAN	0	1	1	1	0	1	3	3	3	4	8	3	3	6	2	1	11	6
10	GERMANY	0	0	0	1	0	3	3	3	4	2	3	4	6	9	1	1	1	1
11	FRANCE	0	1	2	0	1	0	1	1	1	1	2	1	3	11	6	2	2	1
12	JAPAN	1	0	1	1	1	0	0	0	1	0	0	2	3	0	2	4	14	5
13	NETHERLANDS	1	3	0	4	1	0	1	2	3	0	2	1	2	4	1	1	1	3
14	SAUDI ARABIA	0	0	0	0	0	1	1	0	0	1	1	1	0	0	2	0	6	8
15	SOUTH KOREA	0	0	1	2	0	0	0	0	1	1	3	1	0	0	1	2	4	3

limited prior to 2010, have exhibited a remarkable growth trajectory. Commencing with a mere four articles in 2010, the output has surged dramatically, reaching an impressive tally of 117 articles in 2021, with noteworthy advancements observed in 2019. This underscores China's escalating interest in the journal and its encompassing multimedia computing, communication, and applications domains. However, the USA has maintained its status as a prominent contributor since 2005, albeit with a growth rate comparatively slower than China's. Particularly noteworthy is the steady and consistent publication rate that has remained stable over time. Similar to the USA, Singapore has consistently contributed to the journal since its inception. Notably, between 2013 and 2014, Singapore experienced a substantial surge in publication numbers, contributing 28 articles. Over the past three years, there has been a noteworthy increase in publication numbers from countries such as England, Australia, India, and Japan. Moreover, despite their initial lower overall contributions and early engagement, emerging countries where multimedia computing research has more recently started like Saudi Arabia, South Korea, and Malaysia have shown significant contributions over the past two years. This trend underscores the global dissemination of interest in the domains of multimedia computing, communications, and applications.

4 Mapping TOMM with VOS Viewer Software

This section visually portrays the interdependencies and relationships among various bibliometric indicators. To accomplish this, the study utilises the WoS Core Collection database in conjunction with the VOSviewer software. This tool accentuates co-citations, bibliometric coupling, and the co-occurrence of authors' keywords. Co-citations mean when two documents that receive a citation from the same third document. Co-citation is a semantic similarity measure that presents the relationship between authors, journals, institutions, and others [39]. The section starts with the co-citations of TOMM, highlighting multiple documents from different journals and obtaining a citation from the same document in the third journal. Figure 3 presents the co-citation of journals between 2005 to 2022 with a citation threshold of 40 and the 100 most representative co-citations link.

Figure 3 highlights four distinct clusters. At the forefront, the node "Proceedings of IEEE Conference on Computer Vision and Pattern Recognition" leads the figure with 2,659 citations, serving as the largest node within the blue cluster. The second most significant node within the same blue cluster is "Lecture Notes in Computer Science," accumulating 1,286 citations. Following this, in the yellow cluster, "IEEE Transactions on Pattern Analysis and Machine Learning" stands out with 981 citations, and in the red cluster, "IEEE Transactions on Multimedia" is notable with 935 citations. Noteworthy to mention is that a considerable number of nodes within the red cluster originate from IEEE transactions and conferences. These encompass titles like "IEEE International

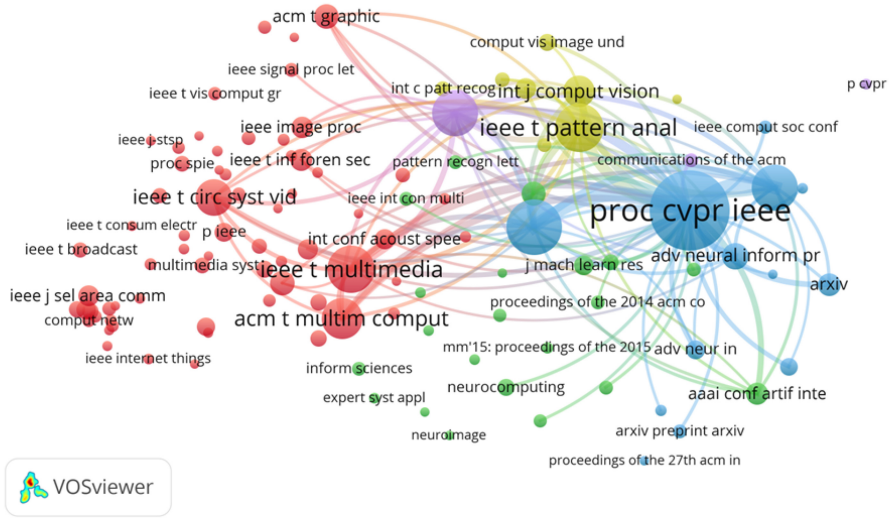

Fig. 3. Co-citation of Journals in TOMM (2005–2022): minimum threshold of 40 and 100 links.

Conference on Computer Visualization," "IEEE Transactions on Image Processing," "IEEE Transactions on Circuits and Systems for Video Technology," and "IEEE Journal on Selected Areas in Communications." Notably, IEEE journals and conference proceedings emerge as prominent nodes across multiple clusters, including "IEEE Transactions on Information Forensics and Security," "IEEE Transactions on Image Processing," "IEEE Access," and "IEEE Transactions on Multimedia." Other notable sources attracting significant citations encompasses "arXiv"—an open-access repository for electronic preprints and post-prints, with 214 citations, and the journal "Journal of Machine Learning Research," with 164 citations.

Analysing journal co-citations within TOMM for 2005–2013 and 2014–2021 uncovers a dynamic shift in shared citations among these journals. Figures 4 and 5 portray the co-citation patterns, considering a minimum citation threshold of 10 and 30, respectively, showcasing the 50 most significant linkages. From 2005 to 2013, noteworthy venues like IEEE Transactions on Circuits and Systems for Video Technology, IEEE Transactions on Multimedia, Lecture Notes in Computer Science, and IEEE Transactions on Pattern Analysis and Machine Intelligence emerged as leading co-cited sources. However, a substantial transformation in this landscape transpired in the subsequent years, spanning from 2014 to 2021. Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition took precedence over other venues, signifying its ascendancy in co-citation connections. Other influential journals during this period encompass Lecture Notes in Computer Science, IEEE Transactions on Pattern Analysis and Machine Intelligence, and IEEE Transactions on Image Processing.

Table 10 provides a comprehensive breakdown of co-citations on a global and temporal scale, unveiling the evolving prominence of journals across time. The analysis findings demonstrate that in the initial span of 2005 to 2013, the journal "IEEE Transactions on Circuits and Systems for Video Technology" held the foremost position. However, its position slid to the 8th slot during the subsequent years from 2014 to 2021. In contrast, "Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition" ascended from the 7th position in 2005–2013 to claim the top rank in 2014–2021. Moreover, 2014 to 2021 introduced new influential venues into the landscape. These include "IEEE Conference on Computer Visualization," "Advances in Neural

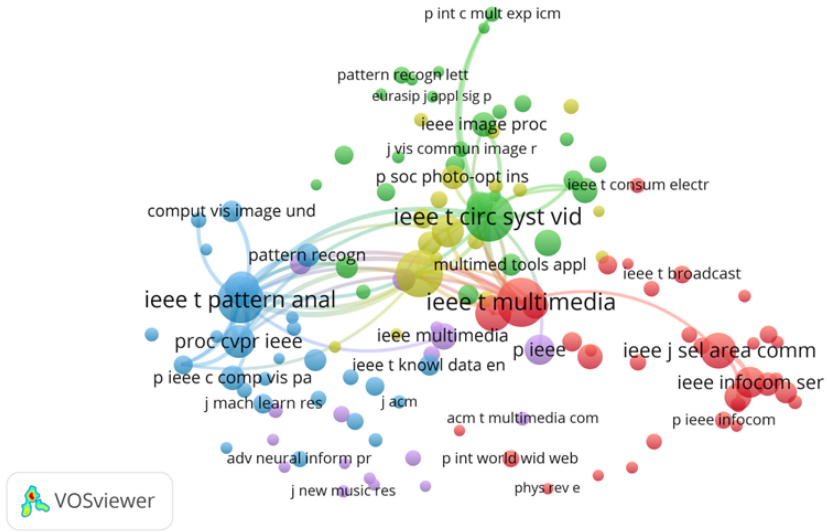

Fig. 4. Co-citations of Journals in TOMM: 2005–2013 (minimum citation threshold of 10 and 50 links).

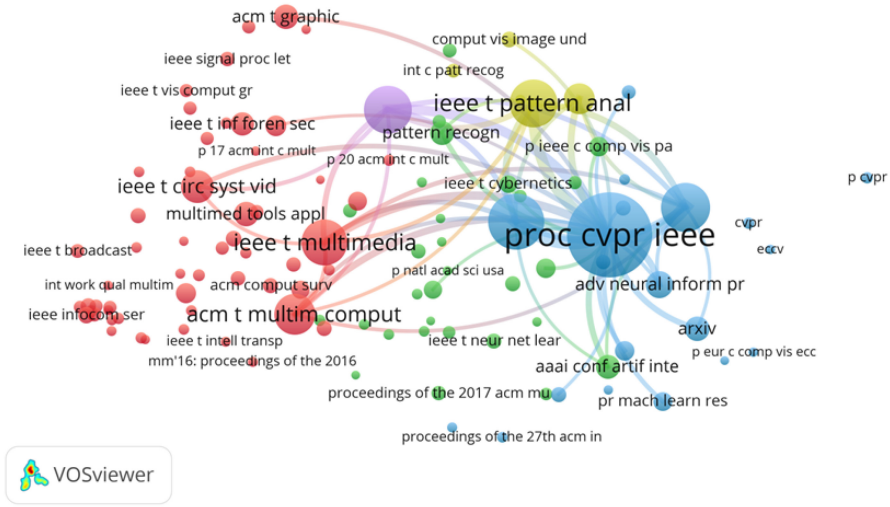

Fig. 5. Co-citation of Journals in TOMM: 2014–2021 (minimum citation threshold of 30 and 50 links).

Information Processing Systems," "IEEE Access," "AAAI Conference on Artificial Intelligence," and others. Comprehensive details can be found in Table 10.

The subsequent section delves into the bibliographic coupling of institutions contributing to TOMM, as illustrated in Figure 6. This analysis relies on a minimum publication threshold of 5 articles and 100 links. As observed in the preceding analysis, the Chinese Academy of Sciences and the National University of Singapore emerge as primary contributors with dominant nodes. Notably, the University of Technology Sydney, Huazhong University of Science and Technology, and King Saud University stand out as prominent nodes, indicating substantial collaboration with

Table 10. Co-citation of Journals in TOMM: Global and Temporal Analysis

	Global			2005–2013			2014–2021		
R	Journal	Cit	CLS	Journal	Cit	CLS	Journal	Cit	CLS
1	proc cvpr ieee	2,659	79,283	ieee t circ syst vid	177	3,404	proc cvpr ieee	2,581	79,934
2	lect notes computer sc	1,286	37,933	ieee t multimedia	174	3,028	lect notes computer sc	1,124	36,218
3	ieee t pattern anal	981	32,805	lect notes computer sc	162	2,684	ieee i conf comp vis	867	32,984
4	ieee t multimedia	935	25,210	ieee t pattern anal	160	3,434	ieee t pattern anal	821	30,409
5	ieee i conf comp vis	894	32,848	ACM t multim comput	94	1,387	ieee t image process	811	27,390
6	ieee t image process	888	28,221	ieee j sel area comm	94	1,210	ieee t multimedia	761	23,016
7	ACM t multim comput	699	16,328	int j comput vision	84	2,072	ACM t multim comput	605	15,461
8	ieee t circ syst vid	570	13,390	proc cvpr ieee	78	1,917	ieee t circ syst vid	393	10,622
9	int j comput vision	423	13,855	ieee t image process	77	1,344	int j comput vision	339	12,233
10	adv neural inform pr	291	9,674	ieee infocom ser	69	827	adv neural inform pr	271	9,640
11	multimedia tools appl	257	6,173	p ieee	67	1,037	multimedia tools appl	220	5,772
12	ACM t graphic	254	7,087	ieee acm t network	55	628	ACM t graphic	214	6,607
13	pattern recogn	246	8,429	ieee multimedia	52	885	arxiv	214	7,376
14	arxiv	214	7,125	commun acm	51	878	aaai conf artif inte	209	8,748
15	ieee t inf foren sec	212	5,126	multimedia syst	51	961	pattern recogn	206	7,786
16	aaai conf artif inte	210	8,489	p ieee int c mult ex	49	1,079	ieee t inf foren sec	195	4,851
17	ieee image proc	199	5,506	p acm mult	46	714	ieee image proc	155	4,743
18	p ieee c comp vis pa	182	4,544	proc spie	46	831	ieee access	144	2,978
19	ieee j sel area comm	181	2,369	ieee image proc	44	947	adv neur in	138	5,288
20	commun acm	172	3,536	p ieee c comp vis pa	44	715	p ieee c comp vis pa	138	3,987
21	int conf acoust spee	172	3,998	p soc photo-opt ins	43	800	j mach learn res	136	3,916
22	ieee infocom ser	167	2,012	ACM sigcomm comp com	40	487	pr mach learn res	134	4,658
23	j mach learn res	164	4,249	ACM t graphic	40	557	int conf acoust spee	133	3,481
24	p ieee	158	2,794	pattern recogn	40	856	commun acm	121	2,868
25	adv neur in	153	5,395	int conf acoust spee	39	707	neurocomputing	121	4,132
26	ieee access	144	2,870	multimedia tools appl	37	512	ieee t cybernetics	111	4,599
27	pr mach learn res	134	4,529	p 12 ann ACM int c m	36	709	ieee infocom ser	98	1,296
28	ieee multimedia	129	2,607	p ACM int c mult	36	682	p ieee	91	1,989
29	Comput vis image und	123	4,452	p ann joint c ieee c	36	389	Comput vis image und	88	3,870
30	neurocomputing	122	4,091	Comput vis image und	35	741	ieee j sel area comm	87	1,423
31	ACM sigcomm comp com	120	1,615	p sigchi c hum fact	35	618	ACM comput surv	86	1,985
32	ieee t knowl data en	115	2,303	ieee t knowl data en	33	647	proceedings of the 2014 ACM conference on multimedia	85	2,712
33	ACM comput surv	113	2,352	p 11 acm int c mult	30	414	arxiv preprint arxiv	84	2,780
34	ieee acm t network	113	1,363	p acm mult c	30	325	communications of the ACM	83	2,956
35	ieee t cybernetics	111	4,530	ieee signal proc mag	29	506	ieee t knowl data en	82	1,790
36	proc spie	110	2,201	j mach learn res	28	492	ieee t neur net lear	82	3,246
37	multimedia syst	105	1,784	p ieee int c im proc	28	679	signal process-image	81	1,823
38	ieee signal proc mag	99	2,323	ACM comput surv	27	451	ACM sigcomm comp com	80	1,281
39	int c patt recog	99	2,978	ieee i conf comp vis	27	732	inform sciences	80	2,281
40	signal process-image	98	2,090	int c patt recog	27	624	ieee signal proc let	78	2,563

other institutions. The analysis reveals a stronger bond among institutions within the same country, signifying a prevalent trend for national over international collaboration in research.

Figure 7 illustrates the bibliographic coupling among countries contributing to TOMM, employing a minimum publication threshold of five documents and fifty links. The visual representation underscores the dominant role of China within this academic network, positioned as the central hub in the landscape of TOMM publications. Simultaneously, the United States also occupies a substantial position, interlinking with many nations. Furthermore, countries like Australia, Canada, England, and Singapore have emerged as pivotal nodes within this intellectual network due to their notable connections with other nations. European nations such as Italy, Germany, France,

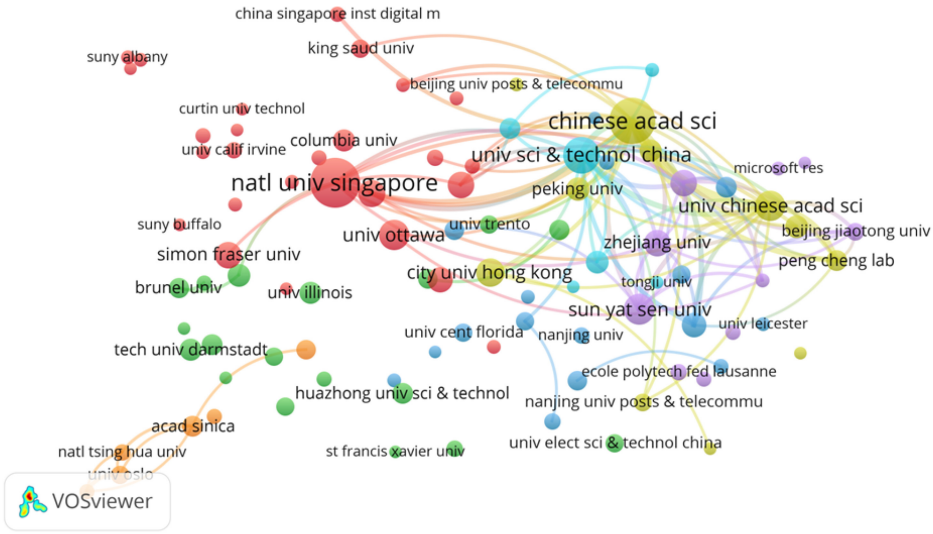

Fig. 6. Bibliographic coupling of institutions publishing in TOMM: Minimum publication threshold of 5 documents and 100 links.

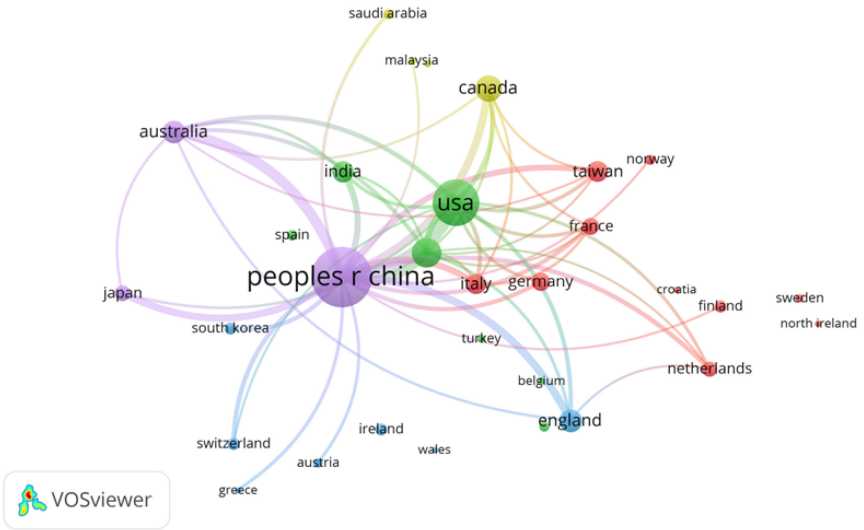

Fig. 7. Bibliographic coupling of countries publishing in TOMM: Minimum publication threshold of 5 documents and 100 links.

and the Netherlands exhibit significant involvement, reaffirming their active participation within the TOMM research community. Moreover, the network delineates certain countries establishing links predominantly with either China or the USA. Countries like Japan, Taiwan, and South Korea predominantly interact with China, indicating their engagement with Chinese research. In contrast, countries such as Austria, Belgium, and Finland exhibit a more unidirectional connection toward the USA, suggesting a pronounced inclination toward citing American research.

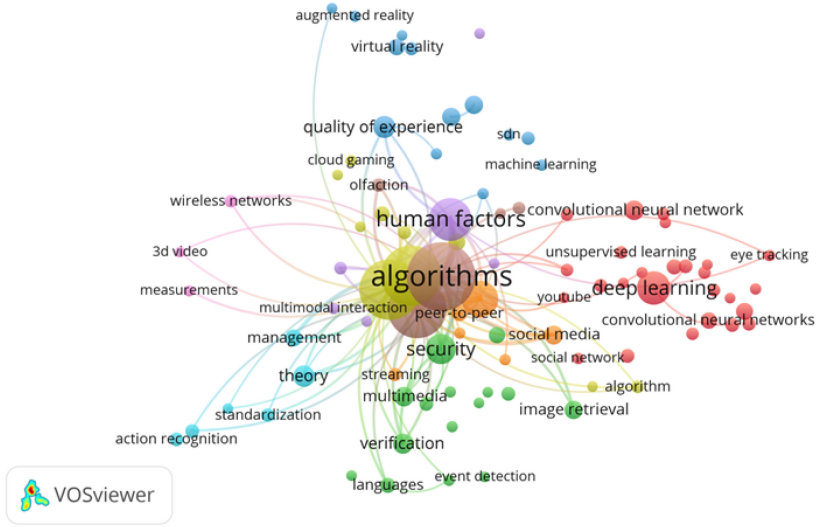

Fig. 8. Co-occurrences of author keywords in TOMM: minimum occurrence threshold of 5 and 100 links.

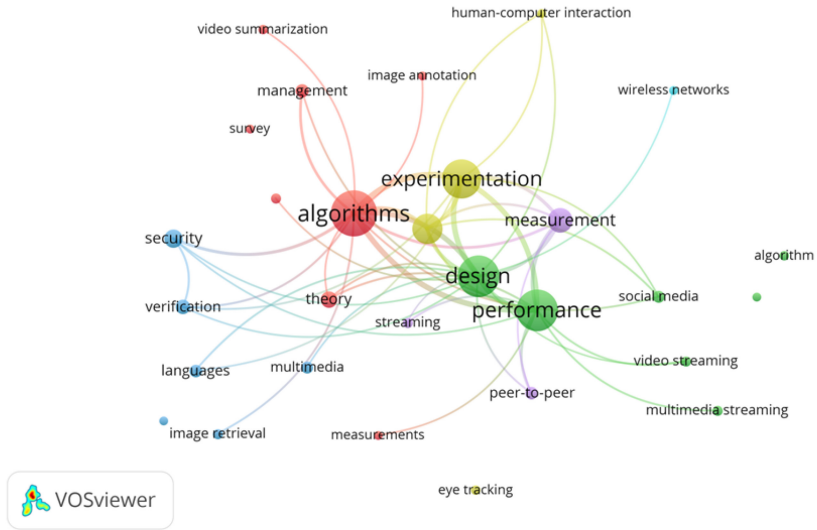

Fig. 9. Co-occurrence of author keywords in TOMM: 2005–2013 (minimum occurrence threshold of 5 and 50 links).

The article proceeds to analyse the co-occurrence of author keywords within TOMM, visually depicted in Figures 8–10. The initial phase involves scrutinising the patterns of author keyword co-occurrences from the journal's inception, utilising a lower occurrence threshold of 5 and featuring 100 links, as depicted in Figure 8. The outcomes of this exploration reveal the enduring prominence of author keywords such as "algorithms," "performance," "design," "experimentation," and "human factors" since the journal's inception.

To gain a deeper understanding of the co-occurrence of author keywords, the analysis data is segmented into two epochs: from 2005 to 2013 and from 2014 to 2021. The fluctuation over time

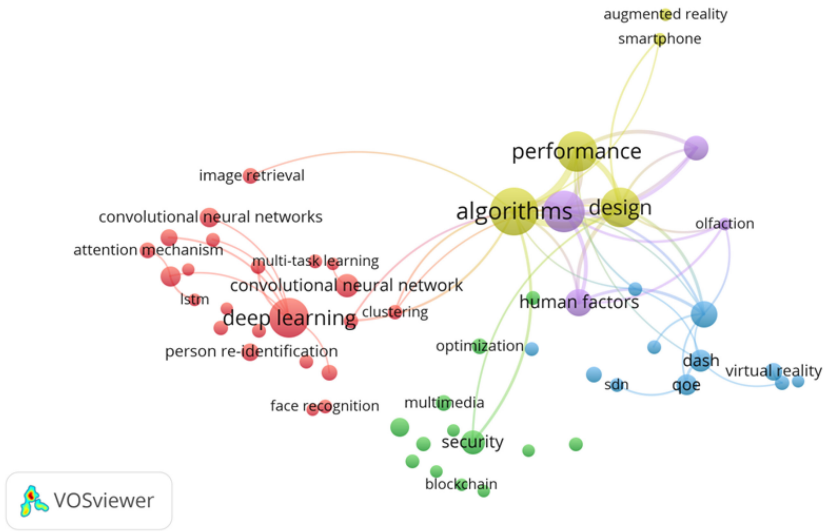

Fig. 10. Co-occurrence of author keywords in TOMM: 2014–2021 (minimum occurrence threshold of 5 and 50 links).

of keyword co-occurrence is portrayed in Figures 9 and 10. Figure 9 shows that from 2005 to 2013, the most prevalent keywords among researchers were "algorithms," "design," and "performance."

However, the study reveals a significant shift in the frequency of author keywords in the recent decade. This could be due to the rise of new technologies and a growing interest of researchers in multimedia computing and communication. Figure 10 shows that from 2014 to 2021, new keywords emerge, such as "deep learning," "quality of experience," and "convolutional neural network" due to the advancement of machine learning algorithms in multimedia communication.

Table 11 provides an overview of the global and temporal analysis concerning the co-occurrences of author keywords. As depicted in the table, the keyword "algorithms" emerges as the most frequently recurring author keyword, with 206 instances observed globally. Following closely is the keyword "performance" with 161 occurrences, succeeded by "design," "experimentation," and "human factors." This analysis effectively highlights the primary thematic areas within TOMM publications, offering insights into the evolving trends within the field.

5 Discussion Conclusion

ACM Transactions on Multimedia Computing and Communication is one of the leading journals in computer science, publishing high-quality original research in multimedia computing, communications and applications since 2005. This article systematically analyses bibliometric data obtained from the Web of Science Core Collection database from 2005 to 2022. The purpose of the article is to evaluate the leading trend of the journal by analysing various indicators. The article evaluated the historical progress and analysed multiple bibliometric indicators—rational, quantitative, and qualitative to analyse and assess results from various aspects.

The key findings from the bibliometric analysis are presented as follows:

(I) The journal's reputation has increased significantly over the decade in terms of the impact factor, number of publications, number of submissions and ranking, as evident from above tables. This signifies the journal's escalating influence in the domain of multimedia computing.

Table 11. Most Frequent Author Keywords in TOMM: Global and Temporal Analysis

	Global		2005–2013		2014–2021	
R	**Keyword**	**Occr.**	**Keyword**	**Occr.**	**Keyword**	**Occr.**
1	algorithms	206	algorithms	135	algorithms	71
2	performance	161	design	110	experimentation	54
3	design	159	performance	110	performance	51
4	experimentation	151	experimentation	97	deep learning	49
5	human factors	81	human factors	58	design	49
6	measurement	58	measurement	39	human factors	23
7	deep learning	49	security	22	quality of experience	22
8	security	40	theory	18	measurement	19
9	quality of experience	22	verification	14	security	18
10	theory	21	management	11	convolutional neural network	17
11	verification	18	languages	10	dash	15
12	convolutional neural network	17	peer-to-peer	10	QUOTE	14
13	multimedia	17	multimedia	9	image captioning	13
14	social media	16	social media	9	convolutional neural networks	12
15	dash	15	image retrieval	7	cloud computing	11
16	image retrieval	15	multimedia streaming	7	person reidentification	10
17	QUOTE	15	standardisation	7	virtual reality	10
18	image captioning	13	streaming	7	action recognition	9
19	management	13	video streaming	7	cross-modal retrieval	9
20	video streaming	13	algorithm	6	attention mechanism	8

(II) During the past four years, 2019–2022, the journal has gained significant improvement in the number of publications and citations.

(III) Most of the submission to the ACM-TOMM is from China, the USA, Singapore, and Canada. However, there are significant contributions from England and Australia.

(IV) The article "Content-based multimedia information retrieval: State of the art and challenges," authored by Michael S. Lew et al., gets a notable scientific impact that has attracted 820 citations in the journal.

(V) C. S. Xu from the Chinese Academy of Sciences is the most productive author that has contributed 24 articles to the journal. The most influential author is R. Jian, from the University of California Irvine, who contributed nine articles to the journal that have received 929 citations.

(VI) The most productive institution is the Chinese Academy of Science, which has contributed 110 articles to the journal and has received 1,469 citations.

(VII) TOMM has a very strong co-citations rate, because it is strongly connected with other journals and conferences discussing multimedia computing, communications and applications, such as IEEE Transactions on Circuits and Systems for Video Technology, Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition, IEEE Conference on Computer Visualization, Advances in Neural Information Processing Systems, and others.

(VIII) The bibliographic coupling of institutions showed that the Chinese Academy of Science and the National University of Singapore have significant collaborations with other universities.

(IX) Bibliographic coupling of countries showed that China and the USA are the most productive countries connected with many other countries.

(X) By examining the co-occurrences of author keywords, this study illuminates the shifting research landscape within TOMM. In its inception, prevailing keywords such as "algorithms," "performance," "design," "experimentation," and "human factors" took precedence. However,

with the advent of new technologies, contemporary research has pivoted toward concepts like "deep learning," "quality of experience," and "convolutional neural networks."

Finally, the analysis shows a general picture of 2022, and the future results might vary because of the bibliometric data and may come with more unexpected changes.

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