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Priyanka Tupe-Waghmare

Symbiosis International University, priyanka.tupe@sitpune.edu.in

Sanjeev Kumar Prof.

Symbiosis International University, sanjeevkumar@sitpune.edu.in

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Bibliometric Survey on Reconfigurable Antenna for MIMO systems

Priyanka Tupe-Waghmare*¹, Sanjeev Kumar²

Symbiosis Institute of Technology (SIT), Symbiosis International (Deemed University),

Pune-412115, India

*priyanka.tupe@sitpune.edu.in*¹, *sanjeevkumar@sitpune.edu.in*²

ABSTRACT

The aim of this study is to analyse the work done on the frequency and polarization reconfigurability of antenna for various design types using the bibliometric study methods. Different articles on reconfigurable antennas for MIMO systems were retrieved using SCOPUS which is one of the most popular databases. The research articles published between 2004 to 2020 were considered and Scopus Analyser was used to fetch the analysis results namely document by source, author, subject, year and country. In the currently available literature, a lot of survey articles on the reconfigurable antennas and MIMO systems is available but there is no bibliometric analysis conducted till date. Hence, this in this article, the bibliometric study with an emphasis on the reconfigurable antennas and their applications in the MIMO systems is undertaken. The aim of this article is to explore the present research conducted referring to the articles published each year, keywords used over time, topmost keywords used each year, journals publishing most papers over time and each year as well. The data that is articulated will support the basic understanding of the topic and emphasize the fact that there is an enormous opportunity for the research clusters to explore the field of reconfigurable antennas.

Keywords: Reconfigurable antenna, MIMO systems, survey, wireless systems, RF current, polarisation, frequency, Scopus, Bibliometric.

1. Introduction

Reconfigurable antenna is the type of antenna which has an ability to dynamically modify its radiation and frequency properties in a precise and reversible method [6]. To achieve this dynamic response, the reconfigurable antennas integrate the varactor diodes, actuators and RF switches to facilitate the deliberate redistribution of the RF currents over the surface of the antenna in order to produce reversible alterations to the properties. The differentiating factor of the reconfigurable antenna compared to the smart antenna is that the mechanism of the reconfiguration lies in the internal part rather than in the external

network. In order to satisfy the ever-changing scenarios and operating requirements, the reconfiguration ability of the reconfigurable antennas is used. Reconfigurability with respect to polarisation is an important aspect in case of MIMO systems as they require multiple inputs in order to reduce fading. The typical antennas pose a limit to the level of intelligence that can be introduced to the MIMO systems as their characteristics are fixed for certain functionalities [1,2]. Subsequently, the realisation of MIMO antennas is an emerging area in the wireless domain with solutions that offer compliance to the ever-changing requirements of the wireless environment [3,4].

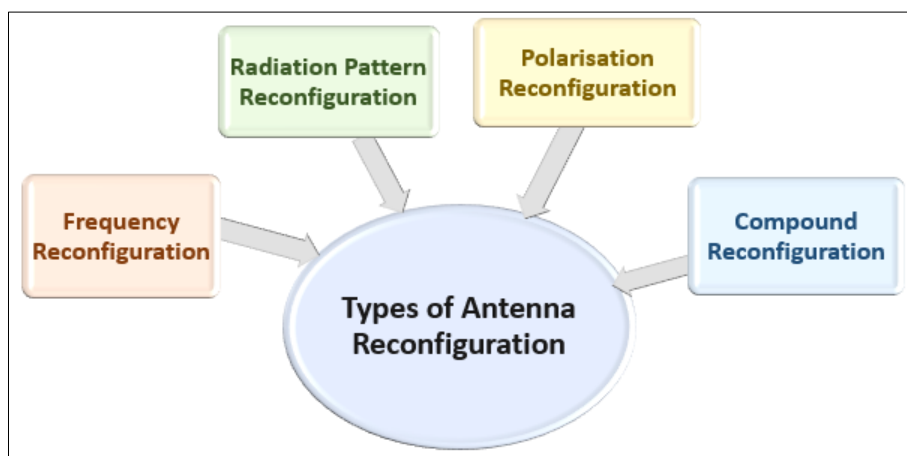


Fig. 1: Types of Antenna Reconfiguration

The reconfigurable antennas can be distinguished on the basis of the antenna parameters like polarisation, frequency of operation or pattern of the radiation and can be adjusted dynamically. Fig. 1 shows the types of the antenna reconfiguration viz.- frequency reconfiguration, radiation pattern reconfiguration, compound reconfiguration and polarisation reconfiguration. Operating frequency can be varied dynamically in case of frequency reconfiguration which is achieved by making electrical and physical alterations to the dimensions of the antenna. Calculated alterations are made on the spherical distribution in the radiation pattern reconfiguration in order to maximize the gain of the antenna. Switching between vertical, horizontal and circular polarization in order to reduce the mismatch loss is achieved using polarisation reconfiguration antennas and ability to simultaneously tune various antenna parameters is achieved using compound reconfiguration antenna [1-15].

2. Preliminary Data Collection

This article is framed by sending a query to the SCOPUS database using main keywords like Reconfigurable antennas AND MIMO systems as shown in Table 1.

Table 1 Query sent to the SCOPUS database

Primary Keywords	"Reconfigurable Antenna"
Secondary Keywords	"MIMO systems" AND "Compact Antenna" AND "Polarisation" AND "Radiation Pattern"

(Source: Scopus DB accessed on 31st December 2020)

Using the aforementioned query string, we retrieved 221 publications from the Scopus database which were in English, 5 in Chinese and 1 in Russian language. Table 2 shown below indicates the publication count for each language.

Table 2 Details of the Language used for Publication

Language of Publication	Total Count
English	221
Chinese	5
Russian	1

(Source: Scopus DB accessed on 31st December 2020)

3. Bibliometric Information and Performance Analysis

The information regarding the query posted on the Scopus database is obtained in the .csv file format. The information that is retrieved for the same is expressed using the following details used for further analysis –

- 1) The statistical analysis of the databases is done considering the documents by – prominent authors, source, year, subject area, type, contributing country, key affiliations and funding sponsors.
- 2) Another important aspect to be highlighted is the representation of the data fetched from the Scopus database in the form of network diagrams and graphs. The information used for the same is based on the co-authorship (authors, organisations, country), co-occurrence (all keywords, author keywords, index keywords), citation analysis (source, author, organisations, country) and bibliographic coupling (documents, authors).

4. Results and Discussion

4.1 Preliminary Data Analysis

Fig. 2 shows the count of the publication from 2004 to 2020. There is a significant increase in the publications from the year 2010 to 2020 which was not observed from 2004 to 2009. This implies that there is a significant surge in this research area till 2018.

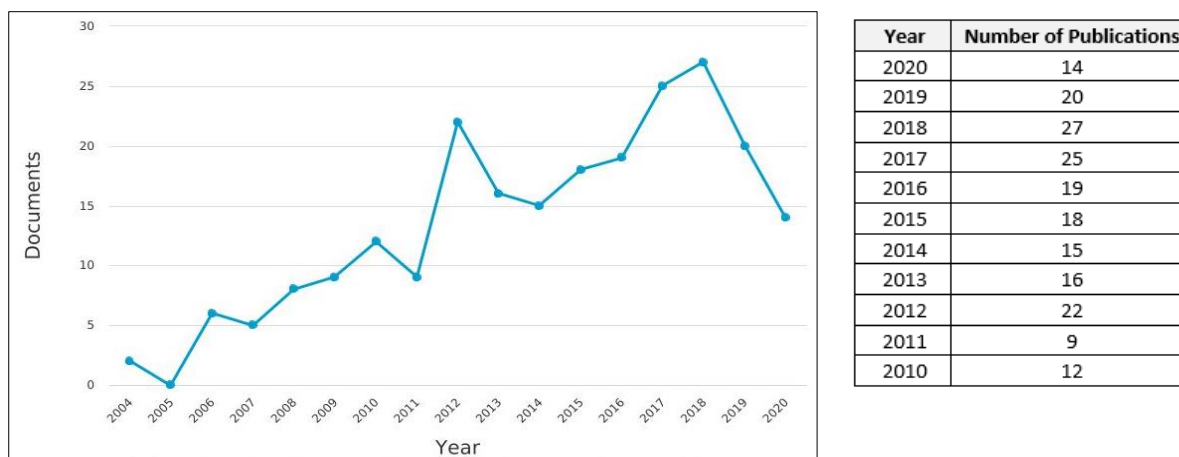


Fig. 2: Yearwise Publication Count
(Source: Scopus DB accessed on 31st December 2020)

Fig. 3 shows the eminent authors with a significant contribution in this research area. The first author has maximum number of Scopus documents (25) on his name where as other second, third and fourth authors have more than 10 documents. The remaining ones have documents varying from 5 to 10 on their name. This clearly points to the scope of this research area and the contribution of the authors towards the same.

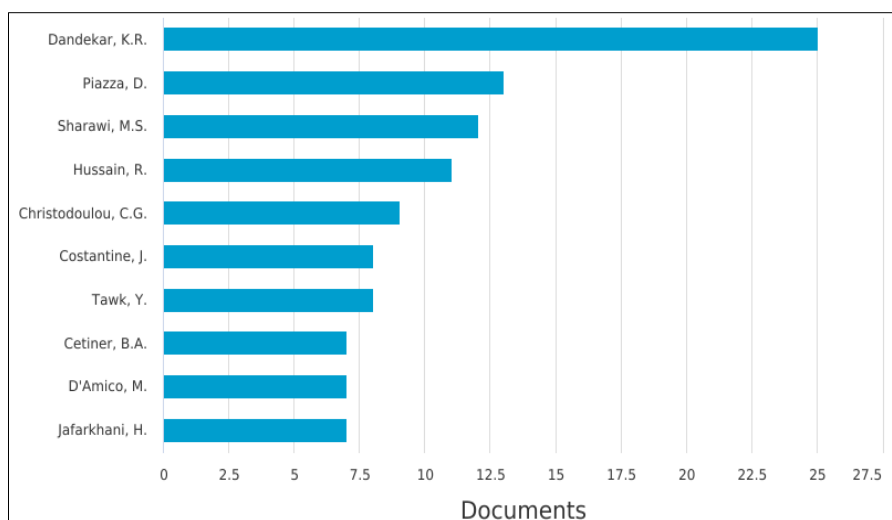


Fig. 3: Prominent Authors (Source: Scopus DB accessed on 31st December 2020)

From the Fig. 4 it is observed that the most popular source titles were *IEEE Transactions On Antennas And Propagation*, *IEEE Antennas And Wireless Propagation Letters*, *IEEE Antennas And Propagation Society AP S International Symposium Digest* and *Microwave And Optical Technology Letters*. While *IEEE Transactions On Wireless Communications* and *IEEE Access* also had significant number of documents.

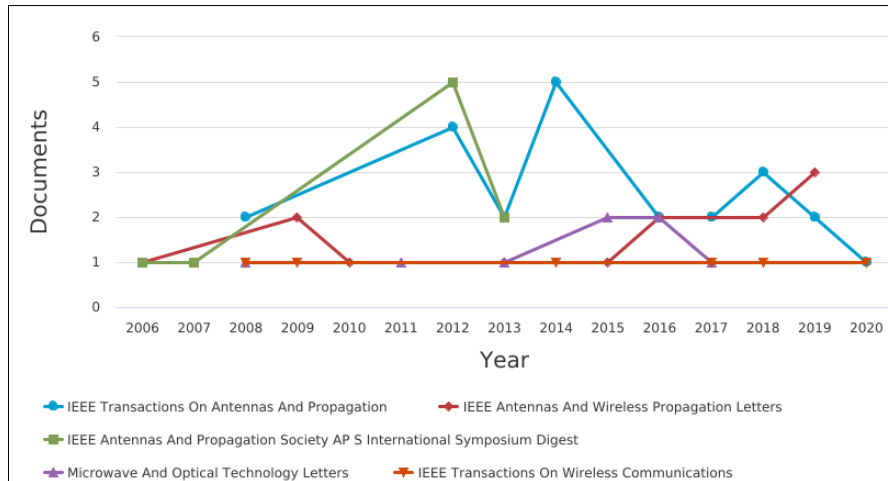


Fig. 4: Documents per year by Source.
(Source: Scopus DB accessed on 31st December 2020)

Referring to Fig. 5, it can be observed that the maximum number of publications are from - Drexel University, King Fahd University of Petroleum and Minerals and University of California, Irvine whereas Fig. 6 indicates that maximum number i.e., 76 publications are from the USA followed by China, Canada and Germany.

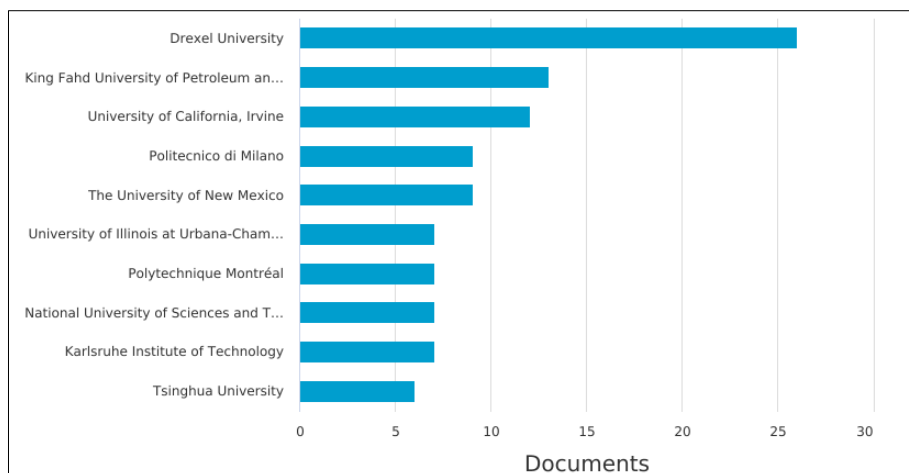
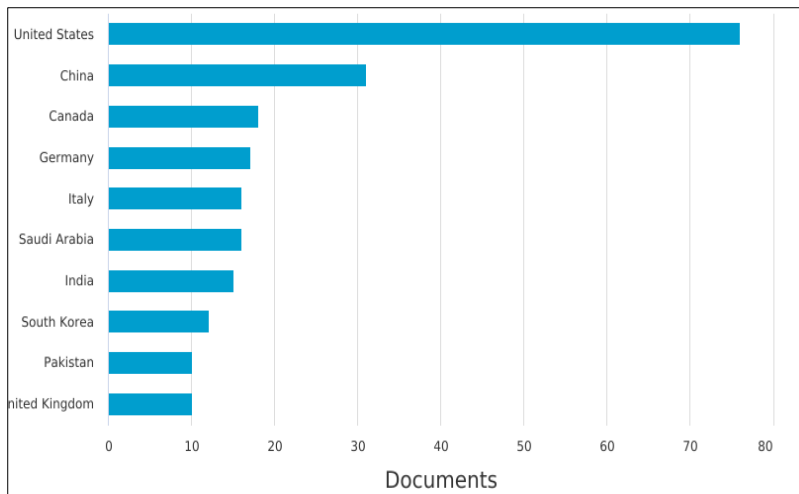


Fig. 5: Documents by Affiliation.
(Source: Scopus DB accessed on 31st December 2020)



Country / Territory	Publications
United States	76
China	31
Canada	18
Germany	17
Italy	16
Saudi Arabia	16
India	15
South Korea	12
Pakistan	10
United Kingdom	10

Fig. 6: Documents by Country or Territory.
(Source: Scopus DB accessed on 31st December 2020)

Fig. 7 indicates maximum number i.e. 113 conference papers and 104 articles are published followed by 4 conference review, 3 book chapters and 2 reviews. Apparently, the count of the editorial and the review is less which has significant scope for improvement.

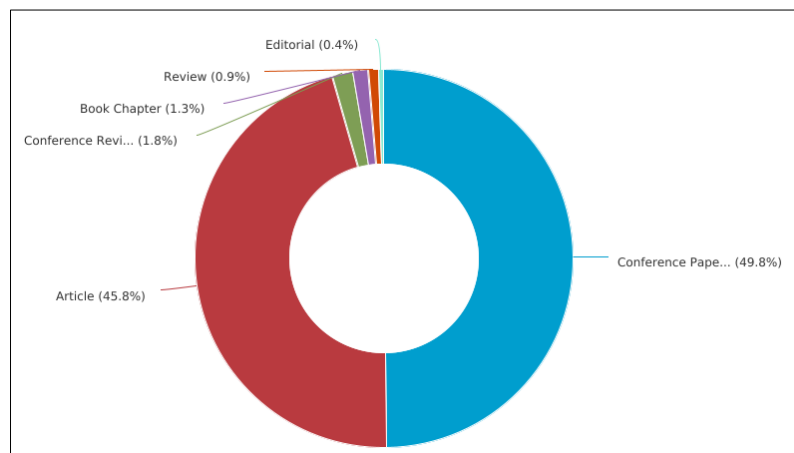
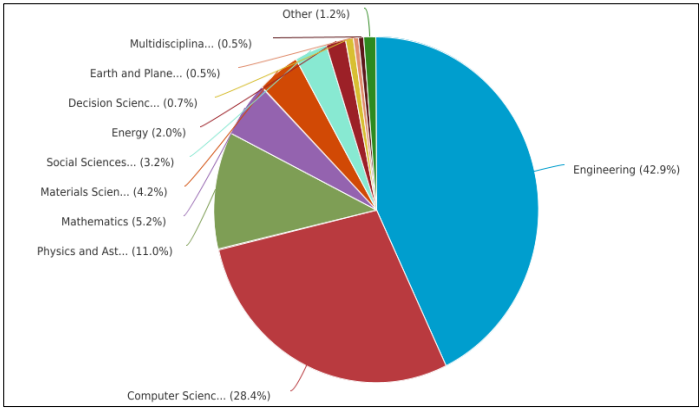


Fig. 7: Documents by Type. (Source: Scopus DB accessed on 31st December 2020)

Fig. 8 indicates that Engineering and Computer Science are the top contributing areas with 172 and 114 documents respectively followed by Physics, Astronomy, Mathematics, Material Science and Social Sciences. Energy being on the lowest research groups.



Subject Area	Publication
Engineering	172
Computer Science	114
Physics and Astronomy	44
Mathematics	21
Materials Science	17
Social Sciences	13
Energy	8

Fig. 8: Documents by Subject Area
(Source: Scopus DB accessed on 31st December 2020)

Fig. 9 indicates that the main funding agencies that has sponsored the research work is National Science Foundation followed by National Natural Science Foundation of China, King Fahd University of Petroleum and Minerals and Air Force Office of Scientific Research

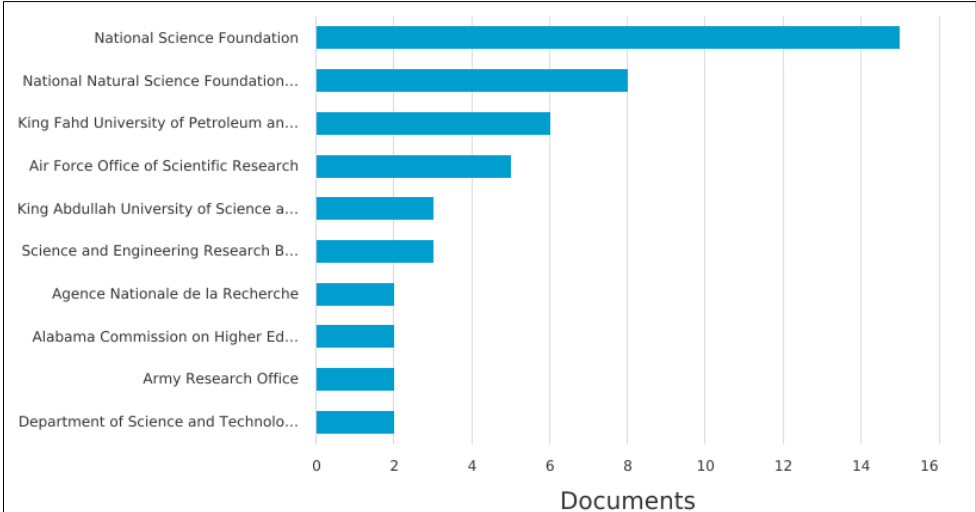


Fig. 9: Documents by Funding Sponsor.
(Source: Scopus DB accessed on 31st December 2020)

Fig. 10 clearly indicates that the CiteScore publication by *IEEE Transactions on Wireless Communications* is the maximum followed by *IEEE Transactions on Communications* and *IEEE Transactions on Antenna and Propagations*.

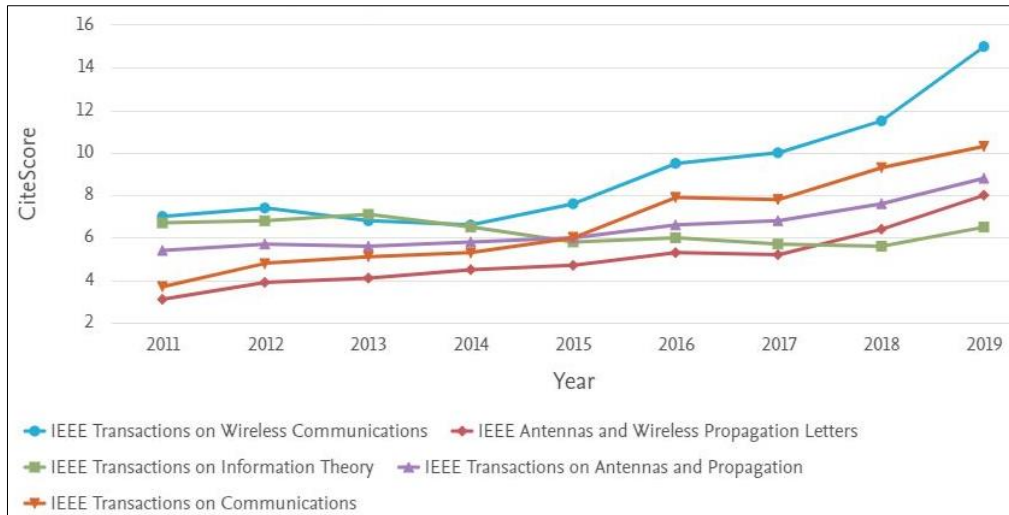


Fig. 10: CiteScore publication by year
 . (Source: Scopus DB accessed on 31st December 2020)

4.2 Bibliometric Analysis through Networked Diagrams

All the network diagrams mentioned from Fig. 11 to Fig. 20 are drawn and enhanced using tools which are available on <https://medialab.github.io/sciencescape/> link and <https://medialab.sciencespo.fr/en/tools/minivan/> link.

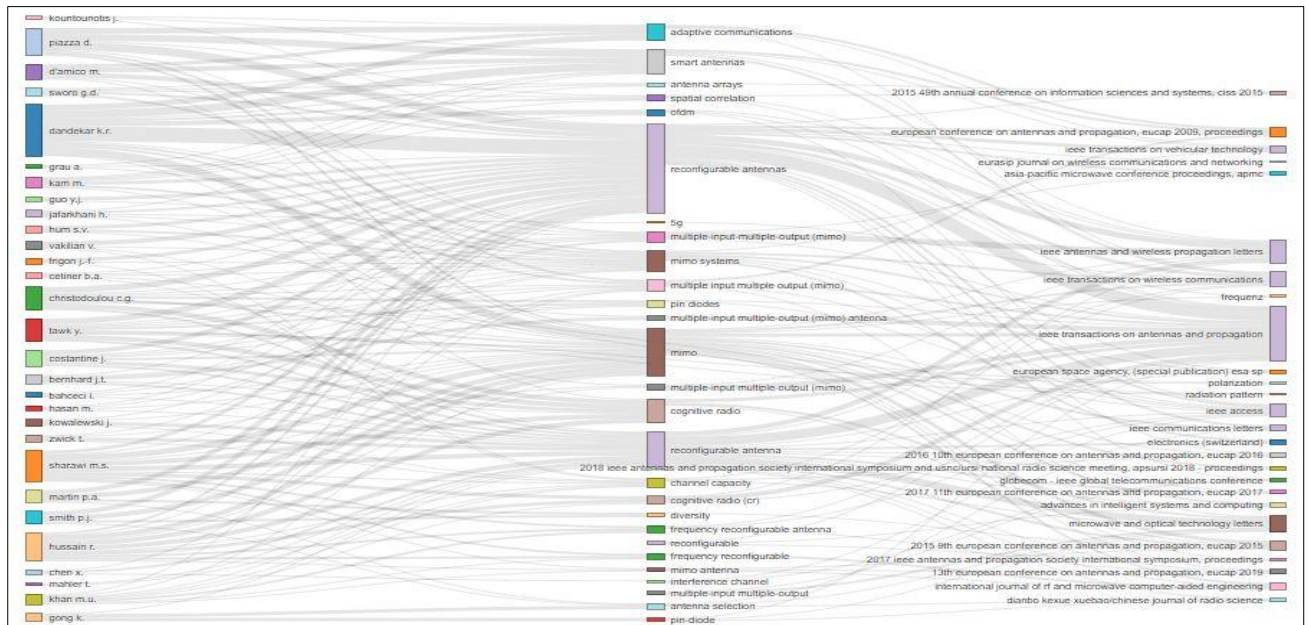


Fig. 11: Graph: Authors-Keywords-Journal (Sankey Diagram)
 (Source: Scopus DB accessed on 31st December 2020)

The graph shown above in Fig. 11 reflects the relation between authors, keywords and journal and is represented using a Sankey Diagram which is also represented in a tabulated form in Fig. 12.

Main authors	Main keywords	Main journals
<ul style="list-style-type: none"> dandekar k.r. (29 papers) plazza G. (13 papers) charaw m.s. (12 papers) hussein F. (11 papers) ohrtelodoulou o.g. (9 papers) costantine J. (8 papers) tsaik Y. (8 papers) oelmer b.a. (7 papers) d'ambrosio m. (7 papers) jafarikhani h. (7 papers) kowalewski J. (7 papers) zylak L. (7 papers) kam m. (6 papers) koumbariotis J. (6 papers) vakilian V. (6 papers) bernhard J.T. (5 papers) khan m.u. (5 papers) marin p.a. (5 papers) smith p.J. (5 papers) sworo g.d. (5 papers) [no author name available] (4 papers) bahecel I. (4 papers) ohen X. (4 papers) frigon J.-f. (4 papers) gong k. (4 papers) grau a. (4 papers) qiao Y.J. (4 papers) hecan m. (4 papers) ham s.w. (4 papers) mahler L. (4 papers) 	<ul style="list-style-type: none"> reconfigurable antenna (36 papers) reconfigurable antennas (34 papers) mimo (40 papers) mimo systems (17 papers) ognitive radio (12 papers) multiple-input-multiple-output (mimo) (10 papers) multiple input multiple output (mimo) (9 papers) multiple-input multiple-output (mimo) (9 papers) smart antennas (8 papers) channel capacity (7 papers) ognitive radio (7 papers) pin diodes (7 papers) reconfigurable (6 papers) adaptive communications (5 papers) antenna selection (5 papers) mimo antenna (5 papers) multiple-input multiple-output (5 papers) ofdm (5 papers) polarization (5 papers) 5g (4 papers) antenna arrays (4 papers) diversity (4 papers) frequency reconfigurable (4 papers) frequency reconfigurable antenna (4 papers) interference channel (4 papers) multiple-input multiple-output (mimo) antenna (4 papers) pin diode (4 papers) pin-diode (4 papers) radiation pattern (4 papers) spatial correlation (4 papers) 	<ul style="list-style-type: none"> IEEE transactions on antennas and propagation (23 papers) IEEE antennas and wireless propagation letters (19 papers) IEEE antennas and propagation society, ap-s International symposium (digest) (9 papers) microwave and optical technology letters (8 papers) IEEE transactions on wireless communications (8 papers) 2016 8th european conference on antennas and propagation, euoap 2016 (4 papers) IEEE soeccs (4 papers) 2017 11th european conference on antennas and propagation, euoap 2017 (3 papers) 2017 IEEE antennas and propagation society International symposium, proceedings (3 papers) IEEE transactions on vehicular technology (3 papers) IEEE wireless communications and networking conference, wocn (3 papers) IEEE microwave, antennas and propagation (3 papers) International journal of rf and microwave computer-aided engineering (3 papers) 15th european conference on antennas and propagation, euoap 2018 (2 papers) 2008 IEEE International Symposium on Antennas and Propagation and USNO/USRI National Radio Science Meeting, spursi (2 papers) 2016 45th annual conference on information sciences and systems, oisc 2016 (2 papers) 2016 10th european conference on antennas and propagation, euoap 2018 (2 papers) 2018 IEEE antennas and propagation society International symposium and USNO/USRI National Radio Science Meeting, spursi 2018 - proceedings (2 papers) Advances in intelligent systems and computing (2 papers) Asia-Pacific microwave conference proceedings, apmo (2 papers) Dianbo Xue Chinese Journal of Radio Science (2 papers) Electronicon (Switzerland) (2 papers) Electronicon Letters (2 papers) Eurasp Journal on Wireless Communications and Networking (2 papers) European conference on antennas and propagation, euoap 2008, proceedings (2 papers) European Space Agency, (special publication) esa sp (2 papers) Final program and book of abstracts - Iwnt 2010: 2010 International Workshop on Antenna Technology: Small Antennas, Innovative Structures and Materials (2 papers) Frequency (2 papers) GlobeCom - IEEE Global Telecommunications Conference (2 papers) IEEE Communications Letters (2 papers)

Fig. 12: Tabular Information: Authors-Keywords-Journal (Sankey Diagram)
(Source: Scopus DB accessed on 31st December 2020)

The A-K-J Sankey helped us to visualize the main authors, keywords and journals and their relation with each other.

2010	2011	2012
<ul style="list-style-type: none"> final program and book of abstracts - Iwnt 2010: 2010 International Workshop on Antenna Technology: Small Antennas, Innovative Structures and Materials (2 papers) IEEE transactions on vehicular technology (1 paper) Asia-Pacific microwave conference proceedings, apmo (1 paper) Dianbo Xue Chinese Journal of Radio Science (1 paper) GlobeCom - IEEE Global Telecommunications Conference (1 paper) Proceedings - IEEE Military Communications Conference MILCOM (1 paper) 2010 International RF Workshop on Smart Antennas, IWSA 2010 (1 paper) Conference record - Astromer conference on signals, systems and computers (1 paper) Dianbo Xue Chinese Journal of Electronics and Information Technology (1 paper) Loughborough antennas and propagation conference, IAPo 2009 - conference proceedings (1 paper) 	<ul style="list-style-type: none"> IEEE antennas and wireless propagation letters (1 paper) microwave and optical technology letters (1 paper) Eurasp Journal on wireless communications and networking (1 paper) 2011 International symposium on modeling and optimization of mobile, ad hoc, and wireless networks, WMOPT 2011 (1 paper) 7th international conference on wireless communications, networking and mobile computing, WICOM 2011 (1 paper) Final program and book of abstracts - Iwnt 2011: 2011 IEEE International Workshop on Antenna Technology: Small Antennas, Novel Structures and Innovative Materials (1 paper) IAPo 2011 - 2011 Loughborough antennas and propagation conference (1 paper) Nanjing Youdian Daxue Xuebao (Ziran Kexue Ban) (Journal of Nanjing University of Posts and Telecommunications (Natural Science)) (1 paper) Proceedings of the 8th European Conference on Antennas and Propagation, Euoap 2011 (1 paper) 	<ul style="list-style-type: none"> IEEE antennas and propagation society, ap-s International symposium (digest) (5 papers) IEEE transactions on antennas and propagation (3 papers) IEEE communications letters (2 papers) Asia-Pacific microwave conference proceedings, apmo (1 paper) IEEE transactions on information theory (1 paper) IEEE vehicular technology conference (1 paper) IEEE transactions on communications (1 paper) Proceedings of the IEEE (1 paper) 2012 45th annual conference on information sciences and systems, oisc 2012 (1 paper) 2012 IEEE GlobeCom workshops, go wkshp 2012 (1 paper)
<ul style="list-style-type: none"> IEEE transactions on antennas and propagation (3 papers) IEEE antennas and propagation society, ap-s International symposium (digest) (2 papers) IEEE antennas and wireless propagation letters (1 paper) microwave and optical technology letters (1 paper) GlobeCom - IEEE Global Telecommunications Conference (1 paper) IEEE vehicular technology conference (1 paper) 2012 7th European Conference on Antennas and Propagation, Euoap 2012 (1 paper) 2013 8th International Conference on Antenna Theory and Techniques, IATAT 2013 (1 paper) 2013 IEEE 14th Annual Wireless and Microwave Technology Conference, Wamtec 2013 (1 paper) International conference on communication and signal processing, Iccsp 2010 - proceedings (1 paper) 	<ul style="list-style-type: none"> IEEE transactions on antennas and propagation (8 papers) IEEE transactions on wireless communications (1 paper) IEEE transactions on communications (1 paper) IEEE transactions on communications conference, apmo 2014 (1 paper) 2014 Australian communications theory workshop, Ausctw 2014 (1 paper) 2014 IEEE Global Communications Conference, GlobeCom 2014 (1 paper) 8th European Conference on Antennas and Propagation, Euoap 2014 (1 paper) Orinlec 2013 - 2013 23rd International Orinlec Conference Microwave and Telecommunication Technology, conference proceedings (1 paper) IEEE mt-t International Microwave Symposium Digest (1 paper) IEEE transactions on terahertz science and technology (1 paper) 	<ul style="list-style-type: none"> 2016 8th European Conference on Antennas and Propagation, Euoap 2016 (4 papers) microwave and optical technology letters (2 papers) 2016 45th annual conference on information sciences and systems, oisc 2016 (2 papers) IEEE antennas and wireless propagation letters (1 paper) Eurasp Journal on wireless communications and networking (1 paper) IEEE International Symposium on Information Theory, Proceedings (1 paper) IEEE transactions on communications (1 paper) Proceedings of the IEEE (1 paper) 2016 IEEE student conference on research and development, scord 2016 (1 paper) 2016 IEEE wireless communications and networking conference, wocn 2016 (1 paper)

Fig. 13: Journals over time: 2010 to 2015
(Source: Scopus DB accessed on 31st December 2020)

The journals published over time period 2010 to 2015 are mentioned in Fig. 13 and the journals published over the time period 2016 to the year 2020 are shown in Fig. 14.

2016	2017	2018
<ul style="list-style-type: none"> • iet microwaves, antennas and propagation 3 papers • iee transactions on antennas and propagation 2 papers • iee antennas and wireless propagation letters 2 papers • microwave and optical technology letters 2 papers • 2018 10th european conference on antennas and propagation, euoap 2018 3 papers • iee transactions on vehicular technology 1 paper • advances in intelligent systems and computing 1 paper • frequenz 1 paper • 2016 IEEE Jordan conference on applied electrical engineering and computing technologies, jsaect 2016 1 paper • 2018 50th annual conference on information systems and sciences, oisc 2018 1 paper 	<ul style="list-style-type: none"> • 2017 15th european conference on antennas and propagation, euoap 2017 3 papers • 2017 IEEE antennas and propagation society International symposium, proceedings 3 papers • iee transactions on antennas and propagation 2 papers • iee access 2 papers • iee wireless communications and networking conference, wocn 2 papers • microwave and optical technology letters 1 paper • iee transactions on wireless communications 1 paper • electronics (switzerland) 1 paper • electronics letters 1 paper • frequenz 1 paper 	<ul style="list-style-type: none"> • iee transactions on antennas and propagation 3 papers • iee antennas and wireless propagation letters 2 papers • 2018 IEEE antennas and propagation society International symposium and ukrainian national radio science meeting, spursi 2018 - proceedings 3 papers • iee international conference on communications 2 papers • iet conference publications 2 papers • iee transactions on wireless communications 1 paper • advances in intelligent systems and computing 1 paper • electronics (switzerland) 1 paper • iee transactions on communications 1 paper • 2017 international symposium on antennas and propagation, isap 2017 1 paper
2019	2020	
<ul style="list-style-type: none"> • iee transactions on antennas and propagation 2 papers • iee antennas and wireless propagation letters 2 papers • iee access 2 papers • international journal of rf and microwave computer-aided engineering 2 papers • 15th european conference on antennas and propagation, euoap 2019 2 papers • iee transactions on vehicular technology 1 paper • 2019 international conference on computing, electronic and electrical engineering, ice cube 2019 1 paper • 2018 international conference on sustainable energy, electronics and computing system, seems 2018 1 paper • 2019 international applied computational electromagnetics society symposium in miami, aces-miami 2019 1 paper • 2019 international conference on microwave and millimeter wave technology, iommt 2019 - proceedings 1 paper 	<ul style="list-style-type: none"> • iee transactions on antennas and propagation 3 papers • iee antennas and wireless propagation letters 1 paper • iee transactions on wireless communications 1 paper • international journal of rf and microwave computer-aided engineering 1 paper • 14th european conference on antennas and propagation, euoap 2020 1 paper • 2020 IEEE students' conference on engineering and systems, soes 2020 1 paper • 2020 international conference on uk-china emerging technologies, ucet 2020 1 paper • 2020 international workshop on antenna technology, iwet 2020 1 paper • advanced functional materials 1 paper • iee antennas and propagation magazine 1 paper 	

Fig. 14: Journals over time: 2016 to 2020
(Source: Scopus DB accessed on 31st December 2020)

The top trending keywords published in the documents from the year 2012 to 2019 is shown in the Fig. 15 in a tabular format.

2012	2013	2014	2015
<ul style="list-style-type: none"> • reconfigurable antennas 10 papers • mimo 6 papers • multiple-input-multiple-output (mimo) 3 papers • reconfigurable antenna 2 papers • multiple-input multiple-output (mimo) 2 papers • channel capacity 2 papers • ofdm 2 papers • cognitive radio 1 paper • pin diodes 1 paper • antenna selection 1 paper 	<ul style="list-style-type: none"> • reconfigurable antenna 3 papers • reconfigurable antennas 3 papers • mimo 2 papers • multiple-input-multiple-output (mimo) 2 papers • multiple-input multiple-output 2 papers • mimo systems 1 paper • multiple input multiple output (mimo) 1 paper • reconfigurable 1 paper • diversity 1 paper • multiple-input multiple-output (mimo) antenna 1 paper 	<ul style="list-style-type: none"> • reconfigurable antennas 5 papers • mimo 5 papers • reconfigurable antenna 4 papers • mimo systems 3 papers • cognitive radio 3 papers • channel capacity 2 papers • multiple-input multiple-output (mimo) antenna 2 papers • pin diodes 1 paper • ofdm 1 paper • antenna arrays 1 paper 	<ul style="list-style-type: none"> • reconfigurable antenna 6 papers • reconfigurable antennas 6 papers • mimo 6 papers • cognitive radio 3 papers • multiple-input multiple-output (mimo) 2 papers • diversity 2 papers • mimo systems 1 paper • multiple input multiple output (mimo) 1 paper • mimo antenna 1 paper • multiple-input multiple-output 1 paper
2016	2017	2018	2019
<ul style="list-style-type: none"> • reconfigurable antennas 5 papers • reconfigurable antenna 4 papers • mimo 4 papers • mimo systems 3 papers • cognitive radio 3 papers • smart antenna 2 papers • multiple-input multiple-output (mimo) 1 paper • smart antennas 1 paper • channel capacity 1 paper • pin diodes 1 paper 	<ul style="list-style-type: none"> • reconfigurable antenna 3 papers • mimo 5 papers • reconfigurable antennas 4 papers • mimo systems 2 papers • pattern diversity 2 papers • spatial modulation 2 papers • blind interference alignment 2 papers • degrees of freedom (dof) 2 papers • cognitive radio 1 paper • multiple input multiple output (mimo) 1 paper 	<ul style="list-style-type: none"> • reconfigurable antenna 11 papers • reconfigurable antennas 4 papers • mimo 4 papers • multiple input multiple output (mimo) 2 papers • multiple-input multiple-output (mimo) 2 papers • cognitive radio (cr) 2 papers • reconfigurable 2 papers • multi-user mimo 2 papers • mimo systems 1 paper • cognitive radio 1 paper 	<ul style="list-style-type: none"> • mimo 9 papers • reconfigurable antenna 7 papers • reconfigurable antennas 6 papers • cognitive radio (cr) 3 papers • pin diodes 3 papers • slot antenna 3 papers • mimo systems 2 papers • frequency reconfigurable 2 papers • frequency reconfigurable antenna 2 papers • filtenna 2 papers

Fig. 15: Top Keywords: 2012 to 2019
(Source: Scopus DB accessed on 31st December 2020)

Authors and source titles co-appearing in the same papers is highlighted in Fig. 18 as shown below. Renowned authors like *Dandekar KR*, *Vakilian V*, *Damico M* etc are mentioned along with the source titles linked to them such as *IEEE Transactions on Antenna and Propagation*, *2017 11th Conference on Antennas and Propagation*, *Eurasip Journal on Wireless Communication and Networking*.

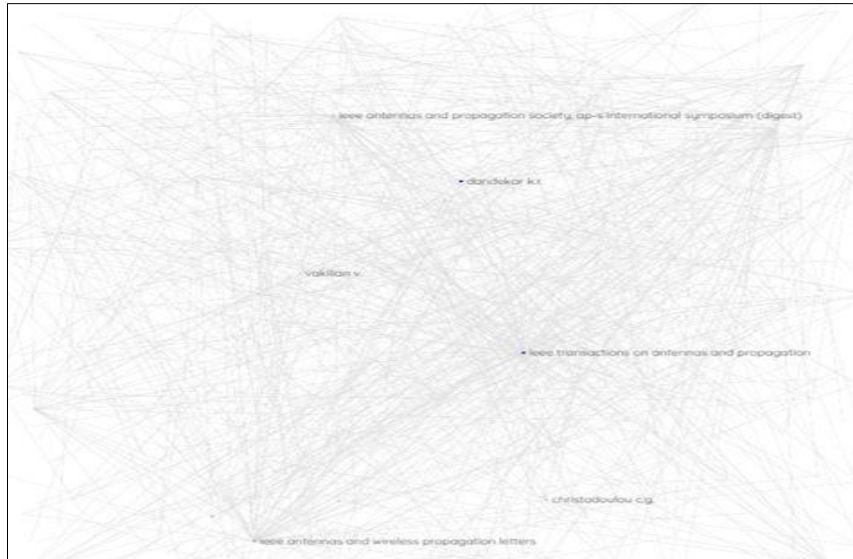


Fig. 18: Authors and Source Titles co-appearing in the same papers
(Source: Scopus DB accessed on 31st December 2020)

Several authors are linked by co-publication as shown in Fig. 19. For instance, authors like – *Dandekar K R*, *D’Amico M*, *Piazza D*, *Kirsch NJ*, *Sworo G D*, *Gulati N* etc are linked to each other by co-publication and is depicted really well in the form of connected nodes in the Fig. shown below.

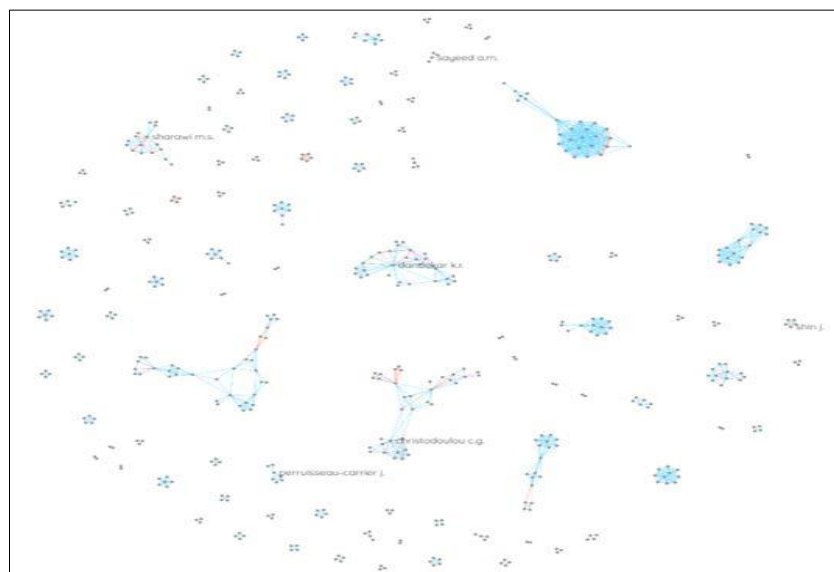


Fig. 19: Authors Linked by Co-Publication
(Source: Scopus DB accessed on 31st December 2020)

Fig. 20 shows a simple node diagram of the papers linked with citations when they have DOI data available. Example of the papers linked as shown in the diagram is – *Impact of pattern reconfigurable antennas on interference alignment over measured channels* and *Design and evaluation of reconfigurable antenna array for MIMO systems*.

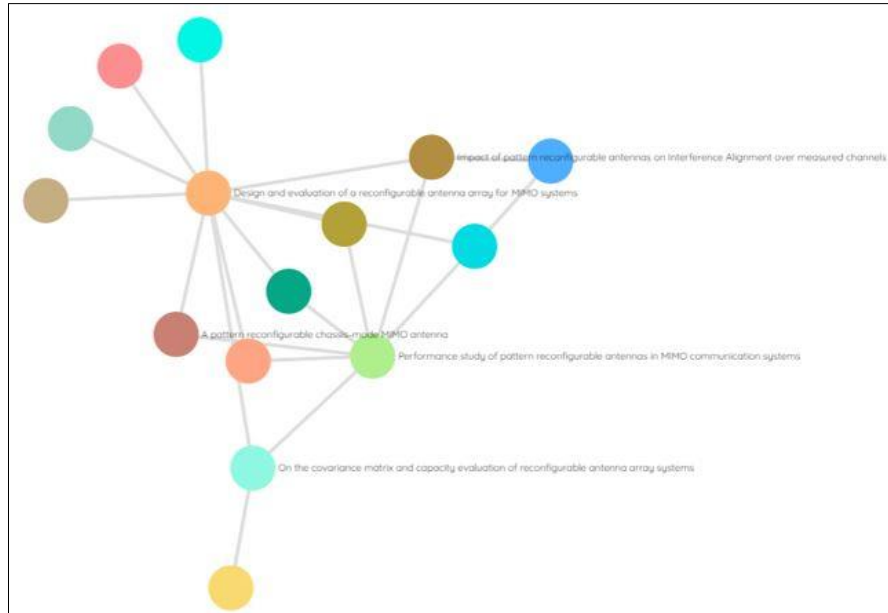


Fig. 20: Papers Linked by Citation (when they have DOI) [35]
(Source: Scopus DB accessed on 31st December 2020)

Source title and author keywords co-appearing in the same paper is depicted in Fig. 21. For example, the titles such as *Microwave and Optic Technology Letters* and *IEEE transactions on Wireless Communication* is a classic example of co-appearing source titles with the connecting author keywords like – *antenna arrays, adaptive and reconfigurable antennas, frequency, diversity* etc.

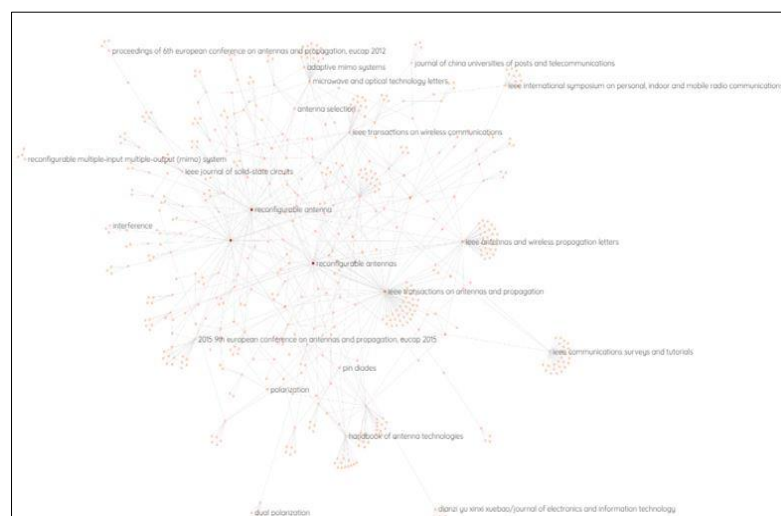


Fig. 21: Source Title and Author Keywords coappearing in the same papers [36]
(Source: Scopus DB accessed on 31st December 2020)

5 Research Implications

Although there are considerable number of research articles available on the given topic, only a few articles or documents are from Indian Universities and by Indian authors. Since India is a developing country and with a lot of potential and talent, there is a lot of scope for a good quality research and publication output. There is an immense scope for the new authors to showcase their work and the count of documents released in the last decade supports the point really well. The articulation of this novel bibliometric review paper on the given research topic will highlight the information about points and keywords which were less focus earlier and also throw some light on the information like – keywords, co-appearance with respect to authors and author keywords, source titles etc. beneficial to the new researchers.

6 Conclusion

In this article, a thorough and comprehensive bibliometric study and analysis is undertaken. The main area of focus was the Reconfigurable antenna with respect to the MIMO systems. All the essential information was extracted from the search engine based on the esteemed Scopus database. With the help and use of the information retrieved from the Scopus database the idea of identifying and relating the authors with the topic to be studied, the journals, the keywords and other information was easily conceivable. Approximately 45% of the work is related to the field of Engineering and 28% to that of Computer Science. Most of the documents that were published in SCOPUS were either the conference papers or the journal articles. The SCOPUS database has suggested close to 227 articles on the topic related to Reconfigurable antennas for MIMO systems which is an excellent opportunity for the new researchers to start their research from and get the necessary literature readily available.

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