June 2021

A Brief Bibliometric Survey on Night Vision Bot using Dynamic IR and Object Detection

Devesh Abhyankar Mr.
Symbiosis Institute of Technology, Symbiosis International (Deemed University), (SIU) Lavale, Pune, Maharashtra, India, devesh.abhyankar.btech2018@sitpune.edu.in

Gurumoorty Suresh Mr.
Symbiosis Institute of Technology, Symbiosis International (Deemed University), (SIU) Lavale, Pune, Maharashtra, India, gurumoorty.suresh.btech2018@sitpune.edu.in

Hrithik Sambhaji Karjule Mr.
Symbiosis Institute of Technology, Symbiosis International (Deemed University), (SIU) Lavale, Pune, Maharashtra, India, karjule.hrithik.btech2018@sitpune.edu.in

Parth Bhardwaj Mr.
Symbiosis Institute of Technology, Symbiosis International (Deemed University), (SIU) Lavale, Pune, Maharashtra, India, parth.bhardwaj.btech2018@sitpune.edu.in

Harish Muleva Mr.
Dell Technologies, Bangalore, harish.muleva@dell.com

See next page for additional authors

Authors

Devesh Abhyankar Mr., Gurumoorty Suresh Mr., Hrithik Sambhaji Karjule Mr., Parth Bhardwaj Mr., Harish Muleva Mr., and Anurag Mahajan Dr.

A Brief Bibliometric Survey on Night Vision Bot using Dynamic IR and Object Detection

Devesh Abhyankar

Department of Electronics and Telecommunication, Symbiosis Institute of Technology, Symbiosis International (Deemed University), (SIU) Lavale, Pune, Maharashtra, India
devesh.abhyankar.btech2018@sitpune.edu.in

Gurumoorty Suresh

Department of Electronics and Telecommunication, Symbiosis Institute of Technology, Symbiosis International (Deemed University), (SIU) Lavale, Pune, Maharashtra, India
gurumoorty.suresh.btech2018@sitpune.edu.in

Hrithik Sambhaji Karjule

Department of Electronics and Telecommunication, Symbiosis Institute of Technology, Symbiosis International (Deemed University), (SIU) Lavale, Pune, Maharashtra, India
karjule.hrithik.btech2018@sitpune.edu.in

Parth Bhardwaj

Department of Electronics and Telecommunication, Symbiosis Institute of Technology, Symbiosis International (Deemed University), (SIU) Lavale, Pune, Maharashtra, India
parth.bhardwaj.btech2018@sitpune.edu.in

Harish Muleva

Dell Technologies, Bangalore, Karnataka, India

harish.muleva@dell.com

Anurag Mahajan

Department of Electronics and Telecommunication, Symbiosis Institute of Technology, Symbiosis International (Deemed University), (SIU) Lavale, Pune, Maharashtra, India
anurag.mahajan@sitpune.edu.in

Abstract

This study aims to analyse the work done in the field of Night Vision Robots using IR and Object Detection from 2011 to 2021, using the bibliometric methods. This paper presents a Scopus database review on "Night Vision Bot using Dynamic IR and Object Detection". The necessity for doing this bibliometric survey is that to know how the technology in the field of mobile robotics and night vision, as well as to object detection, has evolved over the years. This paper shows the importance of Night Vision Robot from the year 2011 and continued up to 2021 April. The database analysis for the robot is done through Scopus and VOSviewer Version 1.6.16. Through this database survey, it is revealed that the maximum number of publications are Conference Paper and most of them are from the field of Engineering and Computer Science, India has the greatest number of publications followed by China.

Methods: The Scopus database was used to obtain the articles for the above topic. The research papers were considered from the year 2011 to 2021. The Scopus analyzer can be used for the analysis of the database with different categories like Source, Subject Area, Country, etc. The analysis such as co-authorship, co-occurrences, citation analysis etc. is done by using VOSviewer Version 1.6.16.

Results: In the study, a total of 69 articles on Night Vision Robot were obtained between the years 2011 and 2021. The statistical analysis and network analysis shows that the maximum number of papers were published in the year 2020. India is the highest contributor followed by China and Australia.

Conclusion: The outcome of the Scopus database is 69 articles with the English Language having the largest number of articles. The Statistic Analysis helps to understand the potential of topic. It is done for Authors, Documents, Country, affiliations, funding sponsors. The Network Analysis indicates the interconnections between different parameters such as Co-author, sources. It indicates that this is a new concept, and the research has been done mostly in the last year, so there is lot of future potential and scope for development.

Keywords: night vision, dynamic IR, robot, object detection, computer vision

I. Introduction

Night vision surveillance plays a vital role in our day-to-day life to protect ourselves from theft and vandalism. The need for high tech night vision surveillance bots is increasing in today's era. These bots are becoming popular due to their potential of providing security at night in many areas including military, commercial and industrial application. Till now developments have been made to provide long-range remote access to the bot, incorporate machine learning algorithms for object detection and using a single camera for capturing different angles. Mobile robots have been using various types of cameras for surveillance, these cameras are mounted on the robot, some of them can tilt as well as pan [1] which can provide a greater field of vision. Currently, multiple cameras are mounted on different walls in an indoor security system which are used for surveillance. The robots in which the cameras are mounted can move to different locations. They are more flexible as compared to the fixed cameras [2] which have been traditionally used for this purpose.

The very recent development involves the integration of IoT (Internet of Things) to control the robot remotely and obtain information from it. The latest addition however is the addition of a new concept, known as Dynamic IR, which involves the control of the intensity of the IR light based on the calculated object distance to produce better images.

Along with surveillance, the bot needs to be aware of its surroundings by measuring various other parameters using Sensor Fusion. It allows us to extract various information which cannot be acquired using a single sensor [6]. We can combine sensors like Vision Sensor, sound sensor, temperature sensor, etc. Different sensors work differently and acquire different kinds of data. Sensor Fusion combines all the data from the sensors which can be used to overcome the drawbacks of other sensors.

There have been great advancements in the past decade in Machine Learning in the field of object detection and recognition. Many algorithms such as Scale Invariant Feature Transform (SIFT), Speeded up Robust Features (SURF), Viola Jones Framework have been developed and a lot of research has already been done [7]. Other works focused on cognitive approaches, as in [9], where authors have proposed to use memory-based cognitive modelling for robust object extraction and tracking. Various developments and techniques introduced after 2011 in this development which this paper indicates with the help of bibliometric analysis of the Scopus database.

II. Materials and Methods

A. Primary Collection of Databases

Google Scholar, Scopus, JSTOR, Web of Science, etc are some of the popular databases worldwide. We have used the largest database Scopus from the above-mentioned databases. Total of 69 publication results has given by the keywords used for search. For searching databases across the world different keywords are used. This information is used for the analysis.

Table 1:List of Primary and Secondary Keywords

Fundamental Keyword	**Night Vision Robot**
Primary Keywords using (AND)	**Night AND Vision AND Robot AND Camera**
Secondary Keywords using (OR)	**Object detection Robot OR Surveillance Robot**

Source: Scopus (accessed on 13th April 2021)

And we have generated the following query,

(TITLE-ABS-KEY (*night* AND *vision* AND *robot*) AND TITLE-ABS-KEY (*camera*) OR TITLE-ABS-KEY (*object* AND *detection* AND *robot*) OR TITLE-ABS-KEY (*surveillance* AND *robot*)) AND PUBYEAR > *2010* AND PUBYEAR < *2022*

B. Search Outcomes

Using different keywords related to this paper, Publications are obtained which are analysed according to the language. Database used is Scopus Database. After analysis it is found that highest no of publications is of English language i.e.,67 followed by Chinese.

Table 2: Trends of Publications (Language)

Publishing Language	Count of Publications
English	67
Chinese	2
Total	69

Source: Scopus (accessed on 13th April 2021)

C. Top 15 Keywords based on the Publications

During the search, many keywords are found in addition to the fundamental keywords. The top 10 keywords are listed here in the table. The "Robot" is the keyword that has the highest number of publications. Most of the Keywords are related to the field of Robotics.

Table 3: Publication Analysis based on Top 10 Keyword Analysis

Sr. No.	Keyword	Publications
1.	Robot	31
2.	Camera	27
3.	Robotics	21
4.	Computer Vision	19
5.	Night Vision Camera	13
6.	Vision	12
7.	Agricultural Robots	11
8.	Object Detection	10
9.	Stereo Image Processing	9
10.	Monitoring	7

Source: Scopus (accessed on 13th April 2021)

III. Analysis of Performance

The software that is used for the database analysis in addition to the analysis from Scopus is VOSviewer 1.6.16. The co-citations, co-occurrences, bibliometric couplings etc can be effetively analyze by VOSviewer 1.6.16. Types of analysis are performed.

- ## Analysis of Databases (Statistical)

1. Documents (Source)

2. Documents (Year)

3. Documents (Area of Subject)
4. Documents (Type)
5. Documents (Country or Region)
6. Documents (Author)
7. Documents (Affiliation)
8. Documents (Funding Agencies)

- **Analysis of Databases (Network)**

    1. Co-Authorship (Authors)
    2. Co-Occurrence (All keywords, Author keywords, Index keywords)
    3. Citation (Documents, Sources)
    4. Bibliographic Coupling (Documents, Authors)

IV. Discussion and Results

Two different ways are used for the analysis i.e., statistical analysis and network analysis of the databases.

4.1 Statistical Analysis

4.1.1 Analysis of Document (Sources)

The table below indicates Year-wise publication statistics from different sources such as conferences, research papers, journals etc. A graphical representation can be seen in the figure below with the number of the documents published per year.

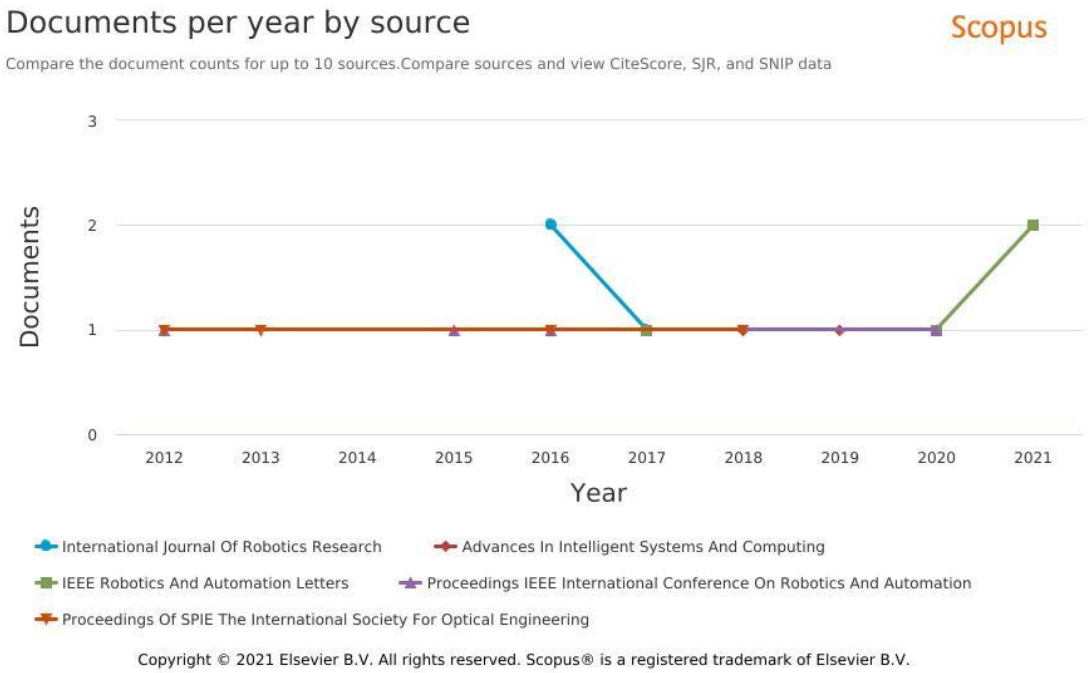

Figure 1: Document analysis by Sources

Source: Scopus (accessed on 13th April 2021)

4.1.2 Analysis of Documents (Year)

Documents are collected from the Scopus database including different sources such as conferences, journal, research papers etc in the year 2011 to 2021. Table below gives the statistical information, and the graphical representation as shown in the figure. The highest number of publications is in the year 2020 as observed from the analysis. In the coming years it shows that there will be a good scope of research.

Table 4: Number Publications (Year)

Year	Number of Publications
2011	0
2012	2
2013	4
2014	7
2015	6
2016	7
2017	7

2018	9
2019	10
2020	14
2021	3

Source: Scopus (accessed on 13th April 2021)

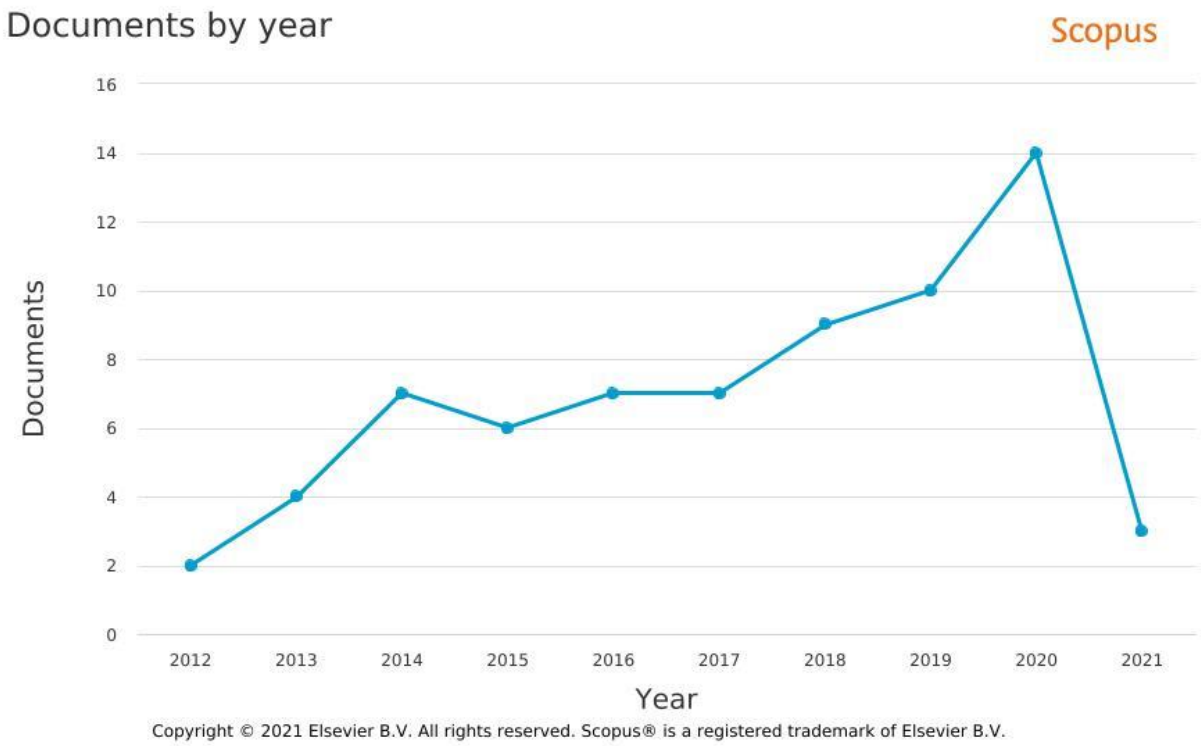

Figure 2: Document Analysis (Years)

Source: Scopus (accessed on 13th April 2021)

4.1.3 Analysis of Documents (Subject Area)

Night vision technology maximum papers are found under Computer Science (33.3%). Engineering covers 31.6% of the papers and the remaining documents are published in other subject areas. The main reason for this is the topic is related to the field of engineering and computer science.

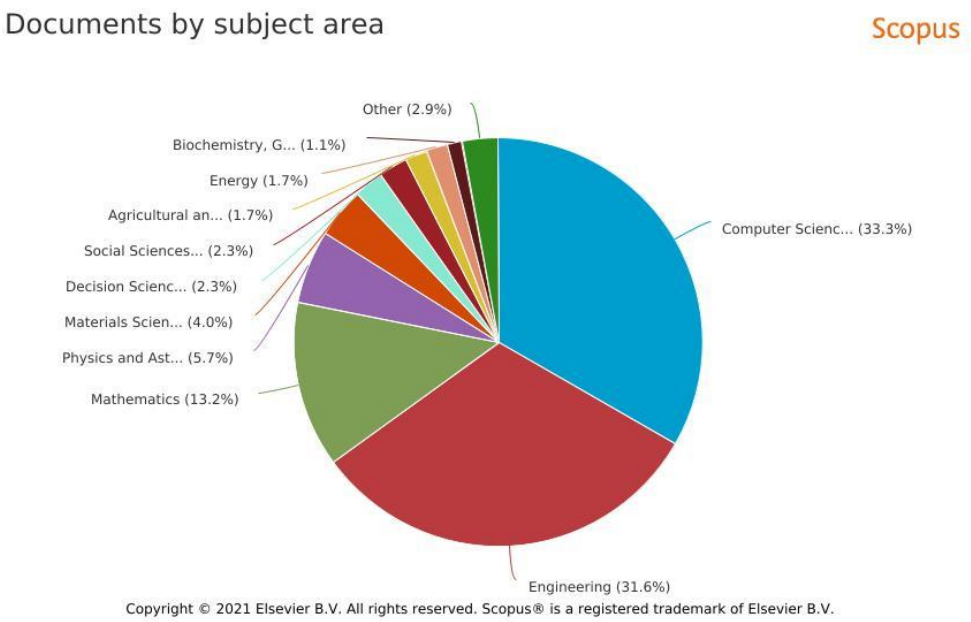

Figure 3: Document Analysis (Subject Area)

Source: Scopus (accessed on 13th April 2021)

4.1.4 Analysis of Documents (Type)

Most of the publications are from conference papers followed by the articles as observed from the analysis.

Table 5: Document Analysis (Type)

No.	Type of Document	Publications
1.	Conference Paper	45
2.	Article	19
3.	Conference Review	3
4.	Book Chapter	1
5.	Review	1

Source: Scopus (accessed on 13th April 2021)

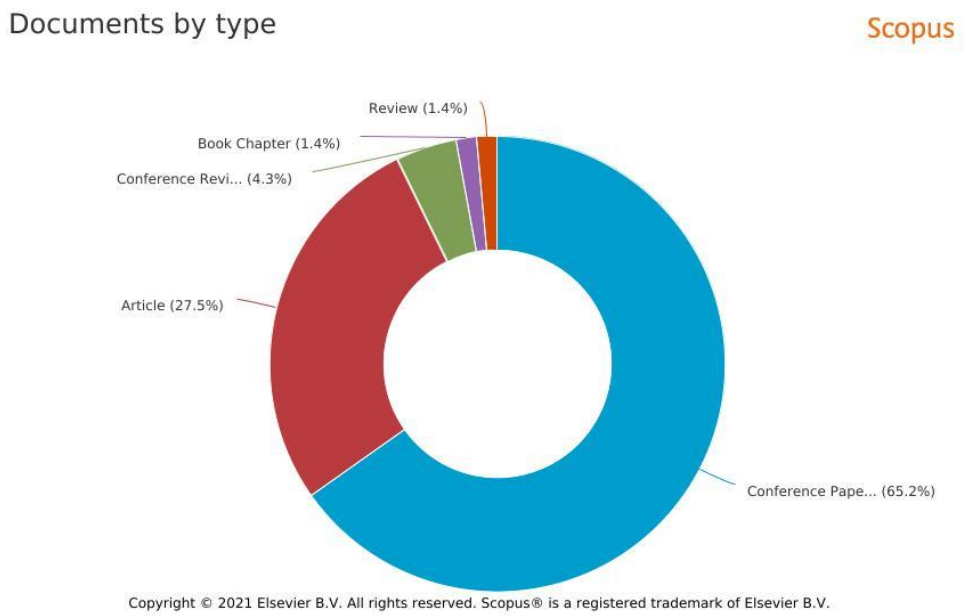

Figure 4: Document Analysis (Type)

Source: Scopus (accessed on 13th April 2021)

4.1.5 Analysis of Documents (Country)

By considering the number of documents published Scopus database is analyzed for countries. For the selected timeline it can be observed that the highest number of documents have been published in India, who is followed by China and then Australia.

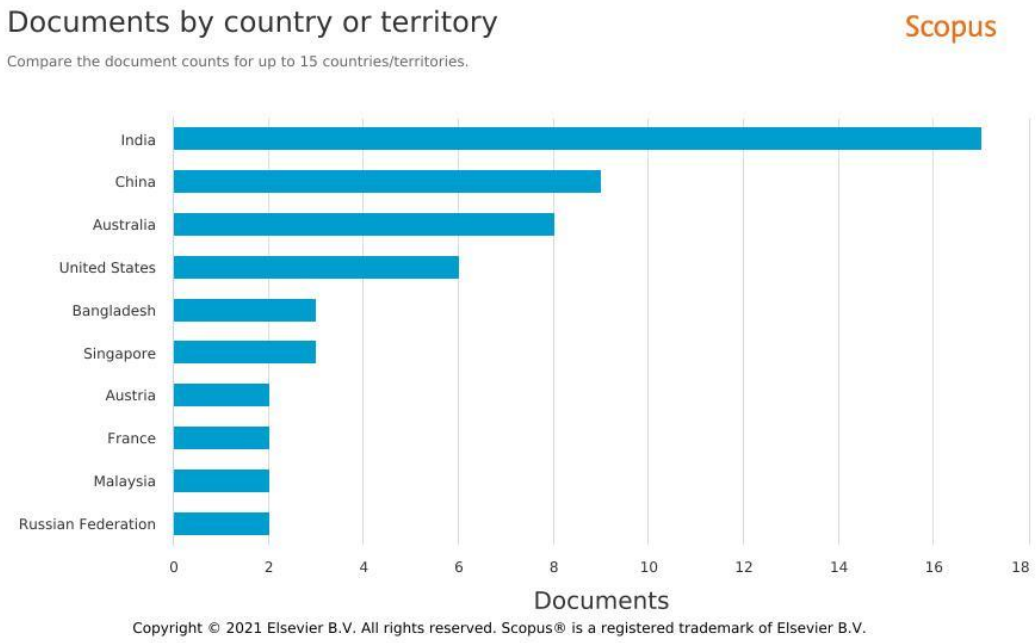

Figure 5: Document Analysis (Country)

Source: Scopus (accessed on 13th April 2021)

4.1.6 Analysis of Documents (Author)

The top 10 authors are being compared as shown below. The highest number of publications in this area is by Milford, M. i.e., he has 6 publications as observed. Maximum authors have 1 to 2 publications.

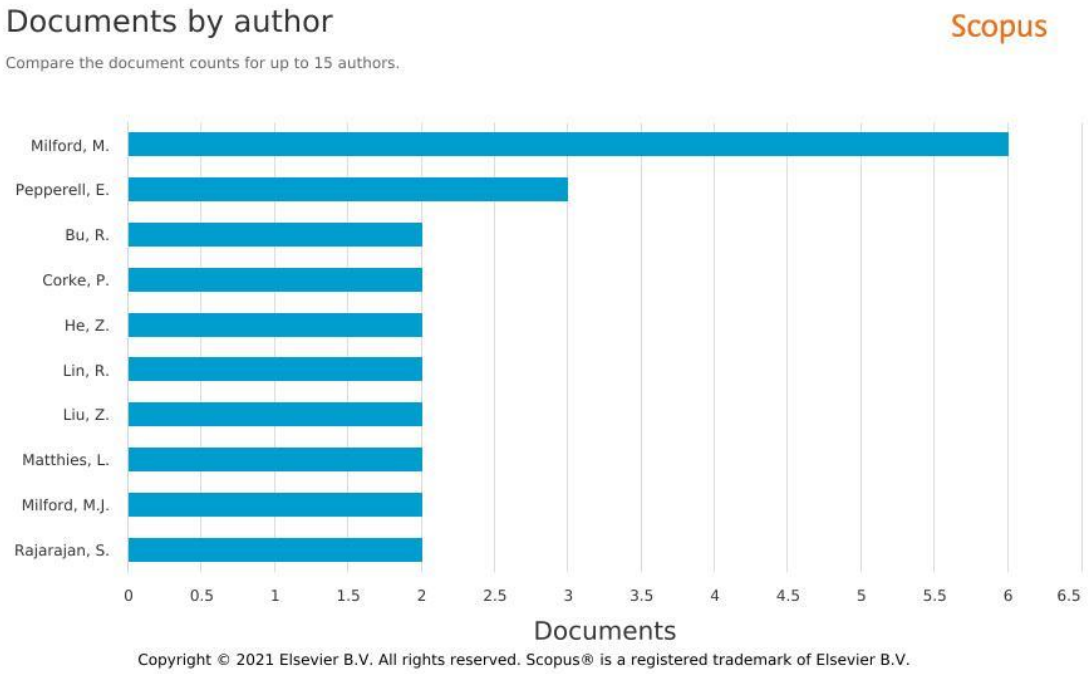

Figure 6: Document Analysis (Author)

Source: Scopus (accessed on 13th April 2021)

4.1.7 Analysis of Documents (Affiliation)

The top 10 affiliations are considered in this analysis. It is found that the 'Queensland University of Technology' and 'Sathyabama Institute of Science and Technology' have done most of the work done in this field. Together they are affiliated with 12 publications. Other than these Nasa (Jet Propulsion Laboratory) has also done some work in this field.

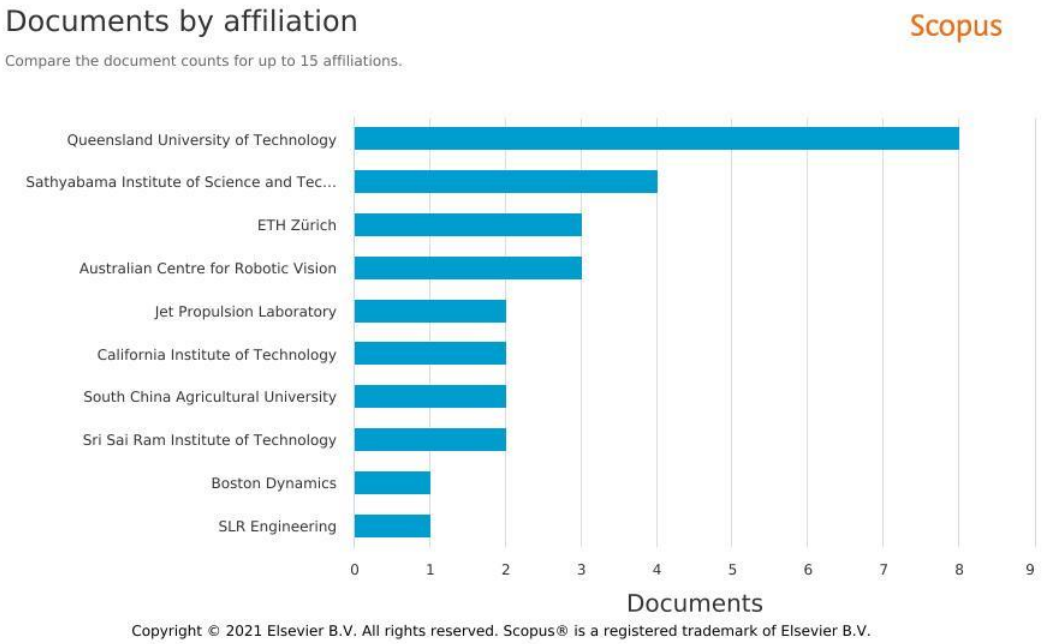

Figure 7: Document Analysis (Affiliation)

Source: Scopus (accessed on 13th April 2021)

4.1.8 Analysis of Documents (Funding Sponser)

China has the highest funding to the National Natural Science Foundation of China. From the analysis, it is found that most of the Funded Papers are from Research Institutes.

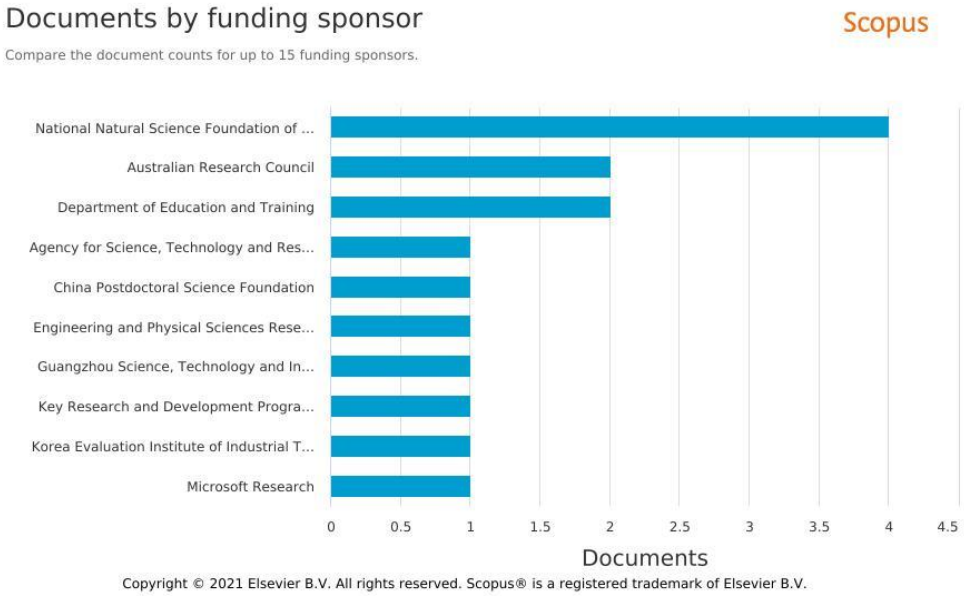

Figure 8: Document Analysis (Funding Sponsor)

Source: Scopus (accessed on 13th April 2021)

4.2 Network Analysis

4.2.1 Analysis of Co-Authorship

A. Co-Authorship (Authors)

If a document has many authors (25 authors in this case), the document is ignored from the analysis. An author with a minimum of 2 documents is considered as a threshold value in this case. It is observed that, within the total of 226 authors, only 13 authors met these threshold criteria. Milford M. has the highest number of documents equal to 6 in this analysis. Also, Milford M.J X. has got the maximum citations which are equal to 514. So, the above-mentioned authors are only in the figure. Analysis is considered in terms of Author, Organizations, and Countries.

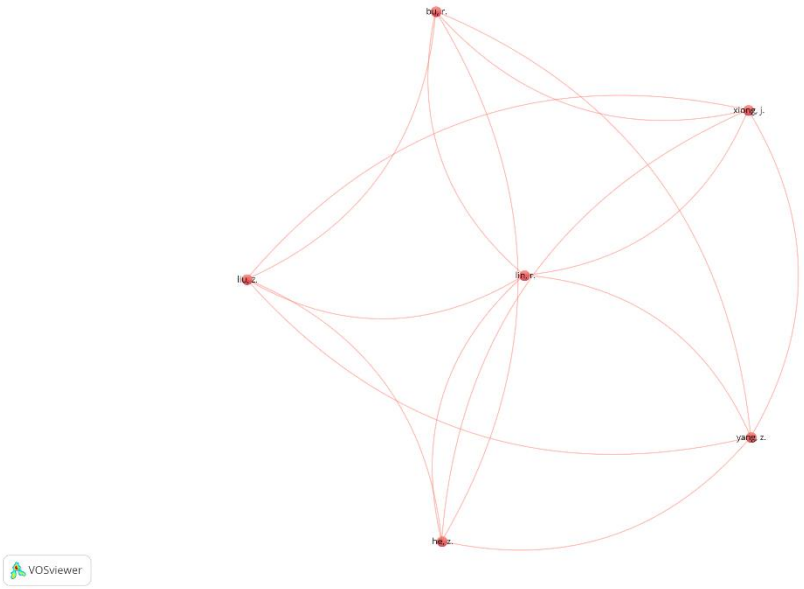

Figure 9: Network Analysis (Co-Authorship (Authors))

Source: Scopus (accessed on 13th April 2021)

4.2.2 Analysis of Co-Occurrence

A. Co-Occurrence (All Keywords)

Keywords are the most important features of any article. Co-occurrences of different keywords are analyzed. 4 is the threshold considered here. It is found that 37 keywords met the threshold out of 781 in total.

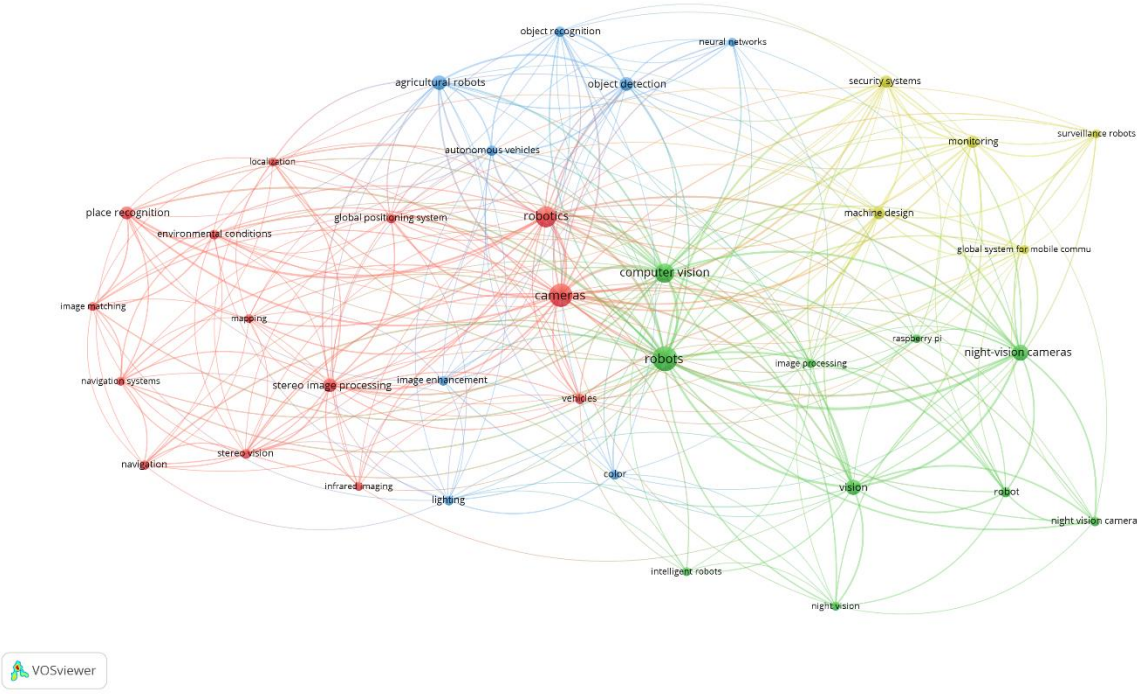

Figure 10: Network Analysis (Co-Occurrence for All Keywords)

Source: Scopus (accessed on 13th April 2021)

B. Co-Occurrence (Author Keywords)

The here analysis is done for co-occurrence of author keywords. The threshold set is 5 keywords per author. The threshold has been met by 21 keywords out of the 221 keywords.

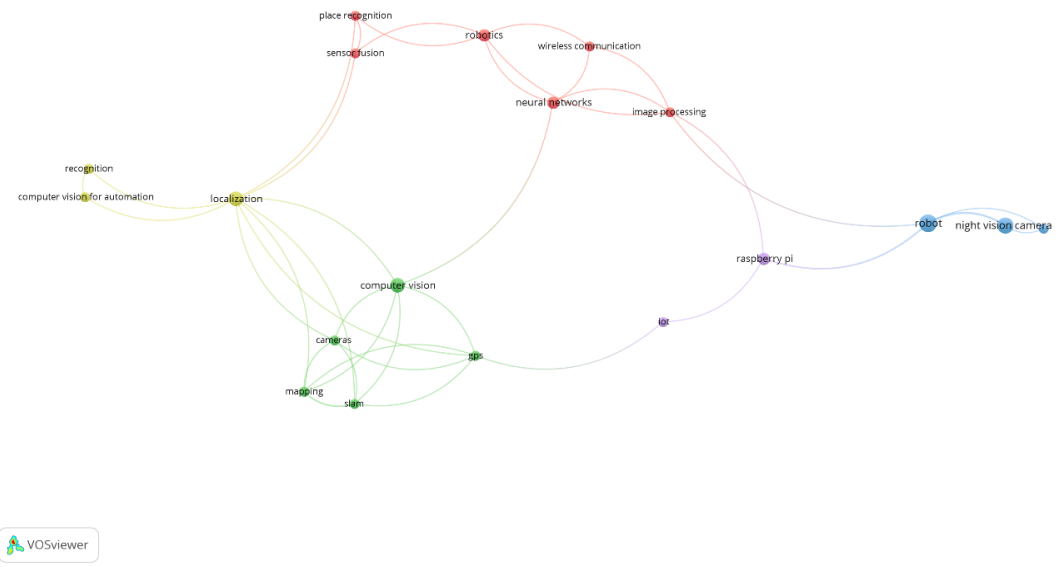

Figure 11: Network Analysis (Co-Occurrence for Author Keywords)

Source: Scopus (accessed on 13th April 2021)

C. Co-Occurrence (Index Keywords)

For this analysis threshold set is 3. Index keywords are 647 in total. The threshold has been met by 48 keywords.

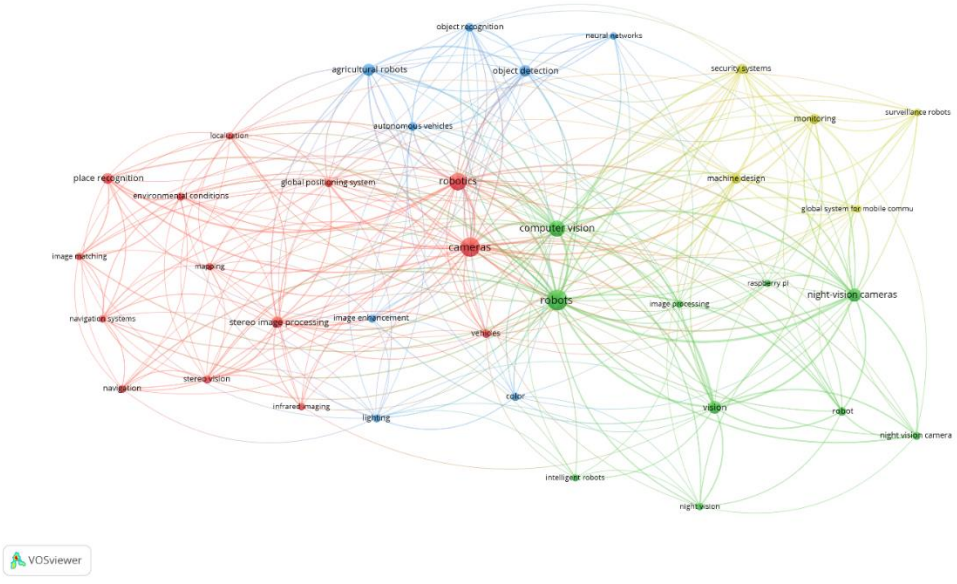

Figure 12: Network Analysis (Co-Occurrence for Index Keywords)

Source: Scopus (accessed on 13th April 2021)

4.2.3 Analysis of Citations

For documents and sources, the network analysis for citations is done.

A. Citations (Documents)

There are a total 69 documents. 3 is taken as a threshold and only 25 documents met the threshold.

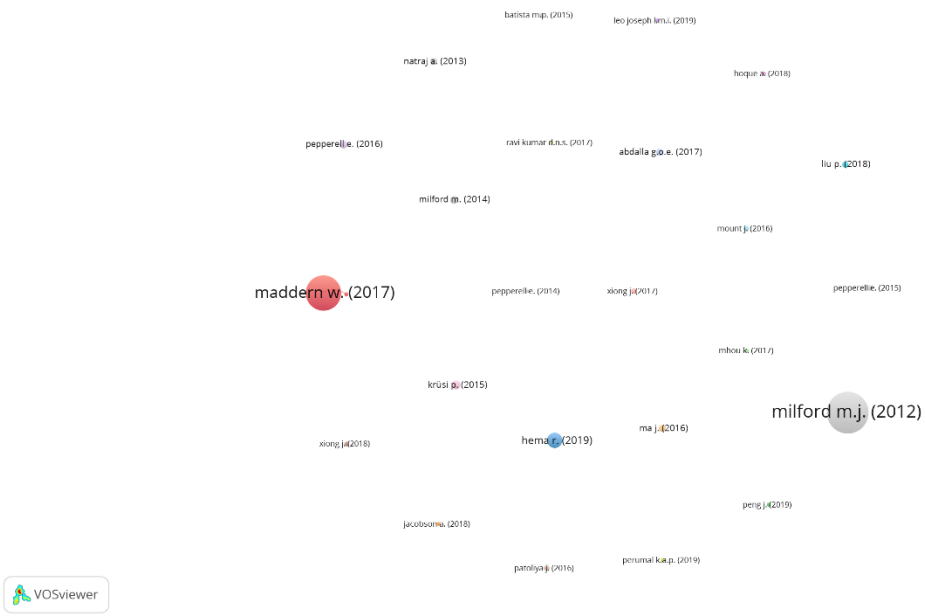

Figure 13: Network Analysis (Citations by Documents)

Source: Scopus (accessed on 13th April 2021)

B. Citations (Sources)

The threshold here is considered as 2 citations per sources for the citation analysis. Out of the 53 sources, only 24 met the threshold. The following is a table of the top ten Sources.

Table 6: Network Analysis of Citations (Sources)

Source	Documents	Citations
2017 2nd Asia-Pacific Conference on Intelligent Robot Systems, ACIRS 2017	1	4
5th IEEE Region 10 Humanitarian Technology Conference 2017, R10-Htc 2017	1	3
Advances in Intelligent Systems and Computing	2	2
American Society of Agricultural and Biological Engineers Annual International Meeting 2014, ASABE 2014	1	2
Australasian Conference on Robotics and Automation, ACRA	1	5
Biological Cybernetics	1	3
IEEE Intelligent Vehicles Symposium, Proceedings	1	2
IEEE International Conference on Intelligent Robots and Systems	1	14
IEEE International Conference on Power, Control, Signals, And Instrumentation Engineering, ICPCSI 2017	1	6
IEEE Robotics and Automation Letters	4	8

Source: Scopus (accessed on 13th April 2021)

4.2.4Analysis of Bibliographic Coupling

A. Bibliographic Coupling (Documents)

In this analysis, 30 sources met the threshold amongst a total of 68 documents. The threshold considered here is 2 documents.

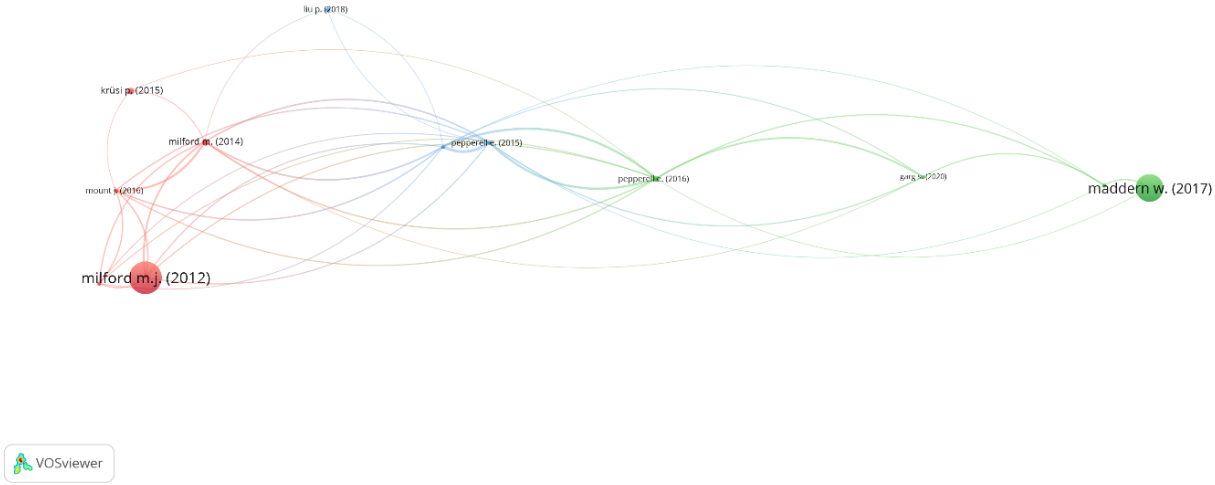

Figure 14: Network Analysis (Bibliographic Coupling of Documents)

Source: Scopus (accessed on 13th April 2021)

B. Bibliographic Coupling (Sources)

In this analysis, 8 sources met the threshold amongst a total of 53 sources. The threshold considered here is 2 documents per source.

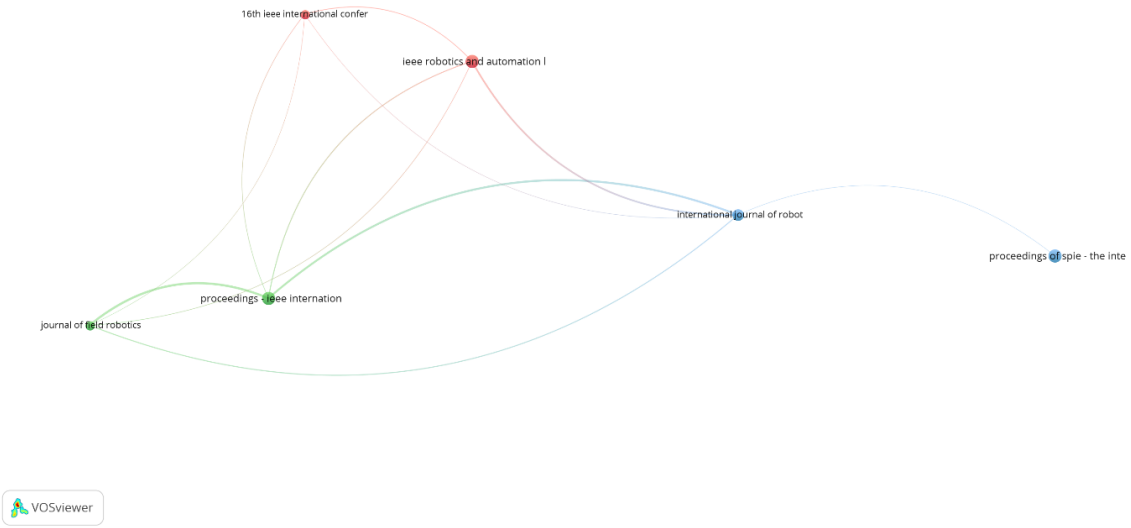

Figure 15: Network Analysis (Bibliographic Coupling of Sources)

Source: Scopus (accessed on 13th April 2021)

V. CONCLUSION

Night Vision Bot using Dynamic IR and Object Detection Bibliometric survey is done by using the Scopus database which is considered to be most popular and largest in the world. The documents for the analysis are considered between the years 2011 to 2021. By the keywords search with AND and OR operators, a total of 69 articles were obtained. The analysis is done by considering different parameters. It is observed that the English language contributed the most to the database with a total of 67 articles. This is followed by China with 02 documents. *"Robots"* is the keyword having maximum documents. It is observed that in 2020 maximum no of documents were published. Computer science and engineering together had the largest contribution of 33.3% of document. According to the type of the document, Conference papers are at first position followed by the Journal articles. India is having the highest documents, as far as the country analysis is concerned. This is followed by China and Australia.

For the network analysis VOSviewer 1.6.16 has been used. Co-authorship analysis co-occurrence analysis and bibliographic coupling are some of the different types of network analysis. Major work in Night Vision Bot has been done in 2020. We can expect major work and advancements in this field in the upcoming years.

REFERENCES

1. Zhang, J., Song, G.: An indoor security with a jumping robot as the surveillance terminal. *IEEE Trans. Consum. Electron*. *57(4), pp. 1774–1781* (2011)

2. Hasan Salman, Samuel Acheampong, and He Xu: Web-Based Wireless Controlled Robot for Night Vision Surveillance Using Shell Script with Raspberry Pi. *Springer International Publishing AG, part of Springer Nature 2019. L. Barolli et al. (Eds.): CISIS 2018, AISC 772, pp. 550–560,* 2019.

3 K. S. Kumar, S. Prasad, P. K. Saroj and R. C. Tripathi, "Multiple Cameras Using Real Time Object Tracking for Surveillance and Security System," *2010 3rd International Conference on Emerging Trends in Engineering and Technology, Goa, pp. 213-218,* 2010.

4. G. O. E. Abdalla, T. Veeramanikandasamy: Implementation of Spy Robot for A Surveillance System using Internet Protocol of Raspberry Pi. *2017 2nd IEEE International Conference on Recent Trends In Electronics Information & Communication Technology*, May 19-20, 2017

5. M. S. Mukundaswamy and G. L. Bhat, "Embedded controller based wireless power monitoring and controlling," *2015 International Conference on Emerging Research in Electronics, Computer Science and Technology (ICERECT*), *Mandya, pp. 392-397,* 2015

6. F. Shahdib, Md. W. U. Bhuiyan, Md. K. Hasan, H. Mahmud: Obstacle Detection and Object Size Measurement for Autonomous Mobile Robot using Sensor. *International Journal of Computer Applications (0975 –8887) Volume 66–No.9, pp. 28-33,* March 2013.

7. Ramík D. M., Sabourin C., Moreno R., Madani K.: A machine learning based intelligent vision system for autonomous object detection and recognition. *Springer Science Business Media New York, pp. 358–375,* (2014).

8. Kursun O, Favorov OV: Feature selection and extraction using an unsupervised biologically suggested approximation to Gebelein's maximal correlation. *Int J Pattern Recognit Artif Intell 24(3). pp.* 337–358, 2010.

9. Wang Y, Qi Y: Memory-based cognitive modelling for robust object extraction and tracking. *Appl Intell 1–16. doi:10.1007/ s10489-013-0437-5,* 2013

10. Micheloni C., Foresti G. C., Piciarelli C., Cinque L.: An Autonomous Vehicle for Video Surveillance ofIndoor Environments. *IEEE Transactions on Vehicular Technology, Vol. 56, no. 2, pp. 487 – 498,* March 2007

11. Sharma D., Chauhan U.: War Spying Robot with Wireless Night Vision Camera. *2020 2nd International Conference on Advances in Computing, Communication Control and Networking (ICACCCN) pp. 550-555,* 18-19 Dec. 2020

12. Yin J., Liu L., He Li, Liu Q.: The infrared moving object detection and security detection related algorithms based on W4 and frame difference. *Infrared Physics & Technology 77 pp. 302–315,* (2016).

13. Prasad D. K., Rajan D., Rachmawati L., Rajabally E., Quek C.: Video Processing from Electro-Optical Sensors forObject Detection and Tracking in a Maritime Environment: A Survey. *IEEE Transactions on Intelligent Transportation Systems Volume No.18, Issue: 8, pp. 1993-2016,* Aug. 2017

14. Scholl, M. S.: Thermal considerations in the design of a dynamic IR target. *Applied Optics / Vol. 21, No. 4 / pp. 660-667,* 15 February 1982

15. Kumar, D. N. S. R., & Kumar, D.: VNC Server based Robot for Military Applications. *IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI-2017), DOI 10.1109/ICPCSI.2017.8391918,* 21-22 Sept. 2017

16. Manasa P., Harsha K. S., Deepak D. M., Karthik R., Naveen N.O.: Night Vision Patrolling Robot. *Journal of Xi'an University of Architecture & Technology Volume XII, Issue V, pp. 172-187*, 2020

17. Surana H., Agarwal N., Udaykumar A., Darekar R.: Blackbox-Based Night Vision Camouflage Robot for Defence Applications. *Computing, Communication and Signal Processing. pp 631-637,* 2018

18 Bhandari A., Kafle A., Dhakal P., Joshi P. R., Kshatri B. D.: Image Enhancement and Object Recognition for Night Vision Surveillance, *International Conference on Recent Trends in Computational Engineering and Technologies*, 2018

19. Brandao P. D., Monge J. D.: Autonomous Robot Control Using Night Vision Camera and TOF Sensor for Depth Scanning and Real-Time Object Recognition. *Solid State Technology Volume: 63 Issue: 6, pp. 3365-3373,* 2020

20. Pawase, Trupti and Mahajan, Anurag, "A Brief *Bibliometric Survey on Flexible and Wearable Microstrip Patch Antennas" (2021). Library Philosophy and Practice (e-journal). 5138.*

21. Napte, Kiran Malhari Mr. and Mahajan, Anurag, "Liver Segmentation and Liver Cancer Detection Based on Deep Convolutional Neural Network: *A Brief Bibliometric Survey" (2021). Library Philosophy and Practice (e-journal). 4903.*