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RESEARCH ANALYSIS ON BIOMETRIC: A SCIENTOMETRIC STUDY

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ABSTRACT

The focus of this study is to assess the research output of Biometric publications from the period of 2010 – 2019 through scientometric analysis. The total number of records were 7335 which is from Web of Science and analyzed using various tools like Histcite, Bibexcel and interpreted using Microsoft Excel and Google sheets. The laws of bibliometrics are also analyzed along with Relative growth rate, doubling time, Degree of collaboration and Collaborative indexes is also interpreted.

Keywords: Recognition, Biometric, Scientometric

INTRODUCTION

Scientometrics means literally "measurement of science". "The term "scientometrics" (derived from the Russian "naukometria") used mainly in the East is defined as the study of the measurement of scientific and technological progress. Scientometrics empirically describes the constantly changing relationship between science, technology, and research productivity. This consequently sheds more light on the structure of subject literature and better organization of information resources which can ultimately be effectively used for various purposes including regeneration of information.

BIOMETRICS

Biometrics is a promising technique to identify a person accurately. The biometric system uses parts of the body and behaviour of a person as biometric traits that cannot be stolen or lost, hence the biometric system is highly reliable to avoid intruders from neighboring countries. . The biometric system is accurate and more reliable compared to conventional security systems such as passwords, PINs, ID cards, etc. The conventional security systems can be easily breached since the password may be forgotten and identification cards may be lifted or lost.

REVIEW OF LITERATURE

Alvarez Betancourt, Y., & Garcia Silvente (2014) has analyzed a bibliometric approach in the field of iris recognition during the period 2000 – 2012. The total paper reviewed was 1,354 which is all written in English. Information retrieved using the Scopus database. They have analyzed data like leading journals, outstanding research topics, enterprises, and patterns, etc. Also analyzed that major advances in iris recognition and study will be use full in the future.

Miraftabi, A., et al (2019) has investigated the ocular biometric changes after glaucoma valve implantation. Patients with refractory glaucoma were included in this study. Refractive status, axial length, anterior chamber depth & volume were evaluated after surgery. This study concludes that the implantation had a significant effect on axial length at 3 months after surgery.

De Mira, J., (2015) have proposed a new method for biometric identification of human iris structures for processing Morphological image. Data for this has been collected from the University of Bath Iris image database and CASIA Iris Image Database. This research concludes that the proposed approach is suitable to be used in recognition systems.

RESEARCH METHODOLOGY AND OBJECTIVES

Bibliometric details of a keyword **"Biometric"** were collected from the Web of Science bibliographic database which is published by Thomson Reuters (WOS). This covers the study period from 2010 to 2019, with a total of 7,335 records were retrieved. The data were collected from the Web of Science database and analyzes were made through Histcite, Bibexcel and calculations were made using Web of Science Analysis, Microsoft Excels and Google sheets to find out the result.

OBJECTIVES:

The Major Objectives framed are mentioned below:

❖ To recognize the year wise and source wise distributions of biometric publications
❖ To recognize the Language-wise and organizational wise contribution.
❖ To identify the most prolific author and most productive country in the study period.
❖ To point out the top 10 publications made in Journals and highly cited references.
❖ To identify the nature of collaboration and collaborative index.
❖ To pinpoint the collaboration of co-authorship patterns and author productivity.
❖ To determine the Relative Growth rate and Doubling time for the study.
❖ To analyze the bibliometric laws.
❖ To identify the funding agencies , research areas , the degree of collaboration and Exponential Growth rate.

DATA ANALYSIS AND INTERPRETATION
Table 1 Year wise publication

S.No	Publication Year	Records	Percent	TLCS	TGCS
1	2010	512	6.5	1443	10447
2	2011	500	6.3	1080	8555
3	2012	554	7.6	1214	9881
4	2013	604	8.5	892	9096
5	2014	725	9.9	1209	8875
6	2015	720	9.8	1104	8688
7	2016	818	11.3	846	6687
8	2017	851	11.6	598	4773
9	2018	978	13.4	420	3131
10	2019	1073	14.6	124	767
Total		**7,335**	**100**	**8930**	**70,900**

Table 1 shows the Year wise publication with a total publication of 7335 articles. The highest number of publications was 1073 (14.6 %) in the year 2019. The lowest number of publications was 500 (6.3 %) in the year of 2011.

Table 2: Document Type Publications

S.No	Document Type	Records	Percent	TLCS	TGCS
1	Article	6738	91.9	8594	66167
2	Review	172	2.3	170	3538
3	Meeting Abstract	133	1.8	0	6
4	Proceedings Paper	121	1.6	141	1011
5	Editorial Material	66	0.9	20	122
6	Article; Early Access	53	0.7	0	6
7	Book Review	15	0.2	0	0
8	Letter	10	0.1	3	14
9	News Item	10	0.1	0	3
10	Correction	9	0.1	1	3

Table 2 reveals the **document** type distribution of publications. This table clearly explains that, the most of the publications are in article type with 6738 records (91.9 %). This reveals that authors feel comfortable in this type of document.

Table 3: Language wise Publications

S.No	Languages	Records	Percentage
1	English	7043	95.99
2	Portuguese	146	1.99
3	Spanish	58	0.79
4	French	34	0.46
5	German	24	0.33
6	Polish	22	0.30
7	Russian	5	0.07
8	Slovenian	1	0.14
9	Slovene	1	0.14
10	Croatian	1	0.14
11	Chinese	1	0.14
12	Italian	1	0.14

Table 3 describes English language is spoken all over the world at a maximum level. This is proved by the total number of publications made in the study period with 7043 papers (95.99%) .

Table 4: Organization wise Publications

S.No	Organizations	Records	Percentage
1	Chinese Academy Science	93	1.27
2	University Sao Paulo	88	1.20
3	King Saud University	76	1.04
4	Indian Institute of Technology	56	0.76
5	University Minnesota	55	0.75
6	Yonsei University	54	0.74
7	Sun Yat Sen University	52	0.71
8	Hong Kong Polytech University	51	0.69
9	University Autonoma Madrid	48	0.65
10	University Sao Paulo	47	0.64

Table 4 the Chinese Academy Science place in the top with maximum number of contributions made by the authors with a total of 93 records with a percentage of 1.27%.

Table 5: Country-wise Publications

S.No	Country	Records	Percentage
1	USA	1409	19.20
2	Peoples R China	875	11.93
3	Brazil	657	8.95
4	**India**	**619**	**8.47**
5	UK	513	6.99
6	Italy	481	6.56
7	Spain	456	6.22
8	France	320	4.36
9	Germany	319	4.35
10	South Korea	313	4.27

Table 5 explains the country-wise distribution of biometric publications; the total observed in the study is 7,335 during the period 2010 - 2019. The analyses bring out the fact that the USA is considered to be the first and it has given the production of 1409 (19.20%) records on Biometric and is considered to the most productive country brought out in research. The second country is Peoples R China with a total of 875 contributions (11.93%). The third-ranked is Brazil, it has produced 657 (8.95%) publications. **India** stands f**ourth** with a contribution percentage of **8.44% with 619 articles.**

Table 6: Author wise Publications

S.No	Author	Records	Percent	TLCS	TGCS
1	Fierrez J	32	0.44	202	1053
2	Teoh ABJ	32	0.44	230	493
3	Zhang D	32	0.44	315	1357
4	Khan MK	31	0.43	122	637
5	He MG	30	0.43	81	444
6	Das AK	29	0.42	197	856
7	Iacono WG	29	0.42	39	393
8	Kumar A	29	0.42	164	493
9	Nappi M	29	0.42	38	387
10	McGue M	28	0.41	34	411

Table 6 Fierrez J, Teoh ABJ and Zhang D with 32 articles(0.44%) respectively. For a total of 7335 articles, 33,310 authors have contributed to the study period of 2010 – 2019.

Table 7: Journal – wise distribution

S.No	Journal	Records	%	TLCS	TGCS	TLCR
1	IEEE Transactions On Information Forensics And Security	172	2.3	1215	4632	469
2	Iet Biometrics	138	1.9	301	1027	448
3	Multimedia Tools And Applications	122	1.7	159	567	402
4	IEEE Access	116	1.6	144	616	558
5	Investigative Ophthalmology & Visual Science	114	1.6	125	1112	91
6	Pattern Recognition Letters	109	1.5	498	1932	219
7	PLOS One	94	1.3	0	1275	137
8	Pattern Recognition	93	1.3	688	2318	283
9	Sensors	87	1.2	181	999	258
10	Expert Systems With Applications	63	0.9	324	1359	180

Table 7 "IEEE Transactions On Information Forensics And Security" journal with 172 records stands first with 1215 Total Local Citations (TLCS) and 4632 Total Global Citations (TGCS). The second journal is "IET Biometrics" with 138 records.

Table 8: Highly cited references

S.No	Author / Year / Journal	Records	Percent
1	Jain AK, 2004, IEEE T CIRC SYST VID, V14, P4	334	4.6
2	Daugman J, 2004, IEEE T CIRC SYST VID, V14, P21	212	2.9
3	JUELS A, 1999, P 6 ACM C COMP COMM, P28	171	2.3
4	Jain AK, 2008, EURASIP J ADV SIG PR	171	2.3
5	DAUGMAN JG, 1993, IEEE T PATTERN ANAL, V15, P1148,	165	2.2
6	Ratha NK, 2001, IBM SYST J, V40, P614	163	2.2
7	Maltoni D., 2009, HDB FINGERPRINT RECO	160	2.2
8	Ojala T, 2002, IEEE T PATTERN ANAL, V24, P971	155	2.1
9	TURK M, 1991, J COGNITIVE NEUROSCI, V3, P71	153	2.1
10	Belhumeur PN, 1997, IEEE T PATTERN ANAL, V19, P711	144	2.0

Table 8 "IEEE T CIRC SYST VID, Volume 14" written by Jain AK in the year 2004 with the total citation score as 334.

Table 9: Year-wise Authorship pattern

Year	Single Author	Double Author	Three Author	4 & Above Author	Total
2010	44	89	96	283	512
2011	33	80	88	299	500
2012	34	94	114	312	554
2013	37	88	111	368	604
2014	38	110	145	432	725
2015	44	94	143	439	720
2016	45	108	164	501	818

2017	48	131	165	507	851
2018	48	144	174	612	978
2019	48	171	193	661	1073
Total	**419**	**1109**	**1393**	**4414**	**7335**

Table 9 indicates that out of the 419 contributions of a single author, the maximum publications were made during the years 2017, 2018 & 2019. The two authors' contribution is more in the year 2019 with 171 articles; the 4 & above authors contribution was highest in the same year with 661 contributions. the lowest contributions of a single author and multiple authors were made during the year 2011 with 33 and 467 articles respectively.

Table 10: Degree of collaboration

Year	Single Author(Ns)	Multiple Author(Nm)	Total Number of (Ns + Nm)	Degree of collaboration
2010	44	468	512	0.914
2011	33	467	500	0.934
2012	34	520	554	0.938
2013	37	567	604	0.938
2014	38	687	725	0.947
2015	44	676	720	0.938
2016	45	773	818	0.944
2017	48	803	851	0.943
2018	48	930	978	0.950
2019	48	1025	1073	0.955
Total	**419**	**6916**	**7335**	**9.401**

Table: 10 the degree of collaboration during the study period is 9.401

Table 11: Exponential growth rate

Year	Publication	Exponential Growth rate
2010	512	-
2011	500	0.976
2012	554	1.108
2013	604	1.090
2014	725	1.200
2015	720	0.993
2016	818	1.136
2017	851	1.040
2018	978	1.149
2019	1073	1.097
Total	**7,335**	**9.789**

Table 11 Exponential growth rates of publication Growth of literature on biometric publications during the year 2010 – 2019. The high growth rate of 1.149 was found during the year 2018 with 978 publications, followed by the year 2019 with 1073 publications and Exponential growth rate as 1.097. It is also found that the Exponential growth rate for the study period is 9.789 and the growth rate shows both increase and decrease trends in the period of study.

Table 12: Analysis of Funding Agencies

S.No	Funding Agencies	Record	Percentage
1	National Natural Science Foundation Of China	516	7.03
2	United States Department Of Health Human Services	265	3.61
3	United States Department Of Health Human Services	258	3.52
4	National Council For Scientific And Technological Development Cnpq	197	2.68
5	European Union Eu	154	2.10
6	Capes	152	2.07
7	National Science Foundation Nsf	127	1.73
8	Fundamental Research Funds For The Central Universities	87	1.19
9	Natural Sciences And Engineering Research Council Of Canada	79	1.08
10	Fundacao De Amparo A Pesquisa Do Estado De Sao Paulo	65	0.89

Table 12 "National Natural Science Foundation Of China "agency has funded for a total of publication of 516 articles and it is placed first.

Table 13: Research Areas

S.No	Research Areas	Records	Percentage
1	Computer Science	2,101	28.63
2	Engineering	1,506	20.52
3	Ophthalmology	552	7.52
4	Agriculture	519	7.07
5	Telecommunications	398	5.42
6	Environmental Sciences Ecology	300	4.09
7	Science Technology Other Topics	277	3.78
8	Obstetrics Gynecology	245	3.34
9	Zoology	194	2.64
10	Plant Sciences	186	2.54

Table 13 a total contribution of 2,101were in the made in the field of Computer Science.

Table 14: Collaboration Index

Year	Total No. of Papers (NP)	Total No. of Authors (NA)	Collaboration Index (NA/NP)
2010	512	2205	4.31
2011	500	2196	4.39
2012	554	2368	4.27
2013	604	2819	4.67
2014	725	3216	4.44
2015	720	3212	4.46
2016	818	3735	4.57
2017	851	3985	4.68
2018	978	4587	4.69
2019	1073	5014	4.69
Total	**7,335**	**33,337**	**4.544**

Table 14 for the total number of 33,337 authors the average collaborative index is 4.544

Table 15: Author Productivity

Year	Total No. of papers (NP)	Total No. of Authors (NA)	AAPP	Productivity per Author
2010	512	2205	4.306	0.23
2011	500	2196	4.392	0.23
2012	554	2368	4.274	0.23
2013	604	2819	4.667	0.21
2014	726	3216	4.435	0.23
2015	720	3212	4.461	0.22
2016	818	3735	4.566	0.22

2017	852	3985	4.682	0.21
2018	978	4587	4.690	0.21
2019	1073	5014	4.690	0.214
Total	**7,335**	**33,337**	**4.544**	**0.220**

Table 15 for the total articles of 7335, the total number of authors contributed was 33,337. For this AAPP is 4.544 and average author productivity is 0.220.

Table 16: Zipf's Law: Frequency of words

S.No	Words	Frequency
1	Recognition	509
2	Growth	319
3	Identification	250
4	System	187
5	Classification	163
6	Security	159
7	Model	155
8	Biometrics	147
9	Features	137
10	Verification	136

Table 16 analyses the keyword and explains "Recognition" stands in the first place with 509 and Biometric stands the seventh with 147 frequencies.
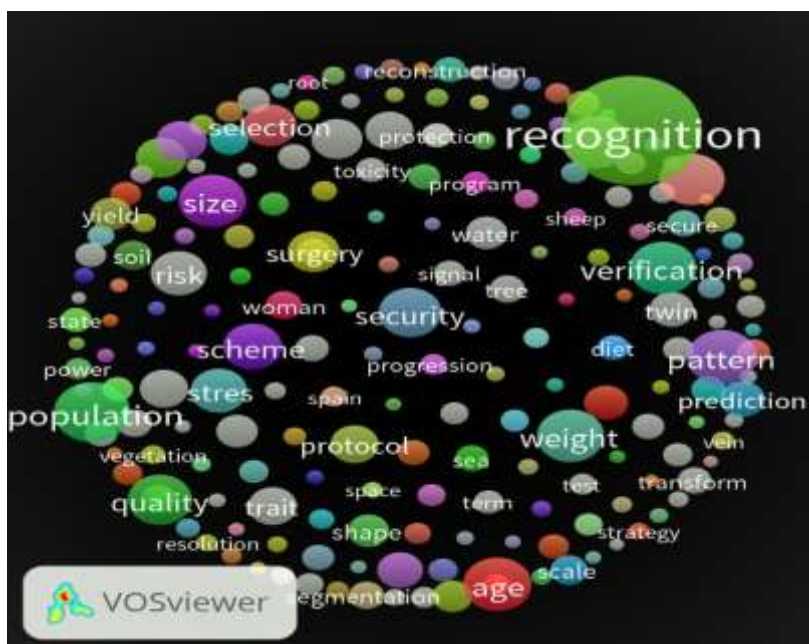
Figure 1 represents the word frequency which is calculated using Zipf's Law. The image is drawn using the VoS Viewer with the help of the data analyzed using Bibexcel Software.

Table 17: Collaboration of Co-Authors

S.No	Author 1	Author 2	Collaboration Times
1	Iacono WG	Mcgue M	21
2	Fierrez J	Ortegagarcia J	18
3	Reichbornkjennerud T	Ystrom E	16
4	Fierrez J	Galbally J	15
5	Yang GP	Yin YL	15
6	Demarsico M	Nappi M	15
7	Kendler KS	Ystrom E	14
8	Kendler KS	Reichbornkjennerud T	14
9	Iacono WG	Malone SM	14
10	Aung T	Wong TY	13

Table 17 The collaboration between the authors were very good. The top stands the authors Iacono WG and Mcgue M have collaborated for 21 times

Table 18: Bradford's Law

Zone	Journals	Number of Records	Multiplier Factor
Zone 1	62 (2.89 %)	2485	
Zone 2	368(17.16 %)	2445	5.935
Zone 3	1714 (79.94 %)	2405	4.657
Total	**2144**	**7335**	**10.592**

Table 18 In the study period of 2010 – 2019, the total number of articles published is 7,335 in 2,144 journals of various fields. The total number of journals is divided into three zones and the number of articles in the zone is noted. As the zone value increases the contributions made in that zone period are getting decreased.

Table 19: Relative Growth Rate

Year	Total Article	Total Cumulative	W1	W2	R(a)(1-2)	Mean R(a)(1-2)	Doubling Time Dt(a)	Mean Dt(a)(1-2)
2010	512	512	-	6.23				
2011	500	1012	6.23	6.91	0.68		1.01	
2012	554	1566	6.91	7.35	0.44	0.348	1.58	1.416
2013	604	2170	7.35	7.68	0.33		2.10	
2014	725	2895	7.68	7.97	0.29		2.39	
2015	720	3615	7.97	8.19	0.22		3.15	
2016	818	4433	8.19	8.39	0.20		3.47	
2017	851	5284	8.39	8.57	0.18	0.186	3.85	3.774
2018	978	6262	8.57	8.74	0.17		4.07	
2019	1073	7335	8.74	8.90	0.16		4.33	
Total	**7,335**					**0.267**		**2.595**

Table 4.20 The overall period has a mean relative growth rate of 0.267. In general, the relative growth rate of publications on Biometric output shows the decreasing trend. The mean doubling time for the years 2010 – 2014 is 1.416 and during the years 2015 – 2019 is 3.774. The overall study period has a doubling time value as 2.595.

FINDINGS:

- The publication was high with 1073 articles (14.6 %) in the year 2019 and the low with 500 articles (6.3 %) in the year of 2011.
- Most of the publications are in article type with 6738 records (91.9 %). This proves that authors feel convenient with the Journal as a medium to publish their works
- The total number of publications made in the English language with 7043 papers (95.96%) and stands first. this proves that English is the universal language.

- Analyzing organizational wise Chinese Academy of Science contributes more to research related to Biometrics.
- The study revealed that the maximum publications was given by Fierrez J, Teoh ABJ and Zhang D with 32 articles(0.44%) and with the contribution of 1409(19.204%).
- The USA is considered to be the first and it has given the production of 1409(19.204%) records on Biometric and is considered to the most productive country brought out in research.
- Out of the top 10 publications "IEEE Transactions On Information Forensics And Security" journal with 172 records stands first with 1215 Total Local Citations (TLCS) and 4632 Total Global Citations (TGCS).
- The most cited article was in the journal ", IEEE T CIRC SYST VID, Volume 14" written by Jain AK in the year 2004 with the total citation score as 334.
- The authors Iacono WG and Mcgue M have collaborated for 21 times and stand first. For the total articles of 7335, the total number of authors contributed was 33, 337, for this AAPP is 4.544 and average author productivity is 0.220.
- The doubling time overall the study period has a value 2.595.
- The keyword "Recognition" stands in the first place with 509 records, "Growth" – 319, "Identification" - 250.
- Using the Bradford's law it is analyzed that the multiplier factor is 10.592.
- "National Natural Science Foundation Of China "agency has funded for a total of publication of 516 articles and it is placed first.
- The degree of collaboration is 9.401 in the study period.
- The exponential growth rate for the study period is 9.789 and the growth rate shows both increase and decrease trends in the period of study.

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