VIRTUAL LIBRARIES

INNOVATION TO INTEGRATION

"Virtual Libraries: Innovation to Integration" is a book that explores the evolution of libraries in the digital age. It delves into the transformative impact of digital technologies on traditional library systems, tracing their historical roots and highlighting how virtual libraries have emerged as pioneering platforms offering unparalleled access to resources and services. Key themes include digital transformation, innovative services, challenges and opportunities, the evolving role of librarians, and case studies and examples. The book chronicles the shift from print-centric libraries to digitally-driven information ecosystems, examining the proliferation of digital collections, online databases, and e-books. It also highlights the innovative services and tools that virtual libraries employ to enhance user experience. The book also addresses issues such as digital preservation, copyright concerns, and the digital divide, while highlighting the potential for democratizing access to information and fostering digital literacy. The book serves as a practical guide for librarians, educators, policymakers, and information professionals to navigate the complexities of the digital information age.

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Chapter 15
Indian Research Output on 'Robots in Libraries'
A Scientometric Mapping of Web of Science Data

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Introduction

Libraries are no longer just havens for bookshelves – they're embracing robots! These mechanical helpers are transforming various aspects of the library experience. On the user side, telepresence robots enable remote users to virtually explore the library and receive assistance from librarians. Friendly, autonomous robots can answer frequently asked questions, guide patrons to specific sections, and even shelve books. For staff, AI-powered robots automate tedious tasks like inventory management and reshelving, freeing up valuable time for librarians to offer personalized assistance and curate engaging programs. Ultimately, robots in libraries are not replacing human interaction, but rather enhancing it – creating a more efficient, accessible, and futuristic library experience for all.

Need for the Study

Libraries are only one of the many fields that are being rapidly transformed by the incorporation of robotics. This increasing interest calls for a thorough grasp of the state-of-the-art research on robots in libraries. This work provides a useful map of the body of research on this topic by using a scientometric approach to analyse publications in the Web of Science (WoS) database. Scientometrics is the use of quantitative techniques in the study of the composition and evolution of scientific knowledge. Libraries are only one of the many fields that are being rapidly transformed by the incorporation of robotics. This increasing interest calls for a thorough grasp of the state-of-the-art research on robots in libraries.

Review of Literature

Nutan Gaud (2019) analyzed 4325 "Robotics" research publications from 2009-2018 using Scopus data. The highest documents were published in 2018 at 18.29%, with the highest growth rate in 2010 and the highest doubling time in 2018. The highest papers were written by more than three authors, with an average degree of author collaboration of 0.93. The highest publications came from computer science and were published in ACM international conference proceeding series.

Sadik Batcha(2017) evaluated the research volume, contribution to world literature, publication forms, and international collaboration in robotics. Data from the Web of Science from 1990 to 2016 showed 3703 institutions, with the top 30 contributing significantly. The majority of contributions come from developed countries like the USA, UK, and Germany. English is the preferred language for exchanging research results, followed by German.

Ajay Kumar (2021) analyzed research productivity trends in robotics research publications worldwide from 2009-2018 using the Scopus database. It found that the highest number of articles was published in 2018, with 12.26% in 2018. The growth rate was decreasing, with the conference type document leading with 53506 articles, computer science leading with 53675, and robotics being the most popular keyword. The Chinese Academy of Sciences contributed 1577 articles.

Vellaichamy and Esakkimuthu(2020) analyzed the research productivity of the International Journal of Robotics Research from 2010-2019, focusing on publication distribution, growth rate, collaboration, authorship patterns, and page count. It finds that most researchers prefer articles, with 29% from three authors, and 32.89% publishing 16-20 pages.

Objectives of the Study

The aim of the study is to explore the selective scientometric aspects of 817 research papers published by India on 'Robots/Robotics in Libraries' as indexed in Web of Science database during 2009-2024 (as son 8/2/2024).

This study attempts to:

- Quantify the research activity connected to robots in libraries by looking at the publishing output, collaboration patterns, and highly cited papers.
- Determine the field's main themes and research areas.
- Draw attention to significant writers and organisations that are advancing this developing field.
- Identify possible areas for further investigation and research gaps.

Materials and Method

a. Source of Data : Web of Science Core collection

b. Keywords used: "Robots" (All fields) and Libraries (Topic) and Country / Region : India

c. Period of Coverage : 2009-2024

d. Method : Data was downloaded in plain text file format (500 each)

e. Software used: Histcite

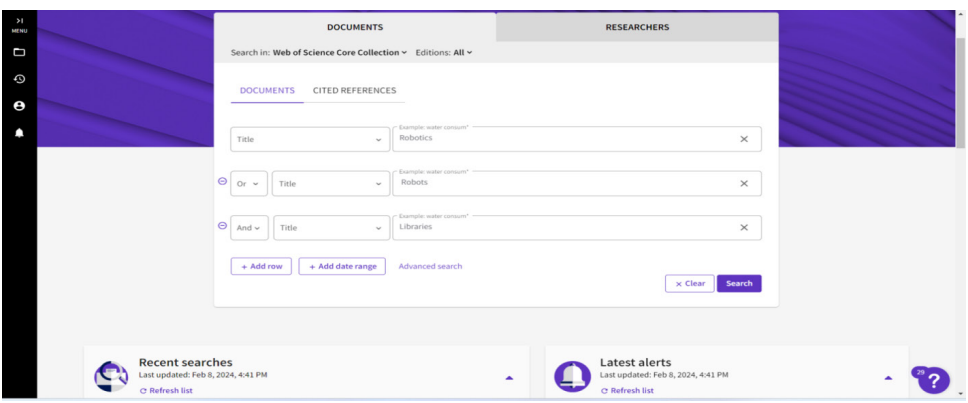

Figure 1. Search Strategy

f. Total Records downloaded: 826

g. No. of Records used for the analysis : 817 (HisCite analyzes only the unique WoS records)

h. Abbreviations used: LCS = Local Citation Scores ; GCS = Global Citation Scores

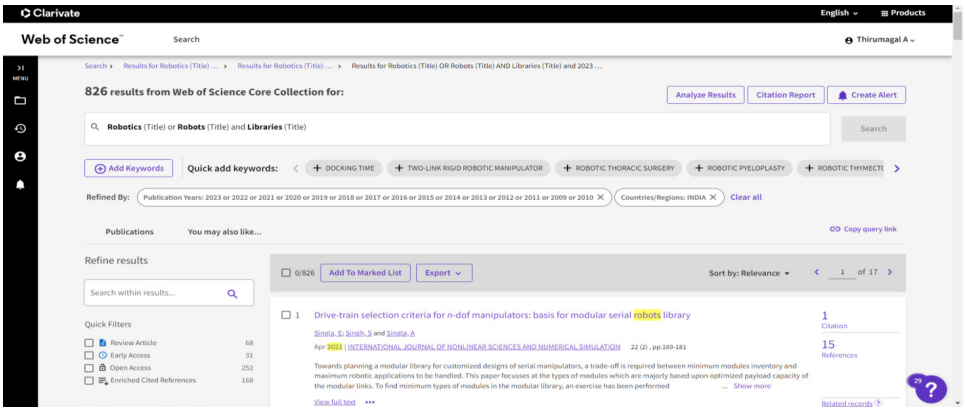

Figure 1. Results from Web of Science Core Collection

Limitations of the Study

- The study focuses only one the research productivity in the area of robotics in libraries from 2009 to 2024
- The study covers only the research productivity of India in the area of robotics in libraries from Web of Science database.

Data Analysis and Interpretation

Table 1: Year-wise research output with LCS and GCS

Publication Year	Records	Percent	LCS	GCS
2009	11	1.3	2	422
2010	13	1.6	5	346
2011	11	1.3	2	229
2012	17	2.1	1	243
2013	16	2	0	60
2014	41	5	51	988
2015	53	6.5	18	800
2016	34	4.2	19	478
2017	49	6	11	692

2018	57	7	23	652
2019	63	7.7	25	862
2020	76	9.3	9	942
2021	90	11	13	716
2022	127	15.5	9	541
2023	155	19	4	156
2024	4	0.5	0	0
Total	817			

Table 1 demonstrates that, with 155 articles, or 18.97% of all research output, 2023 is the most productive year. The next two fruitful years are 2022 and 2021, with 127 (15.54%) and 90 (11%) records, respectively. The least productive years are 2009–2013, with 11, 13, 11, 17, and 16 records, respectively. According to the data, there have been more robotics publications in libraries over the last six years (2019–2024), suggesting that the area has seen a rise in recent years in terms of practical applications. 2014 had the most LCS, with 51 local citations, followed by 2019 (25 local citations), 2015 (18 local citations), and 2016. 2014 leads in GCS with 988 global citations, followed by 2020 with 942 global citations and 2019 with 862 global citations.

Table 2: Document type-wise research output with LCS and GCS

Document Type	**Records**	**Percent**	**LCS**	**GCS**
Article	452	55.3	156	6275
Meeting Abstract	177	21.7	1	14
Review	66	8.1	12	1401
Letter	40	4.9	8	82
Editorial Material	39	4.8	9	184
Article; Early Access	23	2.8	0	29
Article; Proceedings Paper	11	1.3	6	142
Letter; Early Access	3	0.4	0	0
Correction	2	0.2	0	0
Review; Early Access	2	0.2	0	0
Article; Retracted Publication	1	0.1	0	0
Editorial Material; Early Access	1	0.1	0	0
Total	817			

According to Table 2, the most common and favored document genres are reviews (66 records with 12 LCS and 1401 GCS), meeting abstracts (177 records with 1 LCS and 14 GCS), and articles (452 records with 156 local citations and 6275 global citations). Document types such as editorial material (39 records with 9 LCS and 184 GCS) and early access letters (40 records with 8 LCS and 82 GCS) are given preference in the second tier. The survey found that articles have received more citations.

Table 3: Language wise distribution of papers

Language	Recs	Percent	LCS	GCS
English	816	99.9	192	8126
Portuguese	1	0.1	0	1
	817			

Table 3 shows that 99.87% (1647) of records were published in the English language. These documents have received 192 local citations and 8126 global citations. The researchers prefer English as the medium of scientific communication. One article published in Portuguese (with 1 global citation) comes next to English.

Table 4: Distribution of articles in Keywords

Word	Records	Word	Records
Robotic	729	Technique	49
Assisted	119	Outcomes	47
Robotics	91	Fuzzy	38
Using	85	Review	38
Based	77	Learning	36
Experience	71	Design	34
System	71	Single	34
Analysis	52	Manipulator	32
Control	52		
TOTAL			2001

Table 4 revealed that out of 2001 keywords, having 30 or more occurrences, the word robotic was used 729 times, followed by the term 'Assisted'with 119 occurrences. The term 'Robotics' appeared 91 times while the term 'Using' in 85 documents, based 77, experience and system 71, and all the other terms were

used in less than 33 documents.

Table 5: Most published records in the sources

Cited References	Recs	Percent
[No title captured]	29	3.5
Menon M, 2014, EUR UROL, V65, P991, DOI 10.1016/j.eururo.2013.12.006	17	2.1
Yang XS, 2009, WOR CONG NAT BIOL, P210, DOI 10.1109/nabic.2009.5393690	14	1.7
Oberholzer J, 2013, AM J TRANSPLANT, V13, P721, DOI 10.1111/ajt.12078	12	1.5
ZADEH LA, 1965, INFORM CONTROL, V8, P338, DOI 10.1016/S0019-9958(65)90241-X	12	1.5
Giulianotti P, 2010, AM J TRANSPLANT, V10, P1478, DOI 10.1111/j.1600-6143.2010.03116.x	11	1.3
Dindo D, 2004, ANN SURG, V240, P205, DOI 10.1097/01.sla.0000133083.54934.ae	10	1.2
Lanfranco AR, 2004, ANN SURG, V239, P14, DOI 10.1097/01.sla.0000103020.19595.7d	10	1.2
Modi P, 2013, TRANSPLANTATION, V95, P100, DOI 10.1097/TP.0b013e3182795bee	10	1.2
Boggi U, 2011, TRANSPL INT, V24, P213, DOI 10.1111/j.1432-2277.2010.01191.x 9 1.1		
Das S, 2012, ENG APPL ARTIF INTEL, V25, P430, DOI 10.1016/j.engappai.2011.10.004	9	1.1
Sharma R, 2014, EXPERT SYST APPL, V41, P4274, DOI 10.1016/j.eswa.2013.12.030	9	1.1

Table 5 shows the most cited references. The cited reference appearing in 29 records did not have a title, while the cited reference authored by Menon M. (2014)appeared in 17 records. The second layer of the most cited reference includes Yang XS (2009), which has appeared in 14; Oberholzer J. (2013) in 12 records, Zadeh LA (1965) in 12 records and Giulianotti P (2010) in 11 records. The references - Dindo D, 2004, Lanfranco AR, 2004, Modi P, 2013 have appeared in 10 records each and other 3 references appeared in 9 records.

Table 6: Ranking of Authors based on Output Count, LCS and GCS

Author	Recordss	Percent	Author	LCS	Author	GCS
Kumar R	29	3.5	Sood A	44	Ahlawat R	574
Kumar A	28	3.4	Bhandari M	41	Bhandari M	426
Ahlawat R	24	2.9	Menon M	41	Abaza R	426
Kumar S	23	2.8	Jeong W	41	Sharma R	409
Saklani A	21	2.6	Ahlawat R	40	Sood A	396
Bhandari M	20	2.4	Kher V	36	Menon M	393
Modi P	19	2.3	Abaza R	35	Kumar A	378
Sood A	19	2.3	Ghani KR	35	Jeong W	355
Menon M	18	2.2	Kumar RK	28	Kumar V	352
Gupta A	15	1.8	Modi P	25	Eck TF	314
Kumar N	15	1.8	Sharma R	23	Giles DM	314
Sharma A	15	1.8	Ghosh P	19	Goloub P	314
Modi M	14	1.7	Kumar V	14	Holben BN	314
Prasad A	14	1.7	Gaur P	12	Smirnov A	314
Desouza A	13	1.6	Rana KPS	11	Diaz M	302

Table 6 shows that, among the 817 documents, Kumar R has published 29 records, followed by Kumar A with 28, Ahlawat R with 24, Kumar S with 23, Saklani A with 21, and all the other authors have below 20 records. Sood A has 44 LCS, followed by Bhandari M, Menon M, and Jeong W, who got 41 each, and Ahlawat R, who got 40. Ahlawat R got 574 GCS, followed by Bhandari M and Abaza R who got 426, Sharma R got 409, Sood A got 396, Menon M got 393, Kumar A got 378, Jeong W got 355, Kumar V got 352, Kumar V, Eck TF, Giles DM, Goloub P, Holben BN, Smirnov A got 314, and Diaz M got 302. All the other authors got less than 300 global citations.

Table 7: Ranking of Countries based on Output Count, LCS and GCS

Country	Records	Percent	Country	LCS	Country	GCS
India	815	99.8	India	192	India	8125
USA	97	11.9	USA	50	USA	2289
UK	35	4.3	Peoples R China	5	UK	754

Peoples R China	26	3.2	Netherlands	5	Italy	731
Italy	25	3.1	Malaysia	4	France	634
Australia	21	2.6	UK	3	Germany	615
Belgium	20	2.4	Saudi Arabia	3	Peoples R China	544
Germany	20	2.4	Egypt	3	Belgium	388
Saudi Arabia	18	2.2	Australia	2	Netherlands	370
France	16	2	Belgium	2	Saudi Arabia	323
Spain	14	1.7	Singapore	2	Canada	317

Table 7 shows that, among the 817 documents, India is the most productive country with 815 records, followed by the USA with 97 records, the UK with 35 records, China with 26 records, and Italy with 25 records. Other countries have produced less than 25 records. In terms of LCS, India leads with 192, followed by the USA with 50, and all other countries got below 10 citations. In terms of GCS, India leads with 8125, followed by the USA with 2289, the UK with 754, Italy with 731, France with 634, Germany with 615, Peoples Republic of China with 544, and all other countries got below 500 citations.

Table 8: Records staged for Historiograph

S.No	No	Record	LCS	GCS
1	2	Hemal AK, 2009, WORLD J UROL, V27, P89	1	62
2	8	Pandey R, 2009, J CARDIOTHOR VASC AN, V23, P584	1	19
3	12	Sharma SP, 2010, ENG COMPUTATION, V27, P354	1	18
4	14	Kala R, 2010, ARTIF INTELL REV, V33, P307	1	87
5	15	Gupta NP, 2010, BJU INT, V105, P980	1	42
6	21	Hemal AK, 2010, CAN J UROL, V17, P5299	1	24
7	23	Nayyar R, 2010, WORLD J UROL, V28, P599	1	31
8	35	Puntambekar SP, 2011, J THORAC CARDIOV SUR, V142, P1283	2	43
9	78	Abaza R, 2014, BJU INT, V113, P679	3	30
10	82	Menon M, 2014, EUR UROL, V65, P991	17	131
11	83	Menon M, 2014, EUR UROL, V65, P1001	8	69

12	90	Sharma R, 2014, EXPERT SYST APPL, V41, P4274	9	159
13	97	Sood A, 2014, EUR UROL, V66, P371	7	48
14	114	Sood A, 2015, J MINIM ACCESS SURG, V11, P10	2	19
15	115	Bindal V, 2015, J MINIM ACCESS SURG, V11, P16	2	17
16	146	Nilakantan JM, 2015, NEURAL COMPUT APPL, V26, P1379	3	49
17	151	Sharma R, 2015, ISA T, V58, P279	4	95
18	163	Ray PP, 2016, IEEE ACCESS, V4, P9489	6	114
19	164	Datta R, 2016, IEEE T SYST MAN CY-S, V46, P16	2	52
20	178	Inamuddin, 2016, J INTEL MAT SYST STR, V27, P1534	2	14
21	188	Sharma R, 2016, APPL SOFT COMPUT, V47, P565	4	44
22	213	Lamballais T, 2017, EUR J OPER RES, V256, P976	3	129
23	252	Radhakrishnan RK, 2018, NUCL MED COMMUN, V39, P74	3	9
24	265	Tandon V, 2018, WORLD NEUROSURG, V112, P267	2	22
25	268	Sasi S, 2018, COLORECTAL DIS, V20, P554	3	8
26	278	Kammar P, 2018, COLORECTAL DIS, V20, P731	3	8
27	297	Li ZX, 2018, NEURAL COMPUT APPL, V30, P2685	2	45
28	300	Ahlawat RK, 2018, J ENDOUROL, V32, P1160	2	22
29	304	Kumar R, 2019, AM J ROENTGENOL, V212, PW10	2	17
30	308	Chandra PS, 2019, J NEUROSURG-PEDIATR, V23, P187	2	23
31	315	Kumar R, 2019, EUR J NUCL MED MOL I, V46, P838	2	14
32	317	Rout A, 2019, ROBOT CIM-INT MANUF, V56, P12	3	133
33	323	Vedachalam N, 2019, MAR GEORESOUR GEO-TEC, V37, P525	2	27
34	343	Sharma R, 2019, APPL MATH MODEL, V73, P228	2	38
35	349	Dharbaneshwer SJ, 2019, MECCANICA, V54, P1767	3	8
36	362	Singh N, 2019, IEEE T NEUR SYS REH, V27, P2369	2	21

37	455	Megalingam RK, 2021, IEEE-ASME T MECH, V26, P288	2	17
38	527	Varghese CT, 2021, JAMA SURG, V156, P1171	3	7
39	548	Chandran B, 2022, J MINIM ACCESS SURG, V18, P157	2	4
40	603	Varghese CT, 2022, J HEPATO-BIL-PAN SCI, V29, P874	3	5

Table 8 shows the 40 records that are used to create historiograph in HistCite Software. These 40 nodes have 20 links. Out of 817 records, the top 40 records with the highest number of local citation scores are used. The record of 'Menon' has achieved the highest number of local citations (LCS of 17). The result, as obtained from HistCite, is given as Figure 3.

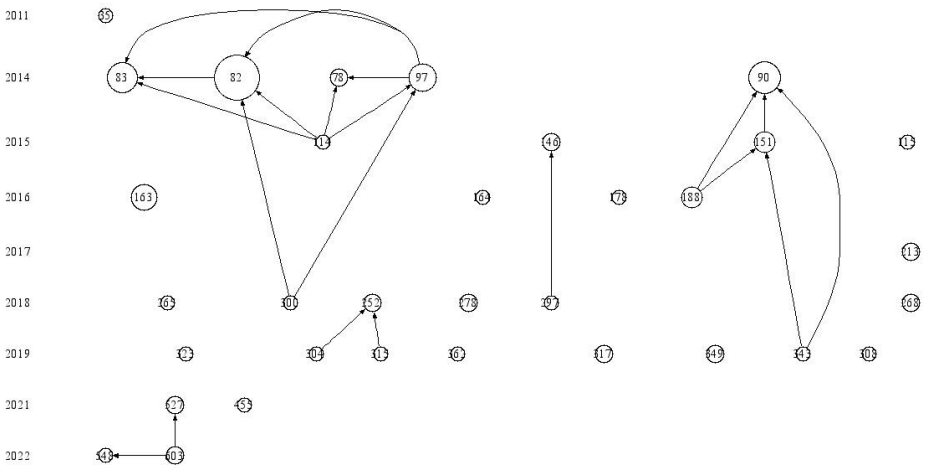

Figure 3: Historiograph

Figure 3 shows the chronological citation map of Indian research output on ' Robots in Libraries'. The size of the circle varies in accordance with the local citation scores of the records. Bigger the size of the circle is the larger the local citation score. The arrow heads shows the link between the documents. It shows which later documents have cited with earlier documents. For example, record number 188 published in 2016 cited record number 151 that was published in 2015 and record number 90 that was published in 2014. It shows the connection between the documents. We can identify the papers that are cited most by the top 40 papers. We can also infer the core papers of the collection, being analyzed.

Conclusion

Research on the application of robots in libraries holds immense significance for the future of information access and service delivery. By exploring how robots can be effectively integrated into library operations, researchers can pave the way for increased efficiency, accessibility, and engagement. Firstly, research can identify the most beneficial tasks for robots to handle, freeing up librarians' time for more complex tasks like research assistance and program development. Robots can excel at repetitive tasks like shelving books, conducting inventory checks, and fetching requested materials. This allows librarians to dedicate their expertise to supporting patrons' diverse needs. Additionally, research can explore how robots can enhance accessibility for individuals with disabilities, such as by providing guidance and assistance through telepresence technologies. This can ensure that libraries remain inclusive spaces for all members of the community.

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