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Article

A Bibliometric Analysis Review: The Emerging Technology of Artificial Intelligence for Non-Bio Inspired and Bio-Inspired Algorithm of Wireless Sensor Network from 2005–2022

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Abstract: Rapid developments in technology, business, and social norms have been observed in the twenty-first century. The fourth industrial revolution has been brought about by most industries moving toward automation and reducing human intervention. Wireless sensor networks are incredibly important to the fourth industrial revolution since they help with modernization. WSNs are networks of sensor and routing nodes that can be integrated into a variety of control systems, such as those used for home automation, electric-power automation, and environmental monitoring. A key problem that typically afflicts wireless sensor networks is node localization (WSNs). As a result, several algorithms, to ameliorate the challenges WSNs confront, both bio-inspired and non-bio-inspired solutions have been presented. From 2005 through 2022, the Scopus database was searched for publications. WSNs are used in published research paper statistical analysis, Microsoft Excel 365, VOSviewer, RStudio, and Biblioshiny packages were used. For this seventeen-year study period, a total of 36,377 published documents were in the Scopus database. 765 papers in all were examined following the implementation of the exclusion criteria. This study highlights the global research production of bio-inspired and non-bioinspired algorithms in wireless sensor networks, together with their status and tendencies. It can assist IoT and wireless sensor network researchers in gaining a thorough understanding of the most advanced algorithms in this area.

Keywords: algorithms; artificial intelligence; bio-inspired; bibliometric; non-bio-inspired; wireless sensor networks

1. Introduction

Studies on energy economy in computer-aided systems have long been a focus, especially when combined with machine learning techniques. In a wide range of information-sharing-related applications, including emergency management, transportation surveillance, medical care, and field monitoring, wireless sensor networks offer the right foundation for information sharing [1]. A Central processing unit, sensors and a transceiver are all included in each node. Batteries with a small capacity are typically used to power these sensor nodes. Since battery-powered devices often make up Wireless Sensor Networks, several protocols and algorithms are developed to increase the energy efficiency of information collecting and transmission [1–3].

Bio-inspired techniques and non-bio-inspired strategies can be used to enhance wireless sensor network energy efficiency. This bibliographic review analyses articles regarding the use of algorithms in wireless sensor networks that aren't bio-inspired and bio-inspired are contrasting the two classes. Algorithms for computer optimization that are based on the principles and inspiration of biological evolution are a novel technique to create fresh and effective competing strategies. For instance, computer science researchers have become interested in how some insects or groups of animals behave in nature, such as ant colonies, bird flocks, bee swarms, and schools of fish [4,5]. Living organisms can adapt to live in practically any ecosystem, including the most hostile, such as abyssal depths and polar areas [6-8].

Wireless sensor network also known as WSNs, usually has a few sensors in an area. WSNs are used to complete one or many goals, but this is dependent on the application [9]. However, the objects within each cluster will be slightly more indifferent to each other. Data mining is used in cluster analysis to break down the term network association into manageable groups [10-12]. It enables us to unravel the different segmentations in bio-inspired and non-bio-inspired emergent approaches for wireless sensor networks (WSNs) research from the banks of knowledge in all ramifications [13–15]. Due to its distributed sensing capabilities and the simplicity of implementation made possible by a wireless communication paradigm, wireless sensor networks have become an integral part of our daily lives. Sensor nodes make up wireless sensor networks that act as data generators and network relays [16-20]. The placement of the sensors should be chosen such that their coverage of the area they are in is maximized. This makes the choice of strategy of deployment very important [21]. In the last half century or so, various optimization models have really been developed in an effort to address issues in the actual world. There are, however, problems experienced during optimization. When the problem dimension is high, they do not produce high-quality solutions which stops them from getting approximate solutions of the global optimum [21,22].

Bibliometric analysis is a technique used as a systemic review for insight and inform decision in data science. Bibliometric analysis is accessible, available, advancement of the software being an open source makes it easier for researchers in recent times [23–25]. The contributions made by authors in this bibliometric analysis and their respective countries to the study of bio and non-bio inspired algorithms are identified solutions proposed by the respective authors [26-30].

In this journal paper we presented the background in Section 1, overview search strategy and research approach processes explained in Section 2, while Section 3 presented the result and analysis of the non-bio-inspired and bio-inspired research, historical analysis. Section 4 is the conclusion.

2. Search Strategy and Research Methodology

2.1. Validation and Quality Assurance of the Search Query

In order to ensure that every published work in the field is as inclusive as possible, the synonyms of the important search phrases were investigated and included. After then, the keywords were changed often to ensure that the search approach was effective. False-positive and false-negative findings were reduced thanks to the adjustment. The likelihood of false-positive results was decreased by analyzing the first document results to make sure they matched the parameters of the study. In order to determine the degree of agreement between the information that has been retrieved and what is actually in the Scopus database about the desired research question, the number of documents for the top active authors shown in the Scopus database was compared with their research profile in Scopus [31-35].

2.2 Search Strategy

Information was taken out of the Scopus database, which offers scholarly articles and the citations they contain. Scopus is the only database that brings together a broad, carefully selected text as well as reference database with enhanced material with connected scholarly literature from a broad variety of fields. Scopus includes almost 36,377 titles from roughly 11,678 publishers, 34,346 of which are peer-

reviewed publications in high-calibre topic areas. However, for this analysis report exclusion terms were used to filter out the documents related to bio inspired and non-bio inspired algorithms. A total of 765 documents were initially identified for analysis with the keywords stated below without any exclusions. One database is sufficient, prior research has demonstrated, and evaluating other databases has little bearing on the outcome of the investigation [60]. The keywords used are “Wireless Sensor Networks”, “Node Localization”, “WSN”, “Localization”, “Localization Algorithm”, “Particle Swarm Optimization”, “Nodes Localization”, “Bio-inspired Algorithms”, “Particle Swarm Optimization Algorithm”, “Sensor Networks”, “Swarm Intelligence”, “Ant Colony Optimization”, “Artificial Bee Colony Algorithms”, “Bat Algorithms”, “Bio-inspired Optimizations”, “Bio-inspired”, “Clustering” for documents published in the domain of years 2005 to 2022.

2.3. Inclusion and Exclusion Criteria

The requirements for papers to be included. Analysis, letters to the editor, editorials, commentaries, expert opinions, articles, book chapters, quick studies, and theses written in dialects other than English before to January 2005 were excluded from the list of included publications. Additionally, articles that did not meet the inclusion requirements were excluded. The keywords used are “Wireless Sensor Networks”, “Node Localization”, “WSN”, “Localization”, “Localization Algorithm”, “Particle Swarm Optimization”, “Nodes Localization”, “Bio-inspired Algorithms”, “Particle Swarm Optimization Algorithm”, “Sensor Networks”, “Swarm Intelligence”, “Ant Colony Optimization”, “Artificial Bee Colony Algorithms”, “Bat Algorithms”, “Bio-inspired Optimizations”, “Bio-inspired”, “Clustering” for documents published in the domain of years 2005 to 2022.

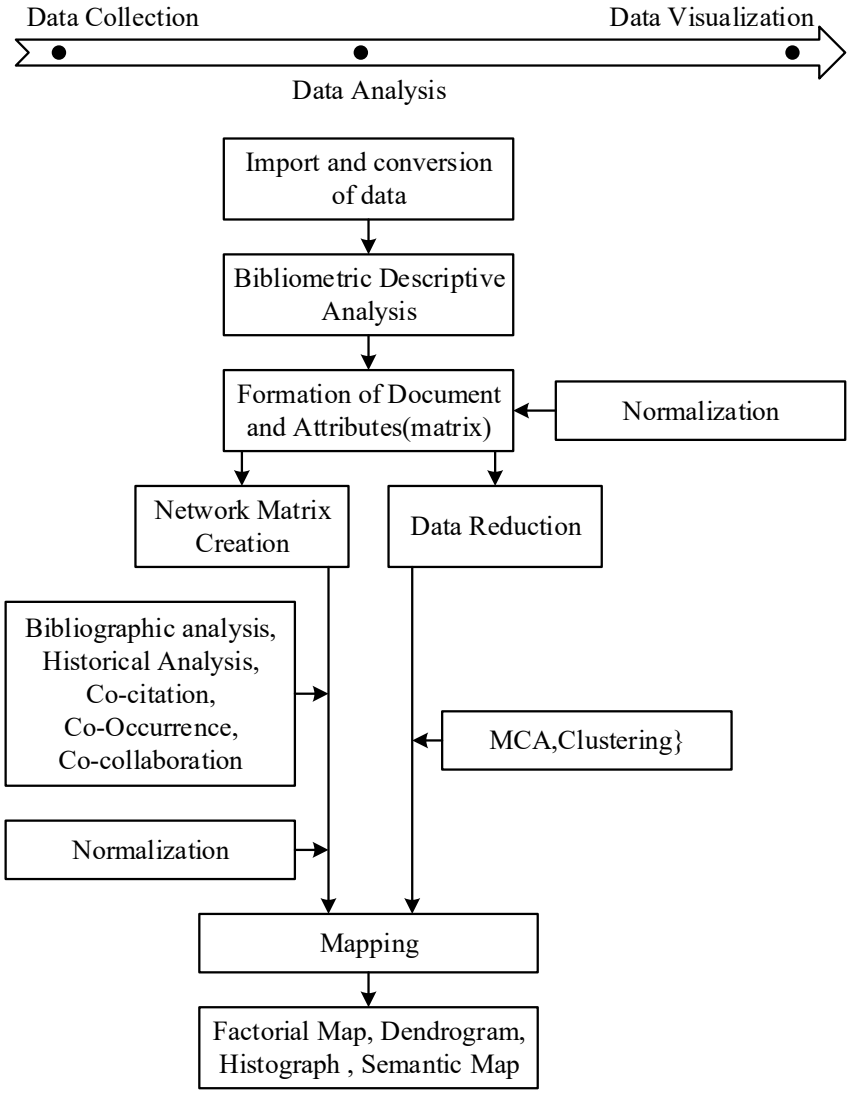


Figure 1. Bibliometric Information Process.

3. Result and Analysis

The restrictions placed on the exported documents were focused on the keywords of the documents. The sum of 765 paper were grafted based on the Scopus literature search. Figure 2a illustrates a flowchart process of the process of the data used in this research studies. In Figure 2b the pie chart illustrates the types of documents identified during the Scopus search. Two of the seven document types can be seen in majority in the pie chart namely conference paper documents representing 49% of the total, followed by article documents representing 46% of the total respectively. The remainder document types make up a small portion of the pie chart which is book chapter with 3% (n = 18), conference review with 1% (n = 10), review with 1% (n = 4), retracted with 0% (n = 2) and lastly book with 0% (n = 1). This research study focused on the bibliometric analysis of the 353 article type documents excluding the remainder documents. In the table below (Table 1), a description of the information extracted from the articles used in this research study can be identified. The average citations, document types, document contents, authors and authors collaboration results are portrayed in the Table 1.

Table 1. Description of main document information used in this research study.

Description	Results
Timespan	2005:2022
Sources (Journals, Books, etc.)	484
Documents	765
Average years from publication	6.64
Average citations per documents	8.886
Average citations per year per doc	1.164
References	14713
DOCUMENT TYPES	
article	353
book	1
book chapter	18
conference paper	377
conference review	10
retracted	2
review	4
DOCUMENT CONTENTS	
Keywords Plus (ID)	3383
Author's Keywords (DE)	1569
AUTHORS	
Authors	1689
Author Appearances	2457
Authors of single-authored documents	32
Authors of multi-authored documents	1657
AUTHORS COLLABORATION	
Single-authored documents	44
Documents per Author	0.453
Authors per Document	2.21
Co-Authors per Documents	3.21
Collaboration Index	2.3

In Figure 2a (below) the data process is performed. The first step is to limit the period of publication of published documents by year, followed by excluding all non-articles type documents to yield the total documents to be analysed.

Figure 2b is a 3D pie chart depicting the document types found during the Scopus document search mentioned in Section 3.1. conference paper and article accounts for a significant portion of the pie chart collectively making up 95% with the other.

Search of articles between year
2005-2022

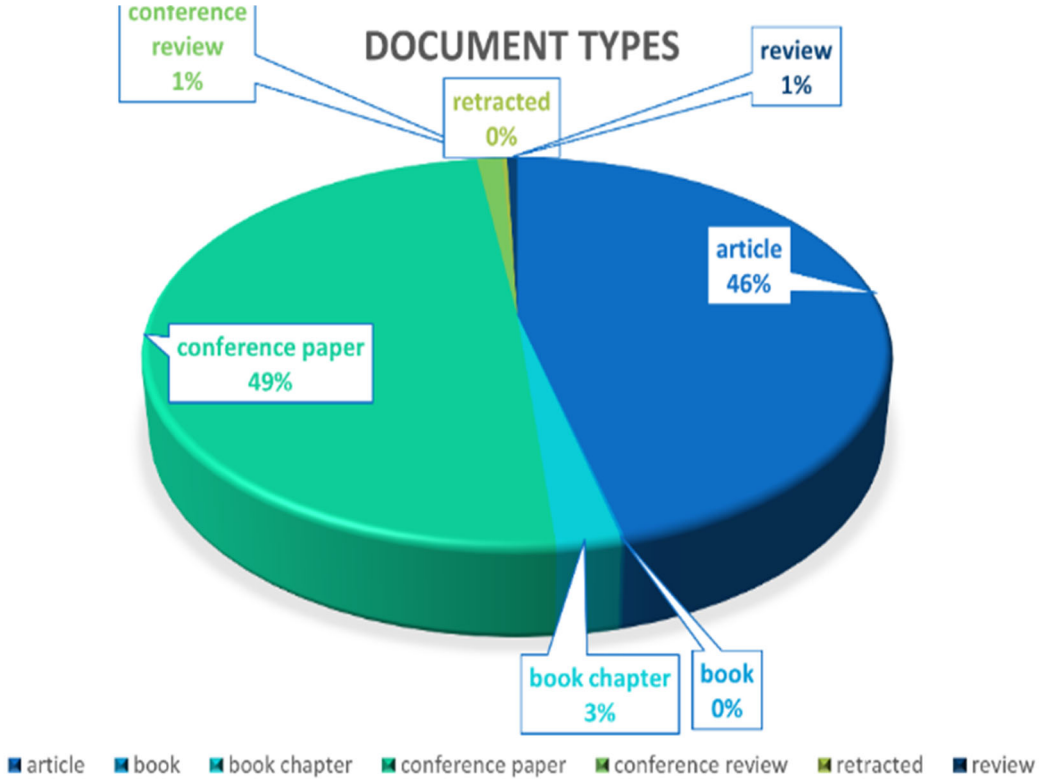
Non article: book chapter, conference review , review, retracted and book: Total remaining-**353 publications**

412 non articles excluded

Included in final bibliometric analysis
Total of 353 publications.

(**a**)

document types collectively making up 5% of the pie chart.



(**b**)

Figure 2. (**a**) Processing of data flowchart. (**b**) Pie chart graphically representing document types extracted.

3.1. Historical Analysis

The results of the historiographic study are depicted as a sequential network map of direct author citations. The outcome, as shown in Figure 3, helps to determine the period for which the papers were examined. Figure 3 depicts the historical direct citations with nodes from year to year starting in 2012. Each node represents an article that has been cited during the year in question. The nodes correspond to the straight lines that connect the articles and citations. Figure 3 shows that there are no nodes in the years 2014, 2016, or 2020, indicating that no related papers were cited throughout those years. However,

from 2020 to 2022, we can see those papers by Kanoosh, Houssein, and Selim, (2019) [34, 36-40].

3.2. Research Methodology

Bibliometric is a method in which one statistically analyses and evaluates bibliometric publications data and scientific and technological literature. It can also be characterized as the use of mathematical and statistical techniques with regard to publications and other methods of communication [41–43]. Common methods found in bibliometric analysis is citations analysis and content analysis. Bibliometric R-application is proposed to be useful for comprehensive scientific mapping analyses. This tool is useful as it provides measures for importing bibliographic data from Scopus. Furthermore, the cooperation of networks in high-producing nations and researchers in the investigation comparing bio-inspired algorithms to non-bio inspired algorithms was depicted and visualized using the VOS viewer package of the R language [44,45].

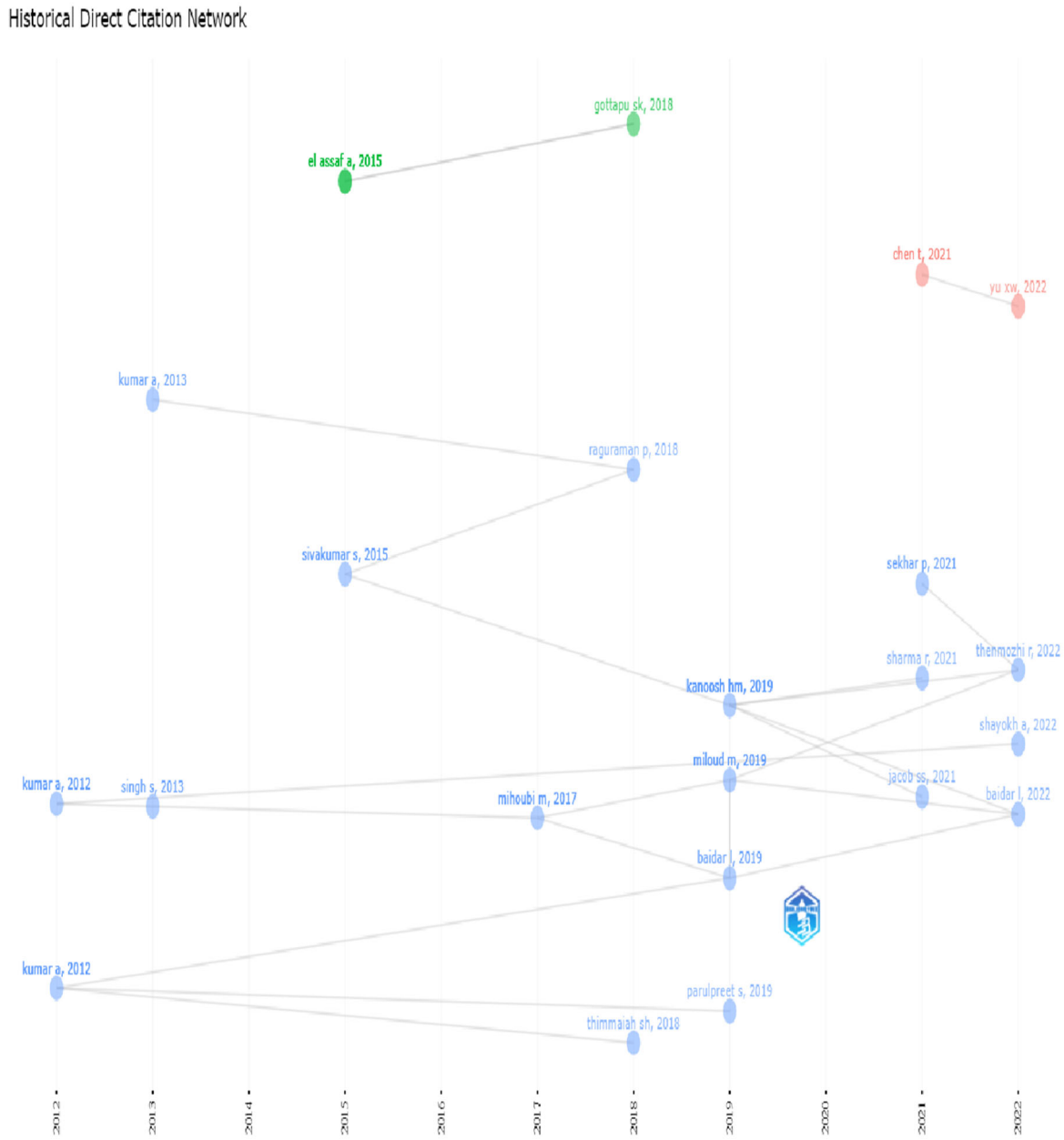


Figure 3. Historical analysis of direct citation of top-cited papers in context to bio-inspired and non-bio inspired algorithms from 2012–2022 (Author's Own Construct).

3.3. Local Citations and Global Citations from the Historical Analysis

In Table 2, the highest GCS and highest normalized global citations is given to a publication by Kulkarni, written in 2011 [37] titled "Particle Swarm Optimization in Wireless-Sensor Networks. Particle Swarm Optimization is a suitable solution for these problems [36–39]. A higher LCS shows a higher level of significance the article has on this particular topic. Table 2 shows the article with the highest LCS and the highest normalized local citations is the paper written by Peng, (2015) [46].

The localization mistake is larger with this approach, though. In order to increase localization accuracy, this article suggested a DV-Hop algorithm based on genetic algorithms [46]. DV-Hop uses hop count to estimate the distance between nodes. As the hop count reaches a neighbor node it increases by one [47-58].

Although PSO is used to solve the problem of localization, it has been challenged by Moth Flame Optimization Algorithm (MFOA). Computer simulations demonstrate that MFOA quickly converge to the optimum node po Computer simulations show that MFOA converge to the ideal node position quickly [47,59,60]. There are multiple different methods studied such as chicken swarm optimization, butterfly optimization algorithm [14]. and Salp swarm algorithm [34].

Table 2. Most local cited documents.

Articles/Documents	DOI	Year	LCS	GCS	LC/GC Ratio%	Normalized Local Citations	Normalized Global Citations
LU & ZHANG Q, INT CONF WIREL COMMUN, NETW MOB COMPUT, WICOM [61]	10.1109/WiCom.2008.850	2008	7	21	33.33	9.63	1.03
ZHANG Q, INT CONF COMMUN NETW CHINA, CHINACOM [62]	10.1109/chinacom.2008.4685104	2008	7	24	29.17	9.63	1.18
KULKARNI RV, IEEE TRANS SYST MAN CYBERN PT C APPL REV [63-65]	10.1109/tsmcc.2010.2049649	2010	8	170	4.71	16.00	11.87
GÓMEZ MÁRMOL F, TELECOMMUN SYST [27]	10.1007/s11235-010-9281-7	2011	12	114	10.53	17.20	5.41
KULKARNI RV, IEEE TRANS SYST MAN CYBERN PT C APPL REV [66]	10.1109/tsmcc.2010.2054080	2011	13	526	2.47	18.63	24.96
ALRAJEH NA, INT J DISTRIB SENS NETW [5]	10.1155/2013/304628	2013	13	137	9.49	19.30	14.98
PENG B, COGN NEURODYNAMICS [67]	10.1007/s11571-014-9324-y	2015	13	109	11.93	23.47	15.64
CHENG J, SENSORS [64]	10.3390/s16091390	2016	7	26	26.92	11.86	3.15
SEKHAR P, PHYS COMMUN 61]	10.1016/j.phycom.2021.101411	2017	4	5	80.00	13.33	3.03
MILOUD M, INT J DISTRIB SYST TECHNOL [47]	10.4018/ijdst.2019010106	2017	4	8	50.00	8.24	1.34
LI J, WIRELESS NETWORKS [68]	10.1007/s11276-021-02563-9	2017	5	12	41.67	16.67	7.27
STOJKOSKA BR, IEEE EUROCON [48]	10.1109/eurocon.2013.6625044	2017	4	15	26.67	5.94	1.64
CAO Y, IEEE ACCESS [17]	10.1109/access.2019.2938558	2017	5	23	21.74	10.30	3.84
AL SHAYOKH M, WIRELESS PERS COMMUN [6]	10.1007/s11277-017-4803-1	2017	4	38	10.53	5.02	3.89
SHAHZAD F, J COMMUN NETW [38]	10.1109/jcn.2016.000108	2017	4	38	10.53	6.78	4.61
RAJAKUMAR R, J COMPUT NETW	10.1155/2017/7348141	2017	6	65	9.23	7.53	6.66

COMMUN [69]							
CHAURASIYA VK, INF FUSION [19]	10.1016/j.inffus.2013.06.003	2017	5	70	7.14	12.05	8.23
ARORA S, ARAB J SCI ENG [14]	10.1007/s13369-017-2471-9	2017	11	97	11.34	13.81	9.94
LUI KWK, IEEE TRANS SIGNAL PROCESS [70]	10.1109/tsp.2008.2007916	2017	5	131	3.82	8.81	10.80
KANOOSH HM, J COMPUT NETW COMMUN [34]	10.1155/2019/1028723	2019	8	45	17.78	16.48	7.52

Note: GCS: global citation score; LCS: local citation score.

3.4. Analysis of Main Researchers

From the standpoint of documents in numbers in Figure 4, the 20 authors that stand out are Liu Y, Wang W, Wang X, Wang Y, Na Na, Zhang Y, Li Y, Wang J, Chen L, Chen Q, Kumar A, Mao K, Zhang L, Chen J, Li H, Li J, Liu C, Liu X, Nguyen TT and Pan JS with 14 articles, "A Hybrid Mobile Node Localization Algorithm Based on Adaptive MCB-PSO Approach in Wireless Sensor Networks" [71,72]. The paper titled "IVCN: An improved 3D node localization algorithm based on virtual central node (VCN) in wireless sensor networks, Liu et al., (2008) [70] is another well documented paper that Liu Yang has contributed to with 6 citations published in the Journal of Information and Computational Science.

Figure 5 shows Graphical Representation of the top authors production over time in relation to Figure 4 (above). The key in the far right of the figure can be used to interpret the information displayed.

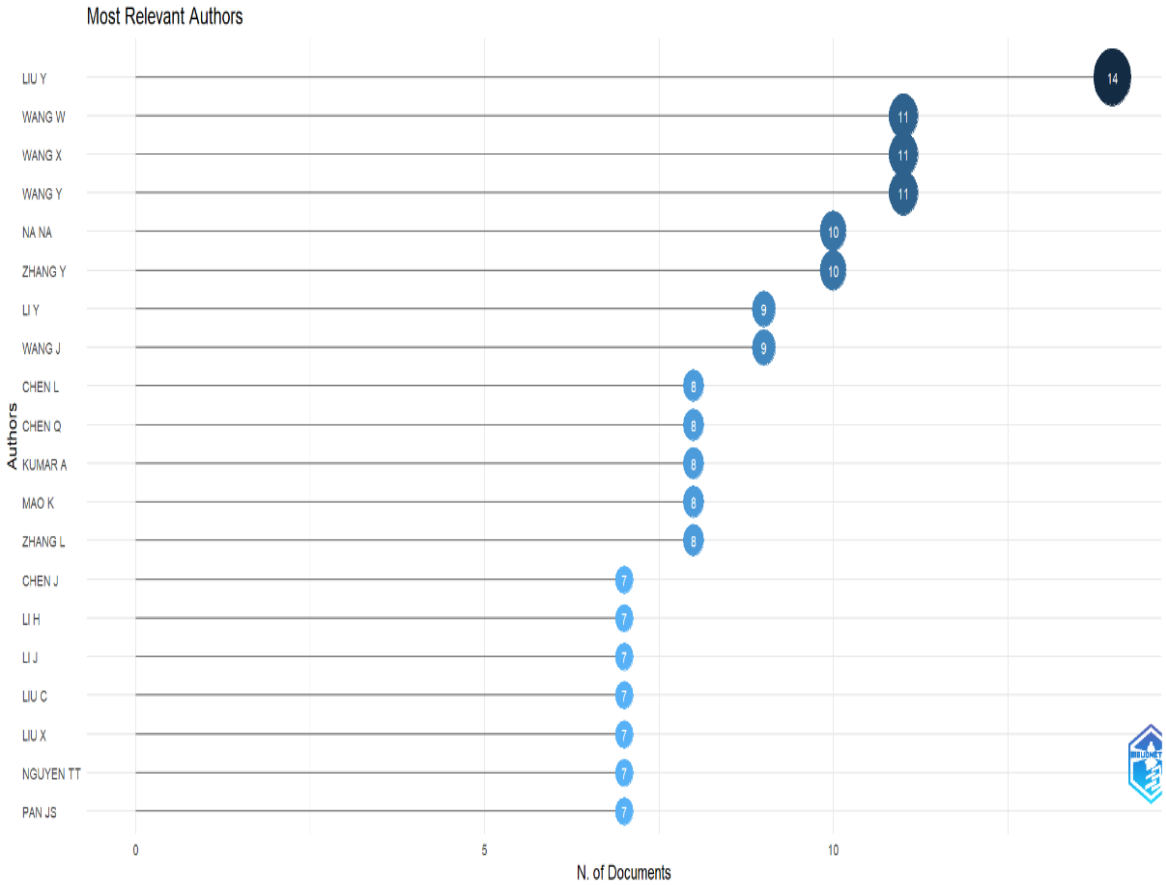


Figure 4. Most relevant authors with articles in context to bio inspired and non-bio inspired algorithms. (Author's Own Construct).

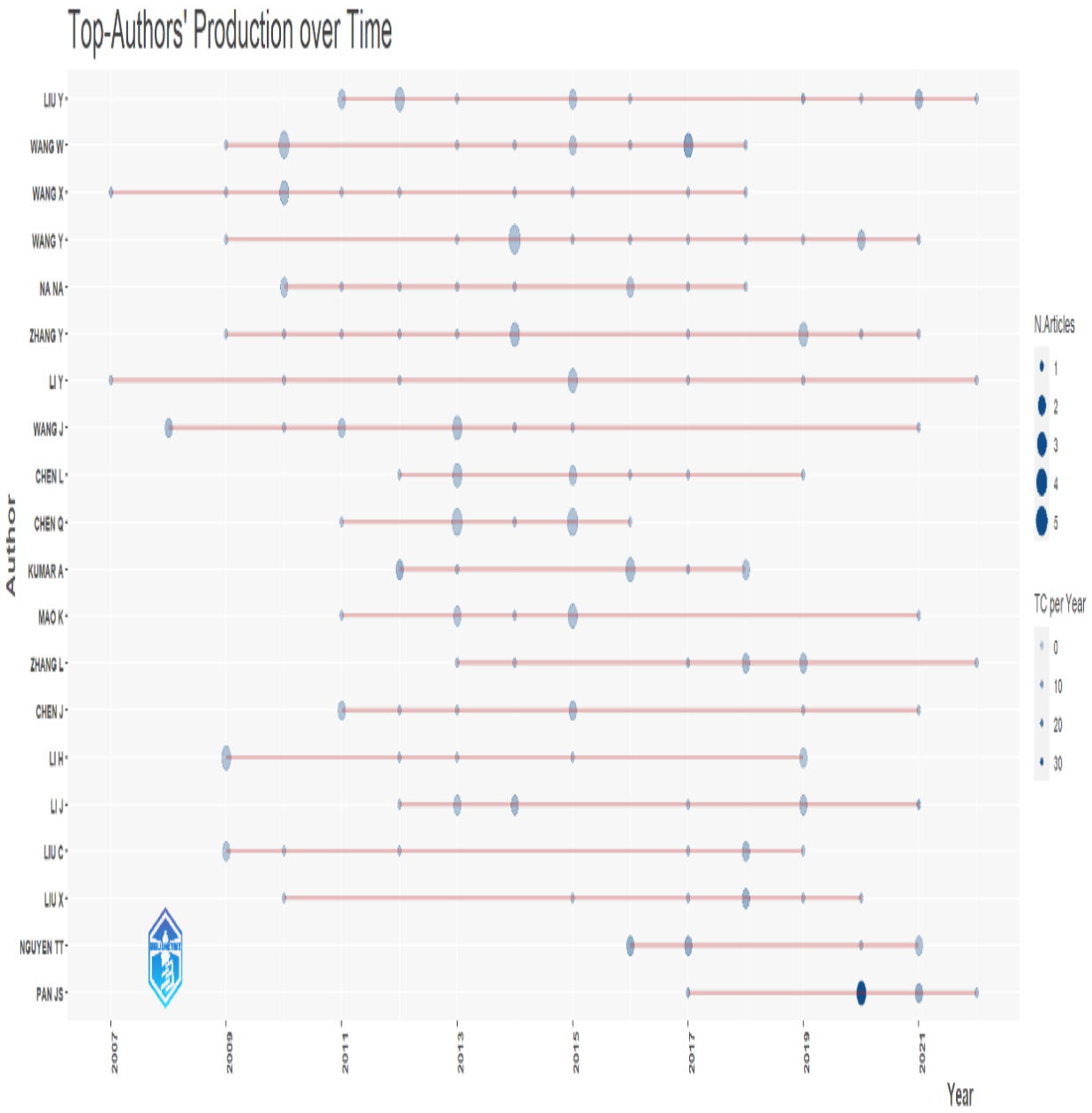


Figure 5. Authors' production over time in context to bio-inspired and non-bio-inspired algorithms (Author's Own Construct).

Another author who has significantly contributed to this field his first article titled Algebraic solution for source localization by using TOA-based asymmetric trip ranging.

3.5. Academic Collaboration

A collaborative network is a network where a node represents the authors and links represent the co-authors. This is a form of collaboration in science that has been well-researched. This is obtained through:

$$\lambda = \beta' \times \beta \quad (1)$$

In Equation (1), β is a bipartite network of documents x authors and λ signifies the academic collaboration. Authors collaboration is vital as it helps strengthen the acceleration in which discussion and expertise takes place, thus widening the vision of a specific subject area. The graph was produced by VOSviewer using the R studio software interface. The nodes/circles in Figure 6 below reflect the writers, the size denotes the number of articles written, the linking line denotes the degree of author collaboration, and each colour denotes a separate cluster.

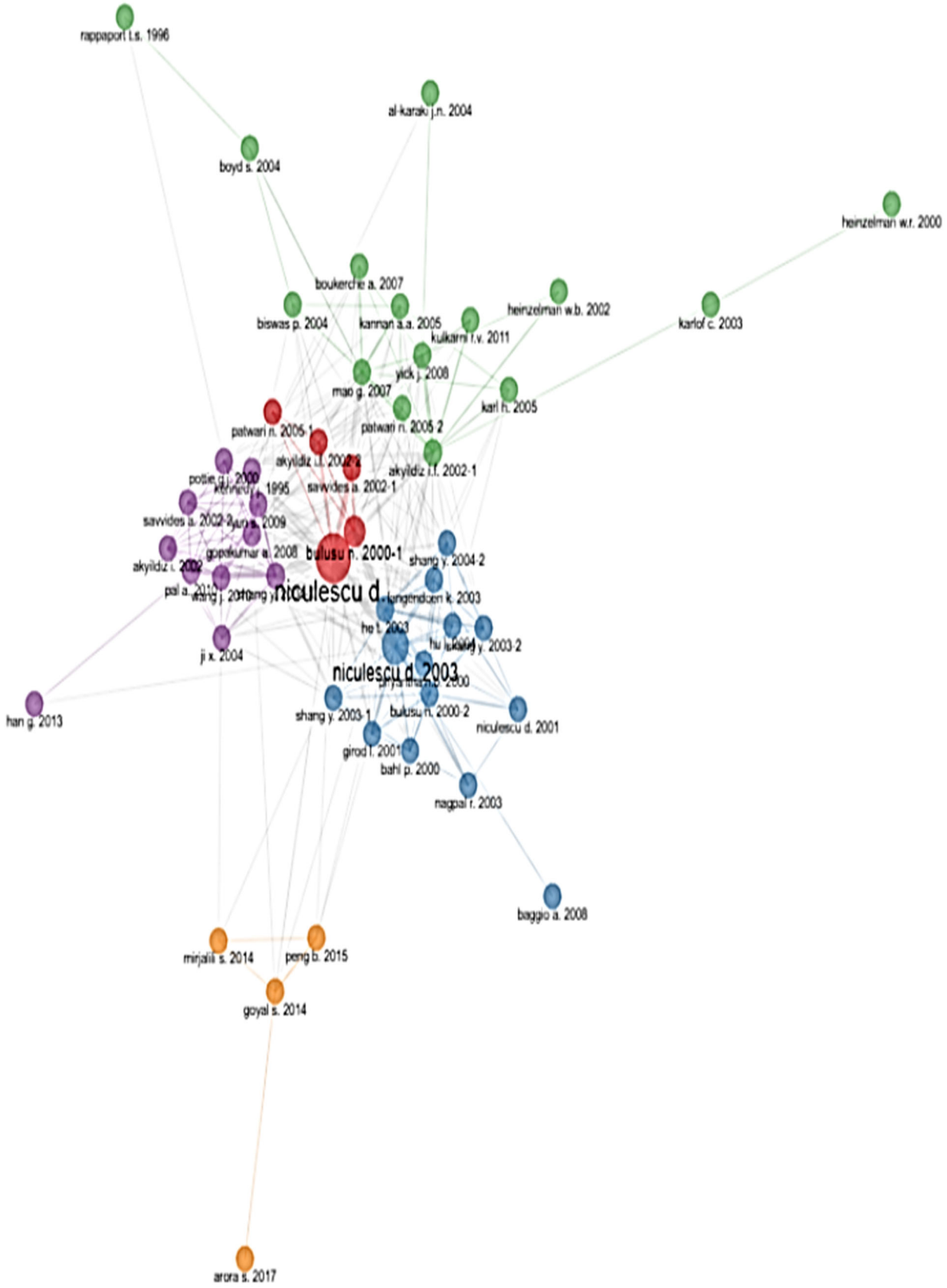


Figure 6. Authors' collaboration map in the field of Non-Bio Inspired and Bio Inspired Algorithm of Wireless Sensor Networks (Authors Own Construct).

Countries that produce more literature have a higher impact and stronger standing within the area of

expertise. China leads with the total number of articles produced being 553 and total citations being 1,587. Table 3 shows the top 20 leading countries in the study of bio-inspired and non-bio inspired algorithms. Arabia and Iraq). Notably, the leading continents are those to be considered as more developed and most likely first world. This justifies the high collaboration and contribution of USA (n = 21) and China (n = 265) however India being a lower power economically show for 102 articles published which surpasses USA. This may be due to the high number of researchers in similar fields of work being higher in India in comparison to other countries. China came out first with regards to citations (n = 1587,5.99), followed by the USA (n = 973,46.33), and India (n = 688, 6.75).

Table 3. Productivity based on number of articles at country level.

Most Relevant Countries by Corresponding Author						**Most Cited Countries**		
Entry	Country	Articles	Freq	SCP	MCP	Countries	TC	AAC
1.	CHINA	265	0.51556	248	17	CHINA	1587	5.99
2.	INDIA	102	0.19844	94	8	USA	973	46.33
3.	USA	21	0.04086	17	4	INDIA	688	6.75
4.	KOREA	16	0.03113	12	4	SAUDI ARABIA	157	39.25
5.	MALAYSIA	13	0.02529	10	3	UNITED KINGDOM	145	16.11
6.	CANADA	10	0.01946	9	1	HONG KONG	142	47.33
7.	UNITED KINGDOM	9	0.01751	5	4	CANADA	126	12.60
8.	ALGERIA	7	0.01362	1	6	SPAIN	125	31.25
9.	GERMANY	5	0.00973	4	1	JAPAN	122	61.00
10.	ITALY	5	0.00973	4	1	MALAYSIA	120	9.23
11.	PAKISTAN	5	0.00973	4	1	KOREA	110	6.88
12.	EGYPT	4	0.00778	4	0	ALGERIA	105	15.00
13.	SAUDI ARABIA	4	0.00778	1	3	TURKEY	84	42.00
14.	SPAIN	4	0.00778	3	1	EGYPT	66	16.50
15.	CZECH REPUBLIC	3	0.00584	2	1	CZECH REPUBLIC	60	20.00
16.	FRANCE	3	0.00584	1	2	ITALY	53	10.60
17.	HONG KONG	3	0.00584	3	0	BRAZIL	49	24.50
18.	IRAQ	3	0.00584	1	2	PAKISTAN	39	7.80
19.	OMAN	3	0.00584	1	2	FRANCE	37	12.33
20.	BRAZIL	2	0.00389	1	1	GERMANY	36	7.20

Note: SCP—single country publications, MCP—multiple country publications, TC—total citations,

AAC—average article citations.

3.5. Multiple Correspondence Analysis and Cluster Analysis of High-Frequency Keywords

A conceptual structure map is depicted in Figure 7. The figure below is a collaboration map of countries. Algeria and France respectively have the highest article collaboration between each other with 12 articles.

Data from Figure 7 (below) was interpreted to create the graph below. In Figure 8 the countries with the highest production is China with 553 articles followed by India with 365 articles, USA with 74 articles, Canada with 38 articles, Malaysia with 28 articles.

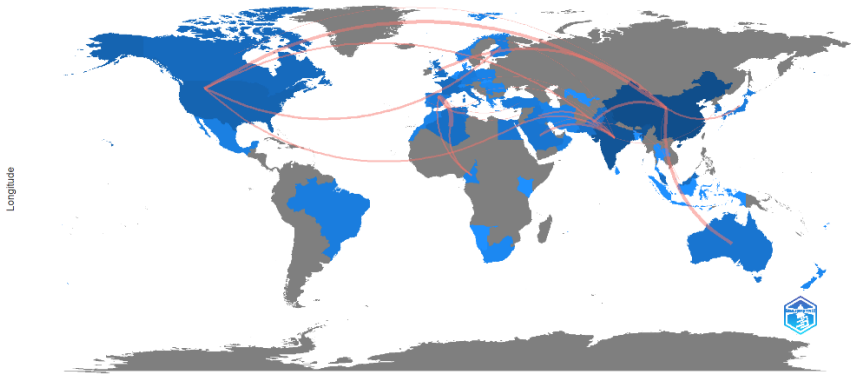


Figure 7. Country research article collaboration map.

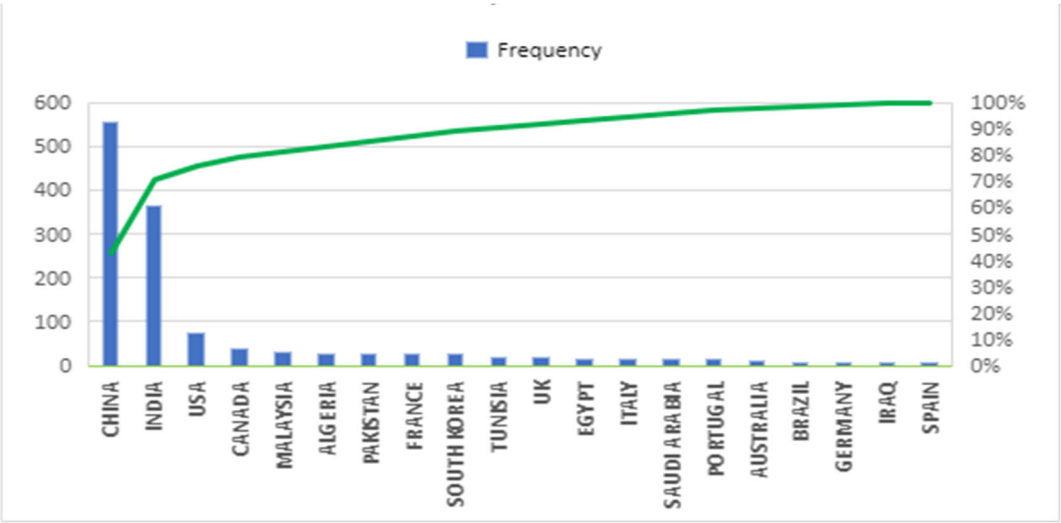


Figure 8. Country Production of research articles.

From the information illustrated in Figures 9 and 10 (below) data from the research articles, the topics sensor nodes, wireless sensor networks, node localization, algorithms and localization algorithms are the top trending topics.

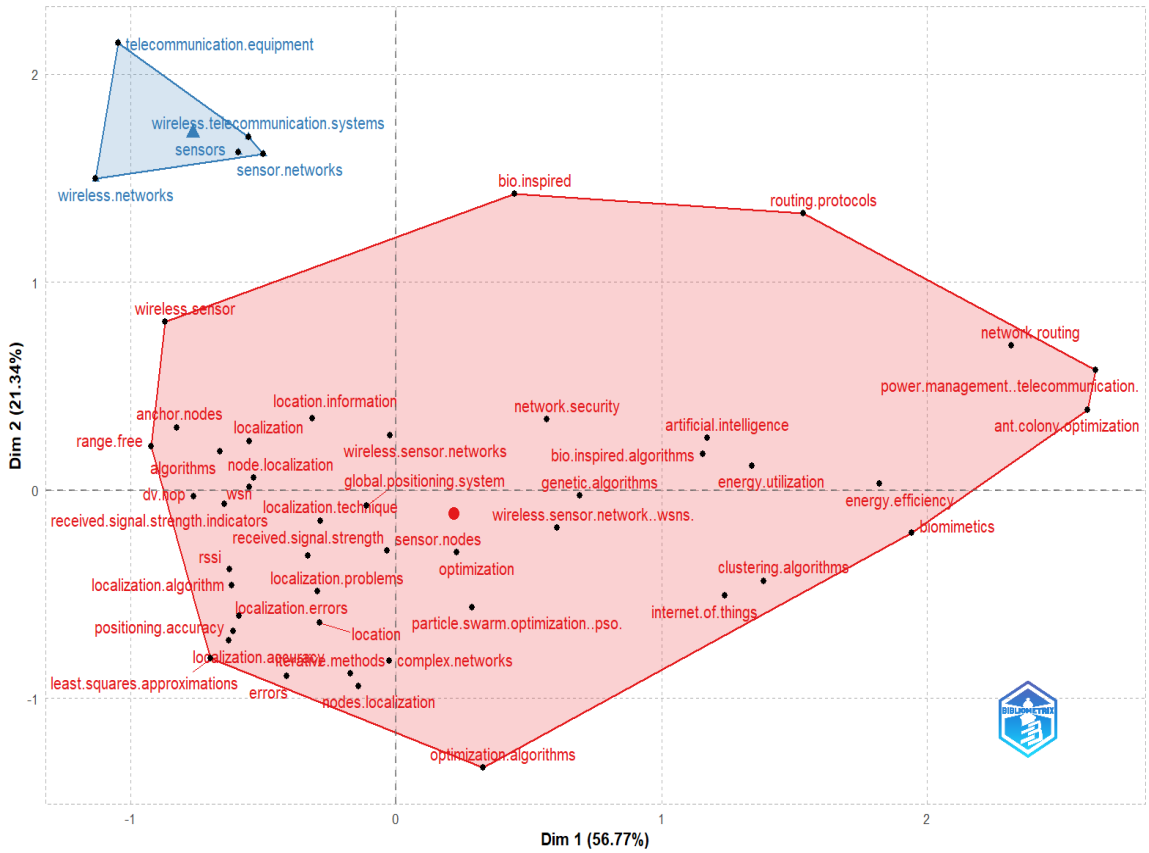


Figure 9. Conceptual Structure map of Trend Topics in research articles (Author's Own Construct).

Zhang et al., (2017) classifies localization algorithms into two groups. Localization methods can be classed as centralized or distributed depending on the computational resources at each anchor. Every sensor node in a distributed algorithm trades data with its neighbor or a set of neighboring sensors nodes and evaluates parameters locally [73-75].

Jia et al. (2017) suggested an alternative one-hop range-based node localization technique. Anchor nodes are used in the article to aid with localization [31].

In a paper titled "An Innovative Gaussian Clustering Hyper-Heuristic Scheme for Energy-Efficient Optimization in Wireless Sensor Networks", Aroba et al., (2020, 2021a; 2021b) suggests a novel DEEC_GAUSS approach for the optimization of localization as well as for wireless sensor network nodes energy efficiency. The simulation conducted by aroba et al revealed that the novel Gaussian algorithm is best suited for optimized performance and contributes to the network lifetime as well as to optimize energy [72-78].

Figure 10. Tree Map illustrating the trending topics in articles from 2005 to 2022 (Author's Own Construct).

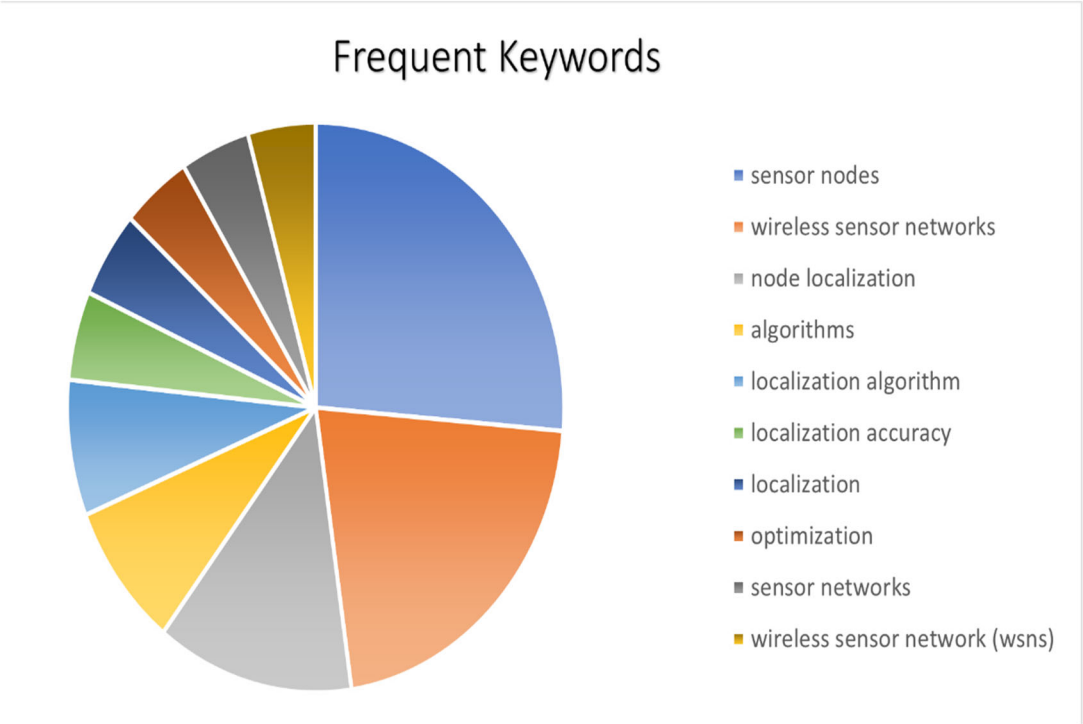


Figure 11. Pie chart of Frequent Keyword in research articles. **Note:** Figure 11 illustrates the keywords that are discovered to be recurring in the research articles being analysed. The information in Figure 10 and Figure 11 allows us to conclude that the trending topics and frequent keywords used are associated.

3.7. Thematic Evolution Analysis

Thematic evolution analysis is a technique for displaying field development and quantifying the evolution of the study field that combines performance analysis and scientific mapping. 2005-2016 and 2017-2022 as shown in Figure 12.

During the first period, 2005–2016, the thematic evolution is observed in 4 research areas: Particle swarm optimization, sensor nodes, wireless sensor networks, and sensor networks. In the second period, 2017–2022, the thematic evolution is observed in 4 research areas as well: optimization problems, sensor nodes, particle swarm optimization and energy efficiency.

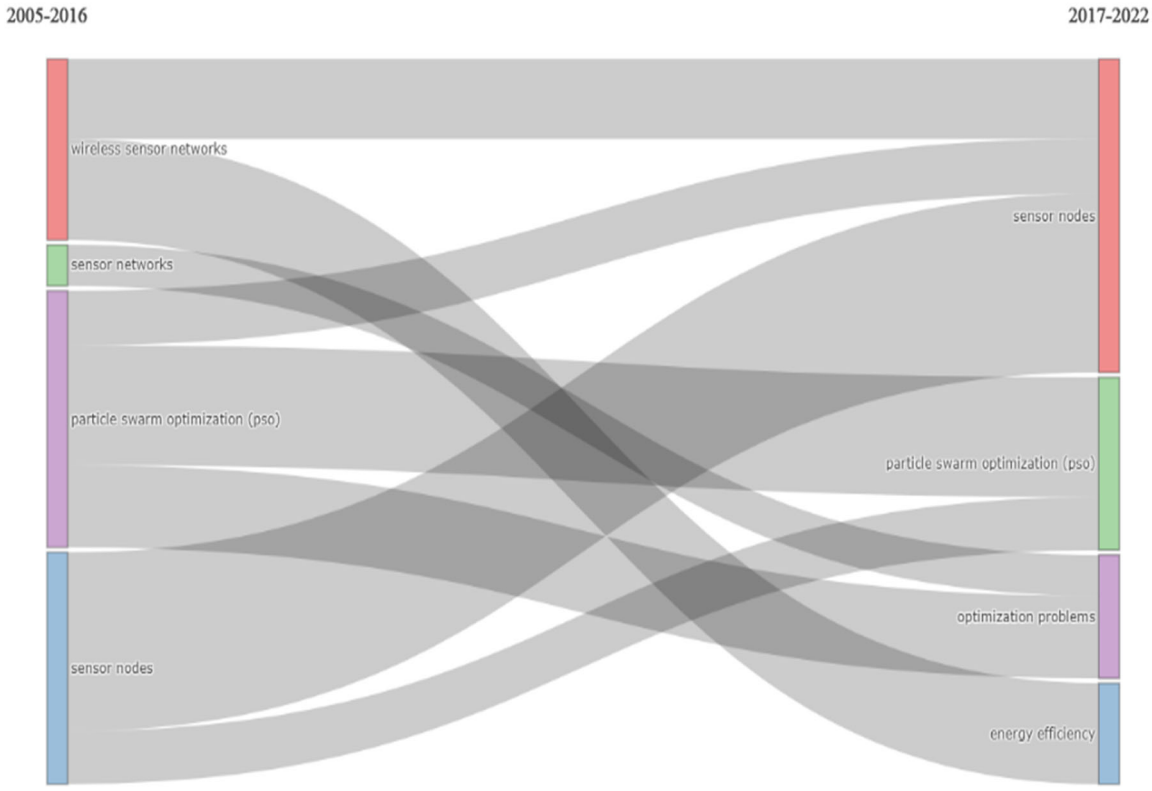


Figure 12. Thematic evolution of keywords in field of research on bio-inspired algorithms in wireless sensor networks 2005–2022 (Author's Own Construct).

When using PSO, researchers have found various modified versions that improve sensor coverage overall . Much better results were found by those who used hybrid versions of GA . ACO as their algorithms reduced the sensing of redundant information and reported higher network coverage rates respectively [77,78].

An energy-efficient setup is very important to WSNs as the sensors have a limited energy supply. The transmission of the data sensed consumes majority of the energy, as longer transmission lengths require much more energy. The use of GA and PSO algorithms overall greatly helped in reducing power consumption, hence extending the lifetime of networks. The most effective algorithm however seems to be the ACO-based proposal by Darwish, (2018) **.** Not only did it give the same results as the other bio-inspired algorithms but also provided high load balancing. The top 20 sources that were analysed were during the period of 2005–2022 were chosen to aid researchers in identifying reliable and relevant studies to assists them in publishing their works. The figure 13 shows the top 20 sources with relevant articles on bio-inspired and non-bio inspired algorithms for multidisciplinary and interdisciplinary research.

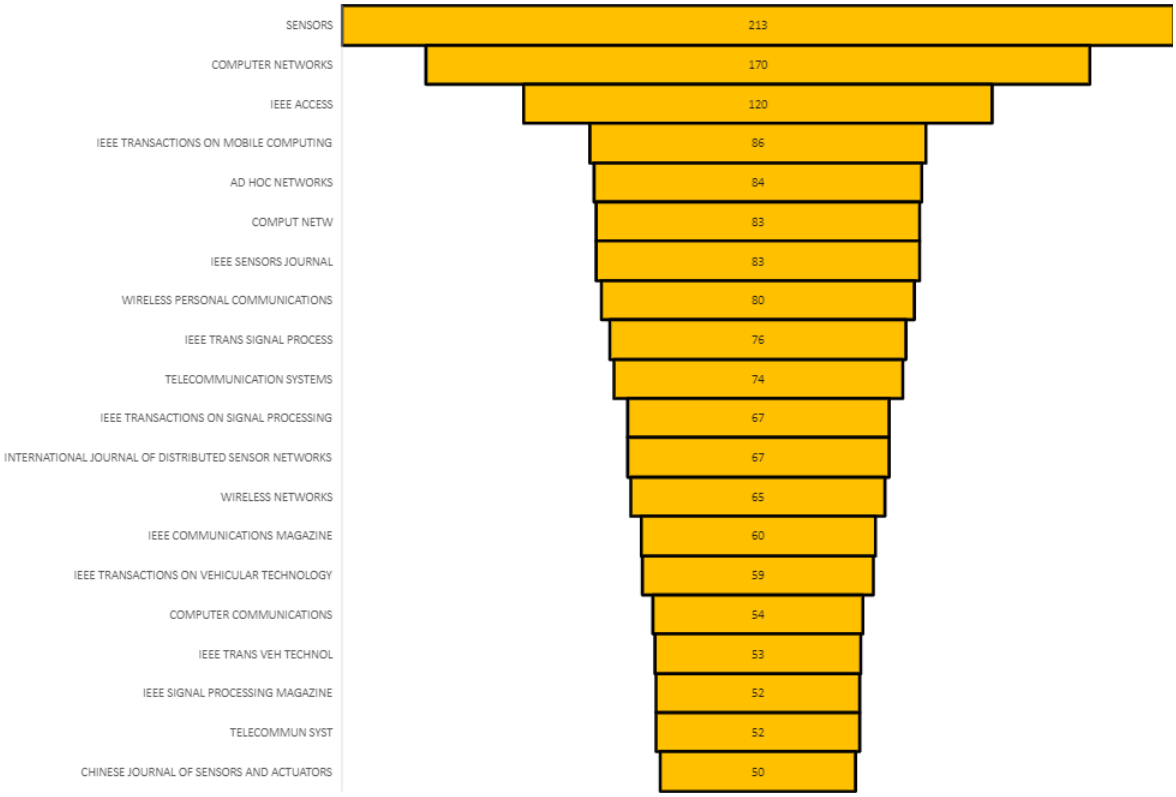


Figure 13. Most cited sources. **Note**: numbers represent the number of articles cited this source.

3.8. Strengths and Limitations

This study presented strong points in comparison to other studies that only make use of systematic reviews. The goal of bio-inspired algorithms is to mimic natural characteristics of living creatures and design elements to help solve human problems. Wireless sensor networks are very useful however they are limited in network lifespan therefore ongoing research on this topic occurs [79].

4. Conclusions

This research paper analysed the global research production of bio inspired and non-bio inspired algorithms in wireless sensor networks. The findings indicated that over the recent decades, both bio-inspired and non-bioinspired algorithms have steadily increased in number in WSN research articles. While our analysis shows that researchers are still actively pursuing wireless sensor network research Hence, there seems to be a steady increase in publications relating to this field. This paper used articles found in Scopus to identify the best researchers and map their geographical distribution and publishing journals. It has also been found that there are a significant number of researchers in this field and papers published. It is a relatively new subject matter which has been taken well throughout global researchers. We believe that this bibliometric analysis will serve as a useful resource on important concerns and emerging trends in this field of study for both established academics and up-and-coming scientists who plan to take an active role in this subject. Additionally, the analysis provides intuitions into scientific research, which will aid in creating descriptions based on facts and visualising study results.

Author Contributions
Oluwasegun Julius Aroba came up with the concept, worked on the methodology, validation and analysis was carried out by Timothy Adeliyi, Avitha Guptar worked on the introduction, while literature review writing was done by Karodia Kadijath, recommendation and conclusion was done by Vinay Bugwandin, Review, editing and validation is carried out by Michael Rudolph and Manduth Ramchander. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest Statement
The authors declare no conflicts of interest.

Data Availability Statement
There is no data used for this research as it made use of public open-access Scopus and Web of Science Database for the bibliometric analysis.

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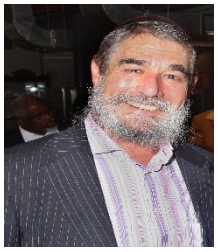

Prof Michael Rudolph has over 48 years of experience in teaching, training, and mentoring a cadre of new leaders in public and environmental **health** in SA. My research covers a wide range of topics, all of which are interlinked, and which have influenced strategic interventions and policies in health promotion, food and nutrition security, and agroecology at local provincial, and national levels. I constantly seek and implement innovative ideas, technologies, and methodologies in my work but ensure that these are both grounded and aligned with government policies and models. I have shown consistent commitment to working with disadvantaged communities in SA.
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