OVERVIEW RESEARCH ON ARTIFICIAL INTELLIGENCE IN SPEECH RECOGNITION

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ABSTRACT

This article aims to provide a comprehensive overview of the use of artificial intelligence (AI) in speech recognition based on data from Scopus and scholar sources from January 2018 to December 2023. The PRISMA model was employed to guide the selection of articles. After careful selection and review, 40 scientific papers were included for analysis. The authors analyzed information such as the number of research articles, countries of origin, authors, citation counts, and keywords. The results indicate a growing number of research articles on the use of AI in speech recognition. The research work on AI in speech recognition by the author group De La Fuente Garcia, Sofia; Ritchie, Craig W.; Luz, Saturnino from the United Kingdom has the most significant influence. Artificial intelligence, speech recognition, machine learning, and deep learning are common keywords in the analyzed articles. Therefore, through this comprehensive overview, researchers can identify crucial information about the use of AI in speech recognition, guiding future research directions.

Keyword: *Artificial intelligence; speech recognition; Overview; PRISMA*

1. INTRODUCTION

Artificial intelligence (AI) has played a crucial role in enhancing speech recognition capabilities, offering valuable applications across various industries. AI serves as more than just a technological advancement; it acts as a potent instrument for comprehending spoken language and extracting information from audio sources effectively. The advancement of speech recognition capabilities owes its progress to the fusion of cutting-edge techniques and algorithms facilitated by artificial intelligence. Machine learning models, particularly deep learning, are employed to optimize this procedure, resulting in notable advancements in the accuracy and processing capabilities of speech recognition systems.

The advantages of AI in speech recognition extend beyond any particular domain. In the medical field, AI can analyze vocal patterns to detect diseases [1], [2], [3], [4], [5], [6]. In education, artificial intelligence aids in the development of students' language skills through speech recognition applications [7], [8], [9], [10]. In industry, the fusion of AI and speech recognition is prominently evident in voice-controlled systems, which streamline work processes and boost overall performance[11], [12], [13], [14], [15]. Furthermore, in the realm of communication, AI contributes to the creation of a more sophisticated user experience and interactive environment, offering numerous opportunities and advancements in the industry [16], [17].

However, many research papers that discuss AI in speech recognition tend to primarily focus on the research methodology and algorithms employed, neglecting to thoroughly analyze essential information such as active authors in the field and influential articles. As a result, there is a lack of comprehensive examination in these areas.

Therefore, this study aims to address these issues by conducting a bibliographic analysis of scientific articles pertaining to the utilization of artificial intelligence in speech recognition. The following research questions will be explored: i) How has the quantity of research articles and scholars focusing on the use of artificial intelligence in speech recognition changed over time within the Scopus database? ii) Which journals, authors, and articles have gained prominence in the field of artificial intelligence in speech recognition? iii) How are the keywords employed in the Scopus database when discussing the application of artificial intelligence in speech recognition interconnected? iv) Which countries have conducted research on the use of artificial intelligence in speech

recognition? Which country has the highest number of studies? v) Which keywords have the highest frequency of occurrence in the Scopus and scholar databases, concerning the utilization of artificial intelligence in speech recognition?

Addressing these research questions will provide researchers with fundamental perspectives to approach the topic of AI in speech recognition. Additionally, it will assist new researchers in identifying potential areas for future research by identifying existing research gaps.

2. METERIALS AND METHODS

This article employs the PRISMA[18] (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) review method as a standard to uphold transparency and objectivity. PRISMA is designed to aid scholars in enhancing the reporting of scientific reviews and meta-analyses. It encompasses a minimum set of evidence-based criteria for systematic review reports, enabling reviewers to clearly articulate the purpose of the review and describe the author's methodology in a systematic manner.

2.1 Search sources

The author selects articles for overview analysis from the Scopus database, and Google Scholar provides flexible search capabilities, allowing access to digital copies or online articles. This flexibility not only quickly gathers information, but also helps ensure diversity and richness of data sources. In this way, research achieves comprehensiveness in evaluating and synthesizing information from diverse sources on Google Scholar.

2.2 Search criteria

To be included in the review database, articles must meet both of the following related criteria:
i) Search terms: at least one term related to artificial intelligence must appear in the article title;
ii) The term "speech".
Applying the aforementioned criteria, Scopus and Google Scholar returned 2283 results for consideration. The article crawl period spans from January 2018 to December 12, 2023.

2.3 Conditions for including articles in analysis

To be included in the final analysis and evaluation, articles must fulfill additional requirements outlined as follows:
• Time: Articles must have been published from 2018 to the present.
• Language: Articles must be written in English or Vietnamese.
• Accessibility: Full-text access to the article is required.
Articles failing to meet any of the following criteria will be excluded from the list:
• The article is not written in English or Vietnamese.
• Articles published prior to 2018.
• The article pertains to artificial intelligence but not to speech.
• The document is not an article (e.g., book, thesis, poster, introductory page, etc.).
Figure 1 illustrates the flow of information through the various stages of the systematic review process utilizing the PRISMA method. Initially, 2283 records were identified through searches in Scopus and Google Scholar. Subsequently, 1742 records published before 2018 were eliminated. Additionally, 391 duplicate articles, those not classified as articles, those not in English or Vietnamese, and those unrelated to speech were removed. Furthermore, 90 articles inaccessible due to access restrictions were excluded. The authors then scrutinized the remaining 60 papers, removing 20 due to inappropriate research content. Ultimately, 40 papers were included in this study for evaluation and analysis.
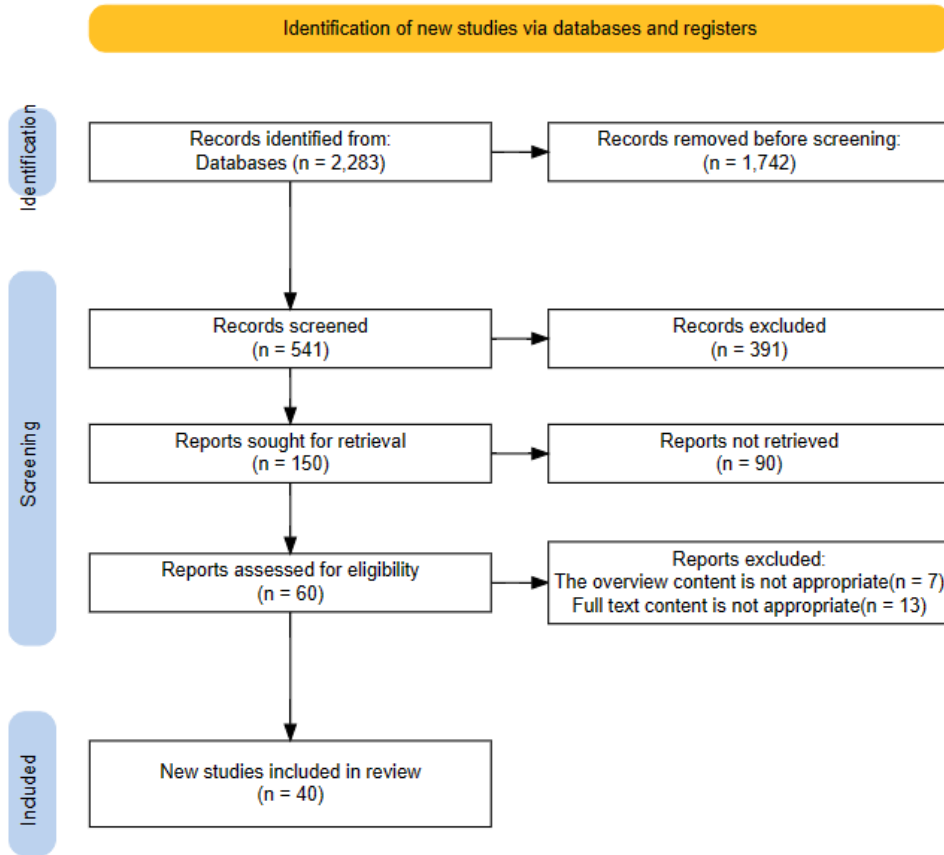
Fig-1: The diagram shows the movement of information through the different stages of a system evaluation

3. Results and Discussion

3.1 How has the number of research articles related to the use of artificial intelligence in speech recognition changed over time on the Scopus and Google Scholar databases?

The chart in Fig-2 provides an overview of the distribution of the number of research papers on the use of artificial intelligence in speech recognition from 2018 to 2023. A total of 40 papers were analyzed, and it is evident that the number of scientific papers is not evenly distributed across the years.
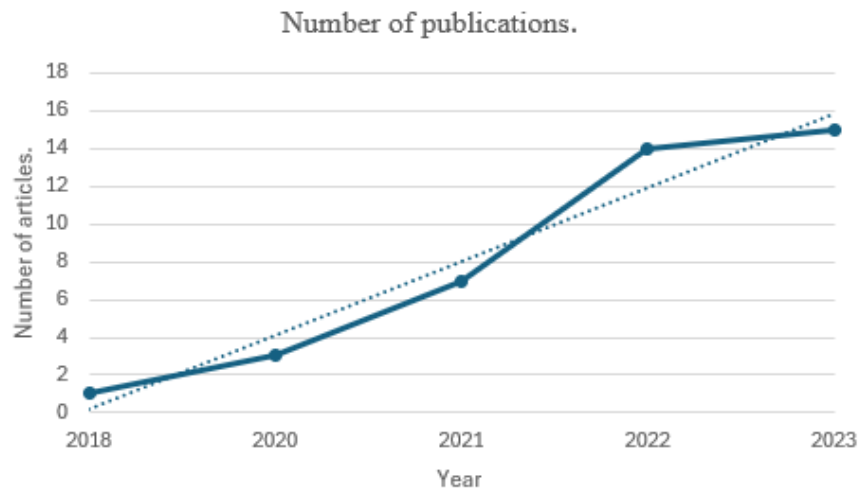
Fig-2: Publication distribution chart on the use of artificial intelligence in speech recognition

In general, there is a gradual upward trend in the number of documents from 2018 to 2023. The number of articles on the use of artificial intelligence in speech recognition has increased, peaking in 2023 with 15 articles. This trend indicates the heightened interest and extensive research efforts of the research community in this field.

Uneven fluctuations in the number of articles over the years may reflect shifts in topics and could be associated with external factors such as technological advancements, the focus of the research community, or significant industry events.

An overview of this trend reveals that the utilization of artificial intelligence in speech recognition is a burgeoning and esteemed area of research. The continual increase in the number of documents also fosters opportunities for innovation and practical application of this technology in fields such as communication, education, and industry.

3.2 Which journals, authors, and articles are most renowned in the field of utilizing artificial intelligence in speech recognition?

Table - 1: Data table of articles on AI use in speech recognition of journals

Journal sources	Number of articles published
Wireless Communications and Mobile Computing [7], [19]	2
Journal of Robotics[10], [20]	2
Journal of Physics: Conference Series[21], [22]	2
https://www.ssrn.com/[23], [24]	2
Aerospace[25]	1
International Journal of Information Management Data Insights [26]	1
JMIR Mental Health	1
Computational Intelligence and Neuroscience [9]	1
IEEE Open Journal of Engineering in Medicine and Biology [27]	1
Seminars in Hearing [3]	1
Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine [28]	1
2020 IEEE International Conference on Consumer Electronics - Taiwan, ICCE-Taiwan 2020 [5]	1
Big Data and Cognitive Computing [29]	1
Face [30]	1
Sensors [31]	1
Journal of Alzheimer's Disease [2]	1
Journal of Sensors [32]	1
Informatica (Slovenia) [11]	1
International Neurourology Journal [33]	1
SAGE Open [8]	1
Journal of Engineering Research (Kuwait) [34]	1
Brain Sciences [35]	1
Information (Switzerland) [36]	1
Cognitive Computation and Systems [37]	1
Mobile Information Systems [38]	1
Scientific Reports [39]	1
Journal of King Saud University – Science [15]	1
Brain Communications [40]	1
IEEE Access [41]	1
Big Data and Society [42]	1
Algorithms [43]	1
Cancers [44]	1
Diagnostics [45]	1
Security and Communication Networks [46]	1
PLoS ONE [17]	1

The table above highlights the diversity and richness in the utilization of Artificial Intelligence (AI) in the field of speech recognition. Each of the 35 journal and conference sources listed has at least one research paper on the topic, indicating widespread interest within the research community.

This study not only delves into the fields of communications and robotics but also extends its scope to encompass disciplines such as medicine, computer science, and information technology. Journal sources like Wireless Communications and Mobile Computing, Journal of Robotics, and Journal of Physics: Conference Series are prolific, indicating significant interest from the research community. The array of journal sources, ranging from comprehensive journals like Seminars in Hearing and Journal of Alzheimer's Disease to conferences such as the 2020 IEEE International Conference on Consumer Electronics – Taiwan (ICCE-Taiwan 2020), underscores the widespread and multidimensional interest in the field. Esteemed journals like IEEE Access and Scientific Reports further contribute to demonstrating the autonomy and quality of published research. In sum, this data table reflects a research community actively exploring and disseminating knowledge regarding the application of artificial intelligence in speech recognition across various domains.

The data table showcasing the Top 5 most cited articles in the field of Artificial Intelligence (AI) and speech recognition from the Scopus and Google Scholar databases offers a comprehensive insight into research highly esteemed by the community. Topping the list is the paper titled "Artificial Intelligence, Speech, and Language Processing Approaches to Monitoring Alzheimer's Disease: A Systematic Review," with 101 citations. This paper focuses on the application of Artificial Intelligence and natural language processing to monitor Alzheimer's disease. Following closely is "Exploring the Use of Artificial Intelligence Techniques to Detect the Presence of Coronavirus Covid-19 through Speech and Voice Analysis," with 43 citations, which addresses the crucial topic of voice COVID-19 detection. The third paper, "Artificial Intelligence Evaluation of COVID-19 Restrictions and Speech Therapy Effects on Autistic Children's Behavior," with 14 citations, centers on evaluating the effects of epidemic prevention measures and speech therapy on children with autism.

Table - 2: Top 5 most cited articles in Scopus database and scholar on AI in speech recognition

Article name	Cited by
Artificial Intelligence, Speech, and Language Processing Approaches to Monitoring Alzheimer's Disease: A Systematic Review	101
Exploring the Use of Artificial Intelligence Techniques to Detect the Presence of Coronavirus Covid-19 through Speech and Voice Analysis	43
Artificial intelligence evaluation of COVID-19 restrictions and speech therapy effects on the autistic children's behavior	14
Active Surveillance for COVID-19 through Artificial Intelligence Using Real-Time Speech-Recognition Mobile Application	12
Social Media Hate Speech Detection Using Explainable Artificial Intelligence (XAI)	10

"Active Surveillance for COVID-19 through Artificial Intelligence Using Real-Time Speech-Recognition Mobile Application" and "Social Media Hate Speech Detection Using Explainable Artificial Intelligence (XAI)" garnered 12 and 10 citations, respectively. Both papers concentrate on the practical application of Artificial Intelligence, ranging from COVID-19 surveillance and detection through mobile apps to the detection of social media stigma.

These papers not only represent the cutting edge of research but also exemplify the attention and practical application of AI in addressing today's social and medical challenges.

3.3 How are the keywords utilized in the Scopus and Google Scholar databases when discussing the utilization of artificial intelligence in speech recognition interrelated?

Fig-3 presents a visualized map of research trends regarding the utilization of AI in speech recognition from 2018 to 2023, generated using Vosviewer software. The chart depicts a total of 4 focus clusters for the research topics as follows:
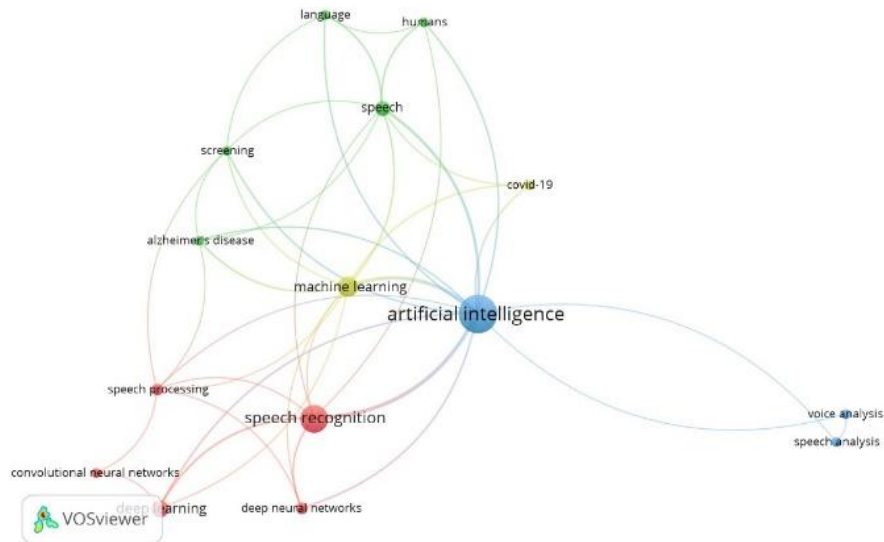
Fig-3: Visualizing a map of keywords appearing in research studies

The first cluster (red with 5 elements) focuses on Artificial Intelligence (AI) combined with Convolutional Neural Networks (CNN) and Deep Learning, particularly through Deep Neural Networks (DNN). This integration is paving the way for new possibilities in speech processing. CNNs are utilized for self-learning and feature extraction from audio signals, while Deep Learning, particularly DNNs, enhances their capacity to comprehend and represent intricate relationships within data. This amalgamation not only enhances speech recognition performance but also facilitates broad applications across various fields, spanning from industry to healthcare. It also brings artificial intelligence closer to the capability of understanding and naturally interacting with sound.

The second cluster (green with 5 elements) focuses on the crucial role of Artificial Intelligence (AI) in screening and early detection of Alzheimer's disease in humans through language and speech analysis. Researchers are harnessing AI technologies to analyze language patterns and voice characteristics, aiming to identify subtle changes that could indicate mental decline associated with Alzheimer's disease. This screening method offers a non-invasive approach and holds the potential to detect Alzheimer's disease early, providing valuable insights into the utilization of AI in healthcare, particularly for neurological conditions like Alzheimer's.

The third cluster (blue with 3 elements) emphasizes the significant role of Artificial Intelligence (AI) in speech and voice analysis. The utilization of AI in Speech Analysis and Voice Analysis facilitates the automation of audio data processing and extraction of crucial information, encompassing audio characteristics and specific speech traits. This integration of AI with analytical techniques holds promise for various applications in speech recognition and enhanced communication, while also unlocking potential in the domain of natural language processing.

The fourth cluster (yellow with 4 elements) centers on Artificial Intelligence (AI) and Machine Learning (ML) during the COVID-19 pandemic, highlighting their crucial role in predicting infection trends and processing health information. AI-driven speech processing aids in symptom detection through voice analysis and assists in evaluating and monitoring health conditions. The integration of AI, ML, and speech processing makes a significant contribution to the global endeavor to combat the pandemic.

3.4. Which countries have studies on the use of artificial intelligence in speech recognition?

Table-3 presents data on research regarding the utilization of artificial intelligence in speech recognition by country, providing a comprehensive overview of countries' contributions in this field. China leads with 13 papers, underscoring their strong focus and dedication to artificial intelligence research in speech recognition. The diverse origins of papers from numerous countries highlight the global nature and widespread interest of the research community worldwide. Significant contributions are also evident from countries like the United States and India, reflecting robust advancements in their artificial intelligence research and applications. Additionally, European countries such as Denmark, the UK, Italy, and Slovenia play crucial roles in this sector. Furthermore, contributions from smaller countries including Qatar, South Korea, Japan, Russia, Iran, Germany, Canada, Colombia, Pakistan, and Ireland illustrate that interest and research in speech recognition extend globally beyond larger nations. In total,

this table underscores the diversity and global reach of research in the field of artificial intelligence and speech recognition.

Table-3: Countries researching the use of artificial intelligence in speech recognition

Country	Number of articles
China	13
United States	4
India	4
Denmark	3
United Kingdom	2
Italy	2
Slovenia	1
Australia	1
Qatar	1
South Korea	1
Japan	1
Russian	1
Iran	1
Germany	1
Canada	1
Colombia	1
Pakistan	1
Ireland	1

3.5. Which keywords appear most often in studies on the use of artificial intelligence in speech recognition of the Scopus and scholar databases?

Fig-4 illustrates the keywords arranged from most to least frequent, represented by the size of the keyword in the image. Research on the utilization of artificial intelligence in speech recognition predominantly emphasizes significant topics. Machine learning and artificial intelligence, particularly "Artificial Intelligence" and "Machine Learning," stand out as top priorities, indicating a strong emphasis on the application of these methods in the field of speech recognition. "Speech Recognition" emerges as a critical topic, underscoring a particular interest in speech recognition capabilities and their applications. Simultaneously, the notable emphasis on "Deep Learning" and "Deep Neural Networks" underscores the focus on developing highly intricate machine learning models.
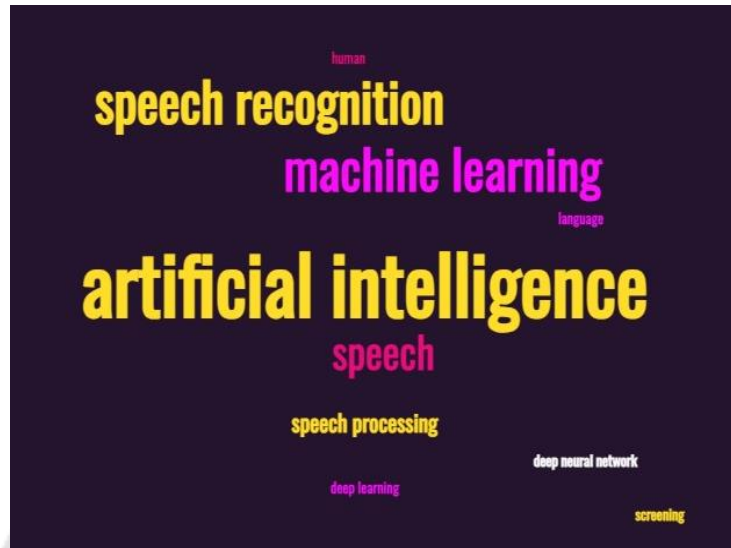
Fig-4: Keyword clouds extracted from the summary content of articles

The study also emphasizes practical applications, including Alzheimer's disease diagnosis and its relevance in the context of the COVID-19 pandemic. Additionally, screening and speech processing aspects receive significant attention. Furthermore, the interest in "Language" and "Humans" indicates a specific focus on language and interaction with learners within educational settings. Keywords such as "Convolutional Neural Networks," "Natural Language Processing," "Speech Analysis," and "Voice Analysis" reflect the diverse range of methods and techniques employed in the study. Overall, this research aims not only to enhance language recognition but also to explore the practical application and interaction of language and individuals across various contexts.

4. CONCLUSIONS

The study aims to analyze papers related to the utilization of artificial intelligence in speech recognition published in the Scopus and Scholar databases between 2018 and 2023. Research results reveal a growing interest in artificial intelligence in speech recognition, as evidenced by the emergence of numerous new papers in the field. Additionally, the study highlights China's prominence with numerous researchers and scientific articles on artificial intelligence in speech recognition. Keywords such as artificial intelligence, AI, machine learning, deep learning, and speech recognition often feature in articles related to this field. However, the study has limitations, including reliance solely on the Scopus database and open-access articles, neglecting articles in other data sources. Nonetheless, this analysis offers insights into the research direction using artificial intelligence in speech recognition, aiding in the identification of both covered and uncovered topics by scholars. This identification of future research gaps, such as utilizing artificial intelligence to develop adaptable models capable of learning new information, creating machine learning systems capable of learning novel tasks without retraining, and constructing speech recognition models for embedded and mobile devices, can guide the development of new research in this field.

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