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Trends in IoT Research: A Bibliometric and Science mapping Analysis of Internet of Things

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Abstract:

Internet of Things (IoT) is about augmenting the existing power of the Internet beyond computers and smartphones to a whole range of other things, processes, and environments involving living or non-living species. It can bring life to the objects and enable them to communicate. This study presents the bibliometric analysis and science-mapping analysis on IoT. The data were extracted from the Web of Science (WoS) database from 1989–2019. In total 14,469 documents (articles, review, editorial material, proceedings, etc) were retrieved, which were further processed by VOSviewer software to perform advanced bibliometric analysis and science-mapping analysis. This research identifies the most productive or leading authors, countries, journals, institutions, keywords and to know their co-authorship pattern, co-citation pattern, bibliographic coupling pattern, the co-occurrence of keywords pattern in the research area of IoT. Results showed that Joel J.P.C Rodrigues was the most productive author, the People's Republic of China was the most productive country, the Journal of EEE Access was the leading journal, Luigi Atzori was the most cited author. The main keywords more frequently occurred were Internet of things, and Internet, and Security. The analysis showed a collaboration relation between authors, countries and institutions. The visualizations conducted on this topic offer exploratory information on current status and trends on the scientific literature of IoT and provides insights for established and novice researchers in the understanding of this research topic.

Keywords: Internet of Things. Bibliometric analysis. Science mapping. Co-citation. Bibliographic coupling. Co-occurrence

Introduction

In today's technological world, the concept of the Internet of things is gaining vast attention day by day. The term "Internet of Things" was first used in 1999 by Kevin Ashton. It was initially proposed to a connected object with radio frequency identification (RFID) technology (K.Ashton 2009). Its infrastructure relies on many devices sensory, communication, networking, and information processing technologies. Weber (2009) defined IoT as "an emerging global, Internet-based information service architecture facilitating the exchange of goods in a global supply chain network on the technical basis of the present Domain Name System; drivers are private actors." It is expected that it will not only change the way we work but also change the way we live. It helps us in our everyday lives includes Smart appliances, such as refrigerators, washers and dryers, coffee machines, slow cookers. Smart security systems, smart locks, and smart doorbells. Smart home hubs that control lighting, home heating and cooling, etc. This study provides a bibliometric and science mapping analysis of literature published on the concept of IoT. This study will deploy advanced bibliometric study and concepts of science mapping to understand the research evolution in the domain of IoT.

Bibliometrics is a statistical technique that studies all kinds of bibliographic data such as titles, keywords, authors and cited references of articles and books. It evaluates the productivity of authors, countries, institutions and their international collaboration. It describes the developing trends, hotspots and predicts future research foci. The term bibliometrics was first coined by Alan Pritchard in his paper "Statistical Bibliography or Bibliometrics" published in 1969. Science mapping is the development and application of computational techniques to the visualization, analysis, and modelling of a broad range of scientific and technological activities as a whole. It aims to visually present and display the conceptual, social or intellectual structures of scientific research, and the evolution, development, and dynamics of the research area.

Literature review

Cabrera, Talamini, and Dewes (2017) conducted a bibliometric study on "What about Scientific Collaboration in Agriculture: A Bibliometric study of publications about Wheat and Potato (1996–2016)," which measures scientific collaboration in the agricultural literature. Web of Science database was used to retrieve the results. Articles published from 1996 to 2016 were searched only. The co-occurrence analysis of words showed that the word "gene" was a hot word. Visser, R.G.F with 106 articles and 493 collaborations was the most productive author. His works were focused on biotechnology, genetics, molecular biology, and plant breeding. The Agriculture Research Service Institute of the United States Department of Agriculture (USDA) published 494 articles in collaboration with 651 institutions. The United States and China were the countries that had the biggest collaboration. This study concluded that this work contributed to the understanding of scientific collaboration in the area of food safety.

Zhao et al. (2018) conducted a study titled "Bibliometric Analysis of Global Scientific Activity on Umbilical Cord Mesenchymal Stem Cells: A Swiftly Expanding and Shifting Focus" that got scientific knowledge regarding umbilical cord mesenchymal (UC-MSC) research. Publications on UC-MSCs were retrieved from the Science Citation Index-Expanded (SCI-E) of the Web of Science (WoS) from 1975 to 2017. Excel, GraphPad Prism, and VOSviewer software were used for data analysis. China was the most productive country. The top 100 UC-MSC research papers contributed to 14,252 citations, China was cited the most (6858 times) and achieved the highest H-index (43). Seoul National University in South Korea contributed most publications. The Journal Cytotherapy ranked the first (55 articles. Most articles were contributed by "W. Oh" with 31 papers. The Most cited article by "Kern" et al. Published in 2006, was the most cited article (1382 times) with an average citation of 115.17 per year. Focused keywords in the study were "characteristics," "treatments and effects." The recent hotspots in this study were "TNF-α," "migration," "angiogenesis," and "apoptosis."

Moral-Munoz et al. (2019) conducted a study titled "Production Trends, Collaboration, and Main Topics of Integrative and Complementary Oncology (ICO) Research Area: A Bibliometric Analysis" , which assessed the current trends in the field of integrative and complementary oncology. Web of Science database was used. VOS viewer and SciMAT software were used for data analysis. The Journal of Ethnopharmacology was the most productive journal. China Medical University (China) was the leading institution that produces research in the ICO field. The most productive country was China with (28.30% of documents. The scientific collaboration relationships among the leading producer showed that the United States and Japan received a higher number of citations than China, South Korea, or Taiwan. Topics such as "Apoptosis," "breast cancer," "oxidative stress," and "chemotherapy" emerged as the hot topics in this area of research. These results provided relevant information to understand the past, present, and future trends in the Integrative and Complementary Oncology Research Area field.

Polat (2019) conducted a study titled "Evolution and Future Trends in Global Research on Cadastre: A bibliometric analysis" , which got a better understanding of the existing scientific information on cadastre and contribute to the development and discussion of future trends on Cadastre. The data were obtained from the Scopus database. It was observed that there was a significant increase in the number of publications after 2000. The analysis of subject categories showed that "Earth and Planetary Science (47.1%)," "Social Sciences (34.9%)" and "Environmental Science (26.9%)" were the most popular subject areas. The most important articles with the highest number of citations were ''Analysis of land-cover transitions based on 17th and 18th-century cadastral maps and aerial photographs''. The Journal with the highest number of publications was ''Survey Review''. Germany was the most productive country. The most productive university includes ''The University of Melbourne''. The keyword and hot topics in cadastre research were ''GIS'', ''surveying'', ''mapping''. The results showed that in the future, publications on cadastre research were continued to grow and repetition of a similar study in the future allow comparison between the findings of this study and future studies.

Scope of the Study:

The proposed study is based on bibliometric analysis and science-mapping analysis of IoT. The study will attempt to analyze the interactions between scientific publications, research organizations, scientific journals, countries, researchers, keywords or terms. It will also identify new trends in the research area of Internet of things; identify the relationships of keywords, countries, authors, and journals through co-authorship, co-occurrence, citation, bibliographic coupling, and co-citation analysis reflecting upon the future directions of research.

The objective of the study:

1. To identify the most productive or influential authors, organizations, countries, and journals in the research area of IoT.
2. To analyze and demonstrate the current status and trends in the co-occurrence network, the co-authorship pattern, bibliographic coupling pattern, citation patterns, co-citation pattern in the research area of IoT.

Research Questions

This study sought the answer to the following research questions about performance analysis and science mapping of IoT literature or its research publications:

RQ1 Who are the most influential or leading contributors in terms of authors, organization, countries, and journals on the research topic of IoT?

RQ2 What are the hot topics or major keywords, the Co-authorship pattern, the Bibliographic coupling pattern and the Co-citation network patterns on IoT?

Material and Methods:

This study attempted to "analyze and visualize the literature on the research topic "Internet of Things." Secondary data were the base for this study. The source of the data was the Web of Science Core Collection database (WoS). The data will be obtained from WoS in txt. file. The analysis tool used in the study was VOSviewer. The time span was from 1989 to 2019.

An advanced search was conducted for the retrieval of data i.e. Topic Search TS = "Internet of Things" from the WoS database. A total 14,469 documents were retrieved after advanced search till 2019. The type of publication and language of documents will not be limited. All retrieved data were exported into folders as the WoS database allows export of 500 records at one time. All the records were exported into txt or tab win files. Then, all the exported records were merged into a single file. All extracted data or documents were exported into the VOS viewer software, and then the software created and visualized the maps. Analyses of the maps were providing the following information: Author productivity, Leading Journals, Citation trends, collaboration trends among authors, institutions and countries and Hot Topics in the research area of IOT. The terminology used in this study includes Clusters, Items, links, link strength and total link strength (TLS) as defined below:

Items: Items include publications, researchers, or terms.

Link: A link is a connection or a relation between two items. Each link has strength, represented by a positive numerical value. The higher this value, the stronger the link.

Network: A network is a set of items with the links between the items

Cluster: A cluster is a set of items included in a map. Clusters usually have cluster numbers 1 and 2, and so on.

Weight: The weight of an item should in some way indicate the importance of the item. In the visualization of a map, items with a higher weight are shown more prominently than items with a lower weight. There are two standard weight attributes, referred to as the Links attribute and the Total link strength attribute

Link: The number of links of an item with other items.

Total link strength (TLS): Each link has strength, the total strength of the links of an item with other items is the total link strength.

Study Limitations:

The information was retrieved from the Web of Science database only as all information not be identified from one database.

Result:

Analysis of Publication Output and their Growth Trends

It was observed from Fig.1 that IoT as a research topic was started gaining attention from 2010 onward with 37 documents, in 2012 it crossed a hundred documents, in 2016 it crossed one thousand documents, 2017 it crossed two thousand documents, 2018 it covered three thousand plus documents and in 2019 it covered five thousand plus documents. We have observed an increasing number of publications on IoT literature every year.

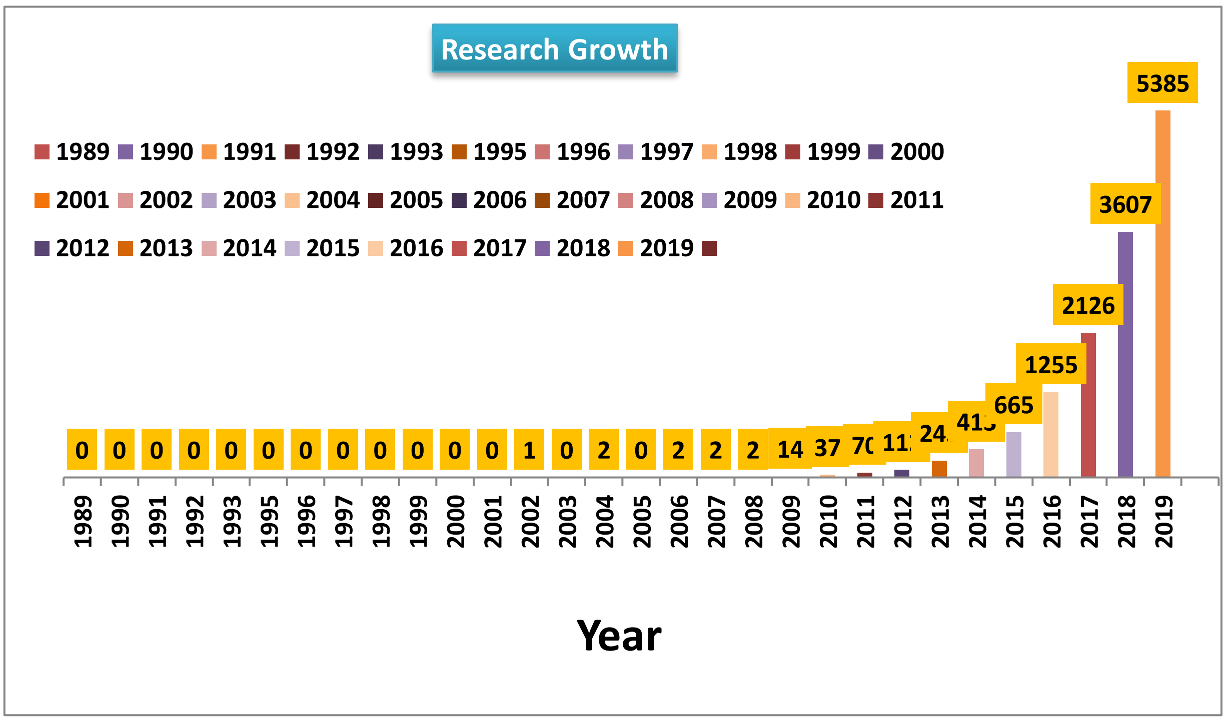

Fig1. Emerging Trends in the number of documents published on Internet of IoT.

Leading authors, countries, institutions and Journals

Most productive author

There were 36220 authors who have published on IoT literature, out of which Joel J. P. C Rodrigues was the most productive author. After analysing the data by using VOSviewer software Table.1 and Fig. 2, we see that Joel J. P. C Rodrigues with 73 documents, 713 citations and 143 Total Link Strength (TLS) was the most productive author written on IoT literature followed by Kim-Kwang Raymond Choo with 60 documents, 728 citations and 104

TLS. Guizani, Mohsen was placed third with 60 documents, 2445 citations, 138 TLS followed by Laurence Yang with 53 documents, 1246 citation, 96 TLS, and Neeraj Kumar with 51 documents, 848 citations,133 TLS.

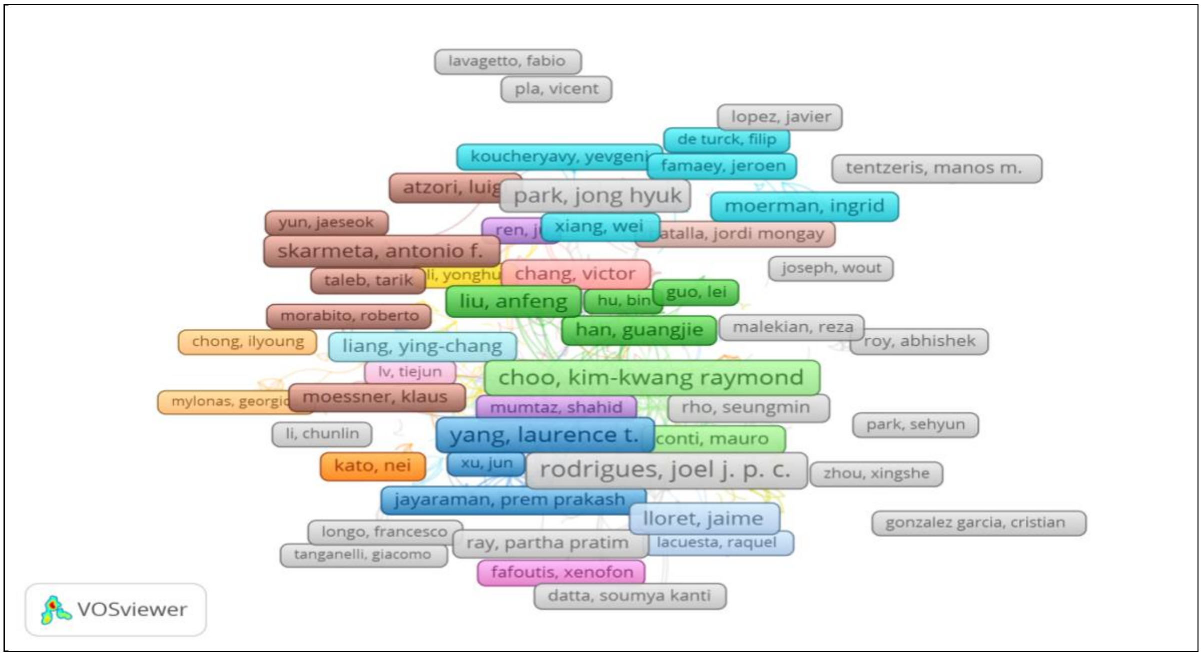

Fig. 2. Network visualization analysis of the most productive authors published in the literature of IoT.

Fig.2 represents the network visualization analysis of the most productive authors published in the literature of IoT. Items (Label or frames or circles) represented in the network visualization show the authors published on IoT literature. The size of an item (Label or circle or frame) determined by the weight of the item. The higher the weight (importance) of an item, the larger the circle or frame of the item.

*Item (Frame)= Author

*Weight= Importance of the author in terms of their productivity (documents)

Table 1 Top 10 most productive authors published on IoT

SN	Author	Documents	Citations	TLS
1	Joel J. P. C. Rodrigues	73	715	142
2	Mohsen Guizani	60	2445	138
3	Kim-Kwang Raymond Choo	60	728	104
4	Laurence t. Yang	53	1246	97
5	Neeraj Kumar	51	848	133
6	Houbing Song	42	814	87
7	Sherali Zeadally	41	1312	38
8	Arun Kumar Sangaiah	40	437	73

9	Jong hyuk Park	40	255	43
10	Huansheng Ning	38	736	73

TLS=*Total link Strength*

Highly cited author

Analysis of bibliographic data by VOSviewer software reveals that Luigi Atzori was the highly cited author in the research field of IoT (Table 2. and Fig.3). Luigi Atzori was the highly cited author with 22 documents, 6351 citations and 2153 TLS followed by Antonio Iera with 18 documents, 6128 citations, 1934 TLS. Giacomo Morabito was placed third with 11 documents, 5919 citations and 1719 TLS followed by Li Xu da with 31 documents, 5028 citations, 2358 TLS.

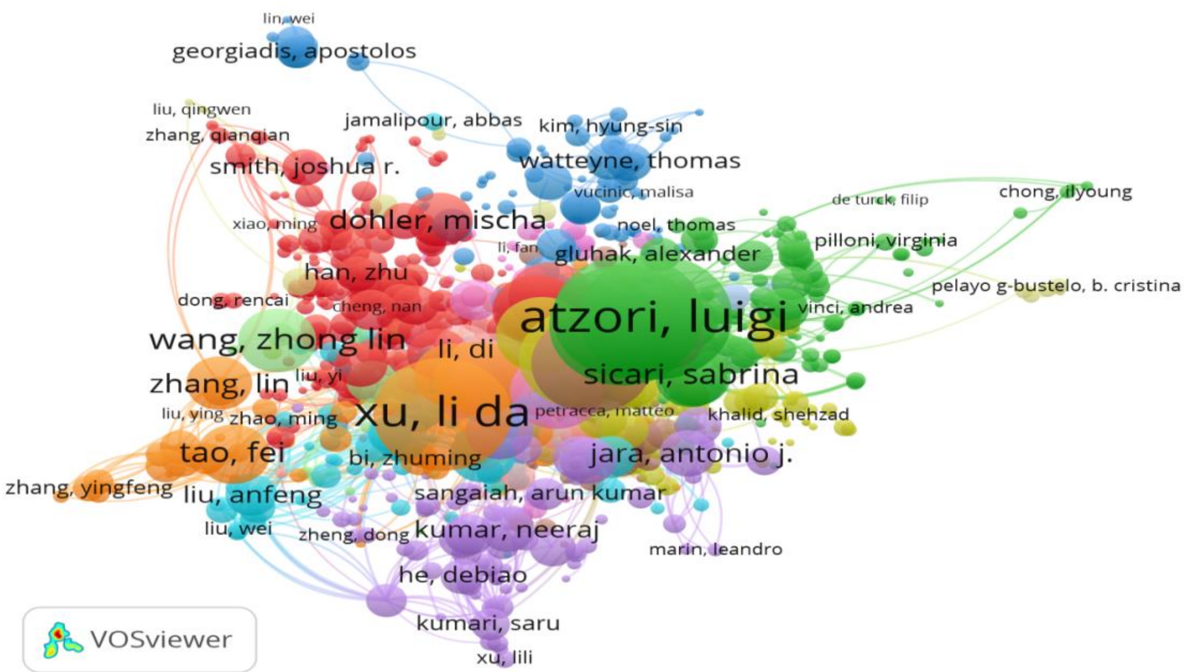

Fig. 3. The network visualization map of highly cited authors in the research area of the IoT.

Fig.3. represents the network visualization map of most-cited authors in the research area of the IoT. In the fig, Circles represent the cited authors. The size of an item (Label or circle or frame) determined by the weight of the item. The higher the weight (importance) of an item, the larger the circle or frame of the item.

*Item (Circles)= cited authors

*Weight= In terms of the number of citations of an author

Table 2 Top 10 highly cited authors published on IoTs

SN	Author	Documents	Citations	TLS
1	Luigi Atzori	22	6351	2153
2	Antonio Iera	18	6128	1934
3	Giacomo Morabito	11	5919	1719
4	Li da Xu	31	5028	2358
5	Rajkumar Buyya	33	4072	1381
6	Marimuthu Palaniswami	10	3977	1043
7	Mohsen Guizani	60	2445	1904
8	Shancang Li	14	2072	999
9	Athanasios V. Vasilakos	30	2061	1202
10	Ala Al-fuqaha	10	1929	940

Leading countries

The People's Republic of China was the leading or most productive country in the field of IoT. After analyzing Table 3. and fig 4. we observed that the People's Republic of China with 4346 documents, 46016 citations, 3105 TLS appeared as the most productive country published on the literature of IoT followed by the USA with 2754 documents, 48763 citations, 2701 TLS, South Korea with 1419 documents, 10727 citations, 836 TLS, England with 1099 documents, 17698 citations, 1442 TLS and India with 918 documents, 6990 citations and 683 TLS.

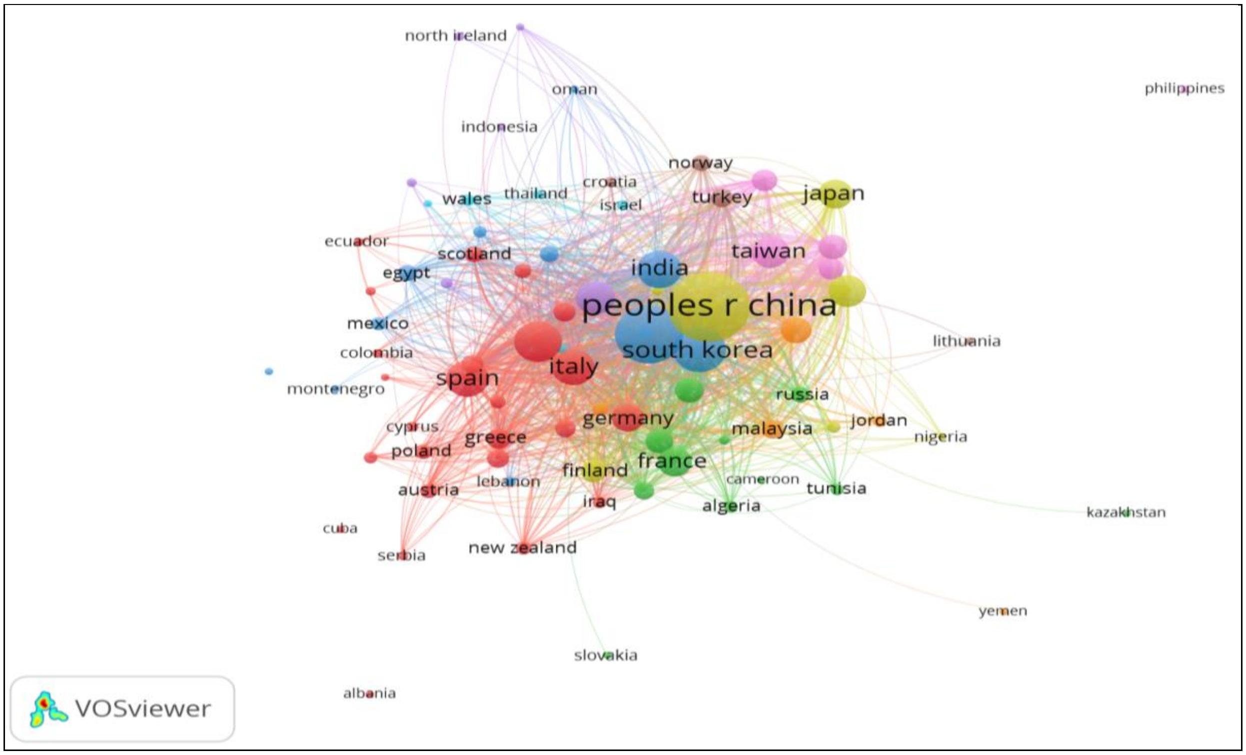

Fig. 4 The network visualization map of the most productive countries in the research area of IoT.

Fig. 4. shows the network visualization map of the most productive countries in the research area of the IoT. Items (circles) represent the countries. The size of an item (Label or circle or frame) determined by the weight of the item. The higher the weight (importance) of an item, the larger the circle or frame of the item.

*Item (Circles) = Country

*Weight= In terms of productivity of a country (documents)

Table.3 Top 10 most leading countries publishing on IoT

SN	Country	Documents	Citations	TLS
1	People's Republic of China	4346	46016	3105
2	USA	2754	48763	2701
3	South Korea	1419	10727	836
4	England	1099	17698	1442
5	India	918	6990	683
6	Italy	877	22046	766
7	Spain	838	10038	660
8	Australia	667	12294	883
9	Canada	646	7434	855
10	Taiwan	618	4437	401

Leading Sources

IEEE Internet of things Journal was the most active or most productive journal publishing on IOT literature. Table 4 and Fig. 5 represents that IEEE Internet of things journal was the most active or most productive journal with 1236 documents, 17214 citations followed by IEEE ACCESS with 1184 documents, 10531 citations. Sensors was on the third place with 993 documents, 6337 citations, followed by Future generation computer systems-the international journal of e-science with 421 documents, 8469 citations and International journal of the distributed sensor network with 292 documents, 1615 citations.

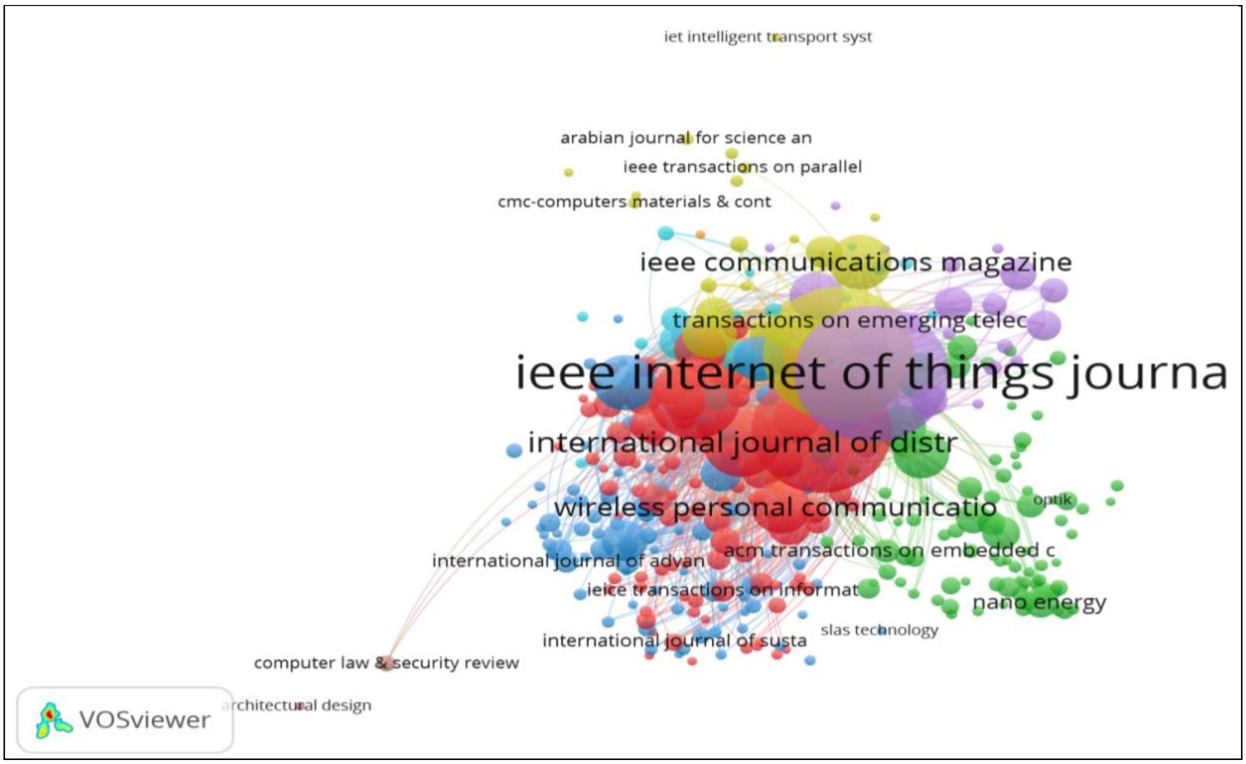

Fig. 5. The network visualization map of the most productive journals in the research area of the IoTs.

Fig. 5 shows the network visualization map of the most productive journals in the research area of the IoT. Circles represent the sources. The size of an item (label or circle or frame) determined by the weight of the item. The higher the weight (importance) of an item, the larger the circle or frame of the item.

*Item Circles = Sources

*Weight= In terms of the number of documents published.

Table 4 Top 10 most productive Journals publishing in the research area of IoT

SN	Journals	Documents	Citations	TLS

1	IEEE Internet of things journal	1236	17214	8221
2	IEEE access	1184	10531	7166
3	Sensors	993	6337	4966
4	Future generation computer systems	421	8469	4033
5	International journal of distributed sensor networks	292	1615	1029
6	IEEE transactions on industrial informatics	208	6669	2651
7	IEEE communication magazine	203	7953	2242
8	Wireless personal communications	178	1396	965
9	IEEE sensors journal	159	2541	1134
10	Computer networks	156	8445	3537

Leading Organizations

Table 5.and fig.6. represents that the Chinese Academy of Sciences was the leading institution with 311 documents, 8129 citations, 6667 TLS followed by Beijing University of posts & telecommunications 284 documents, 2219 citations, 3173 TLS. King Saud University was placed third with 204 documents, 2770 citations, 4361 TLS, Xidian University with 170 documents, 1627 citations, 2291 TLS and Huazhong university of science & technology with 143 documents, 2971 citations, 2370 TLS.

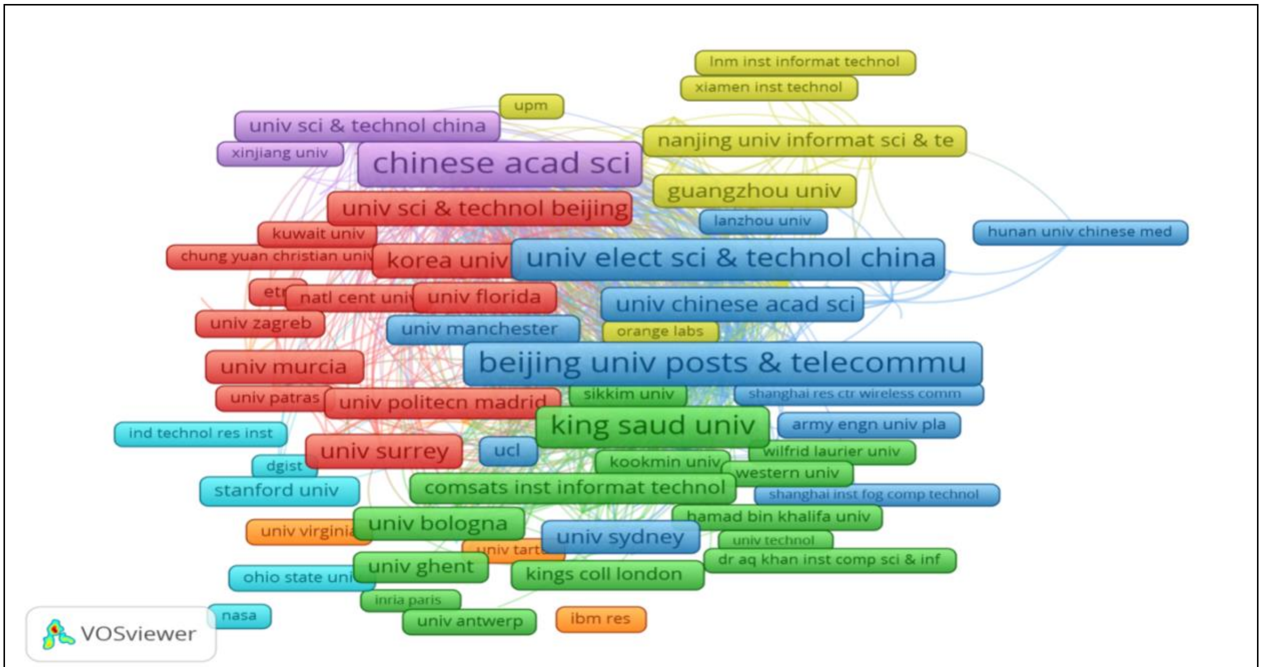

Fig.6 The network visualization map of leading organizations in the research area of the IoT.

Fig.6 shows the network visualization map of leading organizations in the research area of the IoT. Frames represent the organizations. The size of an item (node or circle or frame) determined by the weight of the item. The higher the weight (importance) of an item, the larger the circle or frame or node of the item.

*Item (frames) = Organizations

*Weight= In terms of production of documents

Table 5. Top 10 most productive Organizations publishing on IoT

SN	Organization	Documents	Citations	TLS
1	Chinese academy of sciences	311	8129	6667
2	Beijing University of posts & telecommunications	284	2219	3173
3	King Saud university	204	2770	4361
4	Xidian university	170	1627	2291
5	Huazhong university of science & technology	143	2971	2370
6	Shanghai Jiao Tong university	143	5038	4553
7	Dalian University of technology	126	2207	2372
8	Georgia Institute of technology	123	3137	1400
9	Nanyang technological university	123	1443	1757
10	Beihang university	105	2531	2132

Co-authorship of Countries

The relatedness of the two authors can be measured by the number of documents they have co-authored. It can be used to study scientific cooperation or collaboration between authors, organizations, and countries (Eck, & Rousseau, 2014). Country co-authorship analysis reflects the degree of communication and collaboration between the leading or most productive countries on the internet of things literature. Figure 7 represents country co-authorship analysis. The minimum number of documents of a country was 50 and citation was also 50, out of 118 countries 47 meet the threshold. It showed that primary production was concentrated in the People's Republic of China. It was also observed that China was having TLS of 3105 with other countries. It has a strong connection with the USA, England and Australia. The link strength between China and USA was 900, China and England were 263, China, and Australia were 244. It also showed strong connections with Canada, South Korea, Italy, India, Spain, France and other countries. Overlay visualization showed the countries contributing in the research area of IoT literature by year of publication, which showed that India, Pakistan, Iran, Iraq, Turkey and Qatar were the latest countries published on IoT literature. It showed that scientific research on the IoT has no geographical limitations. More cooperation brings more achievements in scientific research.

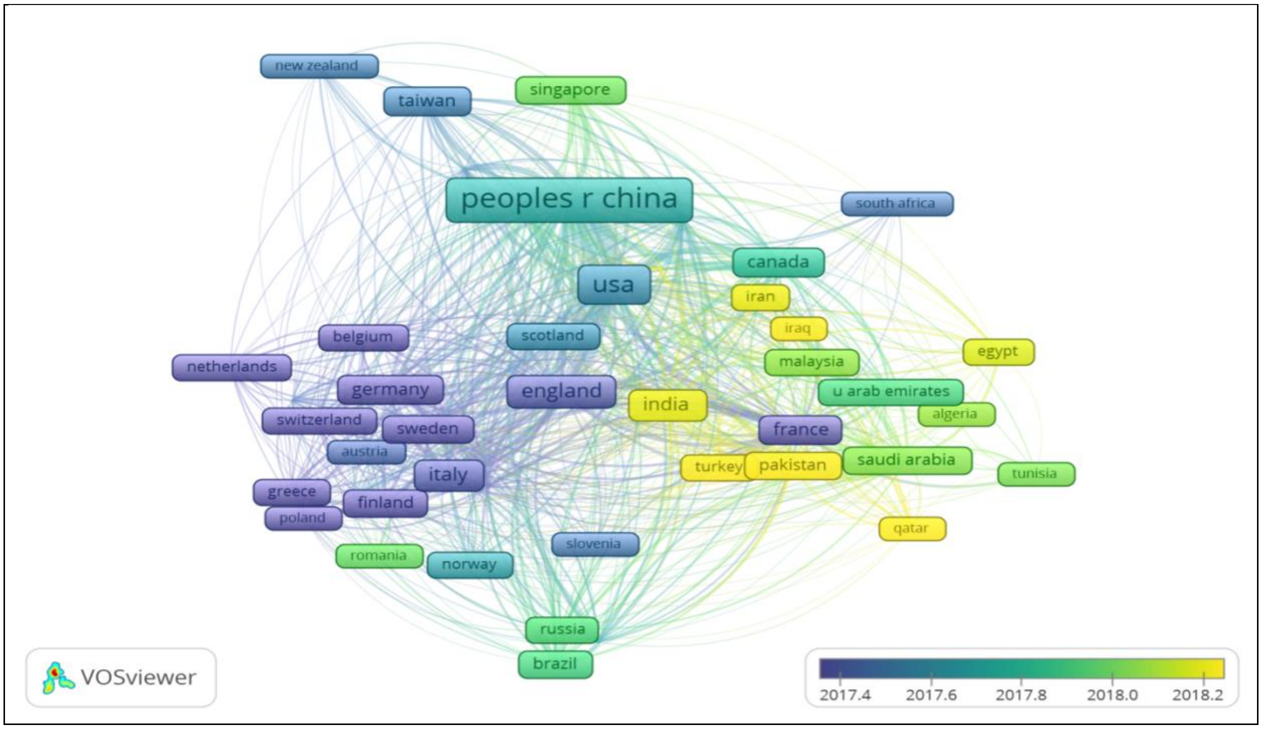

Fig.7 The overlay visualization map of country co-authorship in the research area of IoT.

Fig.7 represents the overlay visualization map of country co-authorship network in the research area of the IoT. Frames in the map represent the country. The higher the weight of an item, the larger frame or the circle of the item. Lines between items (countries) represent links between these items.

*Items (Frames)= countries

*Weight= In terms of connection or relatedness of countries

Bibliographic coupling of Institutions

In the bibliographic coupling approach, two works refer to the common work(s), then the relation between two referring documents is called Bibliographic coupling (Kessler 1963). Bibliographic coupling of institutions presented in Figure.8 with overlay visualization. Institutions that have a minimum number of 10 documents and the minimum number of 10 citations were included. Out of 7268 organizations 684 meet the threshold, for all 684 organizations the TLS of bibliographic coupling links and number of publications and citations were calculated. The 10 organizations with highest TLS were selected. The Chinese Academy of Sciences was the most influential organization with 311 documents, 8129 citations and 378106 TLS. Beijing University of posts & telecommunications was the second most influential university with 284 documents, 2219 citations, 265430 TLS followed by King Saud University with 204 documents, 2770 citations and 260278 TLSs, Shanghai Jiao Tong university with 143 documents, 5038 citations, 186573 TLS, Old dominion university with 61documents, 5947 citations and 177663 TLS. According to overlay visualization, yellow frames represented organizations that have recently been published on China's topic IoT such as the University of electronic science & technology of, Guangzhou University, Army engineering University, Shanghai tech University.

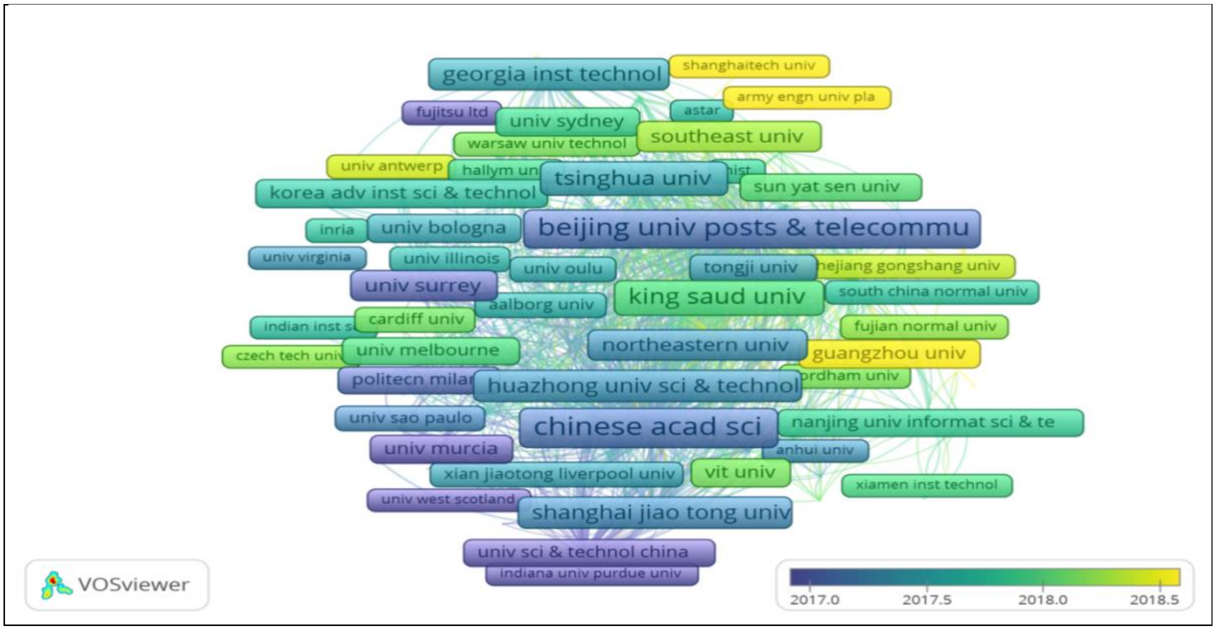

Fig.8 The overlay visualization map of bibliographic coupling of institutions in the research area of the IoT.

Fig.8 represents the overlay visualization map of bibliographic coupling of institutions in the research area of the IoT. Items (Frames) in the map represent the organizations. The higher the weight of an item, and the larger frame or the circle of the item. Lines between items (countries) represent links between these items.

*Items (Frames) = Organizations

*Weight= In terms of connection or relatedness of organizations

Co-citation Analysis of cited Sources

Co-citation is defined as the frequency with which two documents are cited together by other documents. If at least one other document, two documents in common these documents are said to be co-cited. The more co-citations two documents receive, the higher their co-citation strength, and the more they are semantically related (Eck & Rousseau 2014).

Co-citation analysis of cited sources on the IoT is represented in Figure 9. The map included the sources that have received the minimum number of 50 citations and 100 TLS between other sources. Out of 11,2316 sources, 1153 meet the threshold. In the network visualization map, we observed that sources were concentrated in different colors like red, yellow, green and blue. The map represented that sources concentrated in red were highly cited sources compared to sources concentrated on other colors were less cited sources. Sources concentrated on Red included sources such as Lecture notes computer science with 8612 citations and 261166 TLS, IEEE Internet of things with 8538 citations and 297292 TLS. IEEE communications magazine was placed third with 8189citations and 327639 TLS. The yellow cluster included sources such as IEEE wireless communications with 4740 citations and 175669 TLS, IEEE journal on selected areas in communications with 3605 citations and 143329 TLS. The green cluster included sources such as IEEE transactions on industrial informatics with 4806 citations and 173486 TLS, Expert systems with applications with 1283 citation and 48802 TLS and International Journal of production research with 1052 citations and 59571 TLS. Blue cluster included sources such as IEEE sensors journal with 3228 citations and 143225 TLS, IEEE journal of solid-state circuits with 2206 citations and 47280 TLS and Nature communications with 1350 citations and 90918 TL

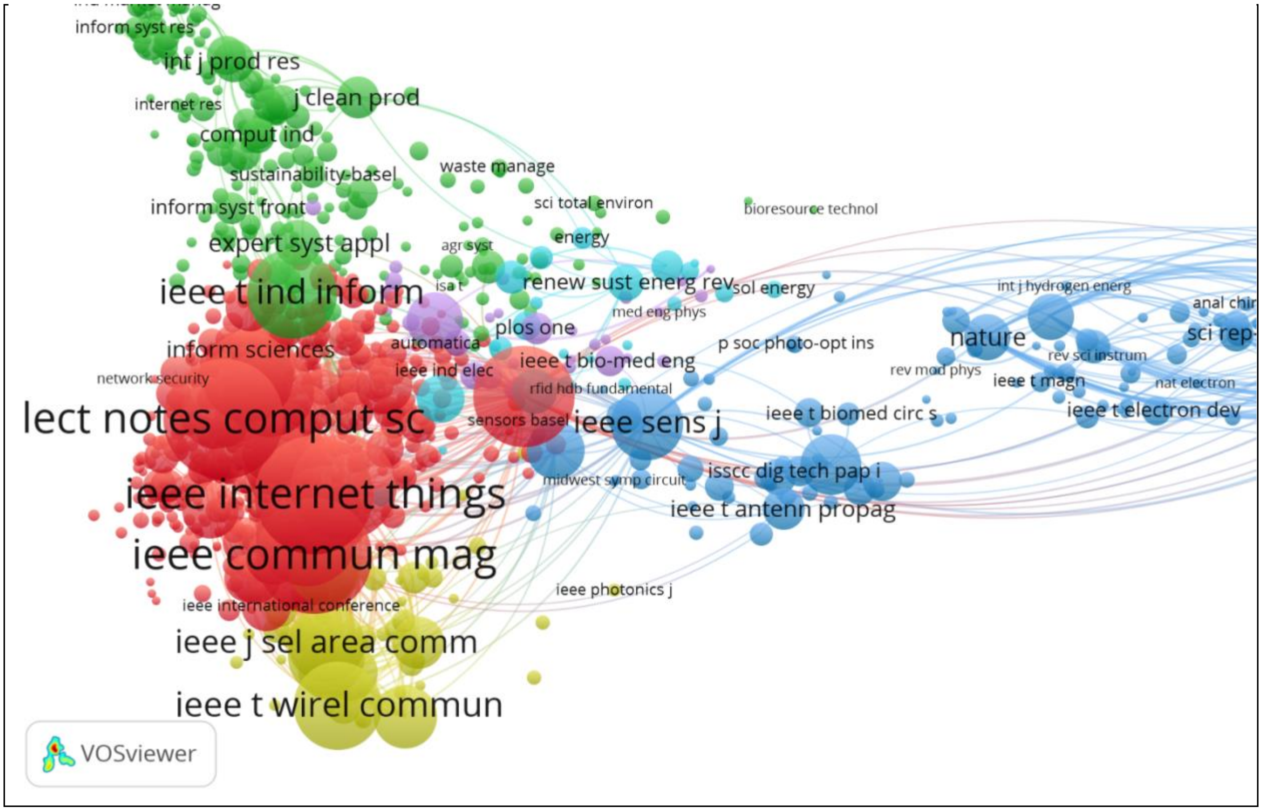

Fig.9 network visualization map of co-citation of cited sources in the research area of the IoT.

Fig.9 represents the network visualization map of co-citation of cited sources in the research area of the IoT. Items (circles) represent the organizations. The size of an item (Label or circle or frame) determined by the weight of the item. The higher the weight (importance) of an item, the larger the circle or frame of the item. Lines between items (sources) represent links between these items.

*Item (circles) = cited sources

*Weight= In terms of connection and relatedness of cited sources

Co-occurrences of Keywords:

The keyword of an article can represent its main content, and the frequency of occurrence and co-occurrence can reflect themes that focus on a special field to some extent (Zong 2013). Figure.10 shows network visualization of co-occurrence of keywords in the research area of IoT. The minimum number of occurrences of keywords was 10. Out of the 35384 keywords, 1183 meet the threshold.

Eight clusters are identified in Figure 10, each cluster indicates the following themes:

Cluster.1 (Red, 247 keywords): represented network *optimizations in the IoT*. The most frequent keywords in cluster 1 were the *Internet of things* and other keywords in the cluster included are networks, systems, communication, 5G, communication, resource allocation, transmission, performance analysis, etc.

Cluster.2 (Green, 195 keywords) IoT was the prevailing concept in this cluster. Represents the *IoT: How it works*. Keywords included in cluster 2 are Internet of things, machine learning, tracking, Zigbee, DDoS, wearable etc.

Cluster 3. (Blue, 169 keywords) *challenges* were the focus keyword in this cluster. Other keywords frequently co-occurred were framework, big data, cyber-physical systems, model, management, technology, etc.

Cluster 4. (Yellow, 146 keywords) *Design* was the prominent keyword in this cluster. Other keywords included in this cluster were system, performance, energy, sensors, power, devices, efficiency, etc.

Cluster 5. (Violet, 122 items) *Interne*t was the main keyword. Other words included architecture, cloud computing, cloud, fog computing, middleware, etc.

Cluster 6. (Turquoise, 107 keywords) *Security* was the main word in this cluster. Other words included in this cluster were privacy, authentication, scheme, protocol, block chain, efficient, attacks, encryption, etc.

Cluster 7. (Orange, 11 keywords) *Clustering* is the main keyword for this clustering. Other words included were Map Reduce, particle, swarm, etc.

Cluster 8. (Brownish, 3 keywords) *Policy, prototype, data were* the main keywords.

From all above clusters, it was observed that *Internet of Things (3975)* was the main keyword, followed by *Internet* (2343), *Things* (1324), *security* (1030), *wireless sensor network* (833), *Design* (763).

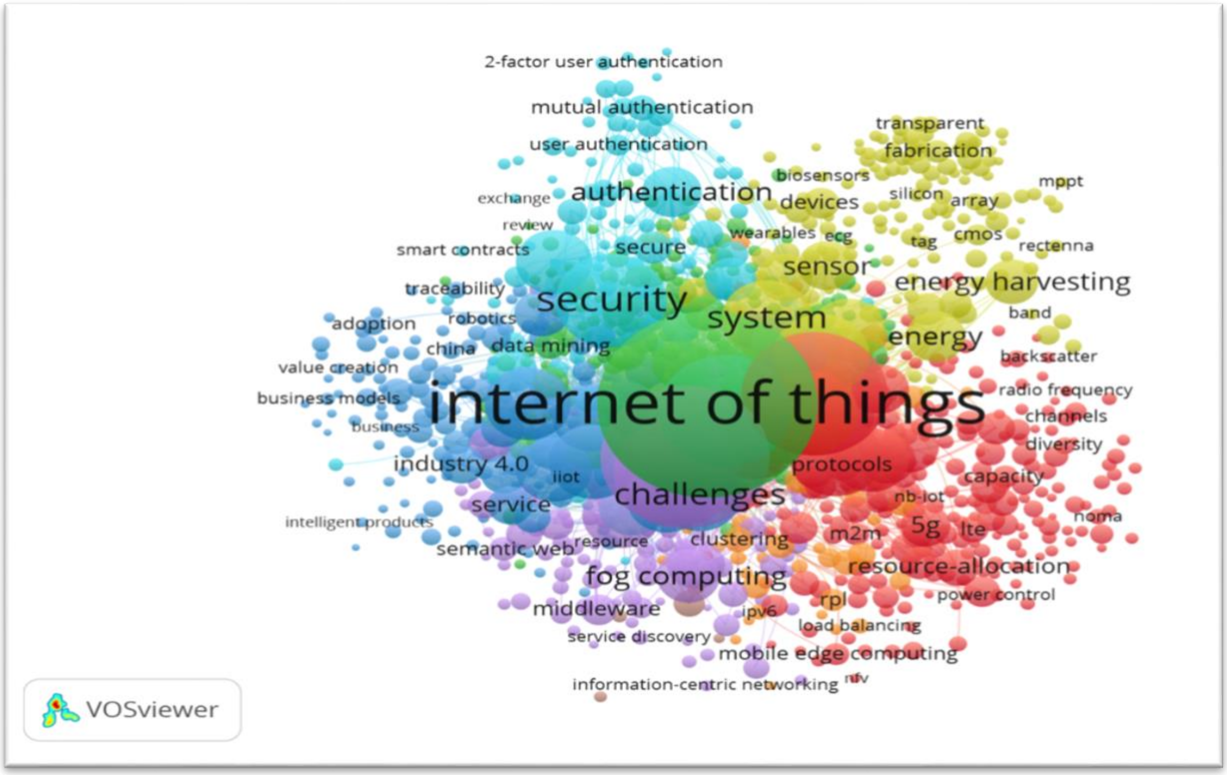

Fig.10 The network visualization map of co-occurrence of keywords in the research area of the IoT.

Fig.10 represents the network visualization map of Co-occurrence of keywords in the research area of IoT. Items (circles) represent the keywords. The size of an item (Label or circle or frame) determined by the weight of the item. The higher the weight (importance) of an item, the larger the circle or frame of the item. Lines between items (keywords) represent links between these items.

*Item (circles) = Keywords

*Weight= In terms of frequency of co-occurrence of a keyword

Conclusion:

In this study, we have presented the bibliometric and science mapping analysis of research area of IoT. The data were collected from the WOS database and VOSviewer software was used to analyze the data. Our bibliometric and science mapping analysis includes the publication trends, most productive authors, institutions, journals, countries. This study analyzes the co-authorship analysis of countries, the Keyword analysis of author keywords, the bibliometric coupling of institutions and the co-citation of sources with network visualization or maps. The result indicates an increase in publication trends, especially from 2010. In terms of most productive author Joel J.P.C Rodrigues was the most productive author. Luigi Atzori was the highly cited author. The most productive country was the People's Republic of China. The most influential journal was the IEEE Internet of things journal. Chinese academic science was the most prolific institution in the field of IoT. The co-authorship analysis of countries represented that the People's Republic of China showed strong collaboration with the USA, England and Australia as well as with other countries like Canada, India, Iran. Keyword analysis indicated that keywords that were more frequently co-occurred in the area of IoT were Internet of things, Internet, security, wireless sensors, etc. In terms of Bibliometric coupling, top institutions included Chinese academic science followed by Beijing university posts & telecommunication and King Saud University, etc. The most co-cited sources included Lecture notes computer science, IEEE Internet of things journal and IEEE communications magazine.

From the above results, we have obtained useful information on the literature of the Internet of Things (IoT) through bibliometric and science mapping analysis. We hope this research on the Internet of things will be helpful for researchers who want further knowledge in the research area of the Internet of Things.

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