Scientometric Analysis of Research Activities in Sensor Networks Research Output in India

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Abstract

This paper deals with scientometric analysis of research activities in sensor networks research output in India having most prolific authors and authorship pattern to the present study. Wireless sensor networks have 428(35.55)% times to the dominant position in the field of sensor network research activities and the sensor networks has 92(7.66) times and sensor nodes has 56 times to it frequency.
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Keywords

Sensor Networks, Research output, prolific authors, authorship pattern.
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Electronic access

The journal is available at www.jalis.in

Journal of Advances in Library and Information Science
ISSN: 2277-2219 Vol. 3. No.4. 2014. Pp300-305

INTRODUCTION

Citation analysis is a valuable area of research. "Citation analysis" refers to references in one text to another text, with information on where that text can be found. Citation analysis is useful for understanding subject relationships, author effectiveness, publication trends, and so on. The authors are mostly used these data for citing their work with the previous work and give citation and references. It is known to others and the previous work and made this as archives for the future utilization and that is in the digital form

BIBLIOMETRIC STUDY

Vimala, V & Pulla Reddy, V (2009) traced authorship pattern and collaborative research in zoology[1.] Zafrunnisha, N. & Pulla Reddy, V (2009) studied authorship trend and collaborative authorship pattern and collaborative research in the field of Psychology.[2.] Amsaveni. N & Vasanthi. R (2013) traces the trend in authorship pattern and collaborative research in network security during 2002 to 2011 was measured.[3.] Karisiddappa, C.R, Maheswarappa. B.S, & Shirol M.V. (1990) studied the authorship pattern and collaborative research in psychology.[4] Thavamani, K. & Velmurugan, C. (2013) studied the analysis has been conducted with 310 contributions published in the journal during the year 2002 – 2012.[5.] Bakri, A. & Willett, P (2008) studied the range of articles published per volume, average number of references per article, the average length per article pages; the percentage of multi-authored papers, geographically affiliation.[6.] Jena, Kamal Lochan (2006) traced the trend of publications such as the year wise distribution of articles, bibliographical distribution of citations, authorship pattern, citation pattern, average length of articles, number of tables and figures used, time lag, geographical distribution of authors and subject analysis have been studied.[7.]

OBJECTIVES OF THE STUDY

- To study the year wise distribution of articles;
- To study the citation pattern of articles
- To study the bibliographical forms of documents
- To study the authorship pattern
- To study the age of citations of taken sample
- To determine ranked list of journals based on citation scores
- To determine Lotka's law of authorship patterns.

DATA AND METHODOLOGY

The necessary data were collected from the Engineering Village Database, includes Inspec, Geobase and Compendex database. A total of 1212 downloaded records after elimination of duplication 1,199 records were analyzed by using the Excel software with manually.

1. Year wise distribution of Indian Journals

Table 1: Year wise distribution of Indian Journals

S. No.	Year	Number of Journals	%	Authors
1	2005	5	0.42	13
2	2006	37	3.09	119
3	2007	111	9.26	332
4	2008	269	22.44	815
5	2009	257	21.43	774
6	2010	208	17.35	599
7	2011	92	7.67	306
8	2012	110	9.17	316
9	2013	110	9.17	299
	Total	**1199**	**100**	**3573**

Table 1 indicates the year 2008, highest publications 269 (22.44) percent of Indian journals published in the field of sensor networks research activities. The lowest publications are in the year of 2006, 37 (93.09) percent, 2005, 5 (0.42) is noted that very lowest publications in the field of sensor networks research activities.

Table 2: Year wise analysis of sensor Network research outputs

S. No.	Year	Records	Cumu-lative records	%	Total authors
1	2005	5	5	0.42	13
2	2006	37	42	3.09	119
3	2007	111	153	9.26	332
4	2008	269	422	22.44	815
5	2009	257	679	21.43	774
6	2010	208	887	17.35	599
7	2011	92	979	7.67	306
8	2012	110	1089	9.17	316
9	2013	110	1199	9.17	299
	Total	**1199**		**100**	**3573**

Table 2 deals with the year wise analysis of sensor network research output, there are 1199 records were published 2005 to 2013. The year 2008 having the highest publication of records 269 documents having the first place, the year 2005 has the least publication of records with less number of 5 documents

Table 3: Authorship pattern of sensor network research output:

Sl.No.	Authorship pattern	No. of articles	Rank	No. of authors	Rank	% of articles	% of authors
1	single	5	**8**	13	**9**	0.42	0.36
2	two	37	**7**	119	**8**	3.09	3.33
3	three	111	**5**	332	**4**	9.26	9.29
4	four	269	**1**	815	**1**	22.44	22.81
5	five	257	**2**	774	**2**	21.43	21.66
6	six	208	**3**	599	**3**	17.35	16.76
7	seven	92	**6**	306	**6**	7.67	8.56
8	eight	110	**4**	316	**5**	9.17	8.84
9	Nine	110	**4**	299	**7**	9.17	8.37
10	ten and above	-	**-**	-	**-**	-	-
	Total	**1199**		**3573**		**100**	**100.00**
	DC	**0.0036.**					

Table 3 indicates that majority of authors preferred to publish their research results in four authorship mode (22.44 %) followed by five authorship mode (21.43 %), six authorship mode (17.35 %) and individual authorship mode (0.42 %). The DC of authors can be calculated as DC = 13 / (13 + 3560) = 0.0036. As DC value exceeds 0.5 and tends to 1, it is deduced that multi-authored citations occupy the prominent position and the research is based on team research rather than non-collaborative authors.

Table 4: Bibliographical forms of documents

S. No	Bibliographical Forms of Published Records	No.of records	%
1	Journal Article	264	22%
2	Conference Article	935	78%
	Total	**1199**	**100%**

Table 4 depicts the distribution of bibliographical forms of citations. It is observed the citations of Conference Proceeding Papers (935), form are the most predominant form followed by,Journal Article (264).

Table 5: Ranking of authors in network security research output

S. No	Name of the contributor	Number of Output	Author-ship Rank
1	Das, Ashok Kumar	53(1.49)	1
2	Jacob, Lillykutty	892(24.99)	2
3	Patel, R.B. & Varma, Shirshu	1149(32.19)	3
4	Desai, U.B.; Merchant, S.N. & Misra, Sudip	790(22.14)	4
5	Desai, U.B. ; Patnaik, L.M. & Venugopal, K.R.	386(10.82)	5
6	Bandyopadhyay, Rajib	138(3.87)	6
7	Manjula, S.H.	42(1.18)	7
8	0	40(1.12)	8
9	0	27(0.76)	9

Table 5 depicts the ranking of authors. There are a total of 3573 authors who contributed 1199 numbers of articles in the subject of sensor network research output in India. It is found that the author Das, Ashok Kumar (53 articles) is the leading author contributing highest articles followed by Jacob,Lillykutty with 892(24.99) articles securing second position and Patel,R.B.&Varma,shirshu with 1149 (32.19) articles securing the third position. Desai,U.B.;Merchant, S.N.,&Misra, Sudip contributed 386(10.82) articles and ranked third with fourth rank. Desai,U.B.;Patnaik,L.M.&Venugopal,K.R. has 386(10.82)articles each securing fifth rank.

Table 6: Top ten control device in the field of sensor networks research activities

S. No.	Control Devices	Total
1	732 Control Devices	924
2	723 Computer Software, Data Handling and Applications	728
3	716 Telecommunication; Radar, Radio and Television	721
4	731.1 Control Systems	698
5	717 Optical Communication	548
6	716.3 Radio Systems and Equipment	532
7	722 Computer Systems and Equipment	481
8	718 Telephone Systems and Related Technologies; Line Communications	461
9	722.3 Data Communication, Equipment and Techniques	459
10	722.4 Digital Computers and Systems	458

Table 6 explains the Total number of 675 control device having the value of 13522. The control device has the first place in control device having the total number of 924 times, computer software, data handling and application having the second place in top ten control devices. Telecommunication radar, radio and television having the 721times and getting the third place

Table 7: Source wise distribution of research output in sensor networks:

Sl.No.	Sources	No.of Recors
1	IEEE Computer Society, United States	385
2	Inst. of Electronics and Telecommunication Engineers, 2 Institutional Area, Lodi Road, New Dehli, 110 003, India	204
3	Institute of Electrical and Electronics Engineers Inc., 445 Hoes Lane / P.O. Box 1331, Piscataway, NJ 08855-1331, United States	124
4	Springer Verlag, Tiergartenstrasse 17, Heidelberg, D-69121, Germany	99

5	Association for Computing Machinery, 1515 Broadway, 17th Floor, New York, NY 10036-5701, United States	45
6	Elsevier Ltd, Langford Lane, Kidlington, Oxford, OX5 1GB, United Kingdom	28
7	Elsevier, P.O. Box 211, Amsterdam, 1000 AE, Netherlands	23
8	International Astronautical Federation, IAF, 94bis Avenue de Suffren, Paris, 75015, France	23
9	Acta Press, Building B6, Suite 101, 2509 Dieppe Avenue S.W., Calgary, AB, T3E 7J9, Canada	14
10	Institution of Engineering and Technology, Six Hills Way, Stevenage, SG1 2AY, United Kingdom	14

Table 7 explains Source wise distribution of research output of sensor network research activities in India IEEE computer society United States having the high number of its document type. The second place going to the institution of electronics and Telecommunication Engineers has 204, and the third place. Springer Verlag, has 99 document values and having the third place**.**

Table 8: Main heading of research output in sensor networks

Sl.No.	Main headings	Frequency	%
1	Wireless sensor networks	428	35.55
2	Sensor networks	92	7.64
3	Sensor nodes	56	4.65
4	Compilation and indexing terms	31	2.57
5	Ad hoc networks	29	2.41
6	Neural networks	24	1.99
7	Wireless networks	14	1.16
8	Computer networks	13	1.08
9	Network security	13	1.08
10	Network protocols	12	1.00
11	Public key cryptography	11	0.91
12	Routing protocols	11	0.91
13	Energy harvesting	10	0.83
14	Target tracking	8	0.66

Table 8 deals with 321 main headings having the dominant role in the field of sensor network research activities in India .Among the 321 main heading for the frequency of total number of 1204 output. Wireless sensor networks have 428(35.55)% times to the dominant position in the field of sensor network research activities. Followed by the sensor networks has 92(7.66) times and sensor nodes has 56 times to it frequency.

Table 9: controlled terms of sensor network research output

Sl.No.	controlled terms	No.of Recors
1	Sensor networks	1047
2	Telecommunication equipment	351
3	Sensor nodes	302
4	Wireless telecommunication systems	299
5	Sensors	214
6	Network protocols	193
7	Wireless sensor networks	165
8	Routing protocols	163
9	Wireless sensor nodes	123
10	Optimization	93

Table 9 shows that controlled terms in the field of sensor network research activities, sensor networks has the dominant position for occurring 1047 times, followed by telecommunication equipment has 351 times routing of protocols 163 times of controlled terms in the field of sensor networks.

Table 10: Uncontrolled terms of sensor network research output

Sl.No.	uncontrolled terms	No.of Record
1	Simulation result	105
2	Energy efficient	101
3	Network lifetime	96
4	Wireless sensor	84
5	Energy consumption	63
6	Energy	59
7	based	55
8	Cluster	45
9	Wireless sensors	45
10	International conferences	42

Table 10 shows that uncontrolled terms in the field of sensor network research activities, simulation result 105 has the dominant position for occurring 1047 times, followed by energy efficient has 101 times, network lifetime has 96 times of uncontrolled terms in the field of sensor networks.

Table 11: Department wise analysis of sensor networks

S. No.	Departments	No of frequency	%
1	Department of Computer Science and Engineering	110	11.56
2	Department of Electronics and Communication Engineering	53	4.54
3	Department of Computer Science	51	2.44
4	Department of Electrical Engineering	33	2.34
5	Indian Institute of Technology	29	1.38
6	Department of Computer Sc. and Application	28	1.34
7	Department of Electrical and Computer Engineering	27	1.15
8	Department of Electrical and Electronics Engineering	25	0.81
9	Department of Electrical Engineering	24	0.81
10	Department of Information Science and Technology	22	0.81
11	Department of Mechanical Engineering	17	0.81
12	Indian Institute of Information Technology	41	1.96
13	Department of Information Technology	17	0.67
14	Dhirubhai Ambani - Institute of Information and Communication Technology	17	0.62
15	Department of Electronics and Tele Communication	11	0.53

Table 11 deals with department of analysis of sensor networks research activities. There are 972 types of departments occurred in the field of sensor networks research activities totally 2135. Department of computer science and engineering having the first place among the 972 departments 110 and the percentage having the 11.56 Department of electronics and communication engineering has the second position of 53(4.54)% followed by the department of computer science 51(2.44)% having the third place in the department wise analysis.

Table 12: Institution wise Distribution of Articles in Sensor Networks

S. No.	Institution wise Distribution	Number of output	%
1	Indian Institute of Technology, Kharagpur	65	3.13
2	IIT Bangalore	65	3.13
3	India Research Labs	47	2.26
4	Indian Institute of Science , Bangalore	70	2.17
5	Anna University Chennai, Chennai	80	3.85
6	Jadavpur University	41	1.97
7	IIT Kolkata	25	1.20
8	IIT Allahabad	24	1.15
9	IIT New Delhi,	21	1.01
10	Pune Institute of Computer Technology	20	0.96
11	Indian Institute of Technology Madras	20	0.96
12	Tata Consultancy Services Limited	18	0.87
13	Ganpat University, Gujarat,	18	0.87
14	Bengal Engineering and Science University	18	0.87
15	Bengal Engineering and Science University	18	0.87

Table 12 deals with Institution wise analysis of sensor networks research activities. There are 759 types of departments occurred in the field of sensor networks research activities totally 2042. Indian Institute of Technology Kharagpur,IIT Bangalore having the first place among the 759 Institutions having 65 number of output 3.13 percentage.

FINDINGS AND CONCLUSION

It is found that the articles from conference proceedings are predominant. It is found that the most productive author is Das Ashok kumar. 53(1.49) Three authored papers are found to be the highest. It is found the collaborative authorship productivities highest. The degree of collaboration is found to be **0.0036.**

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