

Quantifying the Impact of Indian Virtual Reality Research: A Scientometric Study

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Abstract - The last pandemic covid-19 has brought up various technologies in the booming lane. Virtual reality technology plays a vital role in different fields. In this paper, virtual reality technology was analyzed, including the growth pattern in India from 2012 to 2021. The Web of Science platform is a subscription-paid database of multidisciplinary citations that originated from the Institute for Scientific Information, and it is currently obtained and maintained by Clarivate. Analytics have been used to analyze this study of virtual reality technology research. This study has been analyzed with a record of 540 for the period of 2012-2021 to explore trends in publishing, degree of collaboration, authors' partnership, keywords of Virtual Reality, analyzed journals by scientists, funding agencies and organization-wise publications.

Keywords: Virtual Reality, Virtual Environments, Research, Virtual World and Research Publication

I. INTRODUCTION

The emerging technology has changed our lives, it is forcing societal changes around the world. Even post-Covid-19 pandemic, there has been a vigorous surge in business, IT, and electronic commerce towards the digital landscape. Corporations and industries are steadfastly progressing on their path towards digitalization. Technology has incursion into all business areas, creating demand for products and services. This has been magnified by the Covid-19 crisis, which has only increased the amount and type of use cases technology is needed to fulfil. In the last pandemic, COVID-19, the world has learned that there is no possibility of stopping any pandemic crisis with technology. However, it has proven that it can help us alert people and provide awareness of the current impact. After the Covid-19 pandemic, many R&D teams have started to advance their technologies in different fields like robotic technology, deep learning/machine learning, cloud technology, telecommunication/4G/5G, internet of things and augmented/Virtual reality (Lee et al., 2022).

Virtual reality (VR) is a booming technology worldwide, especially since the healthcare markets have boomed with the current pandemic. Virtual reality (VR) is used in different

areas like mobility solutions, Industry 4.0, Gaming technology, and healthcare (Chow et al., 2017). ResearchandMarket.com survey says the worldwide Virtual reality (VR) technology is expected to reach \$188 billion by 2027. With a population of 1.4 billion, India is a rapidly growing global economy with the potential to lead the virtual reality market in the Asian sub-continent.

This study aims to conduct a retrospective scientometric analysis of Virtual reality in India to check the trend, pattern and connection within the publication landscape (Massis, 2015).

II. REVIEW OF LITERATURE

Rojas-Sánchez et al., (2023) has published a study on "Systematic literature review and bibliometric analysis on virtual reality and education". The main core data was collected from the Web of Science (Hakkaraki, 2023) database from 2010 to 2021, with 436 records. The study revealed that in 2015, virtual reality started to boom in the education field with the publication of documents. Post Covid-19 pandemic the analysis has shown a rapid increase in the publication. China, the United Kingdom and Germany are in the top lead with the most publications. Finally, it has been concluded that this technology acceptance is on a high ratio.

Zhen, (2022) has analyzed and published an article on "Virtual Reality Aided Therapy towards Health 4.0: A Two-Decade Bibliometric Analysis (Bobir et al., 2024)." The main source of the data was collected from the Web of Science database from 2000 to 2020. The VOSViewer open-source software helped to analyze the study in different aspects of Aided therapy research on Virtual Reality technology (Huang, 2016). The research has been explored, and more research is forthcoming on different sub-fields in healthcare 4.0 with Virtual Reality technology (Ball et al., 2021). Furthermore, this analysis discovered that many therapists have started to adopt the technology for productive results.

III.SCOPE AND METHODOLOGY

The core database of Web of Science was selected to retrieve the raw data for this study (Sotnikova et al., 2022). Web of Science database covers attributes of analysis topics. This present research has tried to quantify the impact of Indian Virtual Reality technology research. The research objective is to analyse and discover the growth and development of Virtual reality for the duration of 2012-2021.

IV. OBJECTIVES OF THE STUDY

To study this present development of Virtual reality, the objectives are formed to explore quality research output:

- To analyse our year-wise growth in the number of publications
- To find out the document type
- To analyse the authorship productivity
- To examine the most prolific author
- To analyse the subject-wise breakup of publications
- To spot the preferred journals for publication
- To explore the keywords
- To analyse the funding agency
- To explore the organizations wise publication

V. METHODOLOGY

The Web of Science database was selected for this study, and the period considered for this study is from 2012 to 2021. This database was used to retrieve a total of 540 records to analyze different aspects of the research area.

VI.ANALYSIS OF DATA AND INTERPRETATIONS

To study this research, the Scientometric analysis concept was used to explore virtual reality (VR) technology in India.

The VOS Viewer and Excel applications were used to analyse through tables and graphs with 540 data from the Web of Science database from 2012 to 2021 (10 years).

TABLE I YEAR-WISE DISTRIBUTION

Year	No. of Articles Published	Percentage
2021	70	12.96%
2020	85	15.74%
2019	80	14.82%
2018	72	13.33%
2017	61	11.30%
2016	60	11.11%
2015	38	7.04%
2014	38	7.04%
2013	20	3.70%
2012	16	2.96%

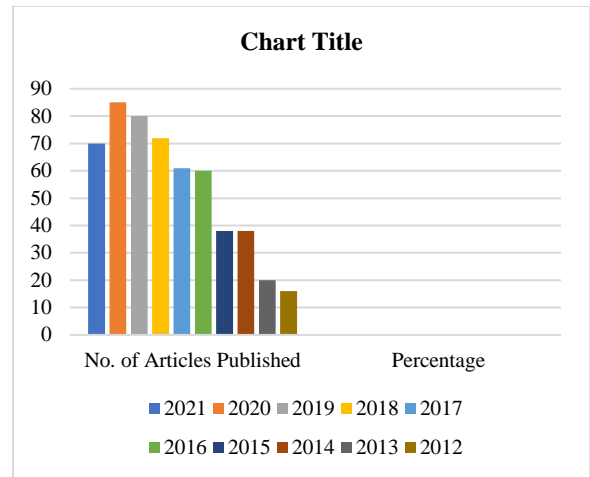


Fig. 1 Year-wise Distribution

Table I Indicates the growth of Virtual Reality (VR) research in the articles published from 2012 to 2021(10 years). Findings discovered that a total of 540 articles were published during the study period. Also, it shows that a total of 16(2.96%) in 2012 were published in India. The year-wise dispensation during the years 2018(13.33%), 2019 (14.82%), 2020 (15.74%) & 2021 (12.96) indicates that these years were radical improvements happening and happening in this research from 2012 until 2021. Figure 1 shows the Year-wise Distribution. In 2021, the publication has reduced due to covid-2019 impact.

TABLE II FORMS OF PUBLICATION

S. No	Document Types	Record Count	Percentage
1	Proceeding's paper	341	62.13%
2	Article	161	29.89%
3	Review	19	3.80%
4	Meeting abstract	7	1.48%
5	Early Access	5	1.09%
6	Editorial material	4	0.91%
7	Letter	3	0.72%

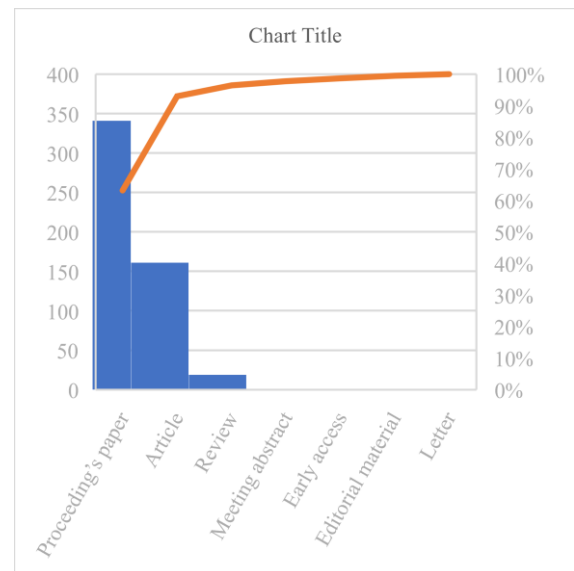


Fig. 2 Forms of Publication

Table II shows that during the period of 2012-2021, overall, 540 publications on Virtual reality technology research were published. The highest number of proceedings papers published was 341, and the lowest number of publications of the letter published was 3. Table II shows that around 55.2 publications were published annually from 2012 to 2021. Figure 2 shows the forms of publication. However, there has been a rise in forms of publication throughout the study period.

TABLE III AUTHORSHIP

S. No	Author	Documents	Citations	Total link strength
1	Abhishek M T	1	5	5
2	Aggarwal, Riya	1	20	1
3	Agrawal, Amit	1	5	4
4	Ahalyadas M	1	8	2
5	Arora, Jatin	1	1	2
6	Aswin P S	1	5	5
7	Baby, Britty	1	10	7
8	Balakrishna G	1	0	2
9	Balakrishnan, Komarakshi R	1	2	5
10	Banerjee, Prasenjit	1	2	3
11	Banerjee, Subhashis	1	10	7
12	Bharath V. G	2	5	2
13	Bhardwaj, Aparna	1	0	3
14	Bhargav, B. M	1	0	5
15	Bhat, Suvarna	1	1	4
16	Bhatia, Chahat	1	0	0
17	Bhirud, Nivedita	1	0	3
18	Bhuyan, Tuhin	1	1	2
19	Chadha, Banita	1	1	1
20	Chakraborty, Argha	1	10	7

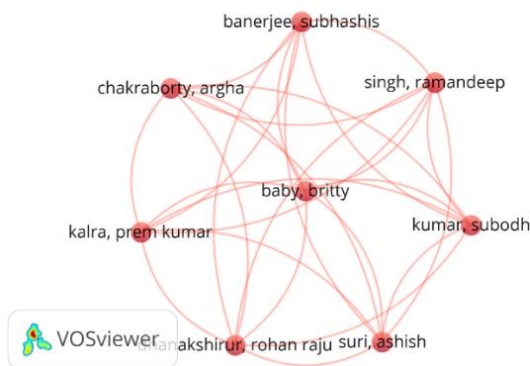


Fig. 3 Authorship

Table III represents data on 156; however, only 20 authors' records were selected for analysis, including the total count of documents they produced and the total number of citations. Figure 3 shows the Authorships.

The following authors, Aggarwal and Riya, have the highest citation rate of 20, which accounts for 16.67% of the total citations in the table. The Baby Britty, Banerjee Subhashis and Chakraborty Argha authors are in second place with 10 citations.

The Baby Britty, Banerjee Subhashis and Chakraborty & Argha authors have the highest total link strength with 7, which accounts for 9.72% each in the table.

The bulk of writers have a low number of citations and overall link strength, with only a few exceptions having greater values in both areas.

TABLE IV MOST PROLIFIC AUTHOR

S. No	Authors	No. of Publication	Percentage
1	Lahiri U	27	5.00%
2	Kumar S	11	2.04%
3	Kumar N	8	1.48%
4	Singh R	8	1.48%
5	Suri A	8	1.48%
6	Baby B	7	1.30%
7	Hemanth DJ	7	1.30%
8	Kumar A	7	1.30%
9	Kumar P	7	1.30%
10	Mantri A	7	1.30%
11	Dutta A	6	1.11%
12	Manivannan M	6	1.11%
13	Pillai Js	6	1.11%
14	Rastogi N	6	1.11%
15	Solanki D	6	1.11%
16	Bhavani RR	5	0.93%
17	Das A	5	0.93%
18	Dutta P	5	0.93%
19	Ganpule A	5	0.93%
20	Gotewal KK	5	0.93%

Table IV shows the first 20 authors of contribution. Mr. Lahiri U has contributed a maximum number of papers with 27(5.00%) publications followed by Mr. Kumar S with 11(2.4%) and Mr. Kumar N 8(1.48%). A total of 156 authors have productively contributed to this research during the study period.

TABLE V RESEARCH AREAS

Sl . No	Research Areas	Record Count	Percentage
1	Computer Science	286	33.73%
2	Engineering	222	26.18%
3	Telecommunications	87	10.26%
4	Automation Control Systems	33	3.89%
5	Neurosciences Neurology	26	3.07%
6	Imaging Science Photographic Technology	24	2.83%
7	Science Technology Other Topics	23	2.71%
8	Surgery	23	2.71%
9	Education Educational Research	22	2.59%
10	Robotics	20	2.36%
11	Instruments Instrumentation	12	1.42%
12	Physics	11	1.30%
13	Rehabilitation	11	1.30%
14	Health Care Sciences Services	9	1.06%
15	Materials Science	9	1.06%
16	Optics	8	0.94%
17	Energy Fuels	6	0.71%
18	Environmental Sciences Ecology	6	0.71%
19	Medical Informatics	6	0.71%
20	Information and Library Science	4	0.47%

Table V reveals the research on virtual Reality (VR) in different fields. The maximum research has been done in Computer Science with a record count of 286 (52.96%) during 2012-2021, followed by the Engineering field with

222 publications (41.11%), Telecommunication ranks the third position with 87 publications (16.11%). Finally, it shows that Information and Library Science has the lowest record count in the research area.

TABLE VI PREFERRED JOURNALS

S. No	Name of Journals/Conference Proceedings	Record Count	Percentage
1	Advances In Intelligent Systems and Computing	10	1.85%
2	IEEE Transactions on Neural Systems and Rehabilitation Engineering	7	1.30%
3	International Conference on Computing Communication and Network Technologies	7	1.30%
4	Lecture Notes in Computer Science	6	1.11%
5	Virtual Reality	6	1.11%
6	Procedia Computer Science – ScienceDirect	5	0.93%
7	Proceedings Of Spie - SPIE	5	0.93%
8	2016 International Conference on Advances in Computing Communications and Informatics ICACCI	4	0.74%
9	2019 26th IEEE Conference on Virtual Reality And 3d User Interfaces VR	4	0.74%
10	25th ACM Symposium on Virtual Reality Software and Technology VRST	4	0.74%

Table VI shows that in the research period on this particular area, the top ten journal titles and conference proceedings are listed based on the number of publications to check the domain-specific impact of virtual reality publications. The maximum number of 10 publications (18.5%) were published in Advances in Intelligent Systems and Computing, followed by “IEEE Transactions on Neural Systems and Rehabilitation Engineering and International Conference” on Computing Communication and Network Technologies with 7 publications (1.30%).

TABLE VII KEYWORDS

S. No	Keyword	Occurrences	Total Link strength
1	Adolescents	1	13
2	3Ds Max 2017	2	9
3	360 Degree Camera	1	6
4	360-Degree Media	1	6
5	Altspacevr	1	6
6	Applications	1	5
7	Architecture	1	5
8	Arcore	1	5
9	Arduino	1	5
10	3D	1	4
11	3D Modelling	1	4
12	3D Objects	1	4
13	3D Visualization	1	4
14	Addiction	1	4
15	Amalgam	1	4
16	Anaglyph Stereovision	1	4
17	Android Smartphone	1	4
18	Anova Test	1	4
19	360 Degrees Narrative	1	3
20	3D Gui	1	3

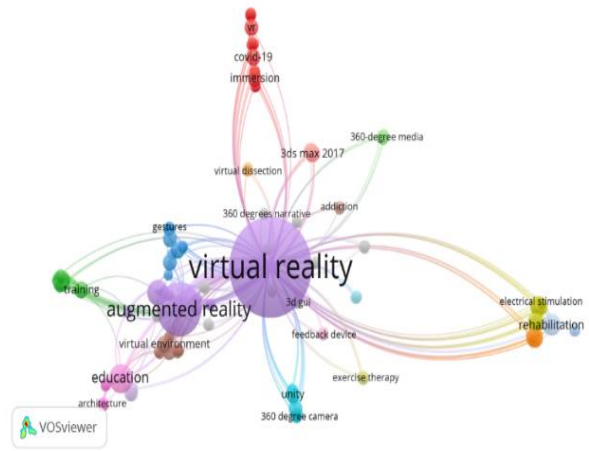


Fig. 4 Keywords

The given Table VII & Figure 4 shows various kind of keywords are used with different “occurrences” and “total link strength”. The “Adolescents” keyword has the highest link strength of 13, which is exposing and pointing to topics of youth. “3Ds Max 2017” is in second place with a total link strength of 9 with towering maximum Occurrences 2. “360 Degree Camera”, “360-Degree Media”, and “Altspacevr” are with the same total link strength of 6. It could be observed that most of the keywords are used for multi-media studies and research. This mix of keywords explores the different aspects of fields involved in the various technologies and tools.

TABLE VIII FUNDING AGENCIES

S. No	Funding Agencies	Record Count	Percentage
1	Department of Science and Technology	16	2.96%
2	National Science Foundation (NSF)	8	1.48%
3	Ministry of Electronics and Information Technology	4	0.74%
4	National Institutes of Health	4	0.74%
5	United States Department of Health and Human Services	4	0.74%
6	European Commission	3	0.56%
7	Indian Council of Medical Research (ICMR)	3	0.56%
8	Indian Institute of Technology, Kharagpur	3	0.56%
9	Cognitive Science Research Initiative Under the Department of Science and Technology	2	0.37%
10	Indian Institute of Technology, Chennai	2	0.37%

Table VIII reveals that from 2012 to 2021, various agencies funded Virtual Reality (VR) technology research, i.e., altogether 101 agencies. These agencies have been funded around 163 times during the study period. The top ten agencies are shown in Table IV. The Department of Science Technology India has funded primarily around 16 times (2.96%).

TABLE IX ORGANIZATIONS WISE PUBLICATION

S. No	Organization wise Publication	Record Count	Percent age
1	Indian Institute of Technology System (IIT), Kanpur, India	113	20.93%
2	Indian Institute of Technology (IIT) Gandhinagar, India	31	5.74%
3	National Institute of Technology (NIT), Trichy, India	19	3.52%
4	All India Institute of Medical Sciences (AIIMS), New Delhi, India	18	3.33%
5	Indian Institute of Technology (IIT), Madras, India	18	3.33%
6	Amrita Vishwa Vidyapeetham, Coimbatore, India	14	2.59%
7	Indian Institute of Technology (IIT), Delhi, India	14	2.59%
8	Indian Institute of Technology (IIT), Kharagpur, India	14	2.59%
9	Indian Institute of Technology (IIT), Bombay, India	13	2.41%
10	Vellore Institute of Technology, Vellore, India	12	2.22%
11	Indian Institute of Science (IISc), Bangalore, India	11	2.04%
12	Indraprastha Institute of Information Technology, Delhi, India	11	2.04%
13	Manipal Academy of Higher Education, Manipal, India	11	2.04%
14	Chitkara University Punjab, Rajpura, India	9	1.67%
15	Council of Scientific Industrial Research (CSIR), New Delhi, India	9	1.67%
16	Indian Institute of Technology (IIT), Guwahati, India	9	1.67%
17	International Institute of Information Technology, Bangalore, India	8	1.48%
18	Karunya Institute of Technology Sciences, Coimbatore, India	8	1.48%
19	SRM Institute of Science Technology, Chennai, India	7	1.30%
20	Amity University, Noida, India	6	1.11%

Table IX shows the top twenty institutions/organizations that have taken part in research development. The table clearly shows that the “Indian Institute of Technology System (IIT)”, Kanpur, has contributed more than 113(20.93%) to enhance the quality of this study based on the analysis of top institutions and organizations.

VII. DISCUSSIONS

This study explains that virtual reality (VR) technology researchers published a maximum number of publications in 2020, with 15.74%. It also indicates that the highest rate of publications increased during the period from 2015 to 2020. In the form of publication, the table shows that the proceedings papers were the highest published form, with 341, and the lowest form of letter, with 3. Aggarwal and Riya received the highest citation rate of 20 (16.67%). Author Lahiri U has contributed and is heading with the most publications. The maximum number of Virtual Reality technology research has been conducted in Computer Science, with 286 (52.96%). The Advances in Intelligent Systems and Computing journal is on the top preferred journal list with 10(18.5%) publications. The most used keyword, “Adolescents”, has the highest link strength with 13. The Department of Science Technology, India funding agency has funded around 16 (2.96%) times. In organization-wise publications, the Indian Institute of Technology System (IIT), Kanpur, India, has contributed a huge number of publications, with 113 (20.93%).

VIII. CONCLUSION

Virtual reality (VR) technology has advanced and greatly impacted several industries, including electronic commerce, gaming, healthcare, and mobility solutions. The present scientometric research underscores the notable surge in virtual reality-related publications in India, particularly during the COVID-19 pandemic. This trend indicates the growing utilization of cutting-edge technologies to tackle worldwide issues. The results show that publications peaked in 2020, proceedings papers dominated the field, and notable scholars and organizations like the Indian Institute of Technology, Kanpur, made substantial contributions. An important part of the financing for these scientific endeavors has come from the Department of Science and Technology in India. By expanding this analysis worldwide, more understanding of the evolution and applications of VR technology across various domains and geographies can be attained. This report emphasizes how VR technology is advancing many industries and shows the room for more research and development in this exciting area.

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