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A Brief Bibliometric Survey on Microstrip Antennas for Machine-to-Machine (M2M) Communication in Smart Cities

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ABSTRACT:

Stupendous progress in heterogeneous communication technologies has allowed smart city gadgets to communicate with one another. However, these communication technologies are not able to offer the connectivity that is needed in smart cities because of the coexistence of hundreds and thousands of devices, which leads to various problems like, high energy consumption, interoperability support among the heterogeneous wireless networks, interference management, scalable wireless solutions, and mobility management. Machine-to-Machine (M2M) communication is one of the key enablers for advanced applications and services. The aim of this bibliometric review is to understand the extent of the existing literature for the area of M2M communications in smart cities using Microstrip antennas. This bibliometric analysis is majorly based on the Scopus database and tools such as VOSviewer and ScienceScape. The research articles published between the years 2013 to 2021 were considered. We observed from this bibliometric analysis that the major publications found are from conference papers, articles and conference reviews by Indian publications followed by Irish, Japanese and Chinese publications. The majority of the contribution is by the subject areas of Engineering, Computer Science, Physics and Astronomy, Material Science and Mathematics.

Keywords: Antenna, Microstrip, Microstrip Antenna, Machine-to-Machine (M2M), Smart cities.

1. INTRODUCTION

Machine-to-Machine communication (or M2M communication) refers to the direct communication between devices/machines using any communication channel (wired or wireless). Figure 1 shows various applications of M2M communication. M2M communication finds its application in remote monitoring. Utilities companies depend on machine-to-machine devices and their applications to bill customers by using smart meters, harvest energy and also to detect on site

factors (pressure, equipment status, temperature, etc.). Machine to machine devices are also useful for keeping track of a patient's vital statistics and dispensing medicine when required. They are transforming and improving the process of mobile payment for different purchasing behaviours. M2M technology is also incorporated in smart home systems. The use of machine-to-machine technology in embedded systems has enabled technologies such as home appliances to have real time control in the operations. It has also enhanced the ability to communicate remotely. M2M communication plays a vital role in robotics, remote-control software, controlling traffic, security, and logistics management.

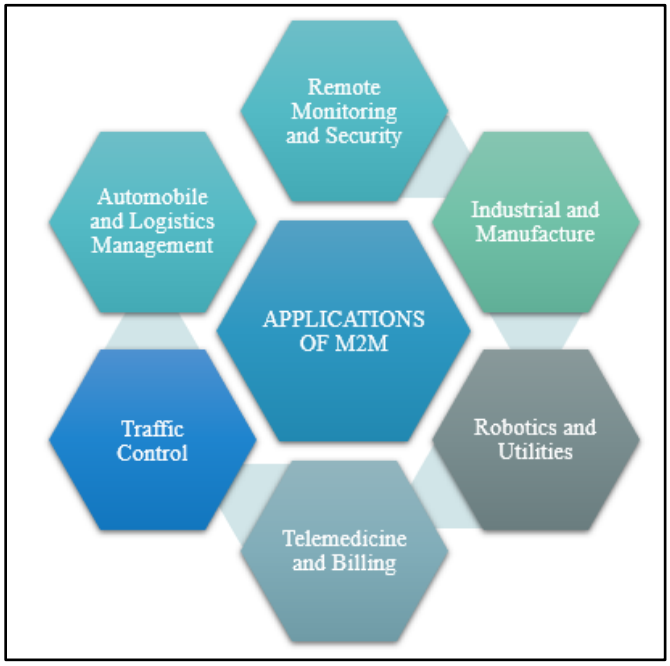

Figure 1: Applications of M2M technology.

In high-performance applications of M2M communications, where cost, performance, aerodynamic profile, size, weight, and simple installation are constraints, small low-profile antennas are needed. At present, there are a huge number of commercial and government applications, like wireless communications and mobile radio, that have similar specifications. To fulfil these requirements, microstrip antennas (also referred to as patch antennas) are often used. These antennas are generally conformable to planar and nonplanar surfaces, low profile, simple and cheap to manufacture using modern printed-circuit technology. When mounted on rigid surfaces they are mechanically robust, and after the actual patch mode and shape are selected, they become very versatile in terms of resonant polarization, frequency, impedance, and radiation patterns. Also, by adding additional loads between the patch and hence the ground plane, like pins

and varactor diodes, adaptive elements possessing a variable resonant frequency, polarization, and radiation patterns, impedance, are often designed.

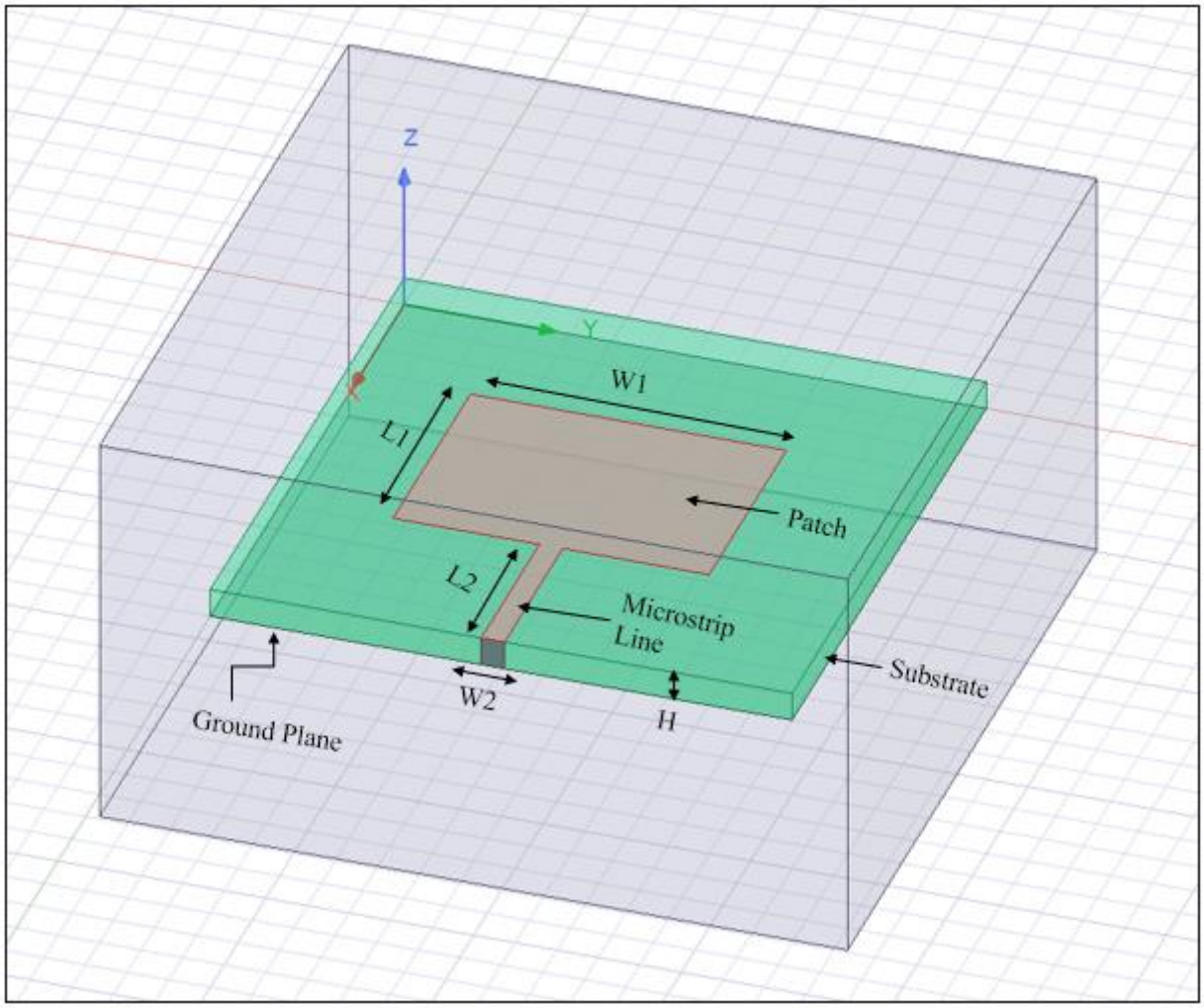

Figure 2: A Microstrip Patch Antenna Design using Ansys HFSS.

Figure 2 shows a simple rectangular microstrip patch antenna designed using Ansys HFSS. This antenna has a resonating frequency of 2.4 GHz. A simple microstrip antenna is made of a ground plane and a conducting patch. A dielectric medium known as substrate, having a particular value of dielectric constant, is kept between them. The dimension of a patch is small as compared to that of the substrate and the ground. W1 and L1 represent the width and the length of the patch. W2 and L2 are the dimensions of the microstrip line. H is the height of the substrate. The dimensions of a microstrip patch antenna are dependent on the value of the dielectric constant and the resonant frequency. The thickness of the ground plane is not of much importance. Figure 3 shows some common shapes of microstrip patch elements. The radiating patch comes in many shapes, as shown

in the figure below but, rectangle, square, dipole and circle are the most commonly used shapes because they are easy to analyse and fabricate and have favourable radiation characteristics.

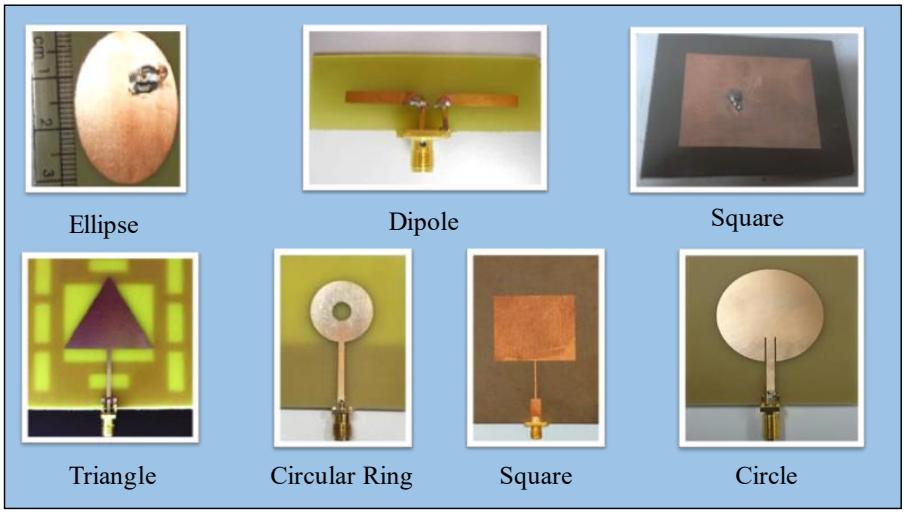

Figure 3: Different Shapes of Microstrip Patch Elements.

2. PRELIMINARY DATA COLLECTION

The above-mentioned paper is articulated by forwarding the query to the Scopus repository using the keywords - “Antenna”, “Microstrip” AND “Machine to Machine” OR “M2M” AND “Smart Cities” OR “Smart City” as shown in Table 1 given below. The following keywords were passed as query strings to obtain the likelihood results.

Table 1: Planned structure of primary & secondary keywords assigned. Source: http://www.scopus.com (content referred on 13th May 2021)

Primary Keywords	"Antenna" AND "Microstrip" AND "Machine to Machine" OR “M2M”
Secondary Keywords	"Smart Cities" OR "Smart City"

By using the above-mentioned keywords, 48 documents were filtered out which were all published in English language as shown below in Table 2.

Table 2: Details of the publications in different languages. Source: http://www.scopus.com (content referred on 13th May 2021)

Language of Publication	Publication
English	48

The majority of popular keywords associated with the selected documents are listed below. Table 3 gives a precise count of these keywords appearing in the earlier publications related to microstrip antennas.

Table 3: List of Principal keywords on Microstrip antennas. Source: http://www.scopus.com (content referred on 13th May 2021)

Keywords	Total Count
Microstrip antennas	36
Machine to machine	18
Microwave antennas	17
Slot antennas	16
Smart city	14
Directional patterns (antenna)	11
Antennas	9
Internet of things	9
Antenna arrays	8
5G mobile communication systems	7
Bandwidth	7
Mobile antennas	7
Computer software	6
Radio frequency identification (RFID)	6

The following pie chart distribution clearly describes the percent wise distribution of the count of the principal keywords that were used in the earlier publications on topics related to the field of Microstrip antennas & their growth in the field of Machine-to-Machine Communication.

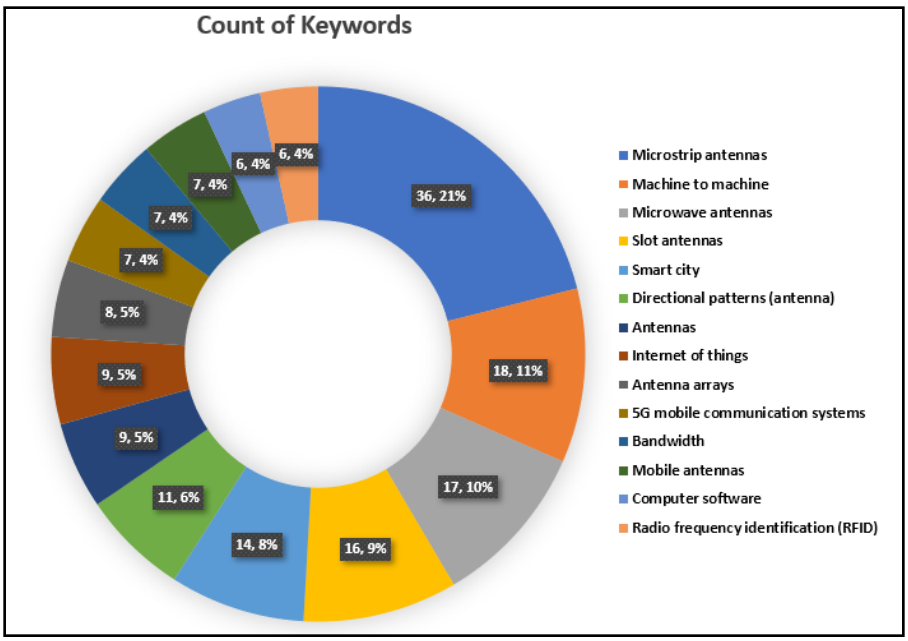

Figure 4: Percentage Distribution of Principal keywords on Microstrip antennas.

Source: http://www.scopus.com (content referred on 13th May 2021)

3. Bibliometric Information and Performance Analysis of Acquired Data:

After putting up the query using the mentioned keywords on Scopus repository, the required information got retrieved in ".csv" file extension and expressed in the following terms for further analysis:

1) The information of the documents by year wise publications, year wise publication by different sources, subject-area wise publication count, funding sponsor, geographical locations around the world, individual authors, affiliations, etc. is used for statistical analysis of the data.

2) Another crucial point which is to be put into account is about visualization of the data fetched from Scopus repository in the form of various graphs & network diagrams. The information used for the following is based on Citation analysis and keyword analysis (network visualization).

4. Results and Observation

4.1 Data Analysis at Preliminary Stage

Documents related to the influence of microstrip antennas for M2M communication is obtained for an interval of past nine years and the mentioned data for the years 2013 to 2021 is depicted in Table 4.

Figure 5 indicates the number of publications from 2013 to 2021. There is a hefty increase in publications in the year 2018, which is 10 times more than that in the year 2013.A sudden drop is observed in the year 2016. Further, it is clear that there exists a considerable gush in the research area after that year.

Year	Count
2013	1
2014	4
2015	6
2016	2
2017	6
2018	10
2019	7
2020	9
2021	3

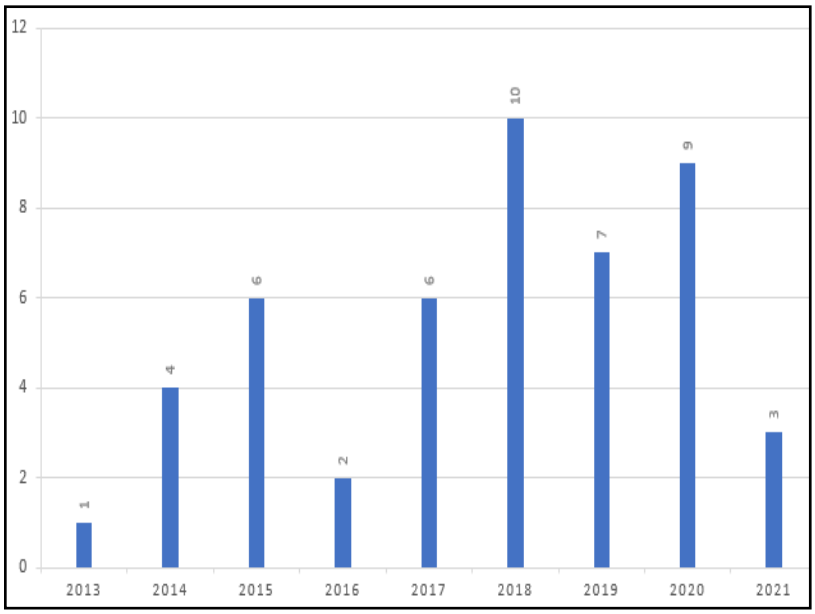

Table 4: Statistics for year wise Publications in accordance with the given keywords.

Source: http://www.scopus.com (content referred on 13th May 2021)

and

Figure 5: Year wise count of publication breakup. Source: http://www.scopus.com (content referred on 13th May 2021)

From Figure 6, it can be visualised that most popular source titles among the various sources of information were, “IEEE Antennas and Propagation Society AP S International Symposium Digest” and “Lecture Notes in Electrical Engineering”. Meanwhile, “Microwave and Optical Technology Letters” also had a significant number of documents published between 2013 and 2015.

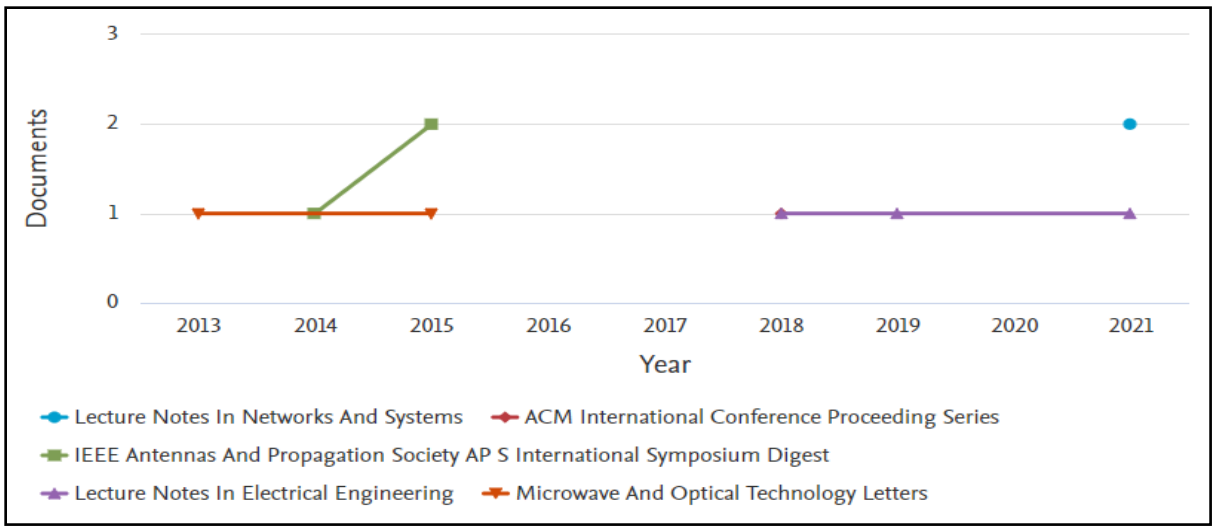

Figure 6: Year wise publication on the basis of count of the source. Source: http://www.scopus.com (content referred on 13th May 2021)

Table 5: Statistics for Subject Area wise Publications. Source: http://www.scopus.com (content referred on 13th May 2021)

Subject Area	Count
Engineering	32
Computer Science	31
Physics and Astronomy	12
Materials Science	6
Mathematics	5
Decision Sciences	5
Energy	5
Social Sciences	4
Environmental Science	4
Medicine	1
Earth and Planetary Sciences	1
Chemistry	1
Biochemistry, Genetics and Molecular Biology	1

Table and Figure 7 collectively show the subjective Area wise comparison for the acquired data in Microstrip antenna publications. It is to be noted that from the following figure, the most amount of research is in the engineering sector followed by computer science, physics & astronomy. It is also noted that least part of the research is being performed by environmental science and energy.

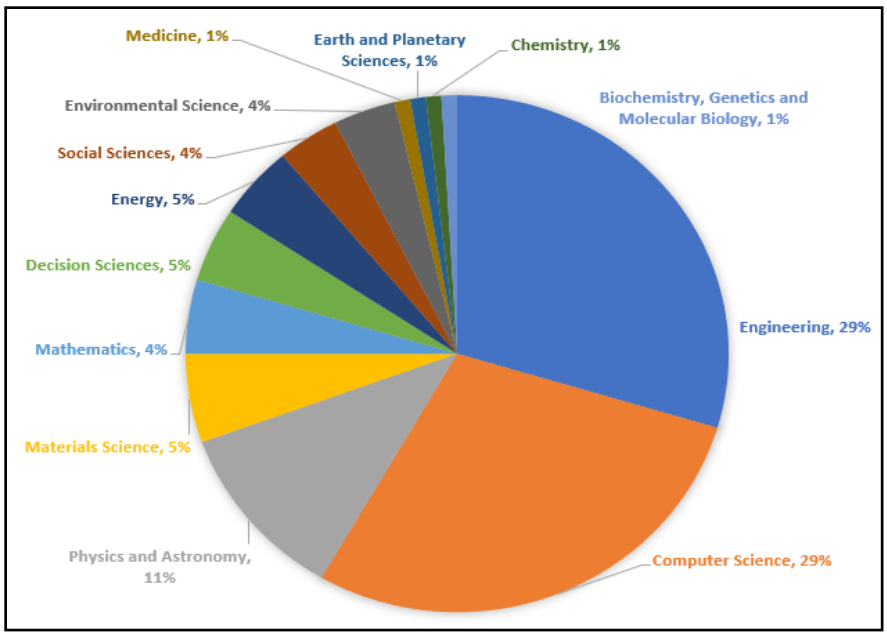

Figure 7: Subjective Area wise comparison on obtained data. Source: http://www.scopus.com (content referred on 13th May 2021)

Fig 8 indicates the major funding agencies which have sponsored the research work being carried out on the mentioned topic of microstrip antennas. These include the Engineering and Physical Sciences Research Council, Science Foundation Ireland, UK Research and Innovation etc. among others who have also been funding the research in this area.

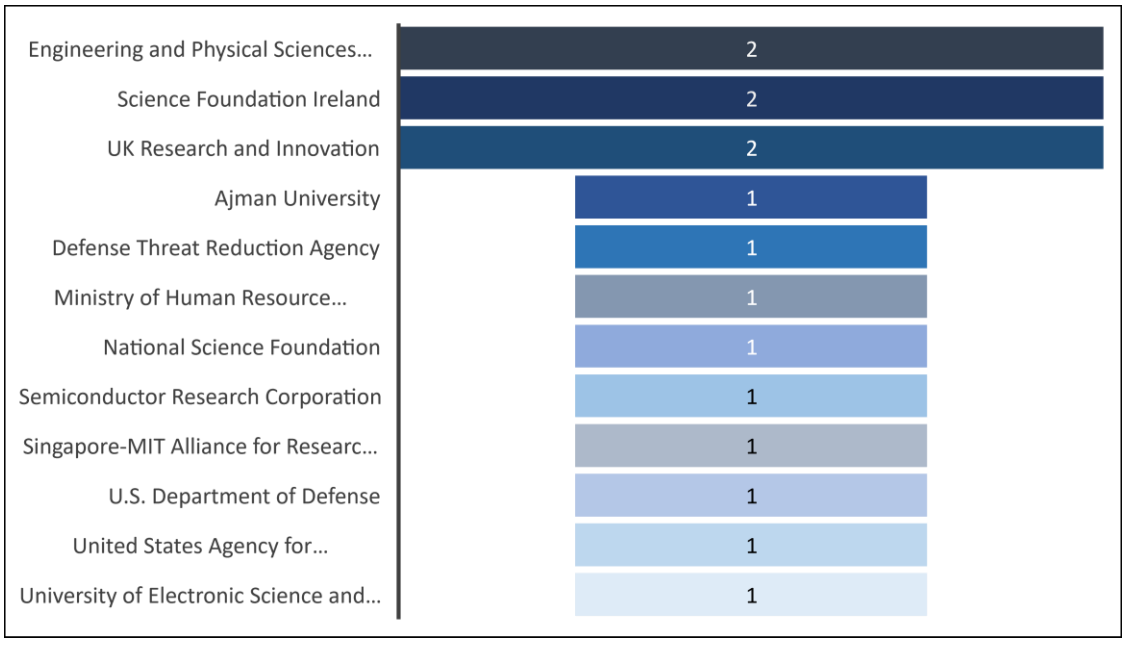

Figure 8: Documents obtained on the basis of Sponsors involved in Funding. Source: http://www.scopus.com (content referred on 13th May 2021)

The obtained Table 6 clearly indicates that most publications are from India, having a count of 11 between (2013-2021) followed by Ireland and Japan, each contributing 5 papers. China, Pakistan, UK & USA are among the other minor contributors with 3 papers each to their name.

Table 6: Statistics for Publications based on Countries. Source: http://www.scopus.com (content referred on 13th May 2021)

Country	Count
India	11
Ireland	5
Japan	5
China	4
Pakistan	3
United Kingdom	3
United States	3
Morocco	2
Romania	2
Australia	1
Canada	1
Egypt	1
Germany	1
Indonesia	1
Iraq	1
Macao	1
Nigeria	1
Singapore	1
South Korea	1
Turkey	1
United Arab Emirates	1
Undefined	7

The major focus here should be that the researcher should know the dependency of research is more in which geographical area or country. It is validated from the below acquired map that maximum researchers were of Indian background.

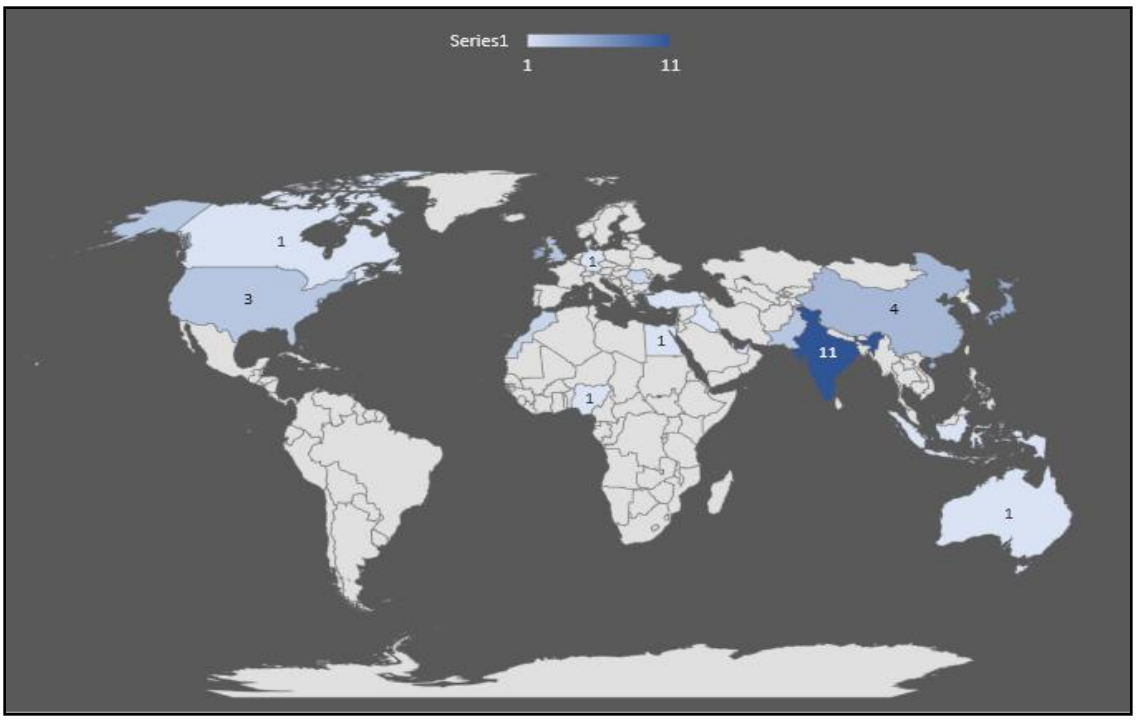

Figure 9: Research Documents available on the basis of Geographical locations. Source: http://www.scopus.com (content referred on 13th May 2021)

Table 7 shows the eminent authors who have been making a noteworthy contribution in the research field. The first author mentioned in the table (John, M.) is noted to have the maximum number of publications (5) in this field of research to his name, whereas, those present on the second, third and fourth row have (4) documents each to their name.

Table 7: Statistics for Prominent Authors in the field of research. Source: http://www.scopus.com (content referred on 13th May 2021)

Author	Count
John, M.	5
Ammann, M.J.	4
Cho, K.	4
Sumi, M.	4
Loutridis, A.	3
Andriesei, C.	2
Gao, Y.	2
Loutrids, A.	2
Parini, C.	2
Sharma, M.	2
Singla, B.S.	2
Suzuki, Y.	2

Referring to Table 8 given below, it is clear that the majority of publications have come through - Trinity College Dublin, Techno logical University Dublin, Chiba Institute of Technology Nippon Telegraph and Telephone Corporation, etc. among others.

Table 8: Affiliation Statistics of Top Universities in the field of research. Source: http://www.scopus.com (content referred on 13th May 2021)

Affiliation	Count
Trinity College Dublin	5
Technological University Dublin	5
Chiba Institute of Technology	4
Nippon Telegraph and Telephone Corporation	3
Punjabi University	2
Universitatea Tehnica Gh. Asachi din IasI	2
Queen Mary University of London	2
University of Engineering and Technology Taxila	2
Chandigarh Group of Colleges	2
Research Laboratories NTT DOCOMO INC.	1
Advanced Science and Technology Laboratories	1
Sule Lamido University	1
Thapar Institute of Engineering & Technology	1
Charles Sturt University	1
University of Glasgow	1
Ministry of Education China	1
Henan University	1
ANSYS, Inc.	1
University of Electronic Science and Technology of China	1
Nanyang Technological University	1
University of South Florida, Tampa	1
University of Vermont	1
Cairo University	1
Indian Institute of Technology, Bombay	1
SRM Institute of Science and Technology	1
Universität Stuttgart	1
Université Sidi Mohamed Ben Abdellah	1
Georgia Institute of Technology	1
School of Electrical and Computer Engineering	1
Shanghai Jiao Tong University	1
Xidian University	1
University of Mumbai	1
Birla Institute of Technology, Mesra	1

University of Illinois at Chicago	1
Sejong University	1
Yaşar Universitesi	1
Xi'an University of Science and Technology	1
Japan National Institute of Information and Communications Technology	1
Universitas Indonesia	1
Government College University Faisalabad	1
Ajman University	1
VSS University of Technology	1
Macao Polytechnic Institute	1
Sona College of Technology	1
ASELSAN A.Ş.	1
COMSATS University Islamabad	1
National Institute of Technology Silchar	1
Government Engineering College, Ajmer	1
University of Diyala	1
Silicon Institute of Technology, Bhubaneswar	1
Saraswati College of Engineering	1
Sreyas Institute of Engineering and Technology	1

Below mentioned Figure 10 indicates the statistics of affiliations of the topmost universities involved in this area of research. Interestingly, the top 2 universities associated with the research belong to Ireland & Japan, respectively.

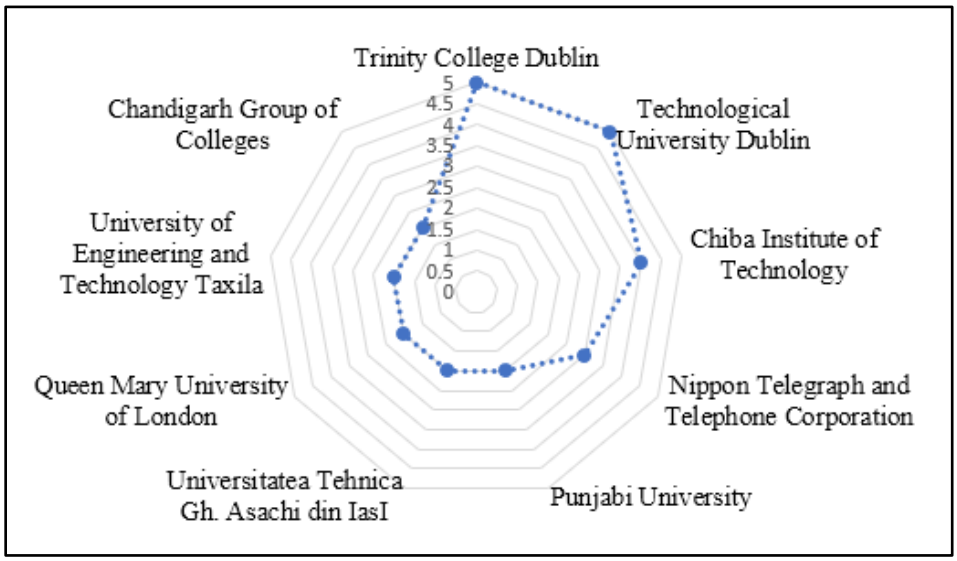

Figure 10: Universities with most Research Documents on the basis of Affiliations. Source: http://www.scopus.com (content referred on 13th May 2021)

Table 9 displays the total documents published as per the type of document. From Figure 11 the maximum number of documents published on the referred research are Conference Papers (32) followed by Articles (9) and Conference Reviews (5).

Table 9: Document by Type. Source: http://www.scopus.com (content referred on 13th May 2021)

Document Type	Count
Conference Paper	32
Article	9
Conference Review	7

Figure 11: Source: http://www.scopus.com (content referred on 13th May 2021)

4.2 Bibliometric Analysis:

All the network diagrams mentioned from Figure 9 to Figure 16 are drawn and visualised utilising VOSviewer and ScienceScape.

Figure 12 shows the main keywords, journals and authors obtained through the data collected Scopus in tabulated form and the relation between the same is represented using Sankey Diagram Figure 13.

Main authors

- [no author name available] (7 papers)
- john m. (5 papers)
- ammann m.j. (4 papers)
- cho k. (4 papers)
- sumi m. (4 papers)
- loutridis a. (3 papers)
- andriesei c. (2 papers)
- gao y. (2 papers)
- loutrids a. (2 papers)
- parini c. (2 papers)
- sharma m. (2 papers)
- singla b.s. (2 papers)
- suzuki y. (2 papers)
- abbasi q.h. (1 papers)
- abdalla a.i. (1 papers)
- adeyeye a. (1 papers)
- adriandi g. (1 papers)
- ahmed v. (1 papers)
- ali i.h. (1 papers)
- altuntas m. (1 papers)
- amin y. (1 papers)
- ammann m. (1 papers)
- anitei g. (1 papers)
- anouar m. (1 papers)
- apriono c. (1 papers)
- arshad k. (1 papers)
- bakirli y. (1 papers)
- behera s. (1 papers)
- bibi s. (1 papers)
- bukkawar s. (1 papers)

Main keywords

- antenna (6 papers)
- iot (5 papers)
- m2m (5 papers)
- bandwidth (4 papers)
- 5g (3 papers)
- microstrip patch antenna (3 papers)
- monopole antenna (3 papers)
- multiband antenna (3 papers)
- smart city (3 papers)
- 3-d printing (2 papers)
- circular patch antenna (2 papers)
- communication (2 papers)
- crosswalk (2 papers)
- gain (2 papers)
- gsm (2 papers)
- internet of things (iot) (2 papers)
- ioe (2 papers)
- lte (2 papers)
- m2m applications (2 papers)
- patch antenna (2 papers)
- pifa (2 papers)
- rf (2 papers)
- slot antenna (2 papers)
- smart cities (2 papers)
- wimax (2 papers)
- 4g (1 papers)
- 5g mobile networks (1 papers)
- 5g systems (1 papers)
- adaptive solver configuration (1 papers)
- additive manufacturing (1 papers)

Main journals

- 2018 international conference on smart city and emerging technology, icscet 2018 (3 papers)
- ieee antennas and propagation society, ap-s international symposium (digest) (3 papers)
- lecture notes in electrical engineering (3 papers)
- 2020 ieee international symposium on antennas and propagation and north american radio science meeting, ieeeconf 2020 - proceedings (2 papers)
- 8th european conference on antennas and propagation, eucap 2014 (2 papers)
- ieee radio and wireless symposium, rws (2 papers)
- lecture notes in networks and systems (2 papers)
- microwave and optical technology letters (2 papers)
- 2015 international workshop on antenna technology, iwat 2015 (1 papers)
- 2015 loughborough antennas and propagation conference, lapc 2015 (1 papers)
- 2018 ieee antennas and propagation society international symposium and usnc/ursi national radio science meeting, apsursi 2018 - proceedings (1 papers)
- 2019 ieee international symposium on antennas and propagation and usnc-ursi radio science meeting, apsursi 2019 - proceedings (1 papers)
- 2020 13th international conference on communications, comm 2020 - proceedings (1 papers)
- 2020 ieee international conference on computing, power and communication technologies, gucon 2020 (1 papers)
- acm international conference proceeding series (1 papers)
- applied computational electromagnetics society journal (1 papers)
- electronics letters (1 papers)
- honet 2020 - ieee 17th international conference on smart communities: improving quality of life using ict, iot and ai (1 papers)
- ieee access (1 papers)
- ieee transactions on magnetics (1 papers)
- ieice transactions on communications (1 papers)
- iet conference publications (1 papers)
- international conference on emerging trends in information technology and engineering, ic-etite 2020 (1 papers)
- international journal of communication systems (1 papers)
- international journal of high speed electronics and systems (1 papers)
- iop conference series: earth and environmental science (1 papers)
- lecture notes of the institute for computer sciences, social-informatics and telecommunications engineering, lnicst (1 papers)
- proceeding of 2016 10th international conference on telecommunication systems services and applications, tssa 2016: special issue in radar technology (1 papers)
- proceedings - 2016 international conference on intelligent transportation, big data and smart city, icitbs 2016 (1 papers)
- proceedings - 3rd international conference on intelligent transportation, big data and smart city, icitbs 2018 (1 papers)

Figure 12: Tabular Information: Authors, Keywords and Journals. Source: http://www.scopus.com (content referred on 13th May 2021)

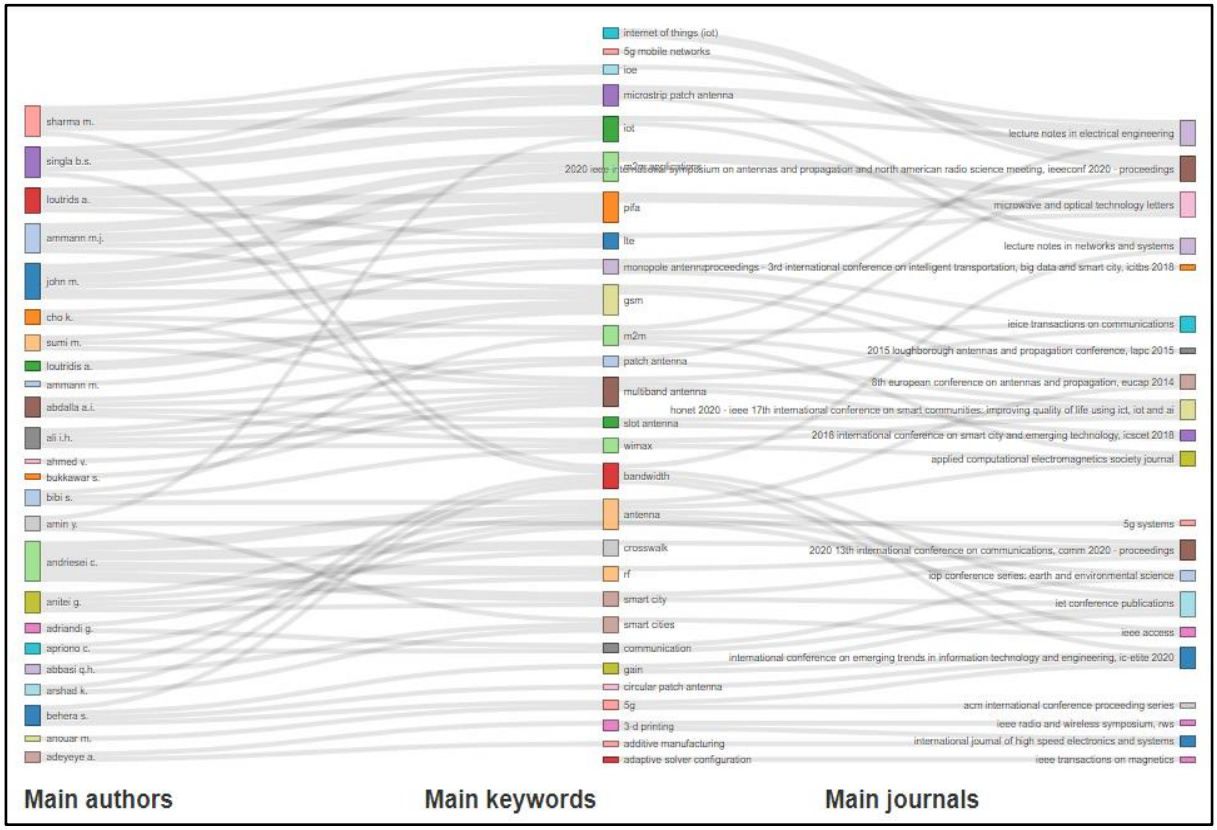

Figure 13: Sankey Diagram: Author-Keyword-Journal. Source: http://www.scopus.com (content referred on 13th May 2021)

The top Keywords in the documents and the top Journals from the year 2013 to 2021, obtained after the analysis of the data from Scopus are shown in tabular format in Figure 14 and Figure 15, respectively.

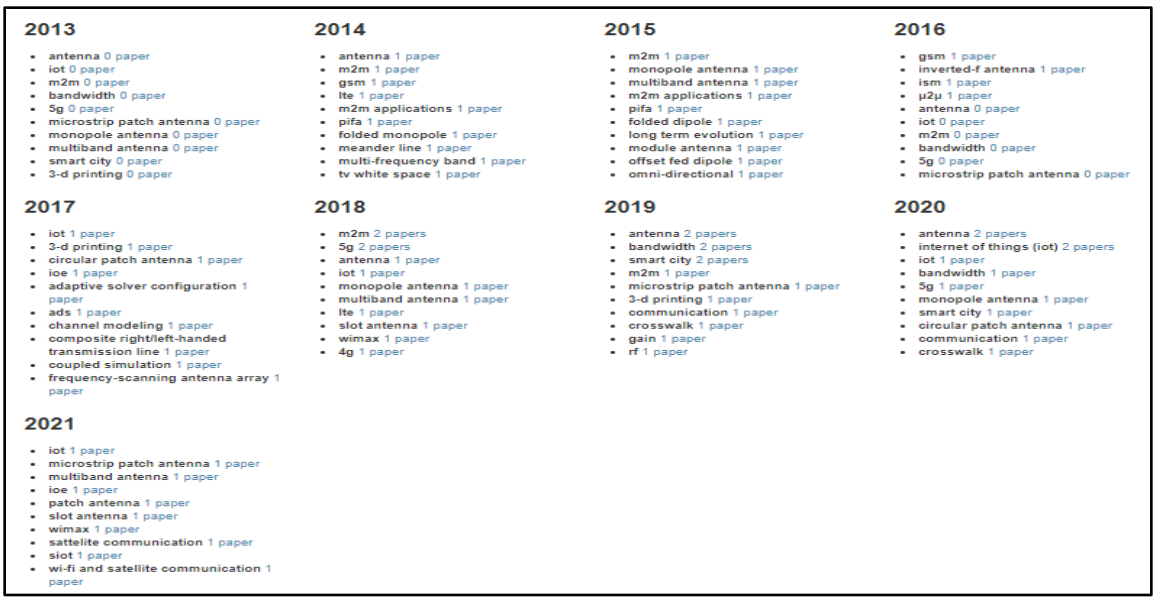

Figure 14: Top Keywords: 2013 -2021 Source: http://www.scopus.com (content referred on 13th May 2021)

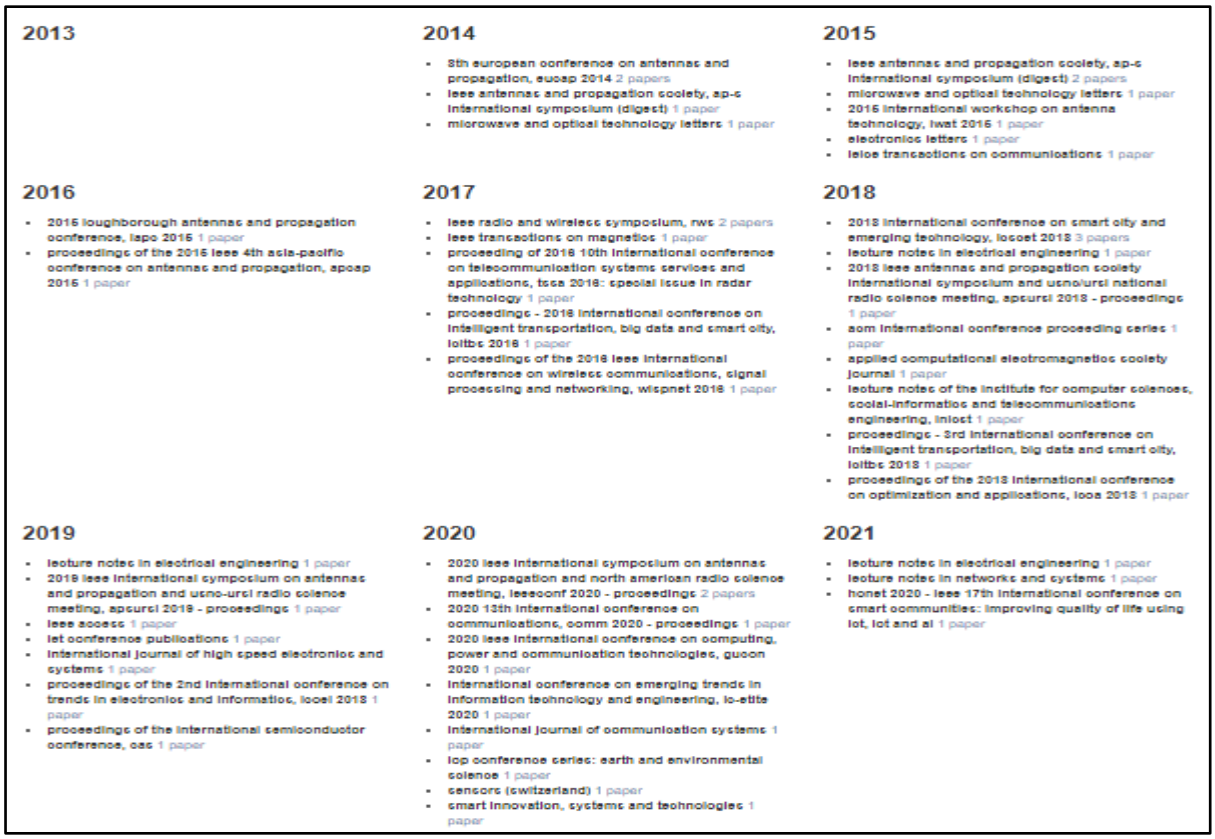

Figure 15: Top Journals: 2013 -2021 Source: http://www.scopus.com (content referred on 13th May 2021)

Figure 16 shown below represents the authors' co-citation network diagram. Some of the highlighted co-citations are those given by – Amman, M.J; Wong, K.; Chen, W, etc. among others.

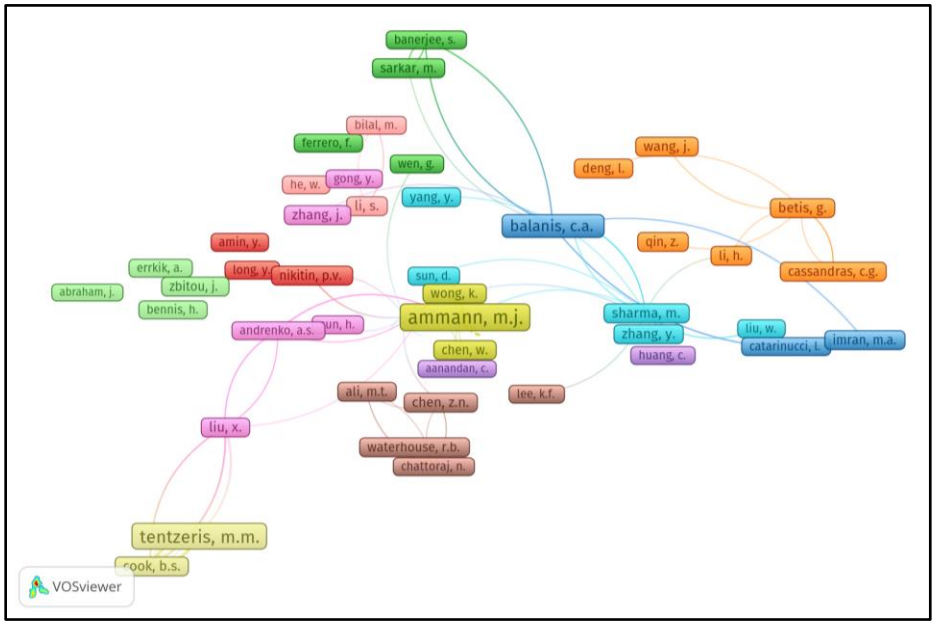

Figure 16: Co-Citation of Authors: Source: http://www.scopus.com (content referred on 13th May 2021)

Figure 17 as shown beneath illustrates some keywords that are appearing in the same paper. Some of the salient keywords to be highlighted are – *M2M, Antenna, 5G, Smart Cities*, etc.

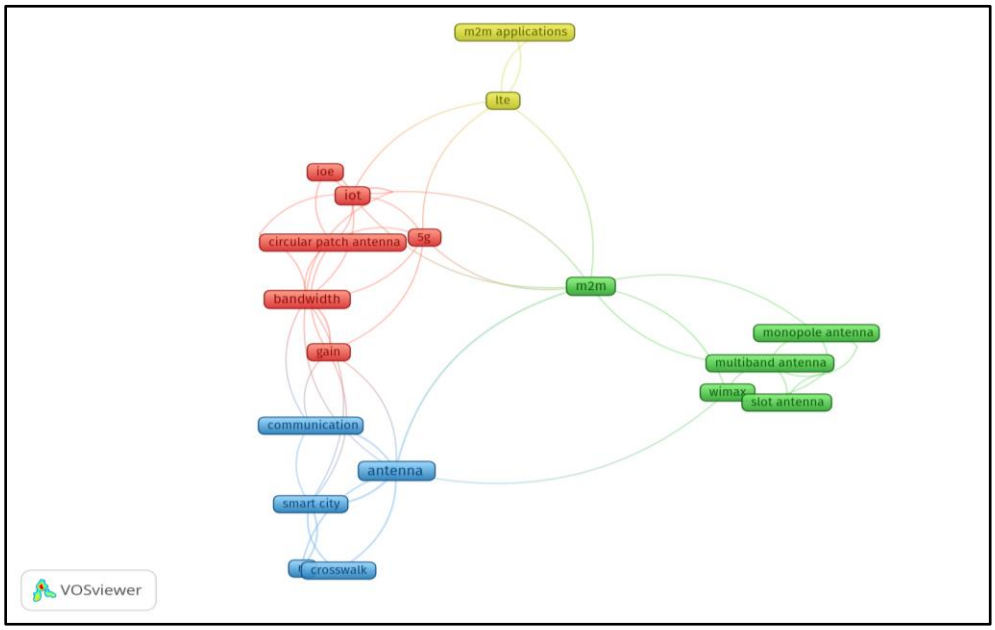

Figure 17: Author Keywords appearing on Same Paper: Source: http://www.scopus.com (content referred on 13th May 2021)

Figure 18 presents network visualization for keywords. Nodes with bigger size show keywords that are mentioned frequently. They are viz. antenna, band, application, frequency, etc. Whereas the keywords that need to be paid attention to include simulation, directivity, return loss, processing, development, VSWR, patch, radiation pattern, substrate, etc.

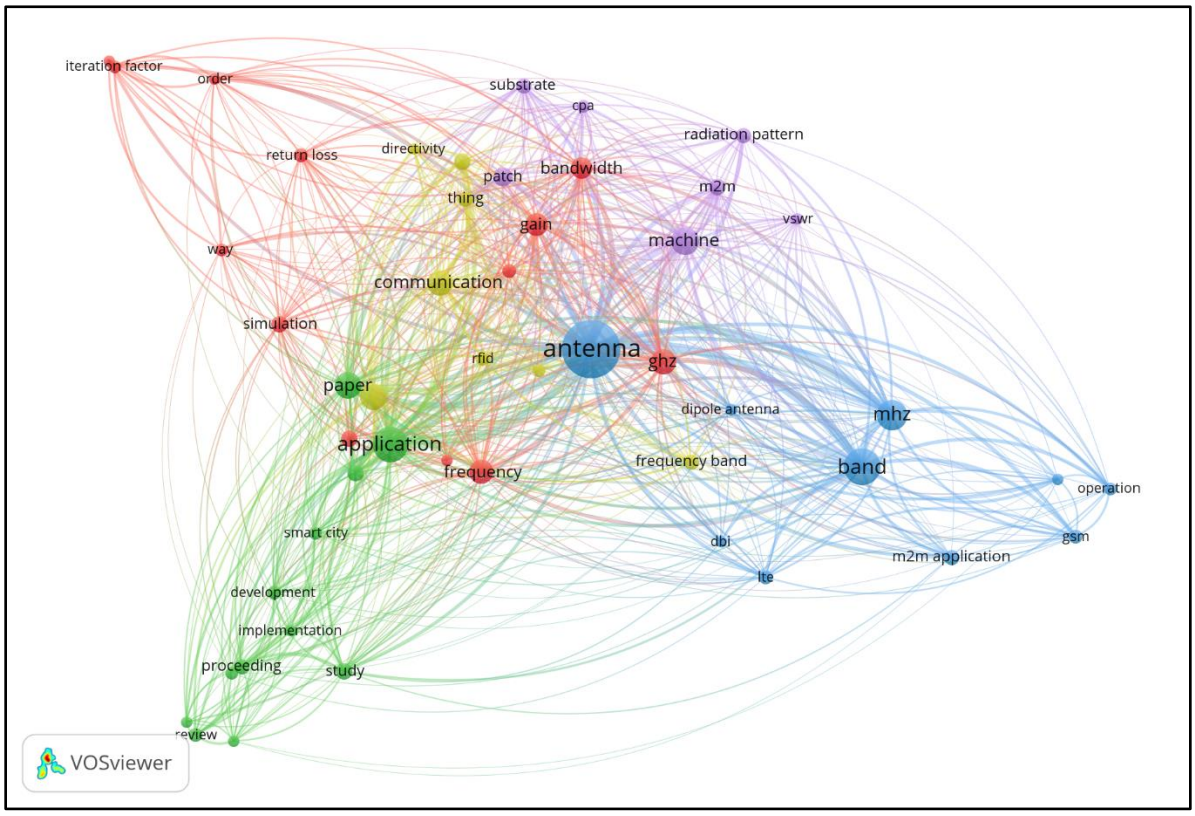

Figure 18: Keywords Network Visualisation: Source: http://www.scopus.com (content referred on 13th May 2021)

Figure 19 displays the reference scape of the acquired data. It can be clearly seen from the visualised representation that the major references are related to antennas.

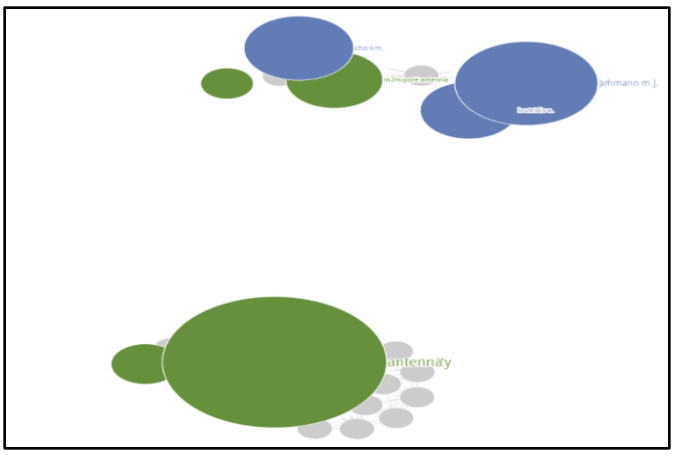

Figure 19: Reference Scape: Source: http://www.scopus.com (content referred on 13th May 2021)

Table 10 beneath presents the top cited articles. The paper written by Loutridis A., John M., and Ammann M. has been cited 15 times followed by another paper by them, which has been cited 11 times.

Table 10: Top Cited Articles: Source: http://www.scopus.com (content referred on 13th May 2021)

Year	Authors	Title	Source title	Cited by
2015	Loutridis A., John M., Ammann M.J.	Folded meander line antenna for wireless M-Bus in the VHF and UHF bands	Electronics Letters	15
2013	Loutrids A., John M., Ammann M.J.	Dual band LTE planar inverted-F antenna for M2m applications	Microwave and Optical Technology Letters	11
2016	Vikram N., Kashwan K.R.	Design of ISM band RFID reader antenna for IoT applications	Proceedings of the 2016 IEEE International Conference on Wireless Communications, Signal Processing and Networking, WiSPNET 2016	8
2014	Yazdandoost K.Y., Miura R.	Compact printed multiband antenna for M2M applications	8th European Conference on Antennas and Propagation, EuCAP 2014	7
2019	Sharif A., Guo J., Ouyang J., Sun S., Arshad K., Imran M.A., Abbasi Q.H.	Compact Base Station Antenna Based on Image Theory for UWB/5G RTLS Embraced Smart Parking of Driverless Cars	IEEE Access	6
2018	Liu Y., Yang X.	Chipless radio frequency identification tag design with modified interdigital hairpin resonators	Proceedings - 3rd International Conference on Intelligent Transportation, Big Data and Smart City, ICITBS 2018	6
2017	Ramirez R.A., Golmohamadi M.,	3D printed on-package tripolar antennas for	IEEE Radio and Wireless Symposium, RWS	5

2015	Ma R., Gao Y., Wang Y., Parini C.	Circular co-planar inverted-F antenna for UHF Machine-to-Machine communications	IEEE Antennas and Propagation Society, AP-S International Symposium (Digest)	5
2018	El Gholb Y., El Bakkali M., El Amrani El Idrissi N.	Wide-band circular antenna for 5G applications	Proceedings of the 2018 International Conference on Optimization and Applications, ICOA 2018	4
2015	Zhang Q., Gao Y., Parini C.	Miniaturized UHF Antenna using a magneto-dielectric superstrate for M2M communications	IEEE Antennas and Propagation Society, AP-S International Symposium (Digest)	4
2014	Sumi M., Cho K.	Operating mechanism of small quad-band printed antenna comprising symmetrically arranged trapezoidal elements and rectangle strip elements	IEICE Transactions on Communications	4
2017	Juettner M., Grabmaier S., Vögeli D., Rucker W.M., Göhner P.	Coupled Multiphysics Problems as Market Place for Competing Autonomous Software Agents	IEEE Transactions on Magnetics	3
2014	Loutridis A., John M., Ammann M.	Printed folded meander line dual-band monopole for TV White space and GSM	8th European Conference on Antennas and Propagation, EuCAP 2014	3

5. LIMITATIONS OF RESEARCH:

Bibliometric studies conducted in the following paper are only based on data from publications obtained from the Scopus Database. Several other magazine articles, publications, and chapters of books from other sources such as Google Scholar, Web Science, Delnet and Pearson could have been considered in this regard. Yet, due to time constraints the study is therefore not included in this following analysis. However, this limitation must be overcome for future research and the additional information should be included in all ongoing studies for better specification. Even

though there are many other databases accessible to the public, the Scopus database remains undeniably the most widely used and popular database among all to. This was one of the major reasons for this study to be purely conducted based on data which was acquired through it. Another limitation to consider in this research is that it is limited to only a single language i.e., English, since it was the only language shared among the researchers writing this paper. This again is a major setback for this paper. The proposed study requires attention in India and its top research institutes. As top companies associated with the manufacturing and working of antennas like Zebra, Abracon LLC, Pulse Larsen Antennas etc., are involved in speculation research, therefore, there is a wide range of patents as well. Also, from updated keywords mentioned already in the beginning of the paper to notifications, this research can also be viewed in a variety of areas such as Machine to Machine (M2M) communication, or Multiple Input Multiple Output (MIMO) technology. Empirical research mentioned is closely related to the distributed programs which will lead to some important research in the near future.

CONCLUSION:

The purpose of this research was to get a good idea about the developments in the field of antennas. For this, a detailed bibliometric study & survey was done. It will be providing rudimentary guidelines to the budding researchers for learning the recent trends and help assess the research process and productivity. All the required information was taken from Scopus Repository. The focus was on Rectangular Microstrip Patch Antennas in Machine-to-Machine (M2M) Communications. From the data collected and visualized in the above research paper as various graphs and network diagrams, all the researchers who worked on this paper got a basic idea about how many countries had been already involved in the mentioned field of study and how much information they have gathered over the years. Scopus suggested around 200 articles which, after using the relevant keywords, the authors of this paper were able to filter and get 48 articles pertinent to the area of research. The analysis done on the data obtained from Scopus played a vital role in guiding the research associated with the role of Antennas in Machine to Machine (M2M) communication in the correct direction as it provided the authors with a deeper understanding of the current research happening in the broad field of Antenna systems.

REFRENCES:

[1] Singh S., Singla B.S., Sharma M., Goyal S., Sabo A. Comprehensive study on internet of things (IoT) and design considerations of various microstrip patch antennas for IoT applications (2021). Lecture Notes in Networks and Systems140, pp. 19-30

[2] Sharma M., Sharma B., Gupta A.K., Singla B.S. Design of 7 GHz Microstrip Patch Antenna for Satellite IoT- and IoE-Based Devices (2021). Lecture Notes in Electrical Engineering701, pp. 627-637

[3] 3rd International Conference on Computing Informatics and Networks, ICCIN 2020. Lecture Notes in Networks and Systems 167.

[4] Abdalla A.I., Ali I.H. Design and Modification of multiband M-slot patch antenna for wireless applications (2020). HONET 2020 - IEEE 17th International Conference on Smart Communities: Improving Quality of Life using ICT, IoT and AI 9322656, pp. 99-102.

[5] Surender D., Khan T., Talukdar F.A. A triple-band hexagonal-shaped microstrip patch antenna for RF energy harvesting in smart city applications (2020).2020 IEEE International Conference on Computing, Power and Communication Technologies, GUCON 2020 9231228, pp. 389-393.

[6] Hussain M., Amin Y., Lee K.-G. A compact and flexible UHF RFID tag antenna for massive IoT devices in 5G system (2020). Sensors (Switzerland)20(19),5713, pp. 1-21.

[7] Sarkar M., Singh A., Gupta S., Hassanien A.E. Smart antenna design for high-speed moving vehicles with minimum return loss. International Journal of Communication Systems 33(11), e4414.

[8] Salman L. Millimetre-Wave Patch Array for 5G Smart City Environment. 2020 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting, IEEECONF 2020 – Proceedings 9329628, pp. 1457-1458.

[9] Shao Z., Fang Y., Ping Zhang Y. Compact Dual-Band Antenna with Broadside and Conical Radiation Patterns for NB-IoT Applications. 2020 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting, IEEECONF 2020 – Proceedings 9330306, pp. 281-282.

[10] Andriesei C. Experiments to Assess the Implementation of A 4 GHZ Proximity Detector for Smart Crosswalk. 2020 13th International Conference on Communications, COMM 2020 – Proceedings 9141951, pp. 359-362.

[11] Sahoo A.B., Patnaik N., Ravi A., Behera S., Mangaraj B.B. Design of a Miniaturized Circular Microstrip Patch Antenna for 5G Applications. International Conference on Emerging Trends in Information Technology and Engineering, ic-ETITE 2020 9077760.

[12] 2nd International Conference on Smart IoT Systems: Innovations and Computing, SSIC 2019. Smart Innovation, Systems and Technologies 141.

[13] Apriono C., Adriandi G. Angle Characterization Radiation Detection of Microstrip Antenna for Short Range Terahertz Communication System. IOP Conference Series: Earth and Environmental Science 396(1),012028.

[14] Andriesei C., Anitei G., Condrea D. A case study of 4 GHz proximity detector for smart crosswalks. Proceedings of the International Semiconductor Conference, CAS 2019-October,8923619, pp. 247-250.

[15] Adeyeye A., Eid A., Hester J., Nauroze S.A., Tehrani B., Cui Y., Tentzeris M.M. Inkjet-/3D-/4D-Printed Wireless Ultrabroadband Modules for IoT, Smartag and Smart City Applications. International Journal of High-Speed Electronics and Systems 28(3-4),1940016.

[16] Zhu L., Chen P.-Y. A compact, zero-power and low-noise harmonic-transponder for liquid and moisture sensing. 2019 IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting, APSURSI 2019 – Proceedings 8888609, pp. 1109-1110.

[17] Sai Satyanarayana D.S., Prasad K.M.W. Multi-layered antenna design for smart city applications. IET Conference Publications 2019(CP758).

[18] Sharif A., Guo J., Ouyang J., Sun S., Arshad K., Imran M.A., Abbasi Q.H. Compact Base Station Antenna Based on Image Theory for UWB/5G RTLS Embraced Smart Parking of Driverless Cars. IEEE Access 7,8931576, pp. 180898-180909.

[19] Chattoraj N., Rajak N., Mahato B., Kumar R. Design and Development of Low-Cost Patch Antenna Using Air Gap for Wireless Applications. Lecture Notes in Electrical Engineering 556, pp. 261-270.
[20] Proceedings of the 2nd International Conference on Trends in Electronics and Informatics, ICOEI 2018. (2018)
[21] Bukkawar S., Ahmed V. Square Shaped Fractal Antenna for Multiband Applications. 2018 International Conference on Smart City and Emerging Technology, ICSCET 2018 8537305.
[22] Sharma S., Mehra R. Dual-band Planner Slot antenna loaded with Split Ring Resonators for WLAN/Wi-Max Applications. 2018 International Conference on Smart City and Emerging Technology, ICSCET 2018 8537254.
[23] Sankhe A.R., Khot U.P. Optimization of Iteration Order and Iteration Factor in Sierpinski Carpet Fractal Patch Antenna. 2018 International Conference on Smart City and Emerging Technology, ICSCET 2018 8537388.
[24] Anouar M., Larbi S. PIFA antenna for future mobile 5G. ACM International Conference Proceeding Series.
[25] El Gholb Y., El Bakkali M., El Amrani El Idrissi N. Wide-band circular antenna for 5G applications (2018). Proceedings of the 2018 International Conference on Optimization and Applications, ICOA 2018, pp.1-4.
[26] Liu Y., Yang X., Chipless radio frequency identification tag design with modified interdigital hairpin resonators (2018). Proceedings - 3rd International Conference on Intelligent Transportation, Big Data and Smart City, ICITBS 2018, pp. 645-648.
[27] Turkmen C., Bakirli Y., Secmen M., Altuntas M. Printed Quasi Yagi Antenna with Closely Spaced and Thick Directors for Triple ISM-Band/Wideband Applications at UHF (2018). 2018 IEEE Antennas and Propagation Society International Symposium and USNC/URSI National Radio Science Meeting, APSURSI 2018 – Proceedings, 8609205 pp. 677-678.
[28] International Conference on Emerging Trends and Advances in Electrical Engineering and Renewable Energy, ETAEERE 2016 (2018). Lecture Notes in Electrical Engineering, 443, pp. 1-808.
[29] International Conference on Future Access Enablers for Ubiquitous and Intelligent Infrastructures, FABULOUS 2017 (2018). Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST 241
[30] Bibi S., Saleem R., Quddus A., Rehman S., Shafique M.F. Dual-band antenna for high gain M2M communication using PRS (2017). Applied Computational Electromagnetics Society Journal 32.11 pp. 994-1000.
[31] Yingkai M. One-dimensional frequency-scanning antenna design based on SIW composite right/left-handed transmission line (2017). Proceedings - 2016 International Conference on Intelligent Transportation, Big Data and Smart City, ICITBS 2016. 8047172 pp. 341-344.
[32] Juettner M., Grabmaier S., Vögeli D., Rucker W.M., Göhner P. Coupled Multiphysics Problems as Market Place for Competing Autonomous Software Agents (2017). IEEE Transactions on Magnetics, 53.6. 7835267.
[33] Ramirez R.A., Golmohamadi M., Frolik J., Weller T.M. 3D printed on-package tripolar antennas for mitigating harsh channel conditions (2016). IEEE Radio and Wireless Symposium, RWS. 7885946, pp 62-64.
[34] IEEE Radio and Wireless Symposium, RWS (2017). IEEE Radio and Wireless Symposium, RWS
[35] Proceeding of 2016 10th International Conference on Telecommunication Systems Services and Applications, TSSA 2016: Special Issue in Radar Technology (2017). Proceeding of 2016 10th International Conference on Telecommunication Systems Services and Applications, TSSA 2016: Special Issue in Radar Technology
[36] Vikram, N., Kashwan, K.R. Design of ISM band RFID reader antenna for IoT applications (2016). Proceedings of the 2016 IEEE International Conference on Wireless Communications, Signal Processing and Networking, WiSPNET 2016 7566454, pp. 1818-1821.

[37] Sumi, M., Cho, K., Suzuki, Y. Broadband folded offset fed printed dipole antenna for GSM/W-CDMA/LTE/Wi-Fi/Bluetooth M2M applications (2016). Proceedings of the 2015 IEEE 4th Asia-Pacific Conference on Antennas and Propagation, APCAP 2015 7374424, pp. 407-408.
[38] Loutridis, A., Yang, K., John, M., Ammann, M.J. Dual band printed antenna for M2M applications in ISM and GSM bands (2015). 2015 Loughborough Antennas and Propagation Conference, LAPC 2015 7366052.
[39] Sumi, M., Cho, K., Suzuki, Y. Printed antenna comprising symmetrically arranged trapezoidal elements, rectangle strip elements, and folded strip elements for GSM/W-CDMA/LTE M2M applications (2015). 2015 International Workshop on Antenna Technology, iWAT 2015. 7365321, pp. 257-259.
[40] Ma, R., Gao, Y., Wang, Y., Parini, C. Circular co-planar inverted-F antenna for UHF Machine-to-Machine communications (2015). IEEE Antennas and Propagation Society, AP-S International Symposium (Digest) 2015-October,7305098, pp. 1418-1419.
[41] Zhang, Q., Gao, Y., Parini, C. Miniaturized UHF Antenna using a magneto-dielectric superstrate for M2M communications (2015). IEEE Antennas and Propagation Society, AP-S International Symposium (Digest) 2015-October,7305009, pp. 1240-1241.
[42] Loutrids, A., John, M., Ammann, M.J. A dual band LTE PIFA antenna for M2M applications Open Access (2015). Microwave and Optical Technology Letters, 57(7), pp. 1655-1658.
[43] Loutrids, A., John, M., Ammann, M.J. Folded meander line antenna for wireless M-Bus in the VHF and UHF bands Open Access (2015). Electronics Letters, 51(15), pp. 1138-1140.
[44] Sumi, M., Cho, K. Operating mechanism of small quad-band printed antenna comprising symmetrically arranged trapezoidal elements and rectangle strip elements (2014). IEICE Transactions on Communications, E97B (10), pp. 2050-2058.
[45] Sumi, M., Cho, K. Small quad-band printed antenna comprising symmetrically arranged trapezoidal elements and rectangle strip elements (2014). IEEE Antennas and Propagation Society, AP-S International Symposium (Digest) 6904525, pp. 386-387.
[46] Yazdandoost, K.Y., Miura, R. Compact printed multiband antenna for M2M applications (2014). 8th European Conference on Antennas and Propagation, EuCAP 20146902331, pp. 2521-2524.
[47] Loutridis A., John M., Ammann M. Printed folded meander line dual-band monopole for TV White space and GSM (2014). 8th European Conference on Antennas and Propagation, EuCAP 2014. 6902420, pp. 2848-2852.
[48] Loutridis A., John M., Ammann M. Dual band LTE planar inverted-F antenna for M2m applications (2013). Microwave and Optical Technology Letters, 55(12), pp. 2925-2929.