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A Bibliometric Analysis on Recent Classification Techniques for Alzheimer's Disease

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Abstract:

Alzheimer's disease (AD) has been studied extensively to better understand the complexities of this disease and to address the numerous unanswered questions about prognosis and diagnosis. To be able to determine and allocate the resources appropriate to the research area, a detailed understanding of the research topic is much needed. Along with the tremendous expansion in the scope of neurodegenerative disease treatment research, the diversity of technologies to help the research continues to expand. Many studies have investigated into how AD affects different brain structures as the disease progresses, using various image processing methods to derive a variety of brain structure steps. To detect AD, structural magnetic resonance imaging (sMRI) is utilized to detect delicate structural variations in the brain. MRI is preferred over other modalities for identifying the structural changes in the brain caused by neurodegenerative diseases and their significance for AD diagnosis and prognosis. Hippocampal atrophy is a significant biomarker for assessing and diagnosing AD. The statistical properties obtained by texture analysis on the MRI based on a biomarker can be used to identify and further evaluate subtle changes in neurodegeneration. To distinguish normal control subjects from AD patients, various Neural Network-based algorithms have been developed. Consequently, this analysis focuses on understanding the recent developments by using an enriched collection of papers available on Scopus, and thus assists in understanding and providing a guided perspective for assigning research resources. The analysis is focusing on various statistical data obtained from Scopus, such as source, document type, affiliations, and so on, to analyze and collate current trends, research activity, and the impact of several notable writers, institutes/organizations, and countries in the respective research domain.

Keywords: Alzheimer's Disease, MRI, Image Processing, Hippocampus, Neural Network, Bibliometric Analysis.

1 Introduction:

Scopus has a wide range of database of published papers since long period of time. We have opted to perform the analysis on all AD related papers which includes image processing and machine learning methodologies using Scopus database. The aim of this paper is to gain a better understanding of the advances made in the world of neurological disorders in terms of diagnosis and prognosis through image processing and machine learning. The aim is to understand the research output linked to the classification of AD affected patients using the biomarkers based on the Magnetic Resonance Imaging (MRI) modality concerning the issues that the researchers have identified and resolved using the publication analysis from Scopus databases.

Analysis for content-based publication is difficult to manage as it demands a great deal of manual efforts and the rapidly increasing number of publications make it even more challenging. Although findings in this study is limited to the hippocampus structure of the brain, there are various other structures of the brain that are studied to observe atrophy in relation to the AD along with the combination of several image processing techniques and machine learning algorithms. Systematic analysis helps in identifying important topics, trends, emerging research fields around the topic, its present developments and future scope to efficiently understand the significance of the research field.

A new area in information science, is useful for delving into an academic field's conceptual structure. The studies may reveal hotspots in each field of study. Furthermore, the reviews are often used to classify important academic papers and publications. Bibliometric studies have previously been used to assess the research output of various fields at the international, national, and local levels. Analysis was carried out from the year 2017 to 2021 to assess the quantity and impact of global AD studies. Globally, the current state and advancement of AD research were investigated. This investigation was not subjected to formal review since it did not include any human subjects and all data was collected from public databases.

This paper is divided into three parts. The “Introduction” section provides background information on the research study. From a Scopus perspective, the “Research Methodology” section contains detailed research methodology related to image processing and machine learning publication

analysis. The “Conclusions” section combines final comments, acknowledgment, and references at the end.

2 Research Methodology

This study covers articles available in the Scopus database in English language only, spanning from a period of January 2017 to April 2021. The study has been initiated with a search procedure with keywords such as Alzheimer’s Disease, MRI etc. with the above-mentioned database within specified time. Explicitly, about 175 documents have been acquired from Scopus (www.scopus.com). Scopus is the most prominent abstract and citation database for peer reviewed journals, books, and conference proceedings. It provides a detailed overview of research performance in science and technology, as well as a variety of other fields. It comes with smart tools with the purpose to track, analyze, and visualize the research topic/domain. Constructing keyword queries for AD and human brain studies, respectively, and then using those queries to extract literature from bibliography databases was a crucial technique during data retrieval. The objective is to increase the number of studies relevant to AD, image processing, machine learning, and the human brain. This search is narrowed down by using keyword hippocampus which led to an in-depth study of the topic. They are analyzed based on their different characteristics which are recorded and distinguished accordingly using a spread sheet prepared for further analysis by utilizing tools such as VOSviewer and ScienceScape (https://medialab.github.io/sciencescape/). All kinds of publications are considered for the above-mentioned period.

2.1 Publication Trends

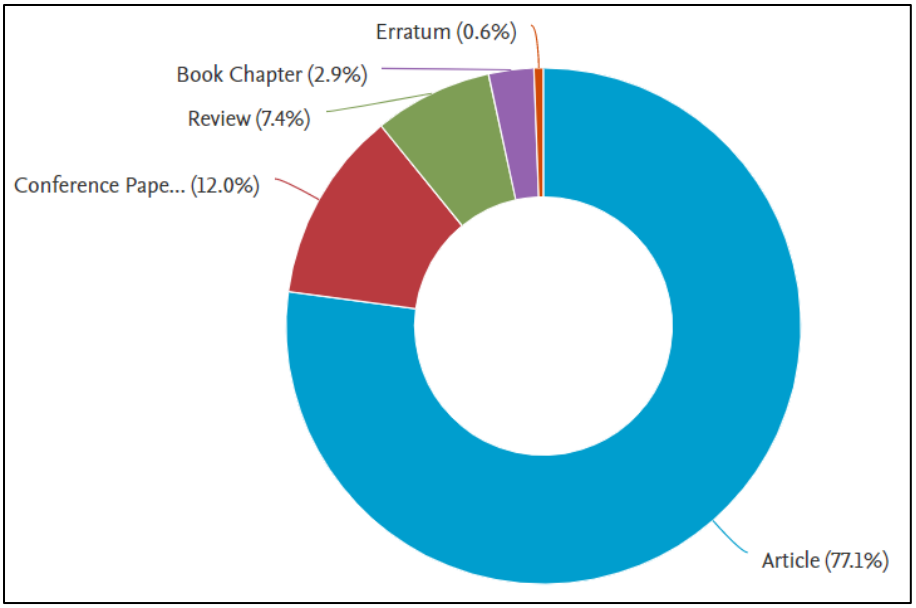

Figure 1. Publication types.

As seen in Figure 1 we realize that most of the publications are from journals, with 135 articles out of 175 total publications, 13 of which are review articles, 5 are book chapters, 21 papers submitted to conferences and one erratum. Articles dominate the top ten most cited publications. Author Shen D. has made the most contributions, co-authoring five of the ten articles. Three of the ten papers were written in the journal Neuroimage.

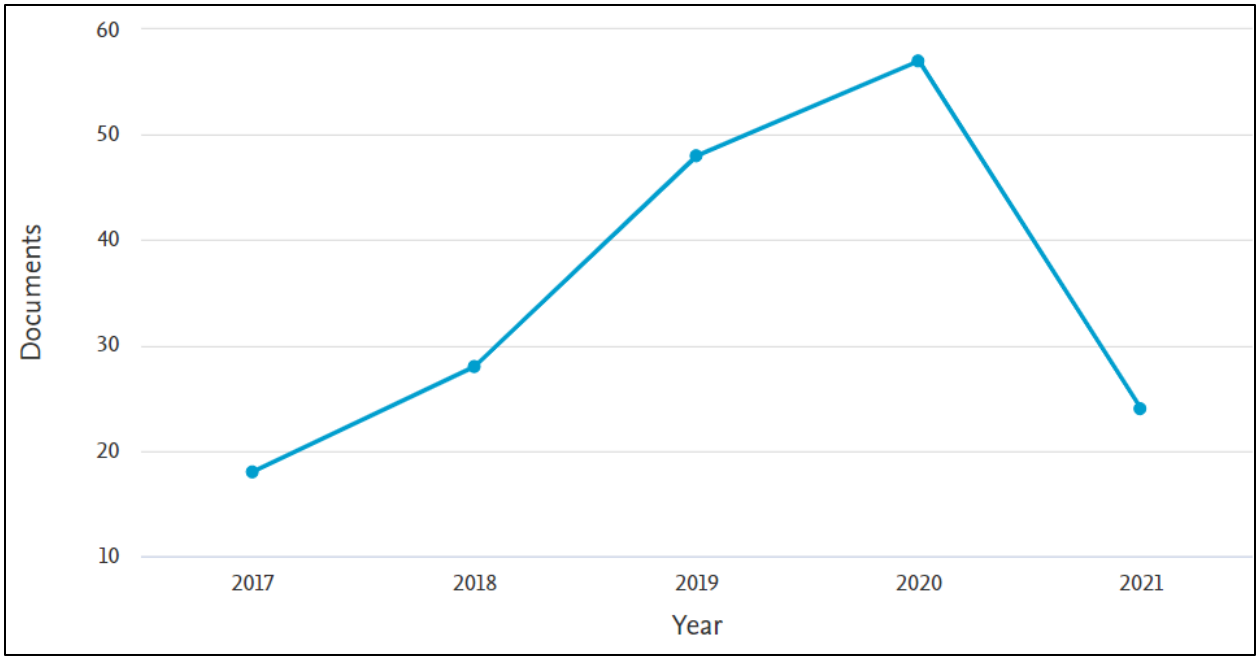

Figure 2. Yearly publication trend.

In the last five years, there has been a steady rate of publishing, with 2019 and 2020 accounting for 60% of the 175 publications from 2017 to 2021 as seen in figure 2. The number of publications on AD has risen steadily over time, from 18 in 2017 to 57 in 2020, with 24 documents already available at the time of this study for the year 2021. The year 2021 got off to a strong start with 24 publications from January to April, and the number is expected to rise as significant progress is made in the fields of neuroscience and engineering.

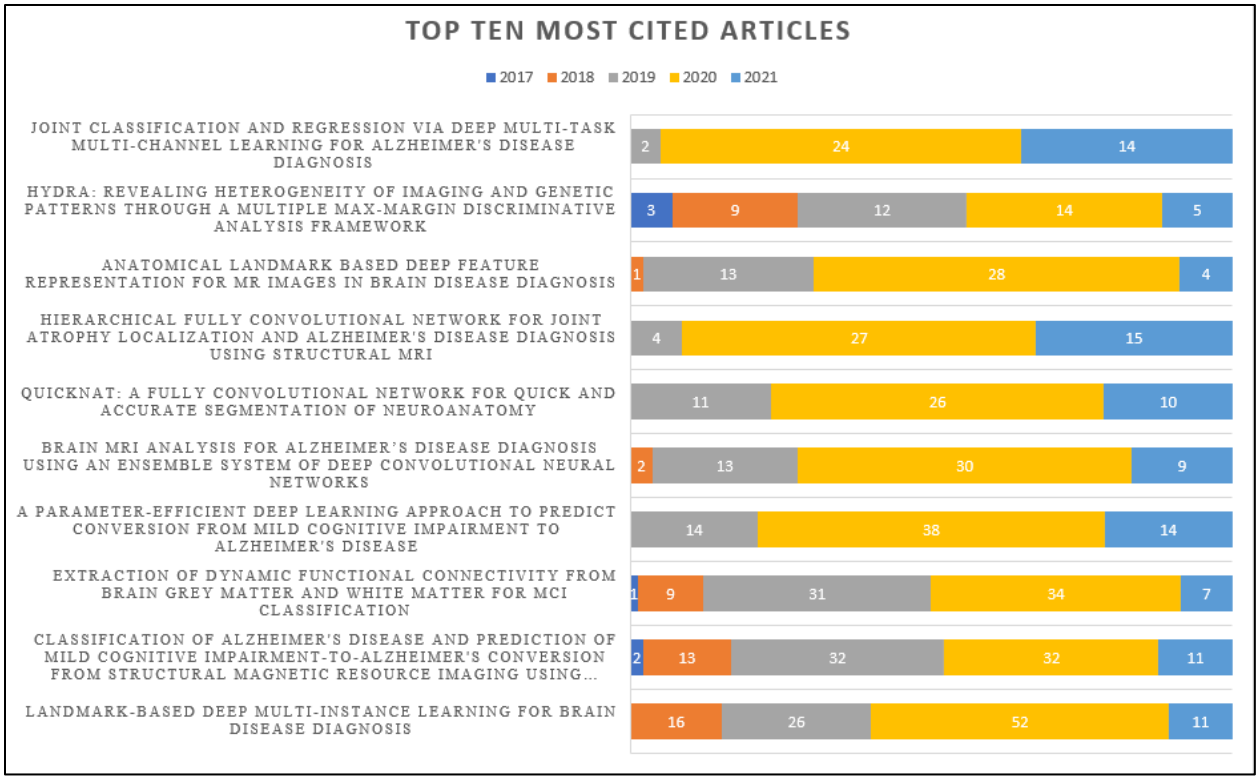

Figure 3. Top ten most cited articles.

We observe from figure 3 that articles make up the top ten most cited published documents. Most of the articles are the product of international collaborations, especially between the United States and South Korea, with 5 of the top ten most cited articles having 319 citations and 63.8 citations per paper. The top ten publications account for nearly a third of all citations (619 out of 1730). Since these papers were published in such well-known journals, they may have accumulated a significant number of citations, as suggested by previous neuroscience reviews. Citations, on the other hand, may have a chain reaction, as posts with maximum impact factors are more likely to be cited. Every AD researcher should be familiar with these extensively cited publications, which are essential for grasping the field's key messages.

2.2 Keywords Statistics

Keywords	No. of Publications	Keywords	No. of Publications
Magnetic Resonance Imaging	109	Mild Cognitive Impairment	48
Alzheimer Disease	104	Image Segmentation	42
Neuroimaging	85	Convolutional Neural Network	39
Nuclear Magnetic Resonance Imaging	81	Computer Assisted Diagnostics	32
Image Processing	69	Brain Mapping	30
Neurodegenerative Diseases	66	Machine Learning	30
Diagnostic Imaging	62	Image Analysis	28
Hippocampus	58	Classification	27
Deep Learning	55	Feature Extraction	26
Diagnosis	52	Support Vector Machine	23

Table 1. Top 20 keywords.

Relevant keywords are important when studying for specific publications in the Scopus database. Table 1 lists the top 20 most important keywords in a tabular format. Table 1 indicates that there is a lot of scope for study in image recognition, neuroimaging, AD, the hippocampus, and deep learning. When referring to the top 20 keywords, it seems that there is a lot of research being conducted using machine learning and image processing techniques around medical imaging for AD.

Keyword co-occurrence associations of large groups suggest significant research areas. Magnetic Resonance Imaging (109), Alzheimer's Disease (104), Neuroimaging (85), Image Processing (69), Neurodegenerative Diseases (66), Hippocampus (58), and Deep Learning (55) are all common research topics. These are good options for strong AD research groups, but they could be dicey for less proven research groups due to the difficulties of obtaining funding and breaking new ground in these underdeveloped areas. The following are some of the less developed research fields such as Fractional Anisotropy (5), Cortical Thickness (brain) (5), Amyloid Beta Protein (5) and Hippocampus Segmentation (6).

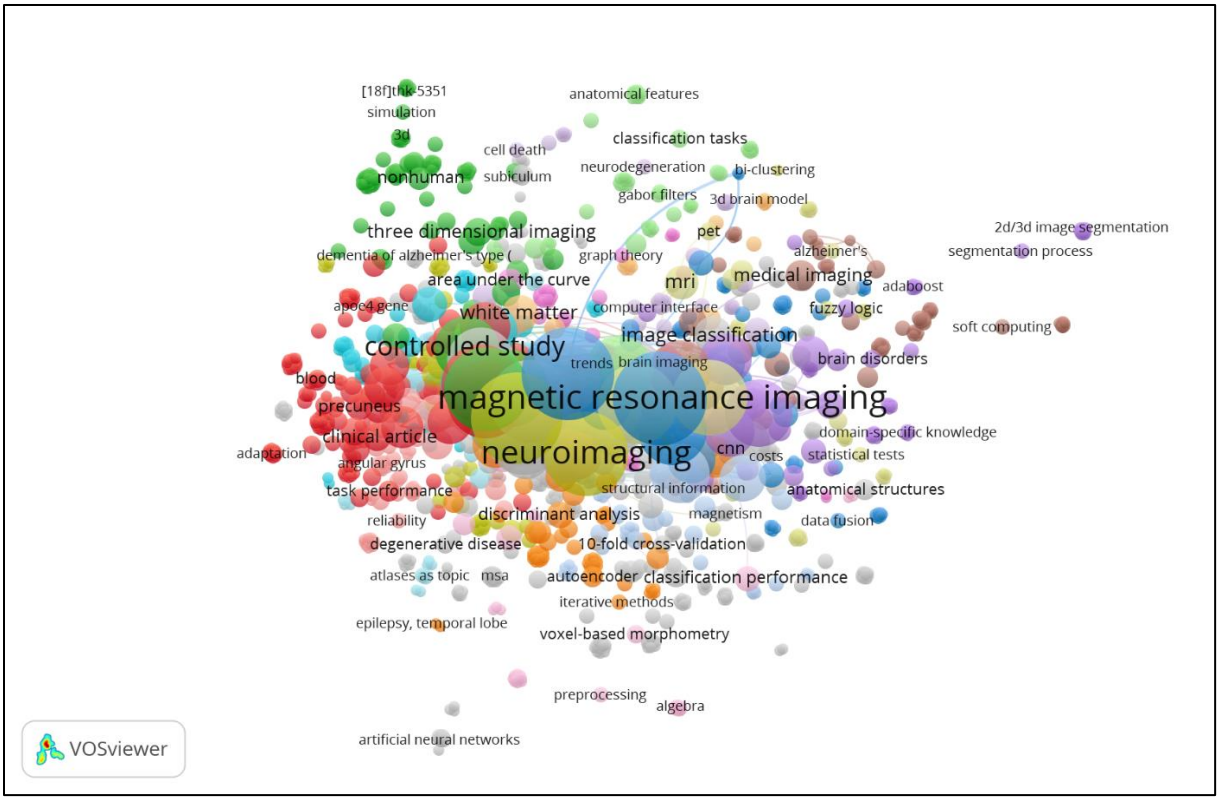

Figure 4. Keyword network visualization mapping.

To recognize shifts in the cluster and make informed assessments on research trends, dynamic research patterns can be observed. In any case, both are areas where we can learn more about AD. The VOSviewer software creates, visualizes, and examines maps for network attributes such as co-authorship, co-occurrence, citation, bibliographic coupling, and co-citation. Three types of maps were generated in the software; the first was network visualization. The size of the circle and label in figure 4 shows the keyword's weight, the bigger the label and circle, the higher the keyword's weight. The intensity of the interrelation and relatedness of two keywords is depicted by the distance between them.

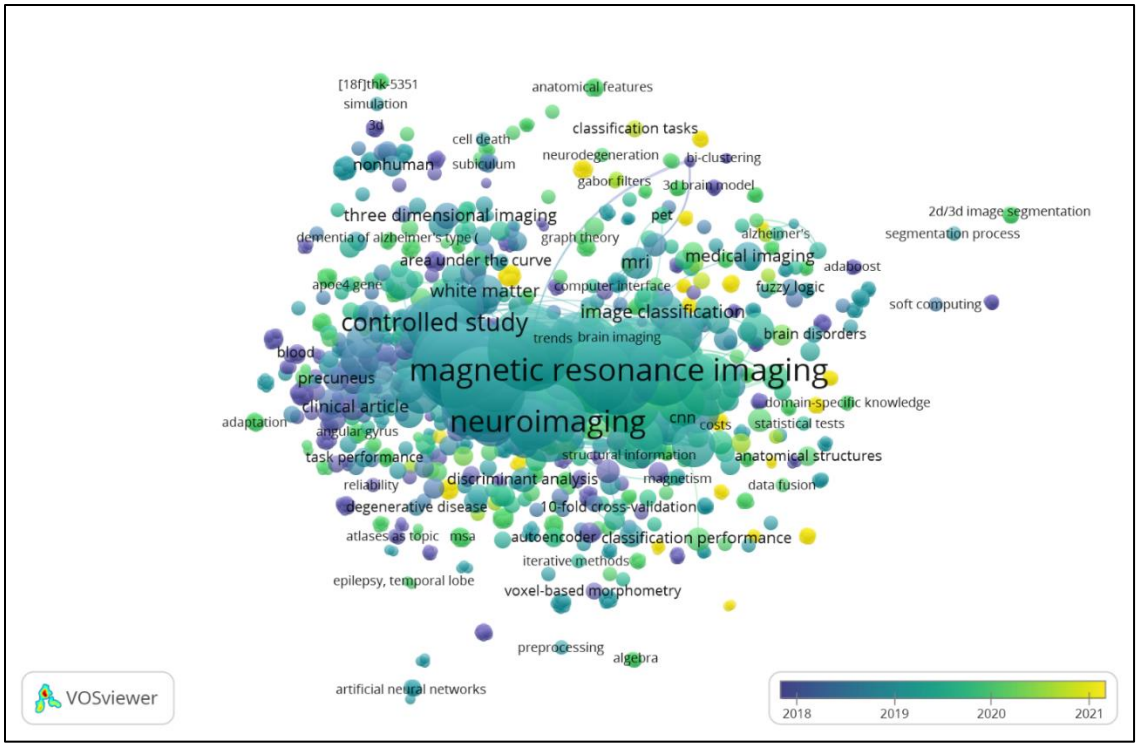

Figure 5. Keyword overlay visualization mapping with publication year scale.

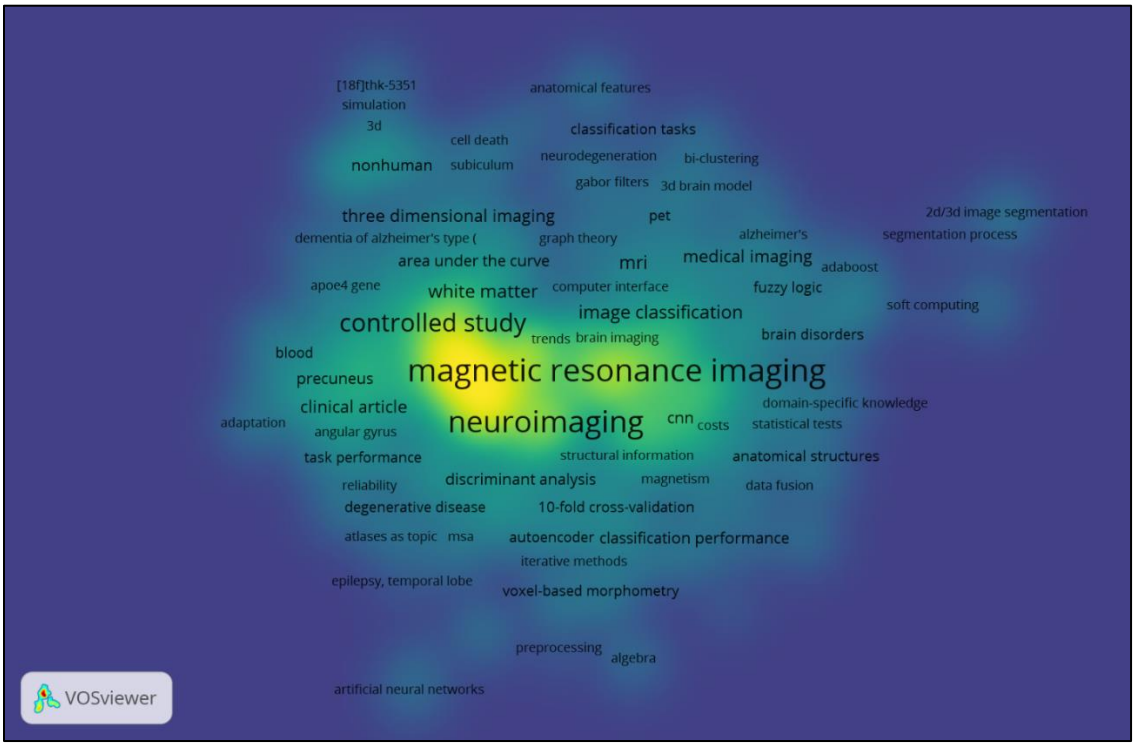

Figure 6. Density visualization of author keywords.

The second view, figure 5, is an overlay visualization that produces keyword mapping using the average publication year scale shown below. The third view in the VOSviewer main panel is about item and cluster density. In figure 6, yellow color density indicates the existence of the author keyword.

2.3 Source and Affiliation Statistics

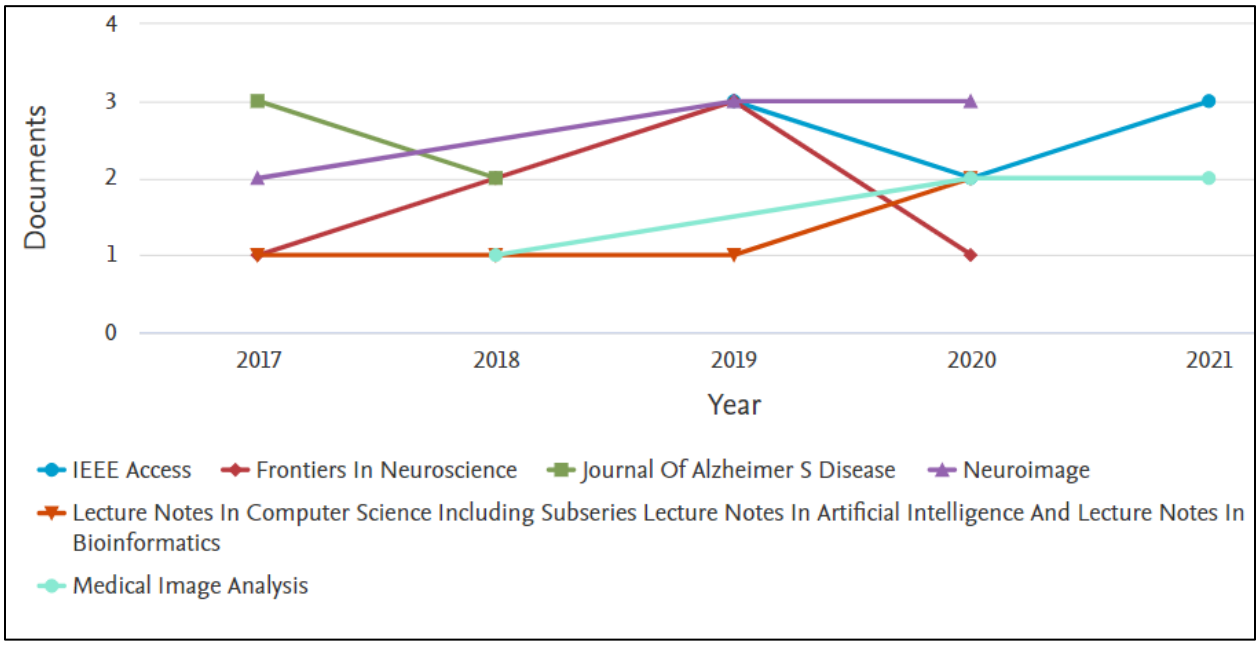

Figure 7. Top six sources.

Figure 7 depicts Scopus database source statistics for publications from 2017 to 2021. There are about 102 different sources that have published AD literature. According to these figures, Neuroimage (227 citations, CiteScore of 10.2) and IEEE Access (30 citations, CiteScore of 3.9) have the most publications with 8 each, followed by Frontiers in Neuroscience (66 citations, CiteScore of 5.1) with 7 and Medical Image Analysis (117 citations, CiteScore of 17.2) with 5 publications. We can derive from this data that, even though Medical Image Analysis has less publications than other sources, it has a much greater influence on the research sector.

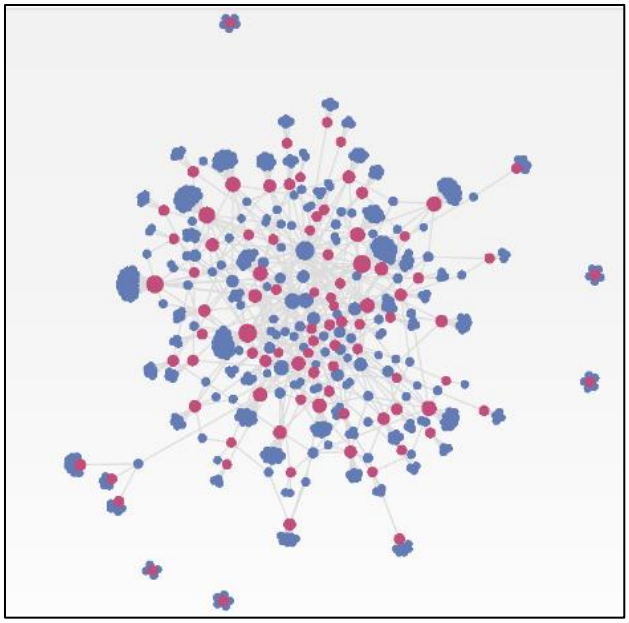

Figure 8. Network cluster for co-appearance of source titles and author keywords.

ScienceScape is a web-based tool that analyses the Scopus .csv file for publication information. It will generate a network for a given database and display articles, keywords, and journals over time as shown in figure 8. Nodes with two colours are around 576, indicating Titles and Author keywords, and edges are around 796, indicating inter-linking or co-occurrence. The filter is applied to disconnected nodes, and as a result, 12 nodes from the above network have been excluded because they are disconnected.

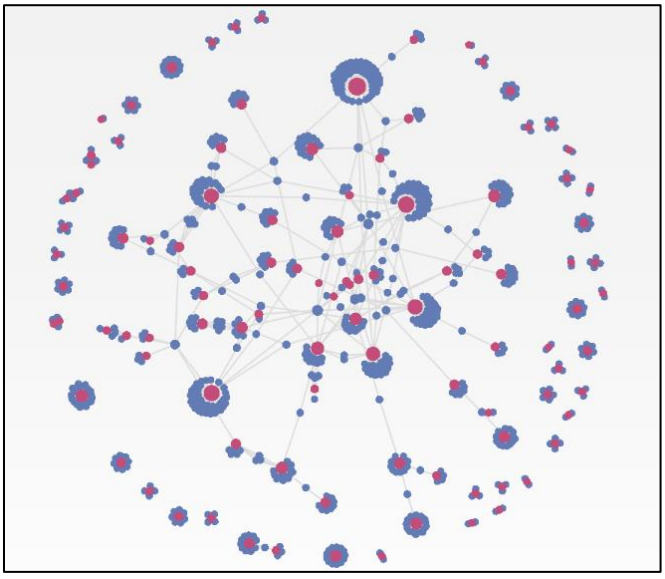

Figure 9. Network cluster for co-appearance of authors and source titles.

The network cluster for co-appearance of authors and source titles is depicted in Figure 9. Authors and source titles are represented by two different colors. The connections between them are shown by the edges. With the co-appearance of authors and source titles, a total of 852 nodes and 881 edges were discovered. The disconnected node filter is used, but the report shows that there is no such disconnected node in the network for co-appearance of authors and source titles.

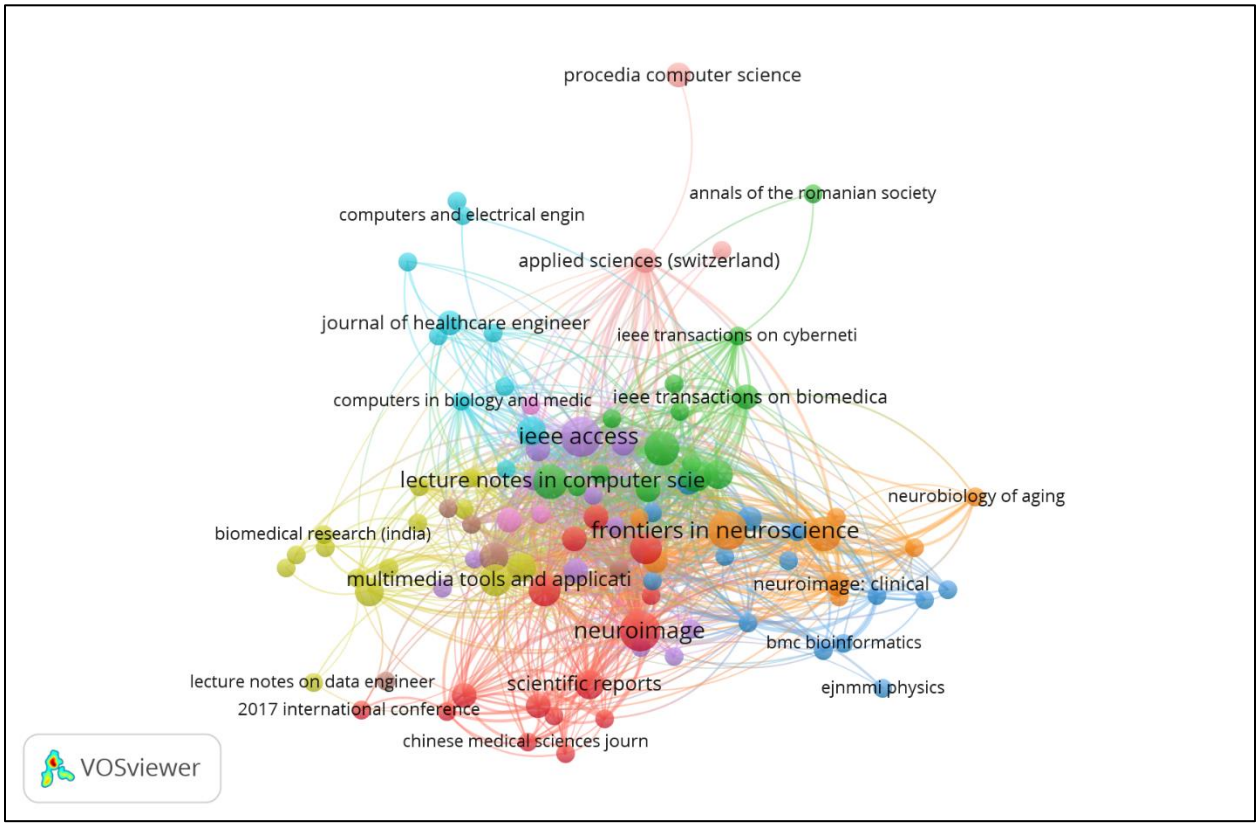

Figure 10. A bibliographic coupling with sources.

The analysis shows the mapping of bibliographic coupling with sources using VOSviewer software. The total number of sources is 102. A source's minimum number of documents is set to one. With this provision, 102 sources will be mapped, as seen in the figure 10. The intensity of the

source is indicated by the size of the circle and label. If the file size is larger, there are more similar documents in that source.

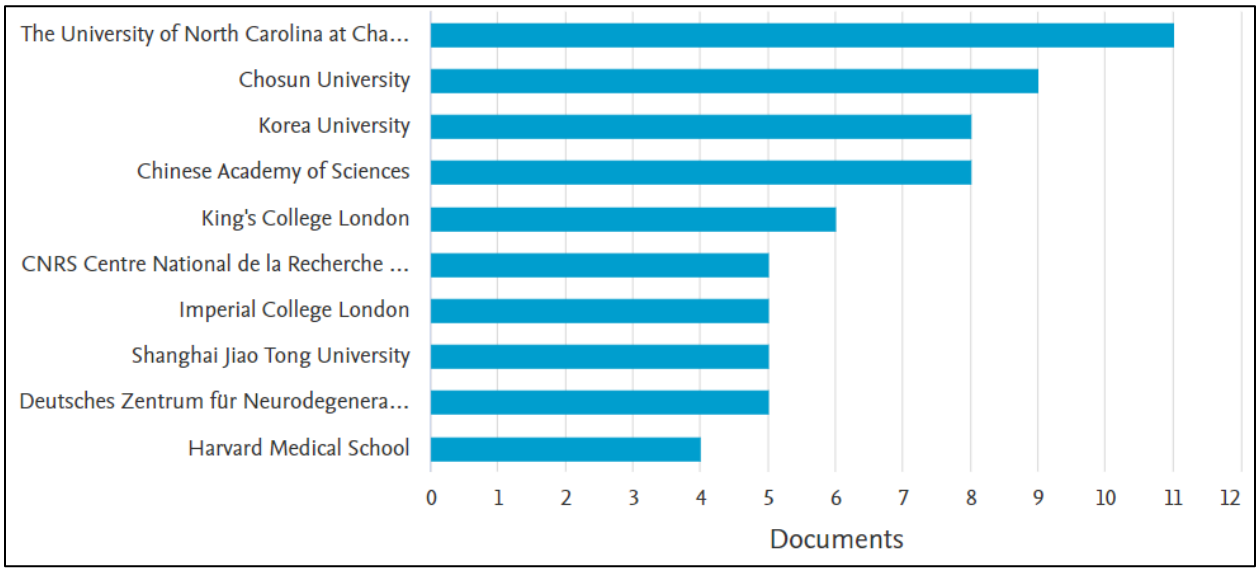

Figure 11. Top ten affiliations.

Figure11 shows the top ten institutes that have been associated with the most research on AD globally in recent years. With 11 documents, the University of North Carolina (363 citations) takes the lead, followed by Chosun University with 9 (87 citations), and Korea University (353 citations) along with Chinese Academy of Sciences (52 citations) with 8 documents each followed by King's College London (15 citations) with 6 documents. Imperial College London (39 citations), CNRS (52 citations), Shanghai Jiao Tong University (90 citations), Deutsches Zentrum für Neurodegenerative Erkrankungen e.V. (110 citations) have 5 documents in Scopus while Harvard Medical School (77 citations) has 4 documents. In the year 2020, 5 of the 11 documents from the University of North Carolina were released. Between 2017 and 2021, about 160 separate institutes published AD literature.

2.4 Top publishing Countries

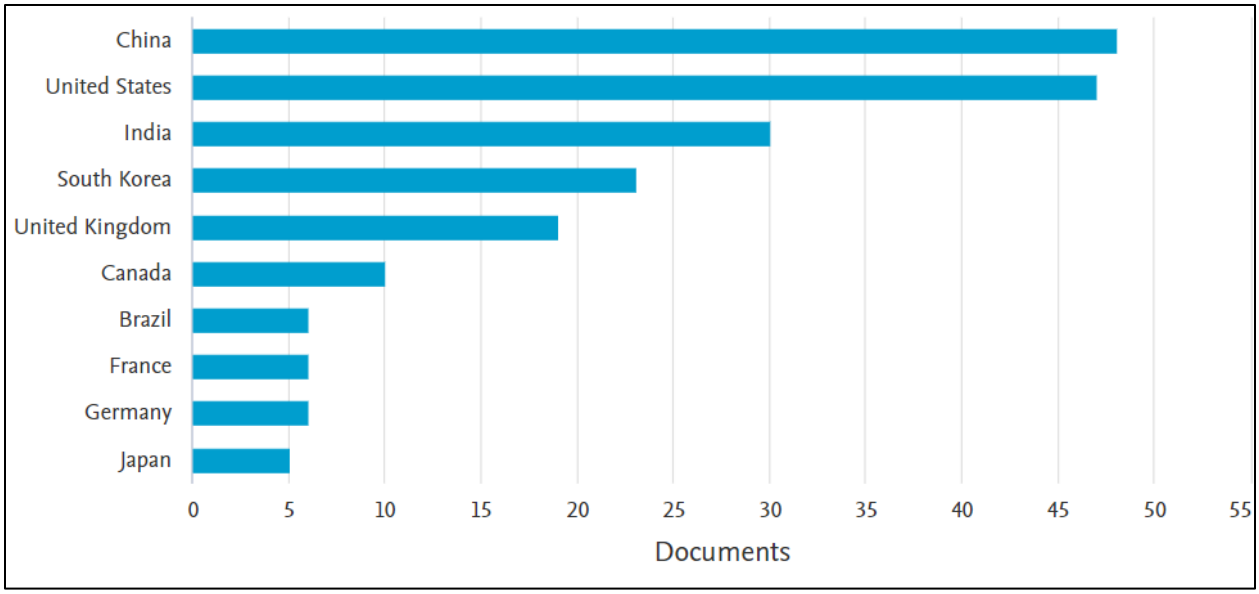

Figure 12. Top ten publishing countries or territories.

Figure 12 depicts the top ten countries with publications from 2017 to 2021 in Scopus database, with China leading the pack with 27.42 percent of all publications (48 out of 175, 356 citations). The United States of America has 47 publications (26.8%, 774 citations) and India coming in third with 30 (17.1%, 128 citations). These three countries have made the most significant contributions in the fields of neuroscience and engineering (61.7%) in recent years, as shown in Figure 12. Surprisingly, the number of AD-related publications from China has increased from seven in 2018 to fifteen in 2019 and 2020 each. Over time, China, the United States, India, South Korea, England, Canada, Brazil, France, Germany, and Japan each established additional AD research and increased international research collaborations. The European Union and the United States are home to most research institutions involved with AD.

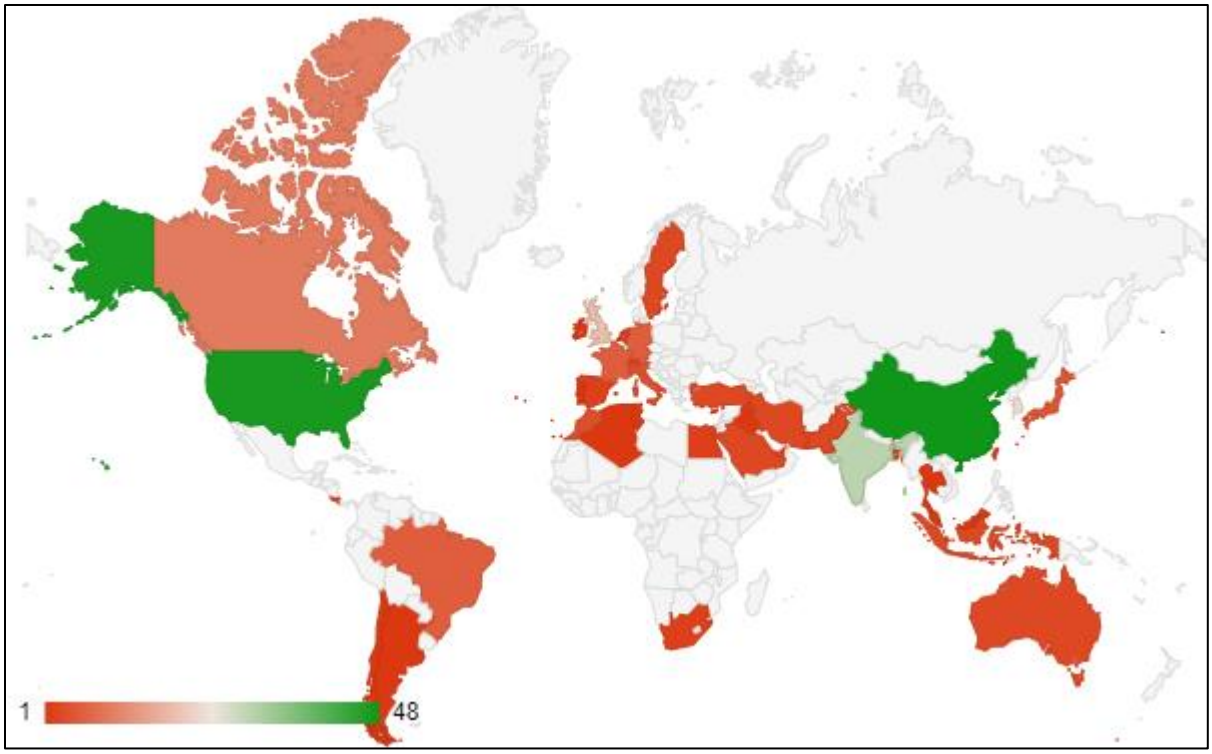

Figure 13. Country wise research work done on AD.

Scopus creates a standard database based on a country or territory. Figure 13 shows how China (48), the United States (47), and India (30) relate to most of the countries that have contributed to AD research. Despite developments in research topics, the countries and institutions that produce the most AD literature have remained relatively constant. China, India, the United States, Canada, and the European Union continue to be significant contributors to AD research. Interestingly, these countries and their institutes have previously been listed as major contributors to neuroscience research, suggesting that they and their institutes play critical roles in global research. In recent years, both South Korea and India have made significant progress. The increased financial support to AD research and the improved financing structure for AD research provides a satisfactory explanation for this development. These findings together reflect light on the role of both ability and financial support in the development of scientific research. A country's economic strength has a significant impact on its medical research investment.

2.5 Authors and Prominent Subject areas

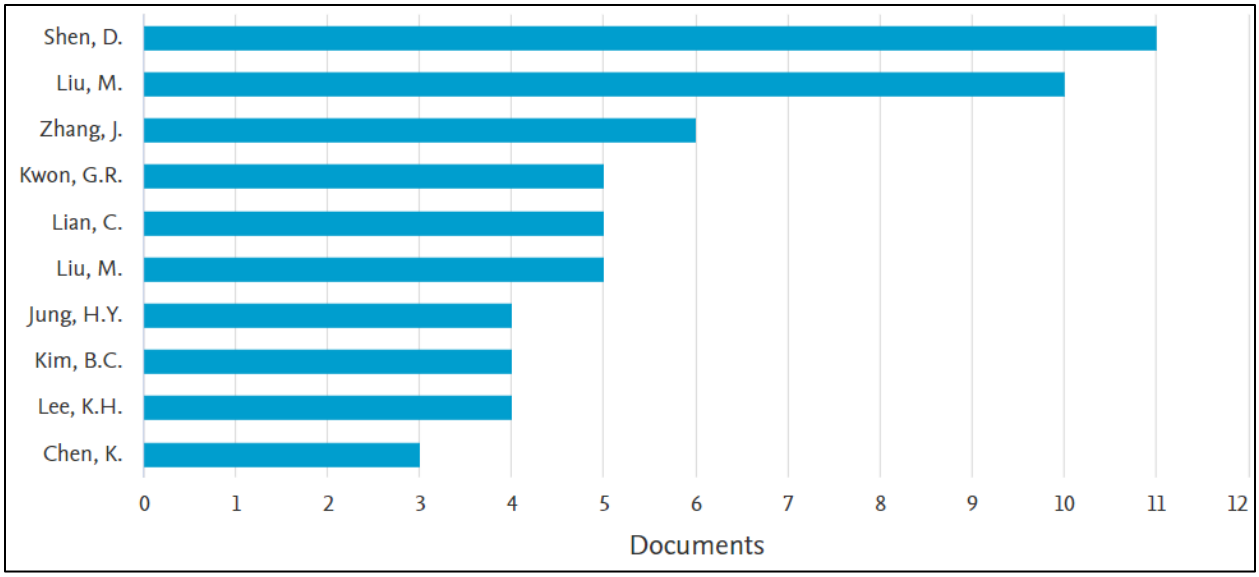

Figure 14. Top ten authors.

Figure 15. (A) Document by Years, (B) Document by Type and (C) Documents by Country/Territory from top ten authors.

From Scopus, figure 14 illustrates the top ten writers contributing to medical imaging. D. Shen, M. Liu, and J. Zhang, all of whom have different affiliations, are the key contributing writers. A total of 160 unique authors have contributed to publishing literature related to AD. From the top ten authors majority document type published were articles (24 of 28, 85.7%, 554 Citations) and rest of the documents were conference papers (4 of 28, 14.3%, 9 citations) as seen in figure 15(B). From figure 15(C) we can derive that authors from South Korea, USA and China have the most contribution amongst top ten authors.

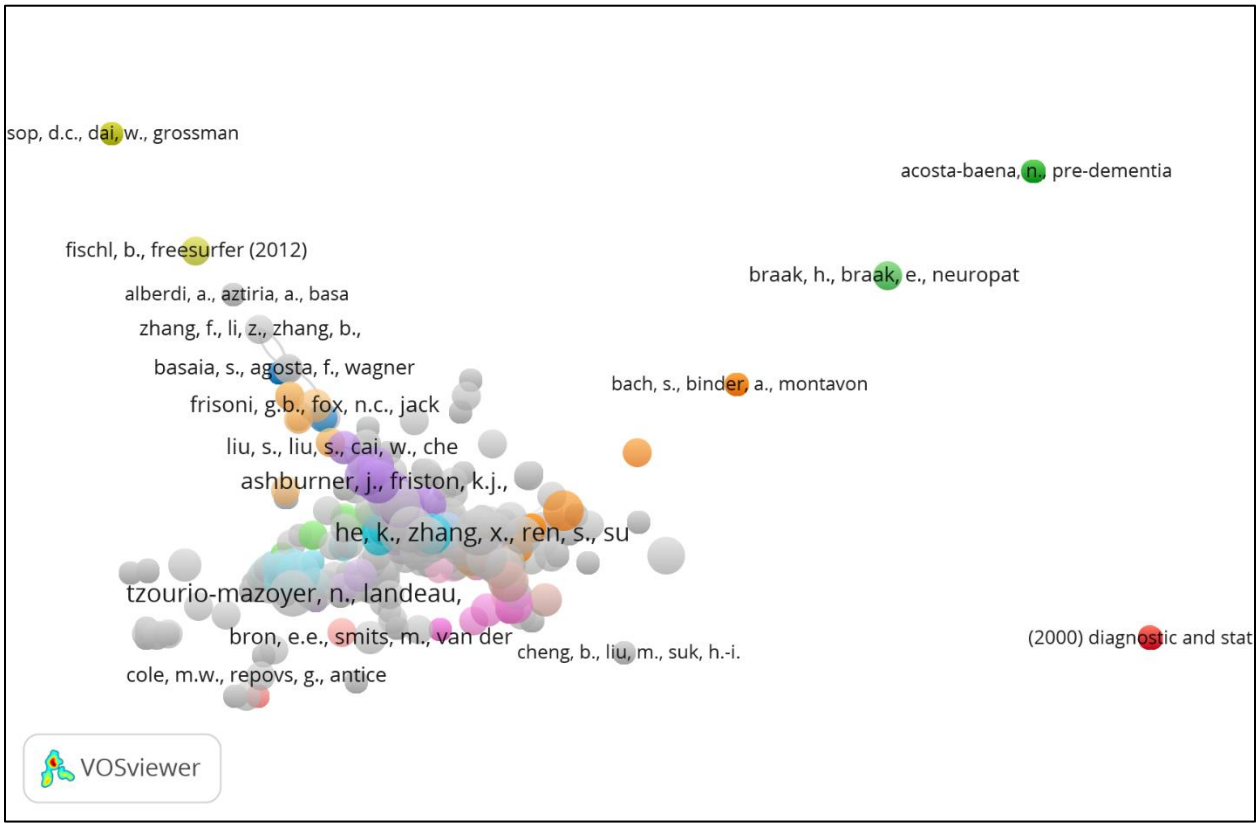

Figure 16. Publications map with citation score.

Citations are the number of times that a research publication has been referred to and used. It is the publication's utility factor. Figure 16 shows the citation score of publications determined with VOSviewer software. The larger the label and circle, the higher the citation score. The inter-linkage of publications with their citations is shown by the map's links.

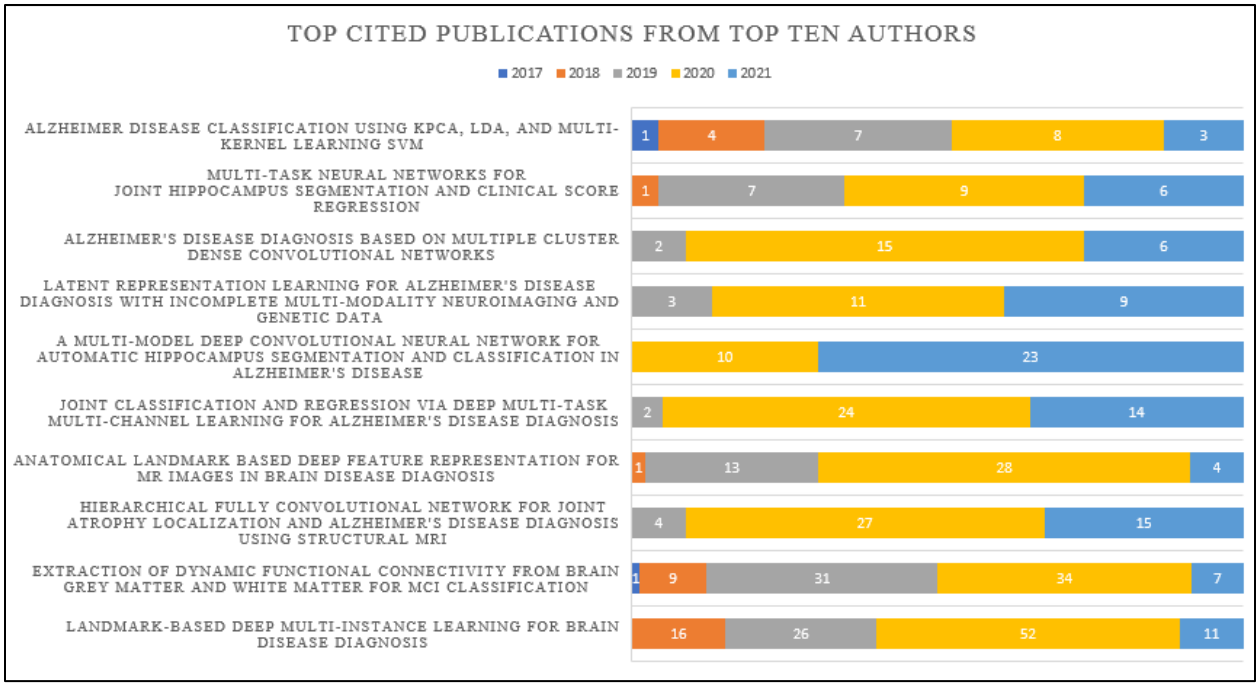

Figure 17. Top cited publications from top ten authors.

Figure 17 displays the top ten authors' publications, which are sorted by least to most cited publication. In the time span under consideration, the authors have a total of 28 publications. All these authors publications have been articles. They had just 3 citations between them in 2017, but the number of citations has steadily increased over time, with the year 2020 having the most citations amongst the authors with 289. The most cited article is “Landmark based deep multi-instance learning for brain disease diagnosis” by Liu, M. et al. published in 2018. The h-index of these 28 documents is 14. They have 98 citations so far in 2021.

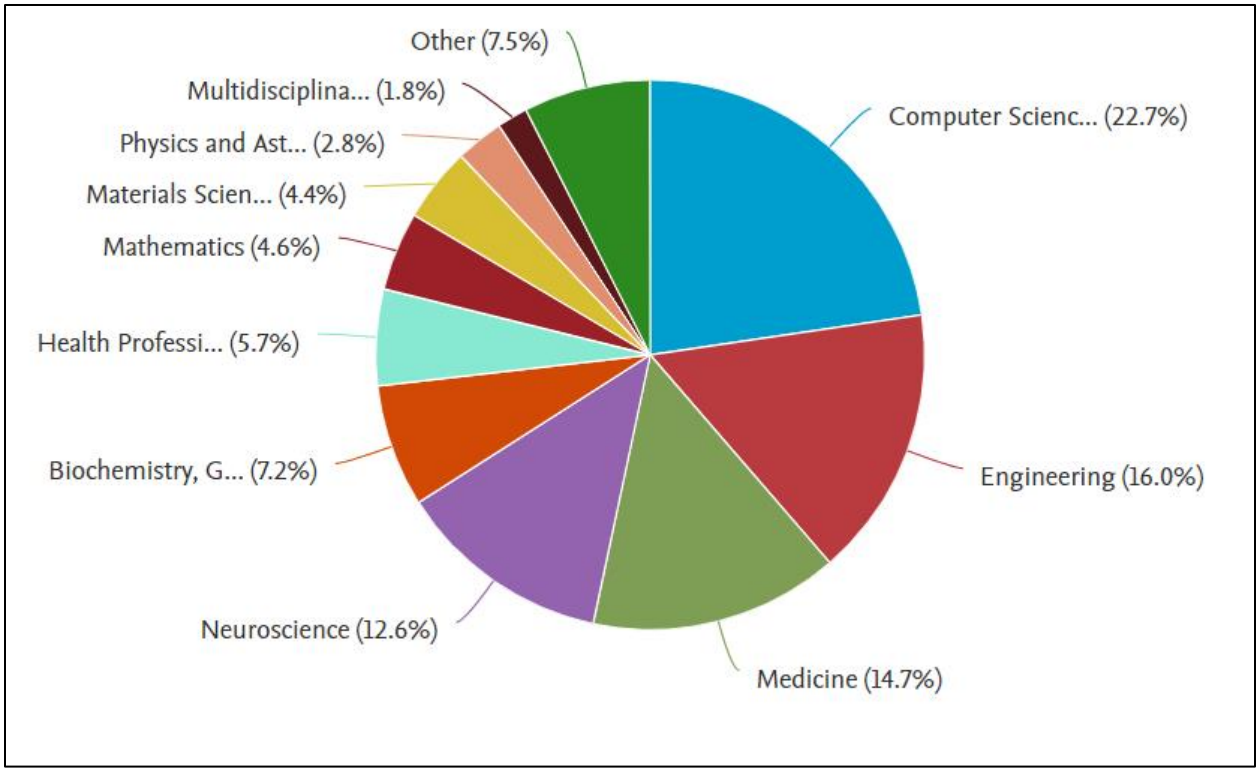

Figure 18. Top subject areas.

Figure 18 displays subject-specific information derived from the 21 different subject areas from Scopus database for medical imaging publications. Computer Science and Engineering accounts for the highest number of publications (22.7%), followed by Engineering (16%), Medicine (14.7%) and Neuroscience (12.6%). China, USA, and India are the top contributors in the subject of Computer Science and Engineering while China and India are top contributors in Engineering field (461 citations) closely followed by South Korea and the USA. There has been a significant growth observed in 2020 with 246 citation for the published work as compared to 75 in 2019.

2.6 Funding Agencies

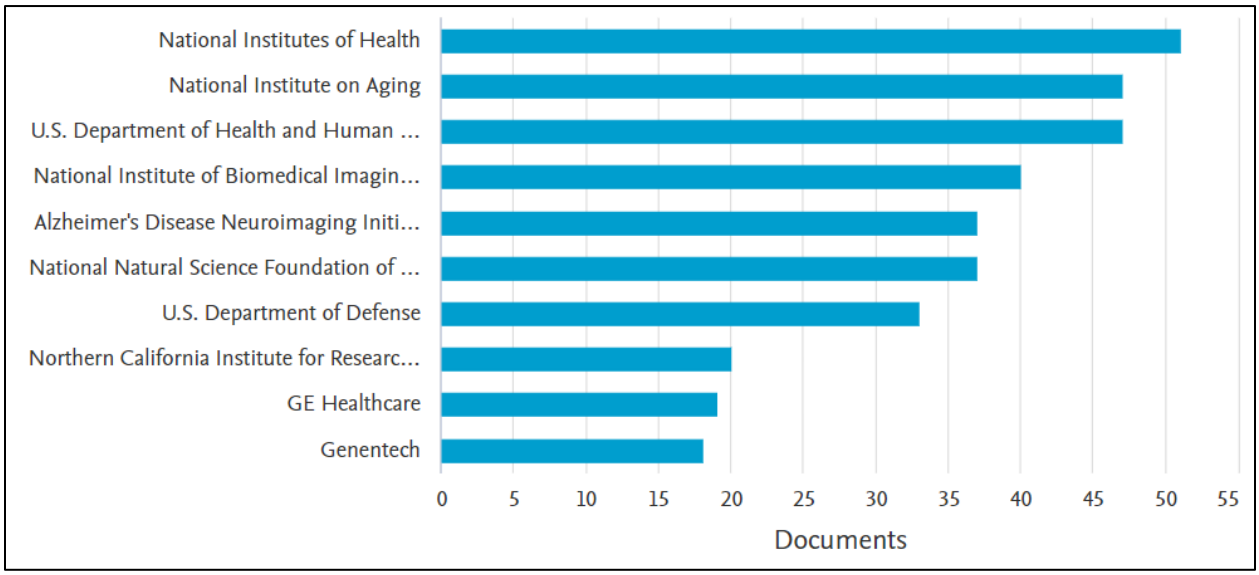

Figure 19. Top ten funding sponsors.

From the Scopus database, Figure 19 depicts the top ten funding sponsors around medical imaging in recent years. Between 2017 and 2021, about 160 unique institutions published AD literature. It should come as no surprise that the United States of America leads the way in funding medical imaging studies, as seen in figure 19, where the top three funding agencies are the National Institutes of Health (51 publications, 788 citations), the National Institute on Aging (47 publications, 719 citations), and the U.S. Department of Health and Human Services (47 publications, 763 citations). The United States of America has nine of the top ten funding organizations, while China has one. This further emphasizes the global significance and dominance of the United States for medical imaging studies and advancements in AD diagnosis and classification.

2.7 A-K-J Sankey Analysis

ScienceScape is used to perform the A-K-J Sankey Analysis, where A stands for Author, K for Keyword, and J for Journal.

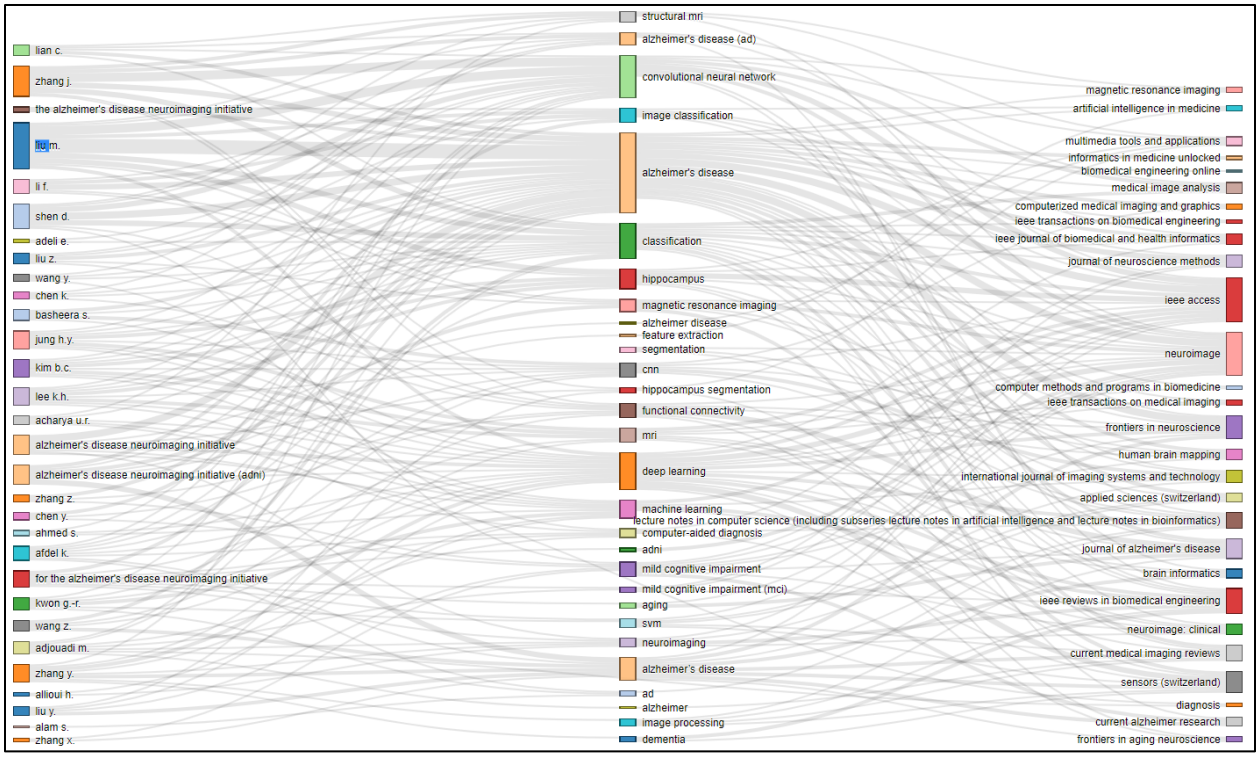

Figure 20. A-K-J Sankey Analysis on AD research.

Figure 20 depicts the relationship between them. This A-K-J Sankey tab accepts a CSV file derived from Scopus as input. The dynamic and complex relationship between the Author, Keyword, and Journal is depicted in Figure 20. The actual online count will be shown beneath this mapping, demonstrating the association between them.

2.8 Limitations of the Analysis

There were some drawbacks to the bibliometric study. First, the analysis could be influenced by delayed publications from the Scopus database. Second, bibliometric studies cannot often determine the authenticity or scientific accuracy of the publications; instead, they must concentrate on the research's influence. A widely cited paper does not always imply that it is of good scientific standard. The number of citations an article receives is determined by several factors, including journal type, research model, and self-citing rate. Third, the study focused on English-language literature, leaving out several non-English publications. Fourth, the Scopus database has different classifications for different forms of literature. When analyzing the findings of this report, readers should keep these conflicting factors in mind.

3 Conclusion

In conclusion, several authors are by now working in the field of medical imaging, according to the comprehensive analysis using available technologies. This review studied 175 publications concerning AD that were published between 2017 and 2021 to find out what was relevant to the field in recent time. Several documents, as seen in the figures, have indeed been successfully published related to the work in medical imaging and AD for many years. These findings will help researchers better understand latent topical popularity, dynamics, correlation, dissemination, and cross-national/regional collaborations in this area. They can also help researchers and project managers distribute resources more effectively in forthcoming study. Furthermore, bibliometric approach serves as a commonly applicable analytical technique to determine underlying topics and development patterns in an academic or practical area by taking maximum benefit of the large-scale scientific information involved.

Medical Imaging is a significant and rapidly expanding area of study that is continuously being investigated by researchers all over the world with a keen interest in addressing issues related to neurodegenerative diseases such as AD using ever-growing data to achieve high-quality outcomes. It reveals most key aspects in this fast-growing, interdisciplinary field over the last decade, as well as their different evolving patterns, diverse distributions among various types of research units, and the role of influential research units in topical advancement and collaboration. It also highlights several promising areas in this domain.

The current report offers a detailed review of AD studies worldwide over the last five years. The global amount of AD research has skyrocketed recently. Over the survey era, there was a linear increase in the number of AD publications, which was consistent with other neuroscience research fields. Most of the study came from China, emphasizing the country's importance in Alzheimer's research. Our results show that a country's economic strength has a major impact on healthcare spending. With its rapid growth in science and technology, the United States has made significant progress and holds a respectable place in AD research among developed countries.

Journal articles must be used to publish research findings. There have been 151 publications that have published AD-related articles worldwide, with the top ten journals publishing the most articles in this area accounting for just 27.1 % of all published AD studies. Journals including IEEE Access, Frontiers in Neuroscience, Journal of Alzheimer's Disease, Neuroimage, and Medical Image Analysis, which publishes many AD-related papers, allow various points of view to be

freely discussed. The journals that publish the ten most cited papers and the journals that publish the most articles are the same. The co-occurrence of selected AD attributes with keywords indicates the exact count of publications available. The statistical analysis of citations given demonstrates the high quality of research implementation.

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