Bibliometric Analysis on Computer Vision based Anomaly Detection using Deep Learning

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Abstract - *Nowadays, there has been a rise in the disruptive activities that have been happening. Due to this, security has been given principal significance. Public places like shopping centres, roads, banks, etc are increasingly being equipped with CCTVs to guarantee the security of individuals. Subsequently, this inconvenience is making a need to computerize this system or make it smart through learning with high accuracy. Since constant observation of these surveillance cameras by humans is a near-impossible task, this will help to detect any threat or suspicious activity in the recorded video and thus create a smart surveillance over the area. Some of the literatures in this topic shows the presence of few works which have implemented to make a smart surveillance system. But they are divided into different types of anomalies and detection methods. Therefore, a need for Bibliometric survey in the area of Anomaly detection using Deep learning is necessary to track the research trends, progress and scope of the future research. This paper conducts Bibliometric study for "Anomaly Detection using UCF-Crime dataset" by extracting documents of total 385 from Dimensions database using keywords like anomaly detection, UCF-Crime dataset, image processing, artificial intelligence and deep learning. The study is conducted since the last decade that is 2012-2021 for the research analysis. Through this study it is observed that there is a vast scope for researchers, surveillance providing companies and public sector to study the used cases and implement anomaly detection to provide a smart surveillance system.*

Key Words: Anomaly Detection, UCF-Crime Dataset, Image Processing, Artificial Intelligence, Bibliometric analysis, Deep Learning

1. INTRODUCTION

Smart CCTV systems include implementing self-learning to the normal surveillance systems using deep learning. Self-learning systems can include many types of implementations. They collect the information based on movements and people visible in the CCTV camera and provide information on the same. Some surveillance systems use the face detection system to detect face structures of known people. If any unknown person is detected it will notify the user about their presence in the surveillance area. It is used to provide access to only authorised persons in the surveillance area and keep an eye for unauthorised people. They have also introduced different techniques to make faster and accurate face detection in real time surveillance [1,3,4].

Along with the face detection system there was also an introduction of object detection system for smart surveillance using deep learning techniques. It can detect different types of objects like bags, weapons or any suspicious object in the surveillance videos. Implementing both face detection system and object detection system together made a good implementation of smart indoor surveillance system [3]. A lot of comprehensive study related to both systems has been done by applying various deep learning techniques to attain the best results and implement the same [6].

To attain a smart outdoor surveillance it was necessary to detect the motion of the objects and people in the camera and learn them. A motion detection system which detects the motion of every person in the vicinity of the surveillance camera and tells the user about each movement of that person in real time. It can detect whether the person is sitting, standing, running, jumping, etc. Each movement of the person is recorded in the surveillance system [2]. Further research was done on how to detect if the person's or intruder's face is covered with a mask or anything and capture their movement. Also it was able to detect the movement of the person in the low light conditions like at the night time [5].

Recently, in the area of smart CCTV there has been a lot of researches related to Anomaly detection system. Anomaly Detection System is defined as a real-time surveillance program designed to automatically detect and account for the signs of offensive or disruptive activities immediately. It helps us to detect anomalies in real time surveillance. It is an

emerging field for outdoor surveillance systems. Most of the study related to anomaly detection is done using UCF-Crime dataset. Many attempts are done to improve the quality of anomaly detection through various deep learning and feature extraction techniques to achieve higher accuracies [7,8]. The anomaly detection system is our area of interest as it is a recent study related to smart CCTV. Including this system in the normal surveillance system will provide a great insight into different business ideas for surveillance providing companies in the market competition. Moreover, there is a vast scope of development in the area of smart surveillance for future work.

The anomaly detection system is our area of interest in the field of smart CCTV and we will be providing a bibliometric analysis for the same. The Bibliometric study helps to know the quantitative analysis of the progress of the research work done in a specific area through the literature available in articles, journals, conference papers, monographs, books and peer-reviewed works. We can use statistical tools and methods, to track the developments in this specific area.

These are the following points mentioned as the goals of this Bibliometric analysis:

- To gain insight in the research work done in anomaly detection systems.
- To know about the countries which have provided research in this area.
- To know about the authors contributing to this field of research.
- To identify and know about different trends of publications based on their organization.
- To perform a citation analysis in this area of research.

This paper represents a Bibliometric survey along with some literature survey for anomaly detection system in smart CCTV. Section 1 is the Introduction of the topic Anomaly detection. Section 2, shows the data collection related to anomaly detection using UCF-Crime dataset. Section 3, represents the Bibliometric analysis in the form of Statistical analysis, Geographical analysis, Network analysis and citation analysis. Here, analysis is done on the data which is obtained from the Dimensions database. Section 4 shows the literature survey done for the topic. Section 5 includes discussions from the analysis. Section 6 contains the future work related to the topic. In Section 7, the limitations are mentioned and Section 8 presents the conclusion of the paper. Lastly, references are mentioned at the end of the paper.

2. COLLECTION OF DATA

We collected documents of our topic from numerous platforms and websites like Google Scholar, Scopus, Web of Science, IEEE, Science Direct, Dimensions and many more. These papers consist of the statistical information of the published documents which can be chosen for the Bibliometric analysis. These websites contain the research papers in the form of the articles, journals, review papers, edited books, conference papers, etc. Some of the research papers can be accessed by giving some fee or are open access.

Here, in this paper we have used Dimensions database which contains enormous data for the Bibliometric analysis.[10]

2.1 Analysis of Keywords

Table 1: List of Primary and Secondary Keywords

Primary - Keyword	“Anomaly Detection”	
Secondary – Keyword	AND	“UCF-Crime dataset”
		“Image Processing”
		“Artificial Intelligence”
	OR	“Computer Vision”
		“Deep Learning”

We used the list of mostly the primary keywords mentioned above to search results related to the domains based in secondary keywords in the Dimensions application.

2.2 Initial Search Result

Dimensions database is used to find out the documents. Using keywords, it gives a total of 385 documents in total. Out of the 385 documents found in the dimensions application, these are different publication types mentioned in the Figure 1. We got 178 documents of 'Edited Books', 90 documents which are in the form of 'Article', 66 documents of type 'Proceeding', 36 documents of type 'Chapter', 13 documents of type 'Pre-print' and 2 documents of type 'Monograph'.

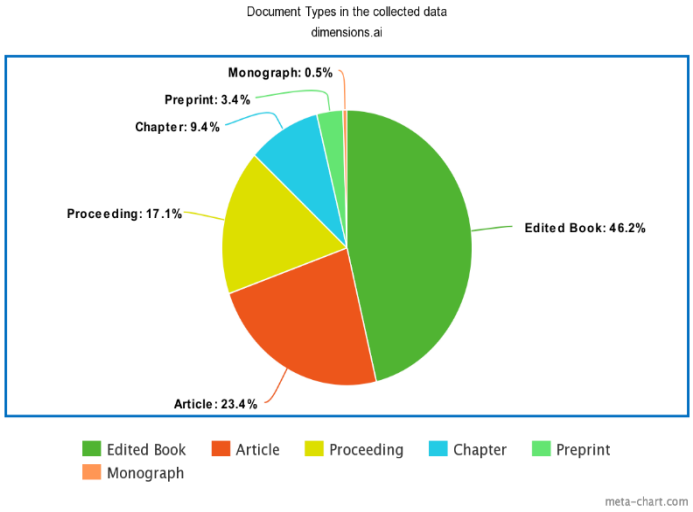

Figure 1: Publication types showings Anomaly detection using UCF-Crime dataset

Source: https://app.dimensions.ai (assessed on 4 January 2022)

2.3 Analysis by year

Figure 2 shows, the documents for Anomaly Detection in UCF-Crime Dataset shows an interval from 2013 to the year 2021. The graph represents the number of documents published in the last years in this specific area. On analyzing, the most of the research work was carried out from 2018 to 2021. However, this finding shows that less work has been done in the span of 2013 to 2017.

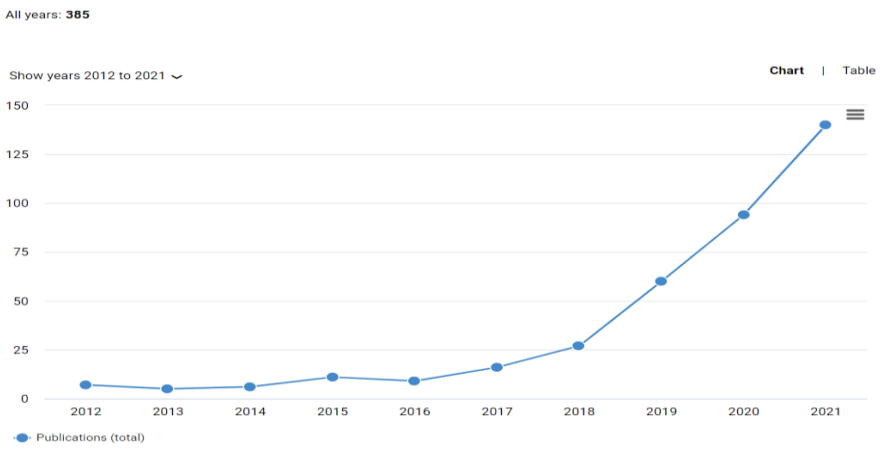

Figure 2: Year-wise Publications

Source: https://app.dimensions.ai (assessed on 4 January 2022)

3. BIBLIOMETRIC ANALYSIS

To initiate the research, in the field of "Anomaly detection" technology using "UCF-Crime dataset" an analysis is required to be carried out that contains data and information about this topic. The aim of this analysis will help to know where the studies have been conducted and the future direction. This analysis will help to analyse the development and growth in detection techniques and advancements in accuracy and dataset. The Bibliometric analysis will help in discovering new trends in this domain. The Bibliometric analysis provides insights into the contribution of various institutes, countries, authors, journals, subject categories in the research field. In this analysis, data are collected from the Dimensions database using the keywords.

3.1 Analysis of geographic location

For geographic location analysis, Vos Viewer tool[9] is used to create the mapping of the countries based on its citations. Here, the inputs required is the bibliographic mapping of the data collected from Dimensions. From the given inputs, a map can be generated, indicating regions where the most of the research work is cited accordingly giving us the idea in which countries most of the research work is done. In the mapping below, it shows the countries whose research work is most cited by other countries in the area of Anomaly Detection using UCF- Crime dataset[11]. In Vos Viewer, we kept minimum number of documents of a country as 2. We got in total 34 countries out of which only 20 met the threshold and produce the following result.

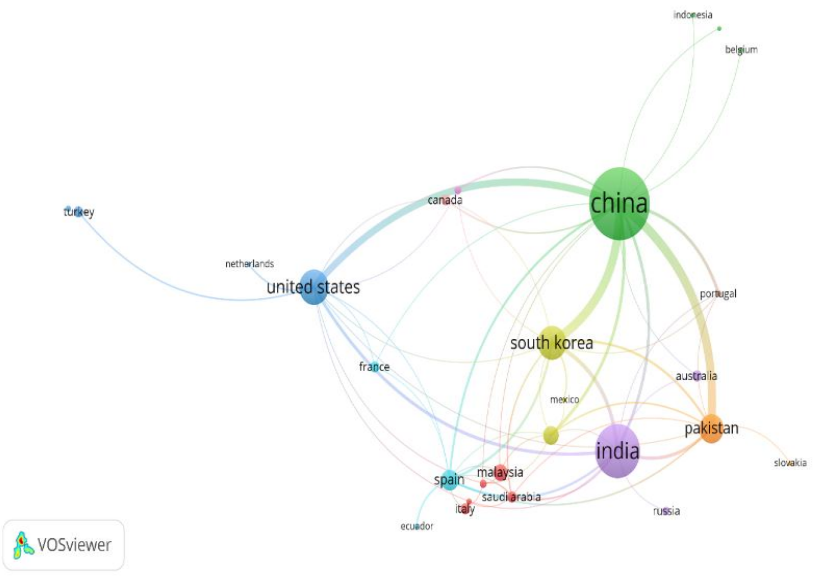

Figure 3: Geographic locations based on citation of research work for Anomaly detection in UCF-Crime Dataset

Source: http://app.dimensions.ai (assessed on 4 January 2022).

Figure 3 shows mapping of geographical region of the citation of published papers. It is drawn using Vos Viewer tool. This mapping of countries based on their research counts and citation. It is observed that maximum research work has taken place in China and India from where the most of research work is cited by other countries. Mild research work has taken place in countries like United States of America (USA), South Korea and Pakistan, and minimum work has been carried out in rest of the other countries present in the map like Spain, Malaysia, Mexico, Saudi Arabia, Australia, etc.

The top 5 countries from where most of the research work is cited are China, India, United States of America (USA), South Korea and Pakistan. Therefore, these are also the top 5 countries to produce the most research in our subject.

3.2 Analysis by Subject Area

Figure 4 shows, the work is done in the subject area for Anomaly Detection using UCF-Crime Dataset. From the bar chart, it is clear that the maximum work and research has been implemented in Information and Computing Science,

followed by Psychology and Cognitive Sciences. But the major research work is done in the field of Information and Computing Sciences which is required by us and is used as the data for the bibliometric analysis.

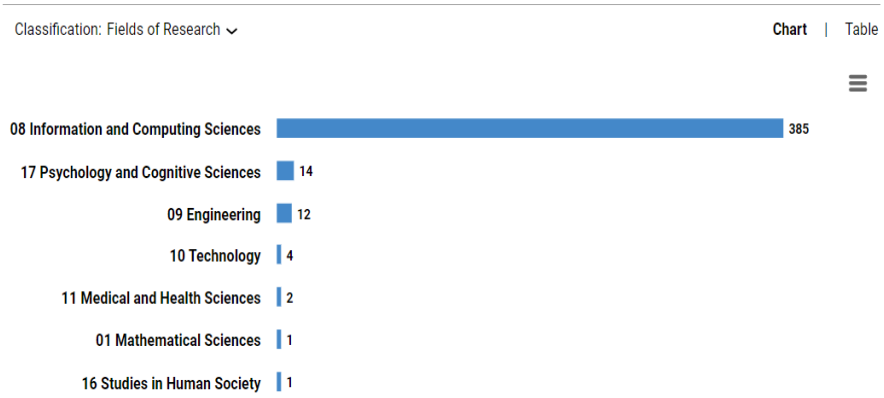

Figure 4: Documents in different subject areas

Source: http://app.dimensions.ai (accessed on 4 January 2021)

3.3 Network Analysis

Network Analysis is a group of Techniques, which is used to show relations among authors and to analyze their association, using the graphical representation. Several tools are used, such as Gephi and VOSViewer. The data is extracted from Dimensions for Anomaly detection using UCF-Crime dataset.

VOSViewer is open-source software that can be downloaded from the VOSviewer website. It is used for analyses, to create Bibliometric network. The data file can be imported to VOSViewer, which is extracted from the Dimensions database. The editor consists of three kinds of visualization: Network visualisation, Overlay visualization, and Density visualization.[9]

Figure 5 represents a cluster of the number of occurrences of co-authors appearing among the papers. The relationship of the work is shown between the authors. The link represents the authors' work on the documents they have published. Here, the minimum number of documents was set to 2, out of 701 authors 70 authors meet the threshold value.

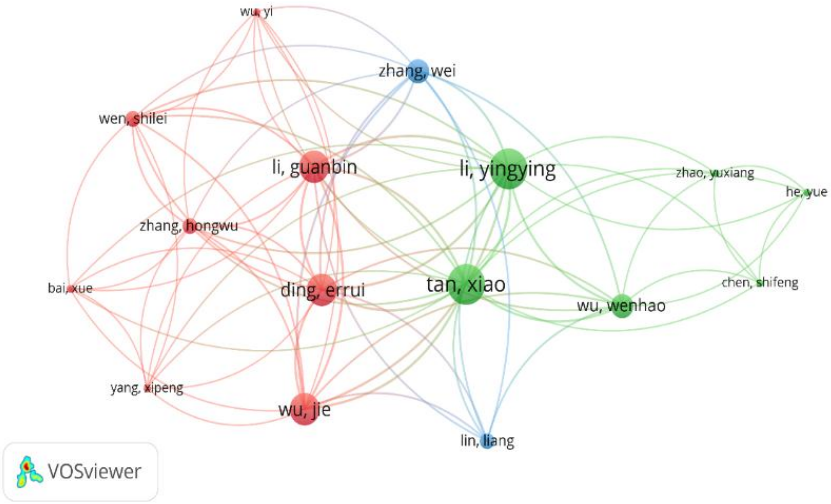

Figure 5: Network visualization diagram for co-appearance of authors among the papers

Source: http://app.dimensions.ai (accessed on 4 January 2021)

Figure 6 shows the network visualization of the citations received by the documents. The threshold value was set to 1 citation for each document, and 219 documents met the threshold out of 385 documents.

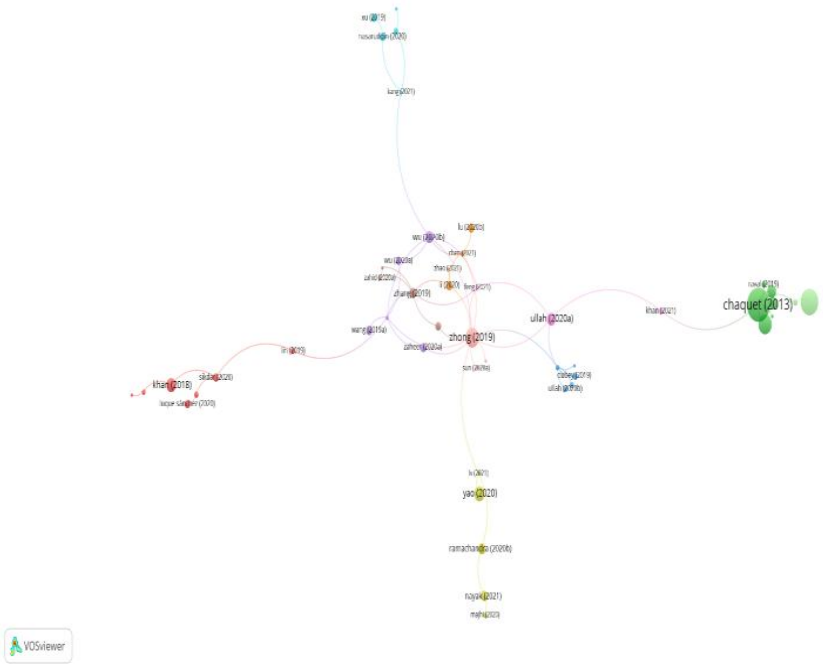

Figure 6: Network visualization of the citations received by the document

Source: http://app.dimensions.ai (accessed on 4 January 2021)

Figure 7 shows the citation based on different authors based on their published research works. This gives an insight on which author majorly contributed for the most cited research work. Most of the most cited authors in our subject are Mahmood Arif, Zaheer Muhammad Zaigham, Lee Seung, Astrid- Marcella, etc.

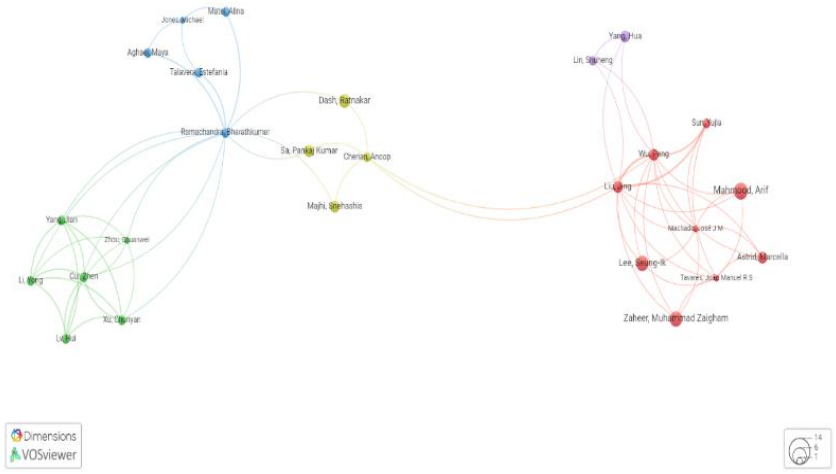

Figure 7: Network visualization of the citations received by the author of the document

Source: http://app.dimensions.ai (accessed on 4 January 2021)

3.4 Analysis based on Affiliations and Authors

Affiliation analysis shows the contribution of research work based on the universities and organisational affiliations of the authors of the documents. Table 2 shows the top ten authors along with their organizations or universities who have produced the most publications in the field of anomaly detection using UCF-Crime Dataset. Here, Information Technology University, Pakistan shows the maximum contribution in the research field followed by Baidu, China. Author Arif Mahmood from Pakistan has published the most of the work related to our subject followed by Xiao Tan from China. Universities or Organizations from various countries like South Korea, Russia and India also have contributed well.

Table 2: Top ten Authors and their organizations with the most publications and their citations related to "Anomaly Detection using UCF-Crime Dataset"

Source: http://app.dimensions.ai (accessed on 4 January 2021)

Sr. No.	Name of the Author and their Organization	Publications	Citations
1	Arif Mahmood Information Technology University, Pakistan	6	17
2	Xiao Tan Baidu (China), China	5	11
3	Seung-Ik Lee Electronics and Telecommunications Research Institute, South Korea	5	17
4	Muhammad Zaigham Zaheer Electronics and Telecommunications Research Institute, South Korea	5	17
5	Sergey Victorovich Zhiganov	4	24
6	Amin Ullah Sejong University, South Korea	4	38
7	Oleg Semenovich Amosov Russian Academy of Sciences, Russia	4	24
8	Ratnakar Dash National Institute of Technology Rourkela, India	4	7
9	Sung Wook Baik Sejong University, South Korea	4	38
10	Errui Ding Baidu (China), China	4	10

3.5 Citation Analysis

Citation analysis is a method of determining the impact and importance of an author, article and publication by enumerating how many times that particular author, article and publication has been cited by other researchers for their work. Below, Table 3 shows the Citation done for Anomaly Detection techniques. The total Citation is 2,128 of a number of publications, to date. Table 4 shows the list of the top ten papers for anomaly detection for UCF dataset is shown.

Table 3: Citations analysis for publications of anomaly detection using UCF-Crime Dataset.

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
No. of Citations	5	21	53	79	88	119	147	262	474	880	2128

Source: http://app.dimensions.ai (accessed on 4 January 2021)

Table 4: Citation analysis of the top ten publication of Anomaly detection related researches.

Publication Title	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total Citation
A survey of video datasets for human action and activity recognition	0	9	32	24	36	39	38	37	21	36	272
Explainable AI: Interpreting, Explaining and Visualizing Deep Learning	0	0	0	0	0	0	0	3	59	103	165
A review on vision techniques applied to Human Behaviour Analysis for Ambient-Assisted Living	1	8	13	24	15	23	10	14	20	10	138
A review on applications of activity recognition systems with regard to performance and evaluation	0	0	0	0	1	5	11	17	29	23	86
Multimedia Internet of Things: A Comprehensive Survey	0	0	0	0	0	0	0	0	24	47	71
Graph Convolutional Label Noise Cleaner: Train a Plug-and-play Action Classifier for Anomaly Detection	0	0	0	0	0	1	8	27	18	17	71
Computer Vision – ECCV 2016, 14th European Conference, Amsterdam, The Netherlands, October 11–14, 2016, Proceedings, Part I	0	0	0	0	0	1	8	27	18	17	71
Fuzzy human motion analysis: A review	0	0	0	7	18	11	8	10	4	5	63
Crowd Scene Understanding from Video	0	0	0	0	0	2	6	11	12	13	44
Unsupervised Traffic Accident Detection in First-Person Videos	0	0	0	0	0	0	0	4	12	18	34

Source: http://app.dimensions.ai (accessed on 4 January 2021)

Table 5: Citation analysis of the top ten journals for anomaly detection techniques.

Journal Title	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total Citations
Lecture notes in Computer Science	0	0	6	17	7	25	45	86	132	199	529
Computer Vision and Image Understanding	021 0	9	32	24	36	39	38	37	21	36	272
Expert Systems with Applications	0	8	13	24	15	23	10	17	28	21	160
IEEE Access	0	0	0	0	0	0	1	5	42	84	132
International Journal of Distributed Sensor Networks	0	0	0	0	1	5	11	17	29	23	86
Advances in Intelligent Systems and Computing	0	0	0	0	0	2	9	11	20	23	80
Pattern Recognition	0	0	0	7	18	11	8	10	8	17	79
ACM Transactions on Multimedia Computing Communications	0	0	0	0	0	2	6	11	12	13	44
Information Fusion	0	0	0	3	5	4	4	5	8	12	41
Multimedia Tools and Applications	0	0	0	0	0	0	0	0	5	32	37

Source: http://app.dimensions.ai (accessed on 4 January 2021)

3.6 Analysis based on Source Title

Figure 8 shows the statistical analysis of the top ten source titles based on the Citation for Anomaly detection. From the chart, it is observed that Lecture Notes in Computer Science Journal receive the maximum numbers of Citation. Information Fusion and Multimedia Tools and Application journals receive the minimum number of citations.

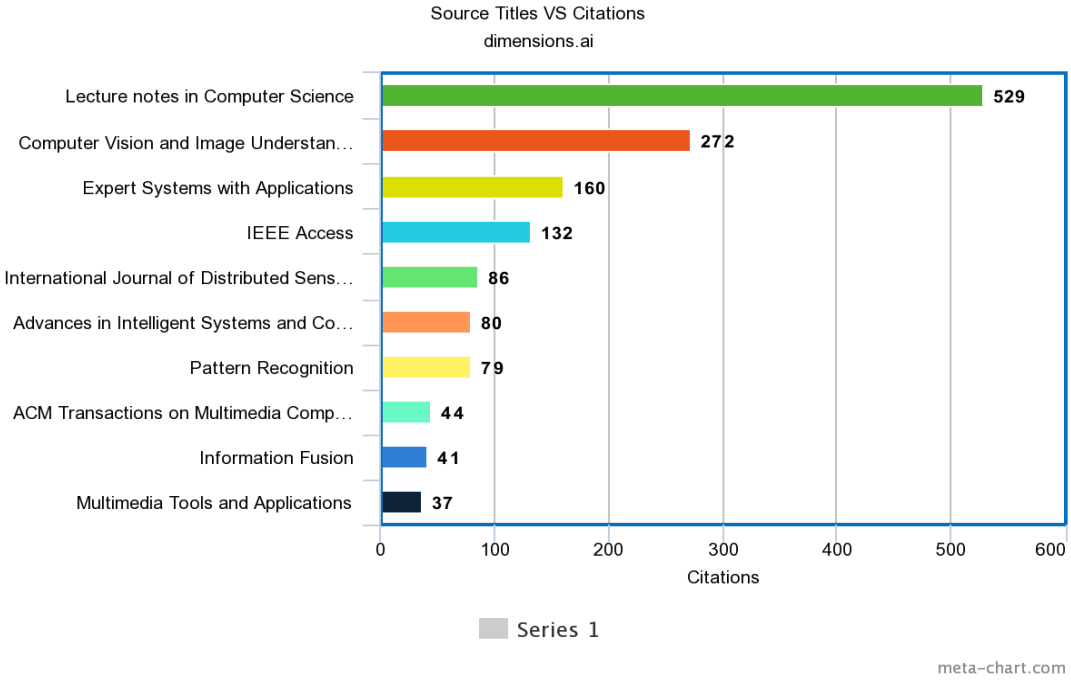

Figure 8: Citation Analysis based on the title Anomaly detection using UCF-Crime dataset for the top ten journals.

Source: http://app.dimensions.ai (accessed on 4 January 2021)

4. LITERATURE SURVEY

We conducted a survey related to work done in the field of smart CCTV i.e. automation of a surveillance system. The automated video surveillance system has risen as a significant research topic in the field of public security. Now-a-days each new place developed is being installed with a surveillance system for providing good level security to the individuals. Also the old places have installed new surveillance systems to increase their security. All these surveillance providing companies have developed new upgrades overtime and these upgrades have been provided useful for the people using them. New features like monitoring an area using an app on our phone or tablet remotely has also been introduced using IOT (Internet of Things). Artificial intelligence has also contributed a lot to these upgrades to reduce workload and increase the efficiency of surveillance.

At first we thought to add a Face Detection System in the normal surveillance system to make it smart. [1,3,4,6] So we looked up for the studies and work related to the same topic and we came across a lot of work which defined this system has already been studied thoroughly and also some of the surveillance providing companies have already applied it in their main surveillance system. It has been trained to capture various features of a face like the structure of the nose, the placement of the eyes, eye colour, shape of mouth, size of the forehead, etc. The face features of the user and the individuals which the user wants to keep in his known people directory are captured and stored in the surveillance system. If an unknown person enters the area or in the vicinity of the CCTV, the user will get informed immediately. The user can also use this feature to allow an individual to enter a place or not including them in the known persons' list. It is a very useful system for a smart surveillance system. But now-a-days due to increase in the Covid-19 pandemic, people are wearing masks everywhere they go. So, detecting their face is impossible as only the eyes and forehead are visible. To recognize a face accurately the whole features of the face should be visible to the camera. Also the use of face recognition system is restricted to certain places like private homes and offices where only known people are allowed. It cannot be implemented on open areas like markets, shopping centres, hotels, conference halls, etc. These days it is included in the Smart Home system which is apart of IOT. Also a higher accuracy rate was achieved on the face detection system which we came to know through related studies.

So, to find an overall solution which could be applied in all areas closed or open we continued our survey. We came across another system related to AI to make the surveillance system smart which is the Object Detection System. [4,6] We found out a lot of studies and work related to this system and we saw that this field is also well researched. In this

system various items or object photos are trained and classified into their specific labels like bat, gun, suitcase, knife, etc. Mainly the photos of harmful objects were used to train and classify in the object detection system. Whenever the objects labelled in the system are visible in the vicinity of the camera, the system marks the object and gives the label of the marked object. If any harmful object is placed or carried by an individual the user will get notified that which object is that and the further action can be taken by the user itself. This object detection system is useful in both closed and open areas. But it is not an overall smart solution as the harmful object detected can also be fake or a toy which will make false alarms. Also a lot many harmful objects can be made and can be used to create any anomaly which are not known to the system. Therefore, a smart surveillance system cannot rely on object detection system alone.

Then we came across research related to combination of face detection system and object detection system both included in a smart surveillance system. [4] This combination system detects the face of known people, and also detects any harmful objects present in the vicinity of the camera. This surveillance system is very useful in closed areas like homes, societies, offices, etc as these are the places where user can keep a note of known people. If the face detection system doesn't work then the object detection system can be useful to detect masks or any cover over the face and notify the user. Many companies have also applied this combination system in their surveillance system to develop a smart home. Also some studies showed that a detailed study is done with this system. Different deep learning algorithms are applied on face detection system and object detection system to get highest accuracy and the result is presented. So we moved further with our survey related to a smart surveillance system.

We then found out a research related to Movement and Behaviour Detection system. [2,5] In this system the movement and behavioural patterns of a person are trained and then classified into different labels like sitting, jumping, crying, running, etc. Whenever a person or group of people are detected in the surveillance camera it continuously informs the user about the behaviour and movement of that person or people. It just tells the user whether the person in the vicinity of the camera is doing what activity at that point of time in real time surveillance. This motion and behaviour detection system is limited only to the behavioural patterns of the person. For implementing this system in the surveillance system there is a need of a person continuously looking at the surveillance to detect a risky or suspicious behaviour by the people in the vicinity of the camera. This does not help in making the surveillance system automated which is the main aim of our survey. So we thought that this research is incomplete in our aspect to make the surveillance system smart.

Then we kept searching for different ways to make a smart surveillance system through deep learning. We found out that while training the movement and behaviour detection system the videos of people performing various actions like sleeping, running, jumping, etc were trained and then classified into their respective labels. In this way we thought we can train the behavioural patterns of the people performing different types of anomalies and then classify them into their respective anomaly labels. In these world various types of anomalies happen on a daily basis. Some of them are captured on camera while some are not. Those which are captured on camera can act as a dataset for the anomaly detection system. So we searched for work related to Anomaly Detection system.

We found research related to anomaly detection system by Waqas Suhani, Chen Chen and Mubarak Shah to make a smart surveillance system.[7] In this system a negative bag was created which contained the videos of 12 different anomalies and a positive bag which had all the normal state videos. The positive bags would help the system to classify anomalous situations with normal situations. Then these two positive and negative bags are passed through 3D Convolutional Neural Networks (CNN) to detect the features, behaviour patterns, sudden movements in the dataset videos with good accuracy. The 12 different anomalies on which they worked on are - Abuse, Burglar, Explosion, Shooting, Fighting, Shoplifting, Road Accidents, Arson, Robbery, Stealing, Assault and Vandalism. After applying the 3D CNN model it was classified into anomaly and non-anomalous situations which is shown in the form of label to the user. In this way they carried out their version of anomaly recognition system with a good accuracy. I think this was a benchmark for anomaly detection system to be described and implemented using 3D CNN model. This system lacks higher accuracy which can be achieved using various image processing techniques and transfer learning. Also the label of which anomaly is taking place in real time should appear for the user.

We also found research which was a further extension of the above mentioned research in which they used the UCF crime dataset which contained 12 different anomaly videos and normal videos.[8] The anomalies used here are as same as above. In this study they used image processing technique to focus only on the area where the anomaly takes place and then trained the videos to achieve a greater accuracy then the previous one. In this system also they have used 3D CNN model to train the videos and then classify them into anomalous and non-anomalous in the real time video

surveillance for the user. The accuracy achieved after the implementation of this research was upto 91% which is better than above, but it can be increased implementing other deep learning methods. Also the labels of the anomalies happening in real time surveillance should be visible to the user and if the situation is normal it should be displayed as normal.

Therefore, taking the research gaps of the mentioned anomaly detection systems we decided to conduct a bibliometric analysis on anomaly detection system related researches which will be useful to conduct future research to detect the anomalous situations in real time and make a Smart CCTV.

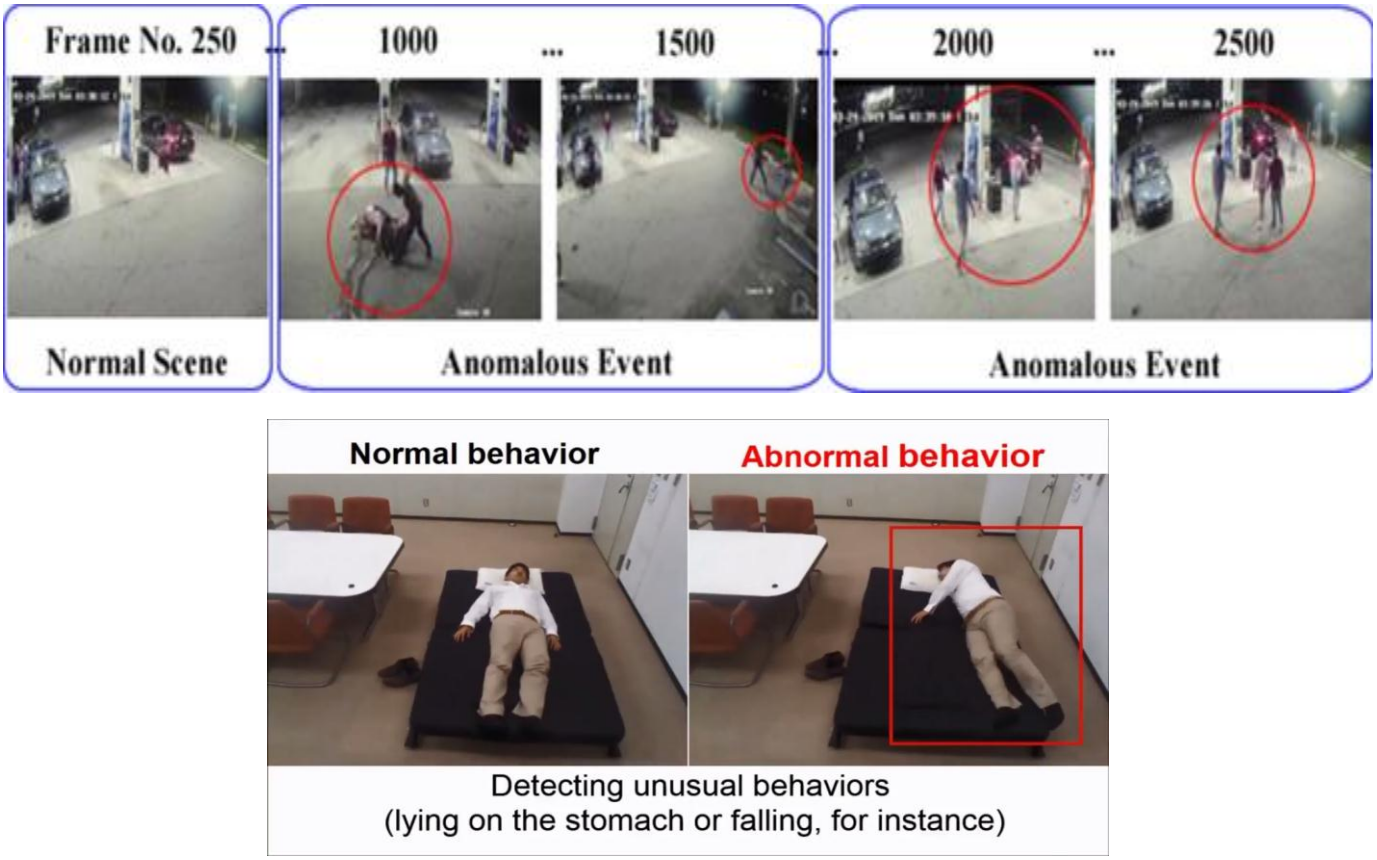

Figure 9: Difference between normal events and Anomalous events

5. DISCUSSIONS

It is observed and analysed that the majority of the research work is represented mostly by the edited books and the articles. It is observed from the year wise publication that though there was initially significantly less research work in this specific field, more work has been recently contributed. If the country-wise publication is considered, China ranks the highest in contributions followed by India. Countries like the USA, South Korea and Pakistan have contributed majorly in this field. From the subject area, it is observed that the research work is predominantly in the field of Information and Computer Science which consists of 385 publications and is our main data for bibliographic analysis. Statistical analysis based on affiliation/university and authors shows top 10 authors who contributed the most in the study of anomaly detection. Among all the authors Arif Mahmood from Information Technology University, Pakistan has contributed the most in publishing research works related to our subject. He is also the most cited author for reference by other authors for reference in their study related to our topic. From the citation analysis, out of total 2,128 citations, 880 citations in the year of 2021 reflect the most significant interest in the research. In the analysis of top ten publications, the title, "A survey of video datasets for human action and activity recognition" achieves maximum citation and is published in "Computer Vision and Image Understanding" journal. "Lecture Notes in Computer Science" journal has achieved the highest citations. All this information is obtained through the bibliographical analysis that we performed on the Dimensions data.

Through the literature survey we got through a number of research works of which regarding real time detection of anomaly or any suspicious behaviour. We found out two studies related to anomaly detection. The first one was by Waqas Suhani which is the benchmark for anomaly detection for the UCF-Crime dataset[11]. In this study the accuracy obtained was around 76%. Another study we found which used a different feature extraction technique to achieve a better accuracy of 91%.

6. FUTURE WORK

According to the bibliometric analysis, we can add documents from several other databases like Scopus, Google Scholar, Web of Science, etc. and combine them to create a huge data for bibliometric analysis. It will give new insights into the new types of documents and its overall analysis. We can use different graph generators and table generators techniques for better visual effects.

According to the literature survey, future work in this research would be introducing a lot of advancements in the surveillance system. We can introduce various other detection systems along with anomaly detection system like face recognition, object recognition, etc. We can also embed high quality IOT systems to have a very tight surveillance over an area. But for this to happen we need to have a accuracy near to 100 or nearly 99 percent. We need to make the system to compute fast and use less resources as well. Also we can include a number of emerging anomalies in the dataset easily and it should be trained accurately for future results in the system. We can develop a number of feature extraction techniques to solve different anomalies for better result.

7. LIMITATIONS

The current study shows the limitation of the paper, where only the Dimensions database has been considered for analysing the literature work done in previous years. On the other hand, another database like Google Scholar, Scopus and Web of Science can be considered for the literature work. Only the documents in the “Information and Computing Science” field are used as a database. The document count can be increased by adding documents from other fields of study. The keywords used for this research work can be rearranged, and according to rearrangement, the outcome of documents changes dynamically. The tools such as Google Sheet, VOSViewer, Microsoft Excel, and Meta-chart has been considered for creating graphs, tables, charts, cluster diagram and figures. Apart from these, other tools such as Gephi and Leximancer can also be considered. Here, for the research purpose, the dataset is taken within the limited span of years from 2012 to 2021. Bigger datasets can give wide approach. A basic literature survey was done which can be increased by studying a large number of researched studies related to the subject which will provide deeper insights into anomaly detection models. According to the cited literature we can see the accuracy of an anomaly detection system to rise from 76% to 91% which can be increased with future research [7,8]. There is a scope to implement new feature extraction techniques and computationally easy deep learning models to make the anomaly detection system faster and more accurate.

8. CONCLUSION

The use of Artificial Intelligence along with normal surveillance systems will have a great advancement for automated monitoring systems. Various detection systems can be included in a normal surveillance system like face detection, object detection, motion detection and anomaly detection, to develop a smart CCTV. Among these, the anomaly detection system is least researched topic and can be used for implementation by the surveillance companies. This system detects any potential threat or suspicious activity in the vicinity of the surveillance camera. It provides with most of the use cases like prediction, prevention, processing and customer experience for the surveillance companies. The Bibliometric study is carried out on anomaly detection with the Dimensions database. The importance of anomaly detection systems is shown by including 385 documents extracted from keywords such as anomaly detection, UCF-Crime dataset, image processing, artificial intelligence and deep Learning. The quantitative analysis in the paper shows that it is a recent topic of research and also it is a trending topic mostly in the countries like China, India, United States of America (USA), South Korea and Pakistan. This bibliometric analysis will give a good insight and knowledge to the future researchers about the work done in the previous decade. The area of anomaly detection in normal surveillance has a potential for opportunities in future research. Through our literature survey, a nice insight of anomaly detection model is obtained. It can be seen from this survey that adopting the anomaly detection system in the normal surveillance system has a wide approach of automation the monitoring system and thus develop a smart CCTV system in the future with further research.

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