

Research on Funding Agencies in the Field of Mechatronics in Global Scenario

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Abstract - The present study aims to bring out the contributions, funding and un-funding publications in the field of Mechatronics in global scenario. The study focuses on country-wise distribution, funding and un-funding in the field of Mechatronics paper publications, type of documents, top funding agencies and top funding journals. Compared to other subjects of science and technology the field of Mechatronics has seen considerably less number of papers being published. Statistics shows that approximately 1% of publications are done in the world as compared to 30 to 35 percent in other fields. The total number of published papers in the said field is 3,359 with 46,043 citations. USA shares the highest portion with a total of 413 (12.27%) published papers and 7,157 (15.55%) citations, India stands twenty-fifth with total paper publications of 53 (1.58%) and 693 (1.51%) citations during a period of 20 years from 2001 to 2020. Out of 3,359 papers with 46,034 citations, 1,446 (43.05%) papers with 17,972 (39.04%) citations received funding and the remaining 1,913 (56.95%) papers with 28,062 (60.96%) citations received un-funding.

Keywords: Mechatronics, Web of Science (WoS), India, Global, Funding Agency, Document Type, Scientometrics

I. INTRODUCTION

The term Mechatronics was coined by combining the words “mechanics” and “electronics”. The word appeared for the first time in 1969 used by Tetsuro Mori as trademark from the company Yaskawa Electric Corporation in Japan. Mechatronics, also known as Mechatronics engineering, is an interdisciplinary engineering branch that focuses on the integration of mechanical, electronic, and electrical engineering systems, as well as robotics, electronics, computer science, telecommunications, systems, control, and product engineering as shown in Fig.1. Science and technology are critical for economic and social progress of a nation, yet scientific innovation potential is unevenly dispersed over the world. A crucial instrument of economic growth and development is the ability to generate scientific and technological information and transfer it into new goods or processes.

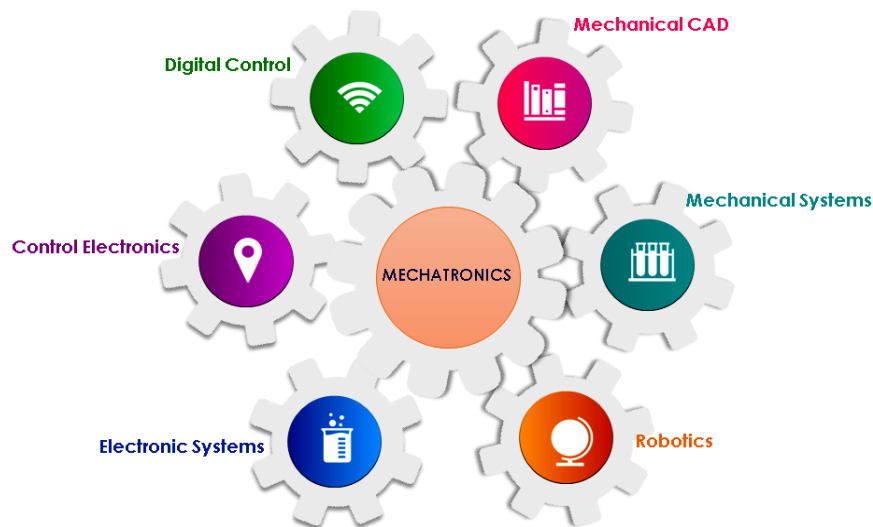


Fig. 1 Dimensions of Mechatronics

The act of providing resources to finance a need, initiative, or project is known as funding. Although it is frequently in the form of money, it can also require an organization's or company's labour or time. The word is most commonly used when an organization uses its internal reserves to meet a financial demand while also acquiring capital from outside sources.

Scientometrics is an important indicator for gauging scientific performance and studying the scientific literature which is the most reliable technique to discover activities related to science and technology. Research activities have resulted in the large production of scientific literature in every discipline of science, and the number of magazines has expanded four folds in the past 20 years. Scientometrics

explores the quantitative qualities and characteristics of science and scientific investigations through the analysis of their publications and references.

II. OBJECTIVES OF THE STUDY

1. To find out the country wise distribution.
2. Year wise funding and un-funding Mechatronics paper publications.
3. To analyze document type distribution funding and un-funding publications.
4. To analyze the top five funding agencies.
5. To find out the top ten journals Mechatronics Publications.

III. METHODOLOGY AND SOURCE OF DATA

This research is based on publishing output, funding and un-funding research on Mechatronics papers as indexed by the Web of Science (WoS) database from 2001 to 2020. The report draws twenty years of data from funding agencies and Mechatronics Journal Publications around the world.

The research quality was calculated using the publication of the paper with citations from the previous 20 years. According to the study’s objectives, a total of 3,359 records with 46,043 citations were downloaded and evaluated using the “MS Excel” and “Histcite” software applications.

IV. SCOPE AND LIMITATION OF THE STUDY

The current research focuses on funding and un-funding research on publication in the field of Mechatronics from 2001 to 2020, as recorded in the “Web of Science” (WoS) Biblio-Graphical information database, consequently, the data is limited to a period of twenty years.

V. RESULTS AND DISCUSSION

A. Country Wise Distribution

The Mechatronics study in globally between the years of 2001 to 2020 twenty years 3,359 with 46,043 citations published.

TABLE I COUNTRY WISE DISTRIBUTION

Sl. No.	Country	P	%	C	%	ACPP
1	USA	412	12.27	7159	15.55	17.38
2	China	404	12.03	4168	9.05	10.32
3	Germany	285	8.48	4208	9.14	14.76
4	Italy	251	7.47	4164	9.04	16.59
5	Japan	175	5.21	2389	5.19	13.65
6	UK	152	4.53	2296	4.99	15.11
7	Canada	140	4.17	2140	4.65	15.29
8	France	132	3.93	1210	2.63	9.17
9	Unknown	112	3.33	957	2.08	8.54
10	Taiwan	110	3.27	1120	2.43	10.18
11	Poland	101	3.01	647	1.41	6.41
12	Spain	95	2.83	1232	2.68	12.97
13	Turkey	95	2.83	1032	2.24	10.86
14	Mexico	94	2.80	544	1.18	5.79
15	Netherlands	82	2.44	1591	3.46	19.40
16	Singapore	71	2.11	1053	2.29	14.83
17	Romania	68	2.02	801	1.74	11.78
18	Belgium	62	1.85	1472	3.20	23.74
19	Sweden	62	1.85	1047	2.27	16.89
20	Australia	59	1.76	1766	3.84	29.93
21	Switzerland	58	1.73	1781	3.87	30.71
22	Lithuania	55	1.64	136	0.30	2.47
23	South Korea	54	1.61	585	1.27	10.83
24	Austria	53	1.58	549	1.19	10.36
25	India	53	1.58	693	1.51	13.08
26	Other Countries	124	3.69	1303	2.83	10.51
Total		3359		46043		13.71
R=Ranking, P=Total Papers, %= Total Percentage, C=Total Citations, ACPP=Average Citation Per Paper						

As observed to other subject areas in the field of science and technology, the field of Mechatronics has seen very less papers published during the twenty years shown in Table I. (Hulloli & Mani, Research on Electric Vehicles in India and USA: A Scientometric Study, 2021) “Research on Electric Vehicles, states total papers published 66,758 with 9,21,127 citations globally and India has 3,131 papers with 21,057 citations with globally ranking 4th (4.7%). USA has 12,524

papers published with 3,07,781 citations and is ranked 2nd (18.9%) whereas China ranks first on research in Electric Vehicles publications constituting 17,958 papers published (26.9%)”. (Cited from p.51).

In the field of Mechatronics USA being in the top place has published 413 (12.27%) papers with 7157 (15.55%) citation and (17.38%) average citation per paper.

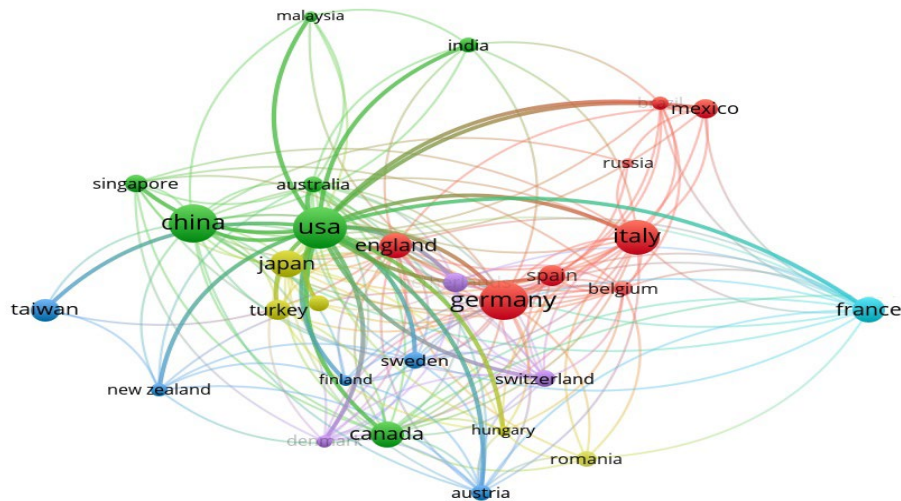


Fig. 2 VOS Viewer Country wise distribution

TABLE II YEAR WISE FUNDING AND UN-FUNDING MECHATRONICS PAPER PUBLICATIONS

Year	TP	TC	FP	%	TC	%	UFP	%	TC	%
2001	62	1575	0	0.00	0	0.00	62	3.24	1575	5.61
2002	92	1681	0	0.00	0	0.00	92	4.81	1681	5.99
2003	93	1227	0	0.00	0	0.00	93	4.86	1227	4.37
2004	98	1630	1	0.07	32	0.18	97	5.07	1598	5.69
2005	106	2524	3	0.21	155	0.86	103	5.38	2369	8.44
2006	119	2726	2	0.14	5	0.03	117	6.12	2721	9.70
2007	140	5010	4	0.28	216	1.20	136	7.11	4794	17.08
2008	147	2280	23	1.59	428	2.38	124	6.48	1852	6.60
2009	137	2529	46	3.18	1321	7.35	91	4.76	1208	4.30
2010	178	2990	75	5.19	1503	8.36	103	5.38	1487	5.30
2011	184	2422	79	5.46	1488	8.28	105	5.49	934	3.33
2012	182	2644	99	6.85	1756	9.77	83	4.34	888	3.16
2013	186	2798	99	6.85	1434	7.98	87	4.55	1364	4.86
2014	206	3251	110	7.61	2273	12.65	96	5.02	978	3.49
2015	215	2854	119	8.23	1934	10.76	96	5.02	920	3.28
2016	236	2528	136	9.41	1453	8.08	100	5.23	1075	3.83
2017	184	2017	119	8.23	1407	7.83	65	3.40	610	2.17
2018	209	1590	129	8.92	1166	6.49	80	4.18	424	1.51
2019	253	1121	180	12.45	914	5.09	73	3.82	207	0.74
2020	332	637	222	15.35	487	2.71	110	5.75	150	0.53
Total	3359	46043	1446		17972		1913		28062	

TP: Total Papers, TC: Total Citations, FP: Funded Papers and UFP: Un-Funded Papers

China standing second sees a contribution of 404 (12.03%) papers with 4,168 (09.05%) citations and (10.32%) ACPP records, Germany 285 (8.48%) papers with 4,208 (9.14%) and ACPP 14.76% contribution of publication is third-ranked. Among the remaining countries, analysis shows Italy, Japan, and UK countries are lowest numbers below 8 percent of output. India stands twenty-fifth ranked, total papers published 53 (1.58%) papers with 693 (1.51%) citations.

B. Year Wise Funding and Un-Funding Mechatronics Paper Publications

Year-wise analysis of funded and unfunded publications in the world during the year 2001 to 2020 is shown in the below Table II. It can be seen that out of 3,359 total papers published with 46,034 citations only 1,446 (43.05%) papers with 17,972 (39.04%) citations received funding and

remaining 1,913 (56.95%) papers with 28,062 (60.96%) citations received un-funding.

From the above table it can be observed that there are no papers published in the funding category between the years 2001 to 2003 and the same is seen to increase gradually from the year 2004 onwards till 2020. The highest funding paper published is 222 (15.35%) in the year 2020 and the highest funding paper cited in the year 2014 is a total of 2,273 (12.65%). The highest un-funded papers published in the year 2007 are a total of 136 with (7.11%) and the highest un-funded citations in the year 2007 total 4,794 with (17.08%). From the above twenty years, we observe that funded papers increased in the year 2020 and the unfunded highest papers published was in the year 2007 after which the number is seen to gradually decrease, as shown in Table II and Fig. 3.

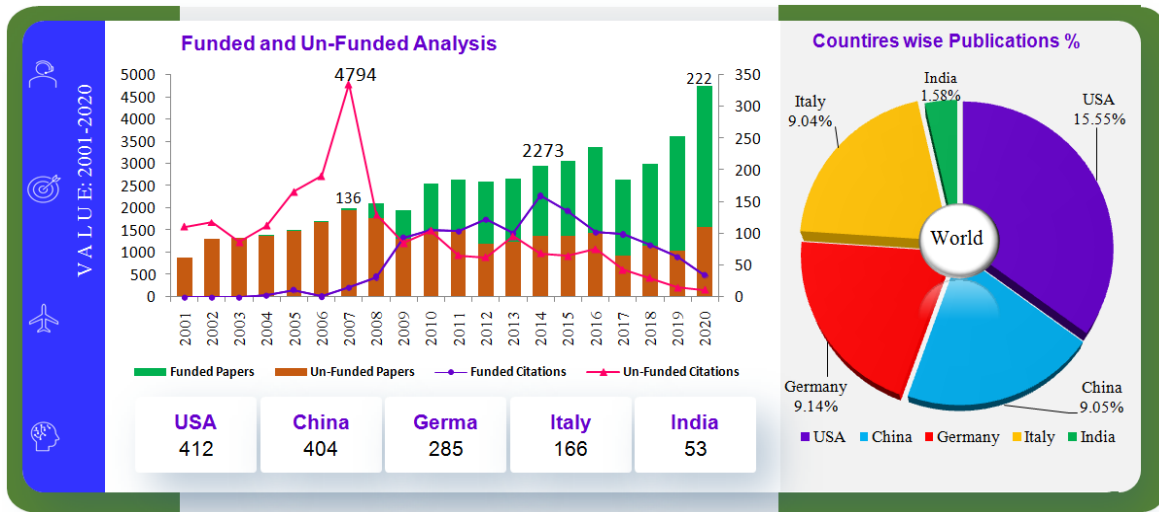


Fig. 3 Year Wise Funding and Un-Funding Mechatronics Paper Publications

C. Document Type Distribution

The five document type distributions in the above mentioned field are Articles, Proceeding Papers, Editorial Material, Review, Meeting Abstract and Book Chapter. Among these the first-ranked is Articles with a total of 2,800 papers and 37,799 citations, out of which funded

papers are 1,349 (48.18%) with 16874 (44.64%) citations and un-funded paper 1,451 (51.82%) with 20,925(55.36%) citations. In the second position the document type is Proceedings Paper a total of 298 and supporting funding papers 45 (15.10%) with 250 (4.76%) citations and un-funding papers total 253 (84.90%) with 5,007 (95.24%) citations. Below given Table III show the details.

TABLE III DOCUMENT TYPE DISTRIBUTION FUNDING AND UN-FUNDING PUBLICATIONS

Document Type	TP	TC	FP	%	TC	%	UFP	%	TC	%
Article	2800	37799	1349	48.18	16874	44.64	1451	51.82	20925	55.36
Proceedings Paper	298	5257	45	15.10	250	4.76	253	84.90	5007	95.24
Editorial Material	137	126	3	2.19	5	3.97	134	97.81	121	96.03
Review	94	2702	46	48.94	705	26.09	48	51.06	1997	73.91
Meeting Abstract	23	2	0	0.00	0	0.00	23	100	2	100
Book Chapter	7	148	3	42.86	138	93.24	4	57.14	10	6.76
Total	3359	46034	1446	43.05	17972	39.04	1913	56.95	28062	60.96

TP: Total Papers, TC: Total Citations, FP: Funded Papers and UFP: Un-Funded Papers

The document type Editorial Material stands third with a total of 137 papers published and 126 citations. The supported funding papers is found to be approx. 3% (2.19%) with 5 (3.97%) citations and un-funding papers published 134 papers with 121 citations. Review stands in the fourth position document type of published papers with 94 papers and 2,702 citations which was the highest is the recorded 20 years. It can be observed that out of the above mentioned

figures funding papers were 46 (48.94%) with 705 (26.09%) citations. The document type Meeting Abstract sees a total of 23 papers published with 2 citations, the funded papers being null and un-funded papers being 23 with 2 citations received. Finally, the document type Book Chapter has 7 papers with 148 citations published and funding 3 with 138 citations published, un-funding papers 4 with 10 citations received.

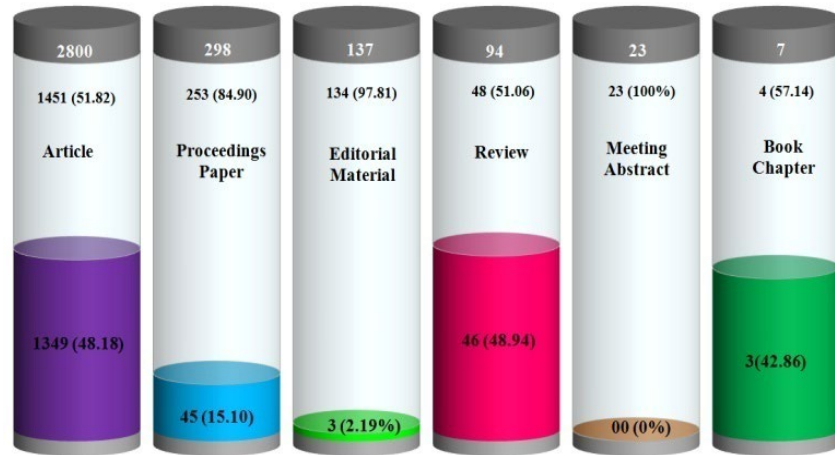


Fig. 4 Document Type-wise Distribution Funding and Un-Funding publications

D. Top Five Funding Agencies

In the field of Mechatronics innovation and research there are nearly 200 funding agencies worldwide that support the activities in research. For this study from 2001 to 2020, only the top five funding agencies were taken into consideration for the purpose of analysis. The below Table IV shows the

details. It can be clearly observed that the top five funding agencies in the world have contributed 3,359 investigation papers. Maximum funded papers were published from “National Natural Science Foundation of China” i.e., 286 papers with 3,585 citations which has bagged 29 h-index and is being placed on the first position.

TABLE IV TOP FUNDING AGENCIES MECHATRONICS PUBLICATIONS

Sl. No.	Funding Agencies	Papers	Citation	H-Index
1	National Natural Science Foundation of China	286	3585	29
2	European Commission from European	183	1984	24
3	German Research Foundation from German	108	852	15
4	National Science Foundation from India	88	1201	18
5	Natural Sciences and Engineering Research Council Canada	80	835	15

Similarly, funding agencies result we observed (Hulloli & Savanur, Thin Film Funding and Research Output of India and China: A Comparative Study, 2020) “... National Natural Science Foundation of China assisted its financial support to publish 21,335 research papers with 69.90%, 1,84,022 (36.20%) citation with 129 h-index” (cited from p.5). The “European Commission” from Europe supports 183 papers with 1,984 citations and 24 h-index published papers standing second-ranked. Ranked third is “German Research Foundation” from Germany 108 papers with 852

citations and 15 h-index. The “National Science Foundation” from India has published 88 papers with 1,201 citations and obtained 18 h-index received. It can be observed that “National Science Foundation India” has only 88 papers published but has received 1,201 citations which seems to be considerably high. The “Natural Sciences and Engineering Research Council” form Canada has 80 papers with 835 citations having 15 h-index and the remaining papers published are below the number 80 for funding agencies.

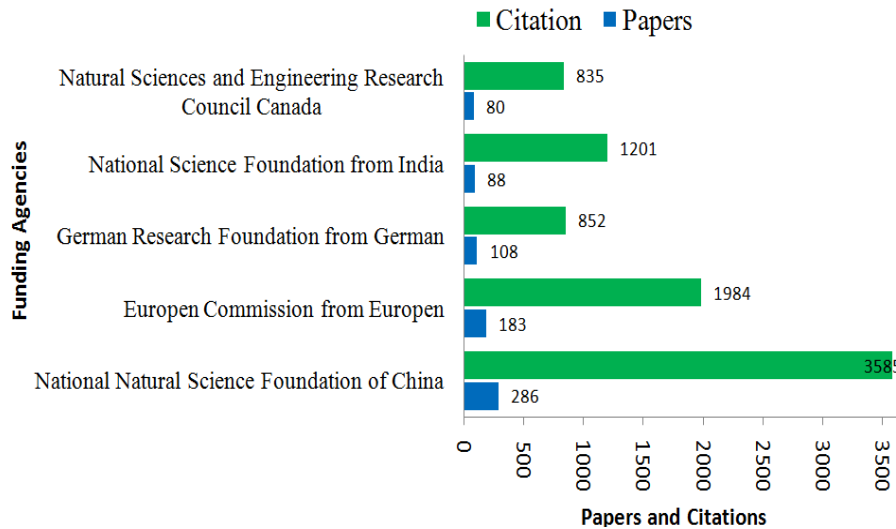


Fig. 5 Top Funding Agencies Mechatronics Publications

E. Funded Top Ten Journals

It can be observed that 433 funding journals supported research study in the field of Mechatronics in world during 2001 to 2020.

Among the top ten journals in the field of Mechatronics Publications funding agencies it is observed that IEEE-ASME Transactions on Mechatronics is ranked first with

188 papers (13%) and 3,096 (17.23%) citations. Here the average citation per paper is (16.47%) followed by second-ranked Mechatronics, total papers published 100 (6.92%) with 1,511 (8.41%) citations received and ACPP (15.11%). Sensors is in the third position with 29 (2.01%) papers published with 176 (0.98%) citations and (6.07%) average citation per paper. In the fourth position is IEEE Access Journals having total papers published 28 (1.94%) with 76 (0.42%) citations received and ACPP (2.71%).

TABLE V FUNDED TOP TEN JOURNALS MECHATRONICS PUBLICATIONS

Sl. No.	Name of the Journal	Funded Papers	%	Citation	%	ACPP
1	IEEE-ASME Transactions on Mechatronics	188	13.00	3096	17.23	16.47
2	Mechatronics	100	6.92	1511	8.41	15.11
3	Sensors	29	2.01	176	0.98	6.07
4	IEEE Access	28	1.94	76	0.42	2.71
5	IEEE Transactions on Industrial Electronics	28	1.94	1040	5.79	37.14
6	IEEE Transactions on Education	26	1.80	500	2.78	19.23
7	Advances In Mechanical Engineering	21	1.45	72	0.40	3.43
8	Robotica	21	1.45	169	0.94	8.05
9	Control Engineering Practice	19	1.31	247	1.37	13.00
10	International Journal of Advanced Manufacturing Technology	18	1.24	152	0.85	8.44
11	Other Journals	968	66.94	10933	60.83	11.29
Total		1446		17972		12.43

The IEEE Transactions on Industrial Electronics stands in the fifth position having 28 papers with 1,040 citations and (37.14%) average citations per paper published. It can be observed here that the IEEE Access and IEEE Transactions on Industrial Electronics both have the same number of papers published but a considerable change is found in the number of citations for each of them. The IEEE Access has

only 76 citations but IEEE Transactions on Industrial Electronics has an exceptional 1040 citations which is a positive indicator of the growth in quality of the papers and the respective authors. The rest of the funding agencies have publishing numbers below 28 as shown in table V.

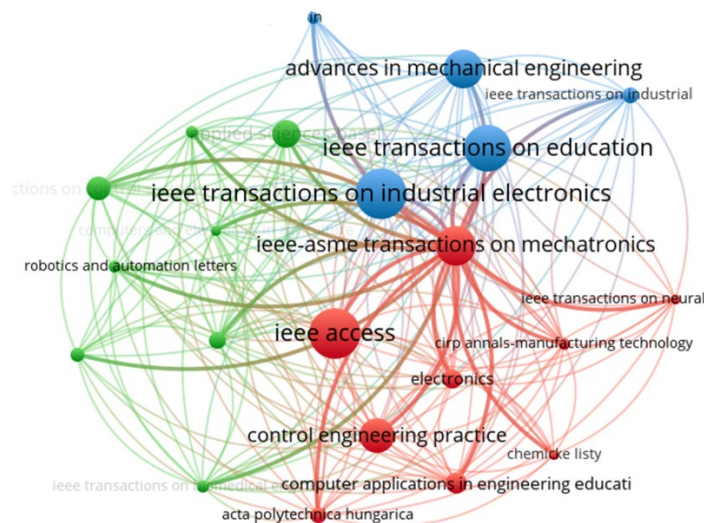


Fig. 6 VOS Viewer Top Ten Journals Mechatronics Publications Network Mapping

VI. CONCLUSION

The present study aims to bring out the contributions, funding and un-funding publications in the field of Mechatronics in global scenario. The study focuses on country-wise distribution, funding and un-funding in the field of Mechatronics paper publications, type of documents, top funding agencies and top funding journals. Compared to other subjects of science and technology the field of Mechatronics has seen considerably less number of papers being published. Out of 3,359 papers with 46,034 citations only 1,446 (43.05%) paper with 17,972 (39.04%) citations received funding and remaining 1,913 (56.95%) papers with 28,062 (60.96%) citations received un-funding. USA stands in the top position with published papers 413 (12.27%) having 7,157 (15.55%) citations and India stands twenty-fifth ranked with total papers published 53 (1.58%) having 693 (1.51%) citations. In Document type of publications maximum number of papers were published in the Article form with a total of 2,800 papers having 37,799 citations of which funding papers were 1,349 (48.18%) with 16874 (44.64) and un-funding papers were 1,451 (51.82%) with 20,925(55.36%) citations. An important aspect to be observed is that the highest funding received is from National Natural Science Foundation of China that has funded for 286 papers which received 3,585 citations having 29 h-index. The concluding factor out of this research is that more number of scientists and researchers need to actively investigate and research on more of the Mechatronics concepts in order to increase the technical advancement and growth in the said field.

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