Bibliometric Review on IoT Based System for Remote Downloading on Microcontroller

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ABSTRACT

Working with sensors has become an area of expertise within the domain of electronic engineering. On a day to day basis, thousands of sensors are put to use around us, for instance, in smoke alarms, speedometers, motors, computers, radiators etc. to accumulate sensor data, cables that connect the sensors to the bottom station after which the information is worked on. But cabling is often expensive especially when handling large scale industrial applications [5]. For an equivalent reason, low-cost wireless networks came into the picture recently and are in high demand. A research paper we found during our review of literatures, explores using raspberry pi type of a server to which other devices are going to be connected which will copy, store, and delete the file on the network itself. For this review, we went through papers that discussed and researched on the subject of downloading programs wirelessly on a microcontroller through a cloud-based system. The advantage of using cloud computing for IoT based applications increases the likelihood of, more devices joining the network. This makes it easier for IoT systems to grow efficiently thanks to reduced bandwidth and storage among other parameters [9]. We found some informative papers on sources such as, Google Scholar and Scopus that mention the MQTT protocol. The survey was conducted using the keywords mentioned below credited by various authors and publications from different countries. We gave more importance to the papers that were cited more often and also administered statistical analysis on the sources of the documents.

KEYWORDS

Microcontrollers, cloud computing, raspberry pi, server, wireless, remote access, download, remote download

1. INTRODUCTION

1.1 Internet of Things

The Internet of Things refers to the interconnection of varied devices over a network with applications including but not limited to, with applications including but not limited to, sharing data and resources over it. It gives users an opportunity to collect, analyze, distribute and transfer data which can act as a seminal trait in many similar applications. It is a system that's made up of a huge number of smart devices which are able to communicate among themselves and exchange resources. Enabling wireless technologies like RFID tags, embedded sensors and actuating nodes, IoT is continually becoming a subsequent revolutionary technology in transforming the online portal into a completely efficient integrated Future Internet [1]. Iot Devices mainly include sensors, actuators, wireless communication devices and microcontrollers. The microcontroller is often considered the brain of the IoT device [4]. With the introduction of IoT, research within the sector of automation practices has become increasingly popular. IoT connects everyday objects like phones, TVs, sensors etc. to the Internet which acts as a strong foundation for communication [7]. The IoT revolution has enabled any device to send information seamlessly without much human intervention [8].

1.2 Raspberry Pi

Raspberry Pi is also a strong and cost-friendly computer board used for educational purposes. It operates similarly to a typical central processing unit with output devices like monitor, keyboard and mouse which are required to be connected separately. It is widely used as low budget computers in schools and colleges as a medium for teaching and learning. In a recent comparative study of a Raspberry Pi module with other architectures like Iris, TelosB and MICAz, the authors checked parameters like price, processing power, flexibility, communication, OS , size and memory, hence concluding that a module of Raspberry pi showed many advantages over its rivals and thereby, serving as a suitable device in IoT applications[8].

Automation helps eliminate menial and unnecessary human labor and attain speed and accuracy in industrial applications [6].

1.3 MQTT

MQTT, which is a short for Message Queuing Telemetry Transport, acts as a uniform publish/subscribe protocol which can send data accurately over a specified network. The protocol has three main factors: the publisher, the subscriber and the broker. The client and server are not connected to each other while sending/receiving the message. The connection is taken care of by the broker that filters all the messages and distributes them to the receivers.

MQTT being a light-weight protocol with a small message size, when used as a communication protocol can save power and bandwidth. The publish/subscribe model is more fitted to IoT

applications than request/response models since request update isn't required resulting in bandwidth and power savings. [3].

There are mainly three kinds of publish/subscribe systems, which are as follows based on topic, type, and content. For topic-based-based, the list of topics are known beforehand usually during the designing of the appliance. Only certain topics are subject to subscription/publication. Type based systems are rather uncommon. For these systems, the subscriber states the type of data they require. For content-based systems, the subscriber describes what type of data they are interested in. These systems are more versatile [10].

2. LITERATURE SEARCH AND RESULT DISCUSSION

For this review, we have used a couple of publication databases. We accessed these databases through the SIU online library which will be accessed through the link: library.siu.edu.in. To conduct our research, we accessed google scholar, database of University of Nebraska, Scopus library, ScienceDirect by Elsevier, among others. These databases were accessed between 15th May and 18th May to finish the analysis. Results from the analysis are elaborated below.

2.1 Keyword-based search

The major important keywords that are used in this data collection are **IOT and Microcontroller, Sever, Remote download.** In secondary view we have included some keywords such as **Testing, Remote accesses, Embedded systems, MQTT, Raspberry Pi.** This data: Table 1 observed below is all based from year 2015-21 keywords and open access publications of related keywords.

Table 1: Publications of keywords

KEYWORDS	NO. OF DOCUMENTATIONS
IOT	750
MICROCONTROLLER	21
SERVER	60
TESTING	29
EMBEDDED SYSTEMS	504
MQTT	90
RASPBERRY PI	80

2.2 Highlights of preliminary data

Preliminary data completes the support on the keywords that extracted 471 documents from Scopus. Only data based on conference proceedings, journal papers, book series retrieved from 2017 to 2021 for this area of research were found. This is further depicted in Table 2.

Table 2: Publication Count per annum

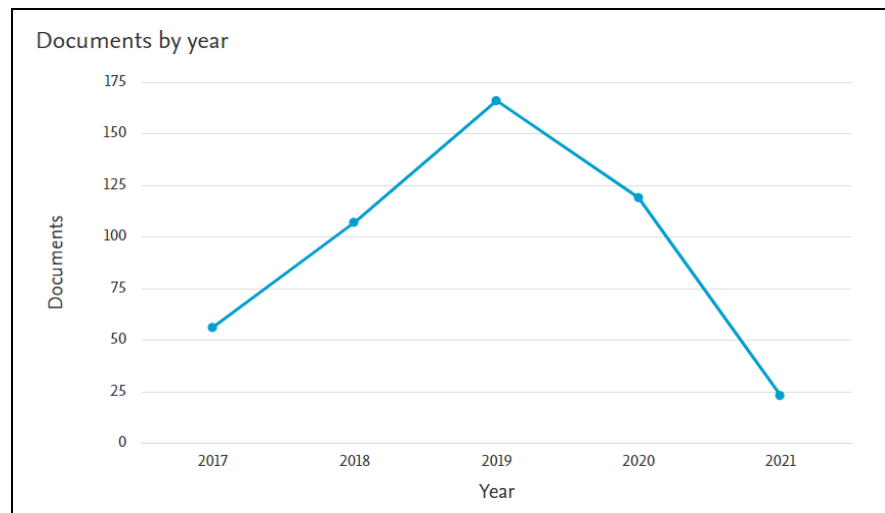| PUBLICATION YEAR	DOCUMENTATIONS
2021	23
2020	119
2019	166
2018	107
2017	56
TOTAL	**471**

Figure 1: Documents by year
Source: Scopus (accessed on 15th to 18th May, 2021)

3. BIBLIOMETRIC ANALYSIS

Starting from the early 1990's basic micro-processors with far less functionality in comparison to the micro-processors we have today, were used for very basic personal computing with dubious connectivity. It was then followed by both Wired and wireless communications which slowly but surely connected people across the globe. The next decade (2010), brought about

with it the creation of Lower power apps and microprocessors which ensured Personal Infotainment and increased mobility. And finally, coming to the present decade, the onset of 2020 got Micro- controllers with multiple functionality, seamless wireless connectivity, sensor aggregation among many other things. This increasing trend in IoT is shown below:
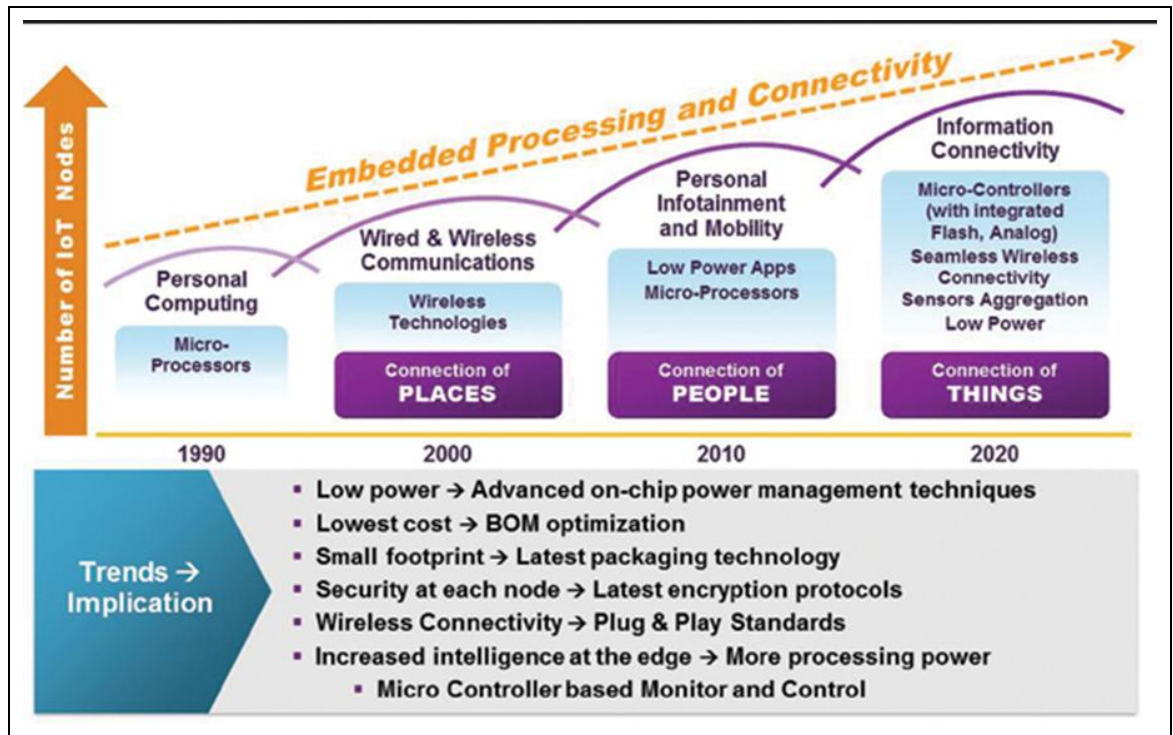

Figure 2: Growing trends

1. Today there is an ongoing hype to incorporate IoT in everything by embedding a sensor (that is connected to a network) in the device.
2. Cost of sensors has come down.
3. Cost of processing is nominal
4. Wireless connectivity is easily available

To manage so much IoT-ification, Cloud is the only answer as of now.

Given below: Table3 are some reasonable complementarities of IoT and Cloud:

Table 3: difference between IoT and cloud

IoT	CLOUD
It is pervasive in nature.	It is ubiquitous in nature.
It is applicable to real world things.	It is applicable to virtual resources
It has limited computational capabilities.	It has virtually unlimited computational capabilities.
It has limited storage capabilities.	It has virtually unlimited storage capabilities.

The Internet is used as a point of convergence.	The Internet is used for service delivery.
It acts as a big data source.	It acts as a means to manage data.

3.1 Geographical Region Analysis

The geographical regions of attentiveness of the published papers in the field of Microcontrollers are shown in figure 3.1 which is drawn using Scopus which reveals that India published the maximum number of papers in the field of microcontroller research.
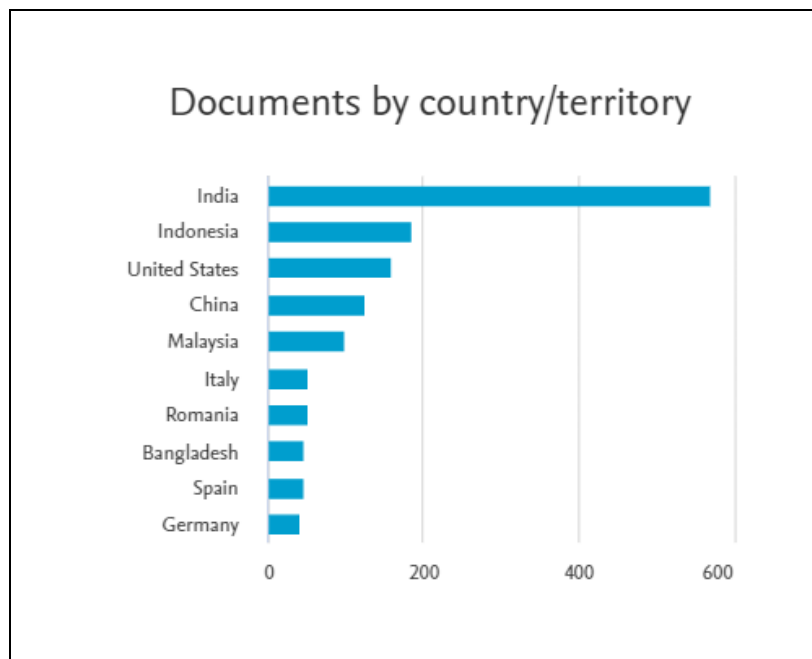

Figure 3: Documents by countries/territories
Source: Scopus (accessed on 15th to 18th May,2021)

3.2 Subject area wise analysis

Categorization supported discipline is shown in figure 4. The analysis reveals the utmost number of research papers published from the world of computing and Engineering.
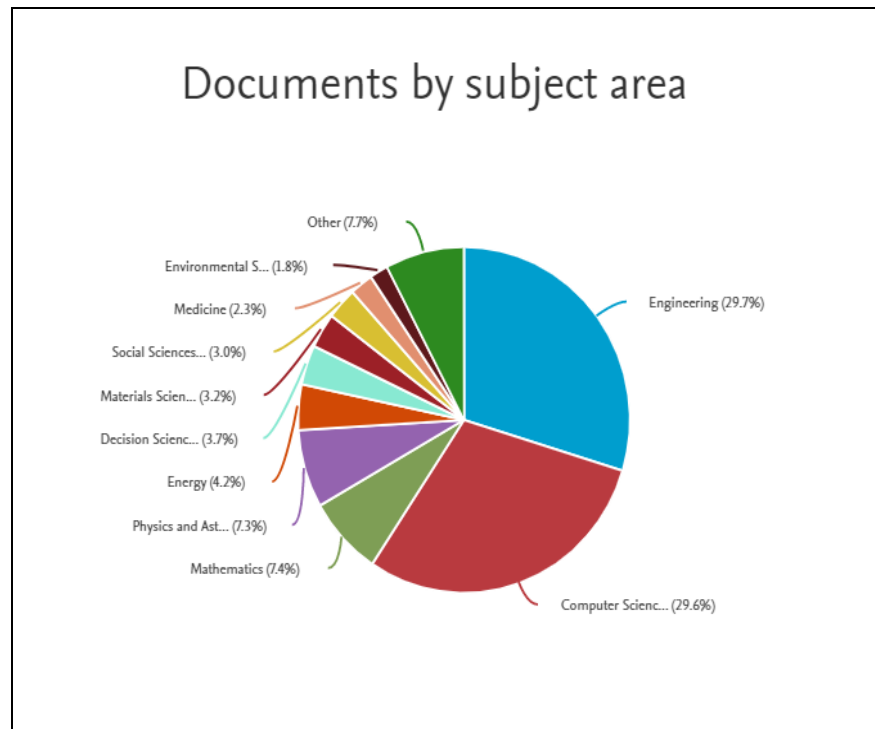
Figure 4: Subject area wise analysis
Source: - Scopus (accessed on 15th to 18th May, 2021)

3.3 Affiliation based analysis

The information about the organizations and universities across the world contributing to the research in the field of Internet of Things and Microcontrollers is shown in Figure 5. Most dominated research in this field is by Vellore Institute of Technology followed by SRM Institute of Science and Technology and Institut Teknologi Bandung.
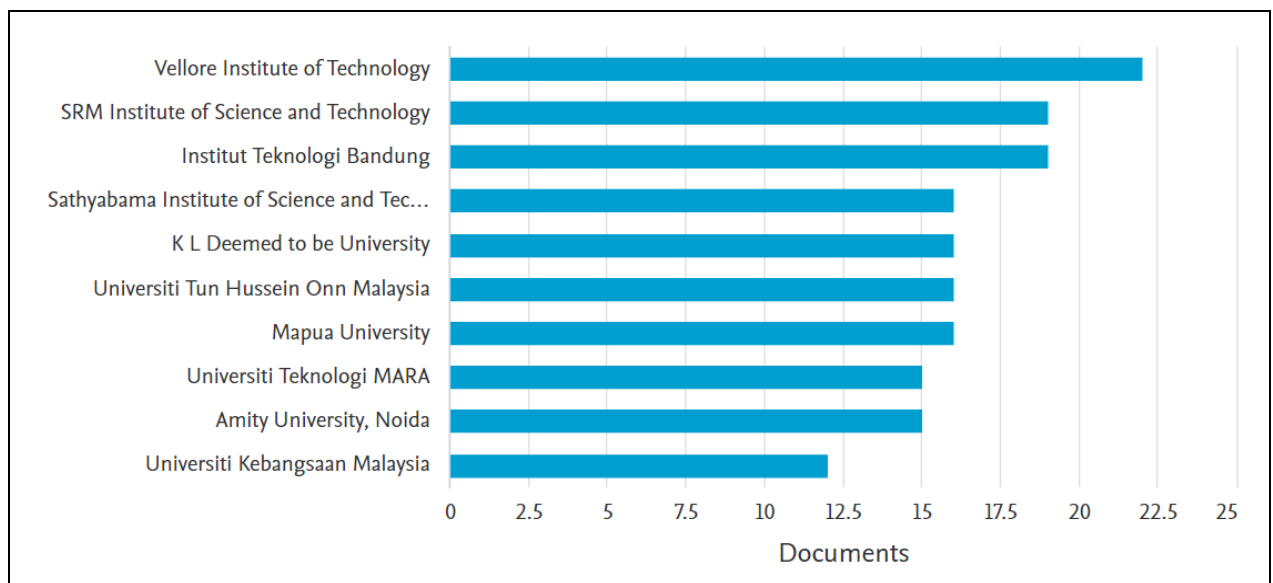

Figure 5: Documents by affiliation
Source: Scopus (accessed on 15th to 18th May, 2021)

3.4 Publication Details according to Authors

Al-Ali A R, Satria D and Urien P are the top three authors contributing to the research in the field of IoT and Microcontroller.
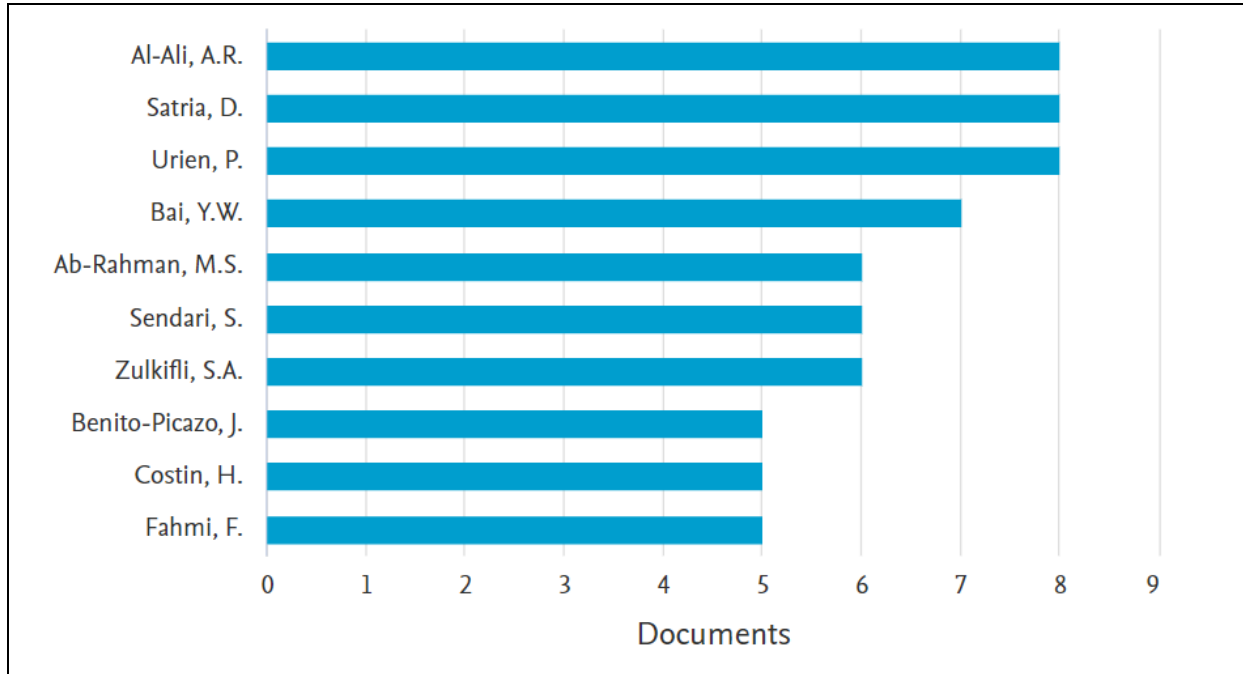

Figure 6: Publication Analysis based on Authors
Source: Scopus (accessed on 15th to 18th May, 2021)

3.5 Funding Sources and Publications

Figure 7 is an analysis based on funding sources and the number of publications. The European Commission has the best funding sources followed by the National Natural Science Foundation of China, which ranks second.
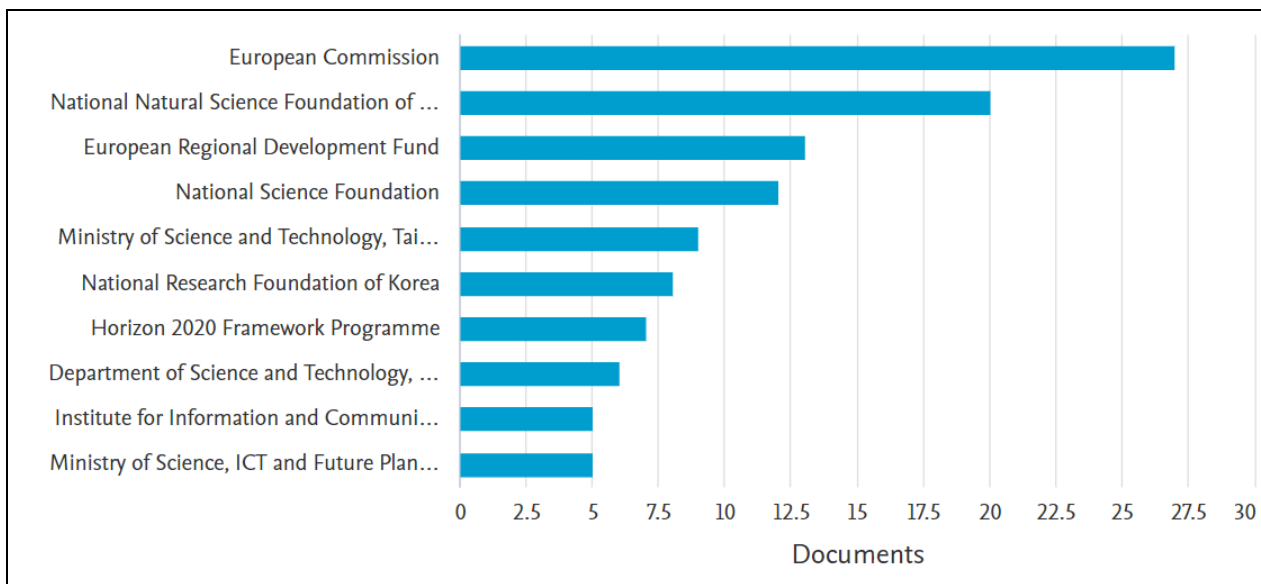

Figure 7: Analysis based on funding sources

3.6 Publication source statistics

Figure 8 gives a thought regarding distributions in the field of IoT and microcontrollers depending on records of types. It is seen that out of the relative multitude of distributions, 67.5% are just meeting papers. Likewise, it is seen that specialists are keen on distributing their examination work as articles which involves 27.7% of the absolute publications. Additionally there are some other fluctuated kinds of publications like book parts, notes, research papers, short reviews and many more.many more.
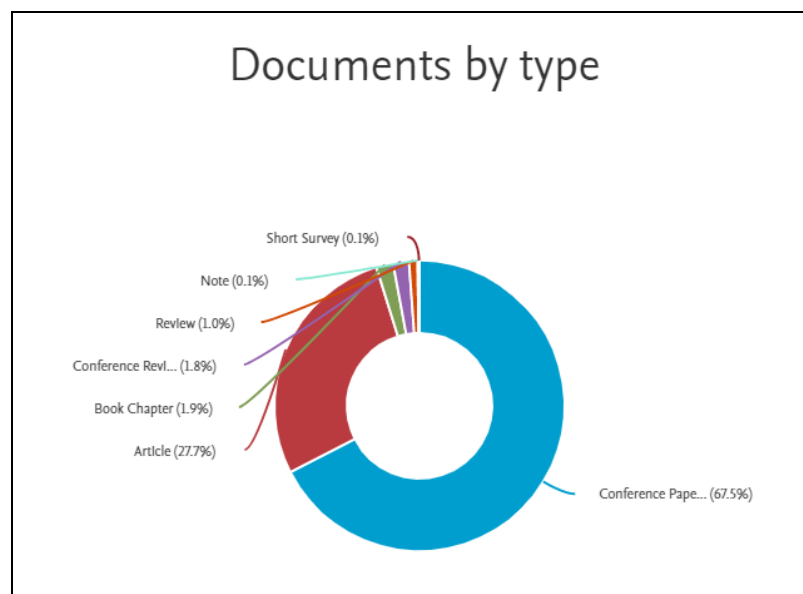

Figure 8: Document Type Based Analysis
Source: Scopus (accessed on 15th to 18th May, 2021)

3.7 Citation Analysis

Table 4 shown below, is the analysis of documents citations on a yearly basis. We have considered the citation data from 2017 to 2021, The documents listed here are from the field of IoT, microcontrollers and cloud-based systems.

For this particular analysis, we fed keywords into the Scopus database search and sorted the documents by most cited. Then we viewed the citation overview for the first 10 documents. We listed the documents along with the graphical analysis below.

Table 4: Yearly citation analysis for the documents

Publication Year	Document Title	Author	>2017	2017	2018	2019	2020	2021	Total
			9	5	6	9	10	3	42
2021	Learning on and at the edge: Enabling remote instructional activities with micro controller and microprocessor devices	McGrath O.G.	0	0	0	0	0	0	0
2018	Facebook Based Home Appliances Security Control and Monitoring Using Raspberry PI 3	Singh V.P., Deshmukh U.	0	0	0	0	0	0	0
2018	Weather tracking system using MQTT and SQLite	Kodali R.K., Gorantla V.S.K.	0	0	0	2	3	1	6
2017	Investigation on raspberry pi microcontroller as digital processing controller in back to back converter	Zulkifli S.A., Mamat I., Mokhtarudin M.N.H., Shah S.A.	0	2	0	0	0	0	2
2016	Implementation of cloud server for real time data storage using Raspberry Pi	Princy S.E., Nigel K.G.J.	0	2	1	4	4	0	11
2016	Development of a cloud-based system for remote monitoring of a PVT panel	Saraiva L., Alcaso A., Vieira P., Ramos C.F., Cardoso A.M.	0	1	1	2	2	0	6
2016	Embedded Web Server based NetLab for Remote Access	Husain Siddiqui M., Purohit V., Mane S.	0	0	0	0	0	0	0
2015	A remotely accessible photovoltaic system as didactic laboratory for	Assante D., Tronconi M.	3	0	1	0	0	0	4

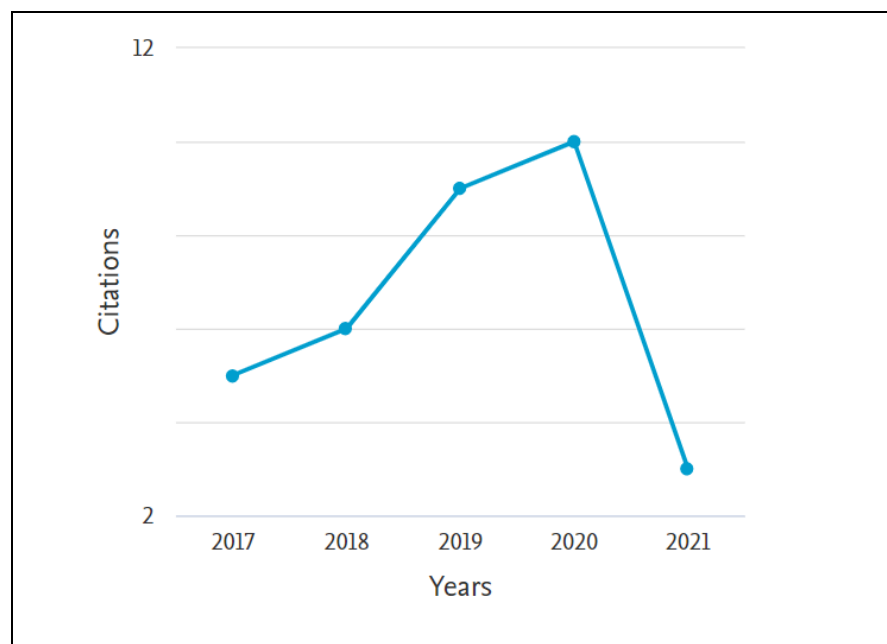|									
	electrical engineering courses								
2013	New architecture of remote laboratories multi user based on embedded web server	Yudi Limpraptono F., Ratna A.A.P., Sudibyo H.	2	0	3	1	1	1	8
2009	Web server based remote health monitoring system	Bosznai I., Ender F., Santha H.	4	0	0	0	0	1	5

Figure 9: Analysis Based on Citations
Source: Scopus (accessed on 15th to 18th May, 2021)
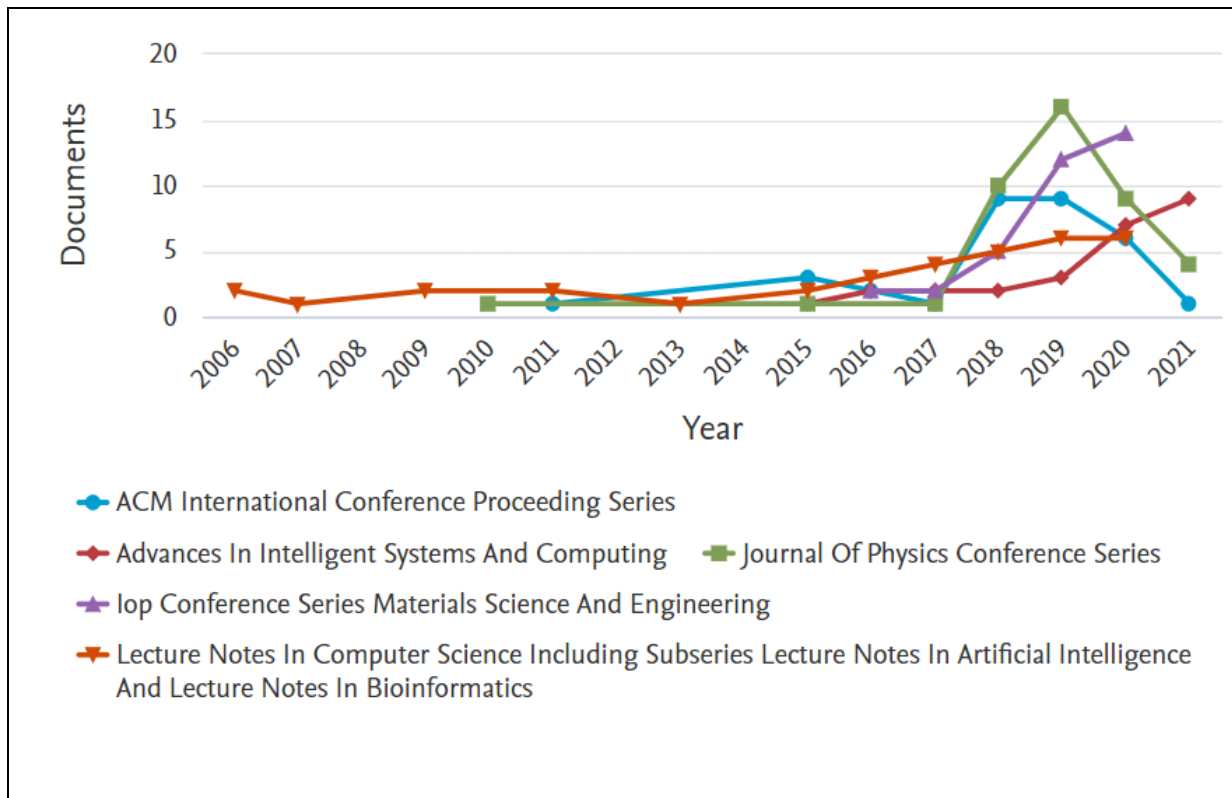
3.8 Document Source based Statistics

Figure 10: Document Source based Statistics
Source: Scopus (accessed on 15th to 18th May, 2021)

3.9 Networking Keywords

This cluster is basically the node connections between the major keywords with **96-ITEM** with **6 CLUSTERS.** Some of the important ones being IoT, embedded systems and cloud computing. According to the sources, MQTT, machine learning, fog computing and 5g mobile communication systems have recently gained a lot of attention while big data, gateways and cyber physical systems have taken a back seat.
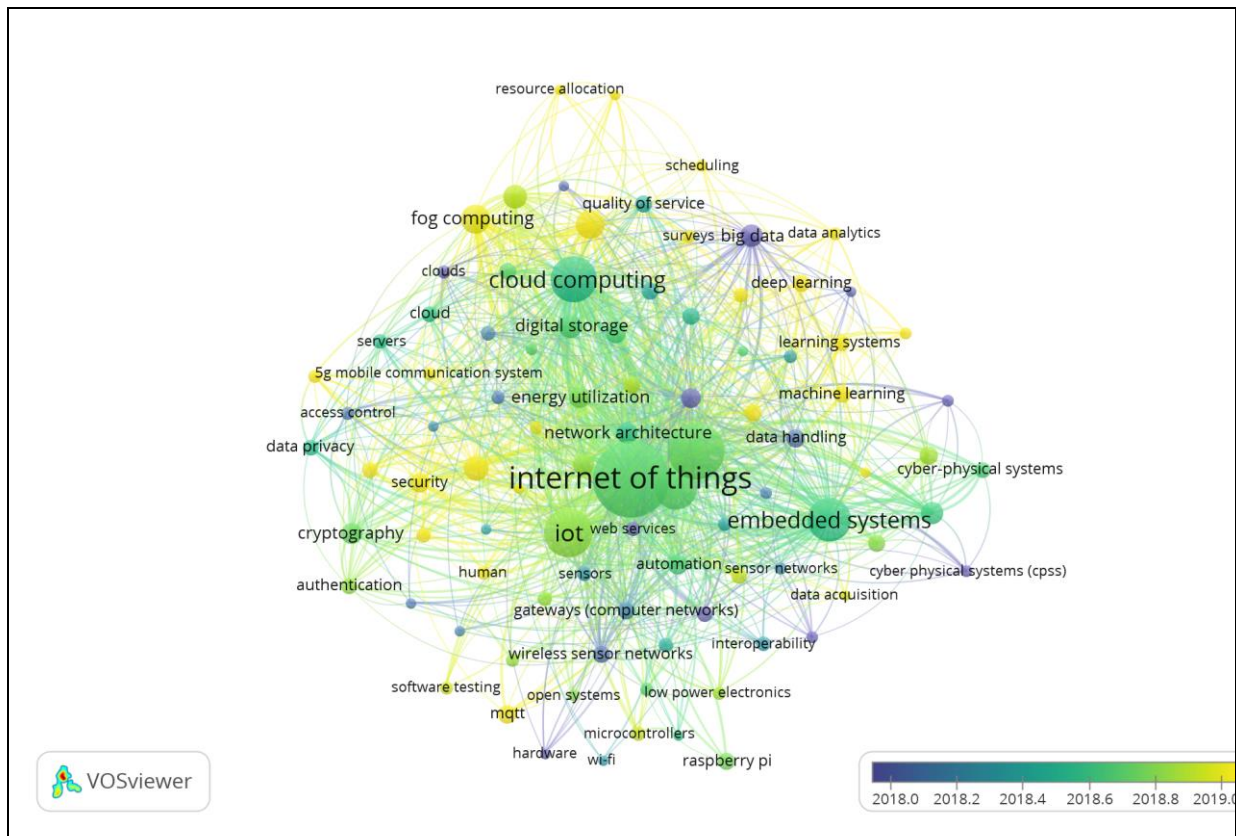
Figure 11: cluster of keywords

4. LIMITATIONS

There were very limited number of papers that we found using the keywords mentioned above. Hence, we had to apply certain permutations and combinations for the same to get a decent number of documents.

5. CONCLUSION

From the audit we can comprehend that the top-level input as far as examination distributions is in this field from the Engineering and Computer Science area. From this bibliometric investigation we can see that significant distributions are from gathering diaries and articles by Indian distributions. This empowers a client, given appropriate access authorizations, to deal with a microcontroller which might possibly be in a similar room or even a similar city as the client. Specialists in nations like India and China are the critical givers in the space of research and can help in the upgrade of the undertaking later on.

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