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Integration of Technologies in Daily Life in Smart Homes: A Bibliometric Approach

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Abstract

This paper aims to analyze research trends related to the integration of technologies in smart homes, which aims to improve the quality of life by automating and connecting devices and systems in the home environment. The study highlights significant gaps in this area. The methodology proposes a bibliometric analysis based on the PRISMA-2020 methodology, in Scopus and Web of Science. The results show a peak of interest in 2016 and 2015, with linear growth. Cook DJ is the primary reference in this field. The research has shifted towards concepts such as automatic resolution and blockchain, with emerging keywords including the Internet of Things and artificial intelligence. The keyword classification indicates a research agenda focused on key concepts. The conclusions provide a comprehensive view of the current landscape and future trends in research, offering valuable guidance for researchers and professionals in the field

Keywords: *Automation, Systems; Equipment, Quality of Life.*

Introduction

The integration of technology into everyday life in smart homes is an area of research in constant development that seeks to improve people's quality of life through the automation and interconnection of devices and systems in domestic environments. The integration of technology into daily life has led to a new paradigm where homes are transformed into intelligent and adaptable spaces capable of efficiently and personally meeting the needs and preferences of their inhabitants. Thakur and Han [1] propose a framework for monitoring human behavior that can be applied in smart homes to improve the user experience and optimize resource usage. Aljawarneh et al. [2] explore conflict resolution mechanisms between multiple users in smart

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home environments, emphasizing the importance of developing systems that promote coexistence and harmony in these technologically advanced environments.

The integration of technologies in smart homes is a crucial issue that is transforming human interaction with the domestic environment. Research by Jin, Kumar & Hong [3] and Vangala et al. [4] emphasizes the importance of addressing data privacy and security concerns in technologically advanced environments. It highlights the need to develop robust solutions that guarantee the protection of information in smart homes.

Although integrating technologies into smart homes is important, there are still significant gaps that need to be addressed. Tiwari, Garg & Agrawal [5] explore the future of smart homes and point out the need to address issues such as interoperability between devices, the integration of emerging technologies, and the socioeconomic and ethical implications. Therefore, a bibliometric analysis is necessary to better understand the current state of the field and guide future research.

The aim of this research is to analyze research trends on the integration of technology in daily life in smart homes. The following research questions are posed:

-What are the years with the most interest in the integration of technology in daily life in smart homes?

-What type of growth do the number of scientific articles on the integration of technology in daily life in smart homes present?

-What are the main research references on the integration of technology in smart homes?

-What is the thematic evolution of scientific production on the integration of technology in smart homes?

-What are the growing and emerging keywords in the research field of integrating technology into everyday life in smart homes?

- How are scientific literature keywords on technology integration in smart homes classified by function?

Guide for Author (Use “Header 1” Style)

Updating reporting guidance for systematic reviews, such as Page et al. [6], emphasizes the importance of staying current with methodological and technological advances in research. This improves study quality and promotes transparency in disseminating scientific findings, facilitating informed decisions regarding technology implementation in the home.

Eligibility Criteria

This bibliometric analysis uses inclusion criteria based on relevant metadata such as titles and keywords that address the topic. Additionally, various ways of citing these concepts in scientific literature are considered.

The exclusion process consists of three stages. The article describes a three-phase process for eliminating records that do not meet specific criteria. The first phase eliminates records with erroneous indexing, while the second phase excludes documents without access to the full text, which is only applicable to Systematic Literature Reviews. The third phase of exclusion addresses specific criteria, such as conference proceedings, non-relevant texts, and documents

with incomplete indexing. This process refines the selection to ensure the coherence and precision of the results.

Information Sources

For this bibliometric analysis, we selected the Scopus and Web of Science databases due to their recognition as the main sources of scientific and academic information. AlRyalat, Malkawi & Momani [7] compared these databases with PubMed, highlighting their broad coverage, data quality, and variety of disciplines covered. They are advanced tools for bibliometric analysis.

Search Strategy

To search the Scopus and Web of Science databases, we created two specialized search equations. These equations were designed to meet the defined inclusion criteria and take advantage of the search characteristics of each database.

For the Scopus database: (TITLE (("Pervasive Systems" OR "Ubiquitous Computing" OR "Pervasive Computing") AND ("Smart Homes" OR "Home Automation" OR "Domotics")) OR AUTHKEY (("Pervasive Systems " OR "Ubiquitous Computing" OR "Pervasive Computing") AND ("Smart Homes" OR "Home Automation" OR "Domotics")))

For the Web of Science database: (TI= (("Pervasive Systems" OR "Ubiquitous Computing" OR "Pervasive Computing") AND ("Smart Homes" OR "Home Automation" OR "Domotics")) OR AK= (("Pervasive Systems" OR "Ubiquitous Computing" OR "Pervasive Computing") AND ("Smart Homes" OR "Home Automation" OR "Domotics")))

Data Management

Arruda et al. [8] used Microsoft Excel to extract and process data from various databases and VOSviewer in conjunction with Excel to graph bibliometric indicators. The article explores the application of VOSviewer for bibliometric analysis in the research on the integration of technologies in smart homes.

Selection Process

According to the PRISMA 2020 statement, it is important to mention the use of an internal automatic classifier and validate the selection process to avoid loss of studies or misclassifications (Page et al., 2021). In this study, Microsoft Excel® automation tools were used as an internal tool to independently apply inclusion and exclusion criteria, reducing the risk of lost studies or incorrect classifications.

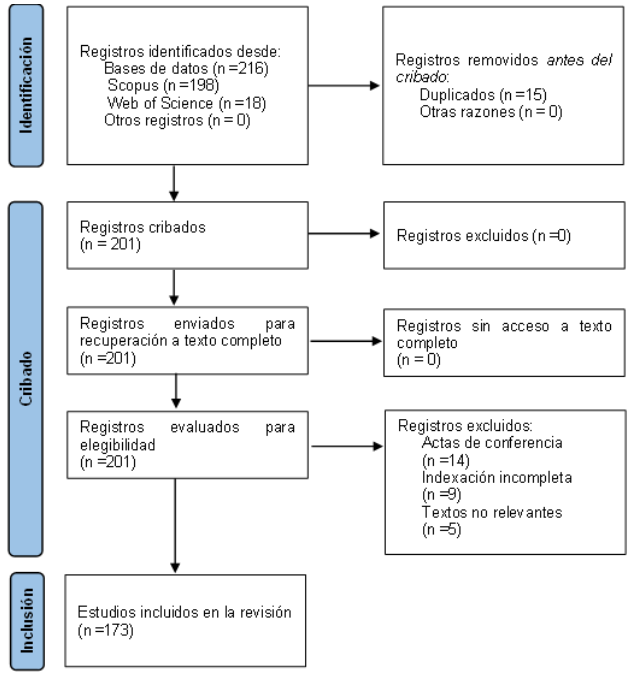

Fig. 1: PRISMA-2020 Flowchart

In this study, we initially identified records and removed duplicates. We then applied three phases of exclusion, resulting in the inclusion of 173 articles for bibliometric analysis.

Results

As shown in Figure 2, there was a linear growth of 97.86%. The years with the highest number of publications on this topic are 2016, 2015, and 2012. Analysis indicates an increasing trend in research related to the integration of technologies in the daily life of smart homes, reflecting a continuous and growing interest in this field in recent years.

Fig.2: Publications By Year

The study identified three groups of notable authors. The first group, led by Cook DJ, exhibits high productivity and impact. The second group, including authors such as Thomas BL, Crandall AS, and Krishnan NC, shows high impact despite low productivity. Finally, the third group, headed by Park S, is distinguished by its high productivity but lower number of citations. These findings highlight the diversity of author profiles that contribute to the field, each with different levels of productivity and impact.

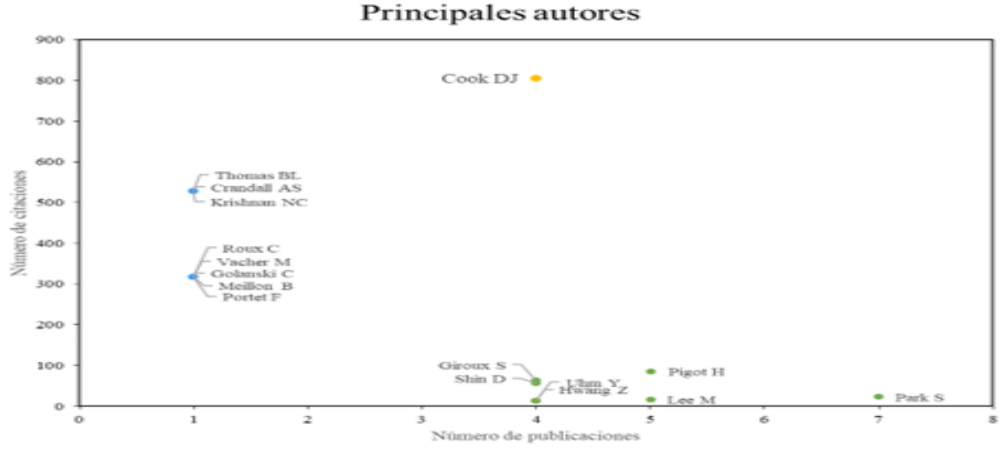

Fig. 3: Main Authors

Figure 4 illustrates the thematic evolution in the literature on the integration of technologies in smart homes. The most used keyword in each year from 2005 to 2023 was analyzed. In 2005, concepts such as Ambient Intelligence were prevalent. However, in recent years, emerging trends in research such as Automatic Resolution, Blockchain, Machine Learning, and Telemedicine have become predominant.

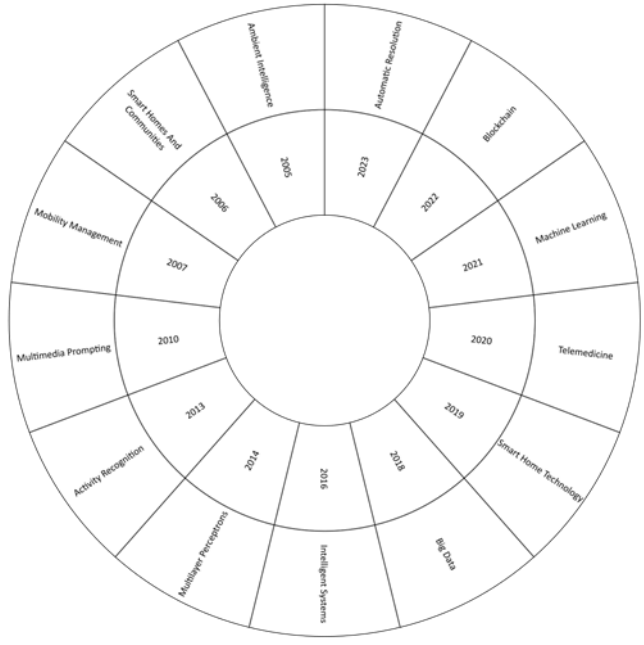

Fig. 4: Thematic Evolution

The research presents a Cartesian plane that analyzes the frequency of use of keywords on the X axis and their validity on the Y axis, generating four different quadrants. Quadrant 4 contains declining concepts such as Smart Home and Ubiquitous Computing, while quadrant 2 contains infrequent but highly current words considered emerging, such as Internet Of Things, Artificial Intelligence, Assisted Living, and Big Data. Finally, quadrant 1 does not present specific concepts, but it is the quadrant that contains the consolidated and increasing terms. This approach provides a structured understanding of the evolution and relevance of keywords in smart home and technology research.

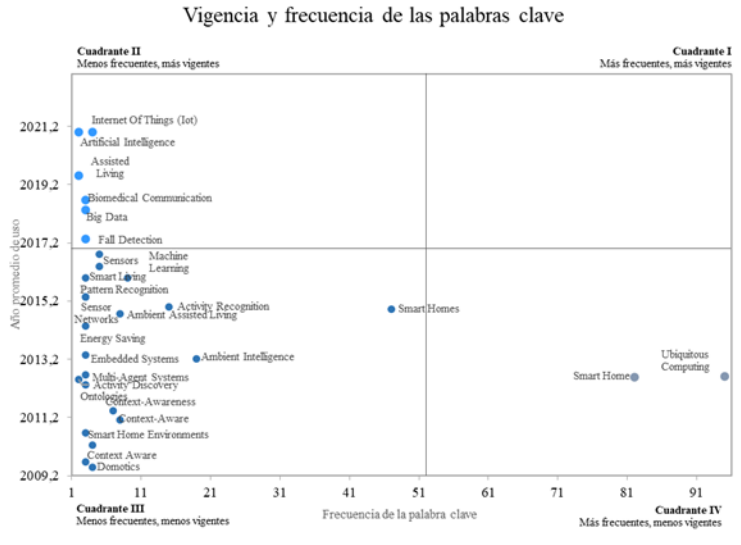

Fig. 5: Frequency and Validity of Keywords

Table 1 classifies the emerging keywords related to the integration of technologies in smart homes according to their function. This table enables the identification of the primary features and applications related to each categorized function, providing an organized overview of the trends and research areas in this field.

Keyword	**Associated Tools**	**Applications**	**Characteristics**
Internet Of Things	Raspberry Pi, Arduino	Home automation, Monitoring	Connectivity, Sensors
	ESP8266, NodeMCU	Home Security, Energy Efficiency	Automation, Interconnection
Artificial Intelligence	TensorFlow, PyTorch	Facial Recognition, Virtual Assistants	Machine Learning, Natural Language Processing
	Scikit-learn, Keras	Automatic Translation, Recommendation Systems	Data Analysis, Optimization
Assisted Living	Wearables, Smart Home	Health Monitoring, Home Assistance	Activity Detection, Emergency Alerts
	Teleasistencia, Robots de Asistencia	Medication Reminder, Activity Tracking	Remote Communication, Personal Assistance
Big Data	Hadoop, Spark	Data Analysis, Prediction	Scalable Storage, Parallel Processing

	Apache Flink, Kafka	Fraud Detection, Service Personalization	Handling Large Volumes of Data, Real-Time Streaming

Table 1: Classification Of Main Keywords According to Their Function

By examining this table, researchers can gain a better understanding of emerging trends and focus areas in the field of smart home technology integration.

Discussion

The discussion section analyzes the research results, detailing the findings, exploring practical implications, and discussing the study's limitations. This analysis contributes to the understanding of the topic and suggests directions for future research.

Analysis of the Results

During the years 2015, 2016, and 2018, significant scientific research was conducted on smart homes. Feng et al. [9] conducted a study on fall detection using ground pressure images, while Lee and Dey [10] explored the observation of daily activities for aging at home. These works reflect the diversity of approaches in this field and its importance during these periods.

Prominent authors in the field of smart home technology integration include Cook, who is known for his work on learning activity models for smart spaces [11]. Additionally, Thomas BL, Crandall AS, and Krishnan NC have made significant contributions, particularly through their involvement in the CASAS project, a comprehensive smart home that has had a major impact on the field of home automation [12]. These investigations have positioned these authors as research references at the intersection of technology and everyday life in the smart home.

The thematic evolution shows a significant shift from the initial emphasis on Ambient Intelligence to contemporary topics such as Automatic Resolution and Blockchain. Early studies, such as Friedewald et al. [13], explored ambient intelligence in home environments. However, more recent research, such as Aljawarneh et al. [2] and Vangala et al. [4], focuses on automatic resolution mechanisms and data security through blockchain in the context of smart homes. This change reflects the adaptation to current demands and the incorporation of advanced technologies to improve daily life in smart homes.

Key emerging concepts such as Internet of Things (IoT), Artificial Intelligence (AI), and Assisted Living were highlighted in Quadrant 2 of the Cartesian plane. These terms reflect fundamental areas at the convergence of technology and daily life. For instance, Thakur and Han [14] delve into fall detection in assisted environments, highlighting the relevance of machine learning methods for resident safety. The growing use of IoT and AI reflects a shift towards smarter and more connected environments, which can improve people's quality of life.

Limitations and Practical Implications

One limitation of this bibliometric analysis is that it only includes Scopus and Web of Science databases, potentially excluding relevant information. Additionally, the use of tools like Microsoft Excel® and VOSviewer® to define bibliometric indicators may introduce biases and limitations in the analysis due to the quality of the data and established search criteria. These aspects should be considered when interpreting the results obtained.

The identified thematic evolution has practical implications for various actors in the field. The shift in focus from Ambient Intelligence to aspects such as Automatic Resolution, Blockchain,

Machine Learning, and Telemedicine reflects an adaptation to current technological needs and advances. This transition suggests that researchers, developers, and professionals in the field of smart homes must be aware of emerging trends and direct their efforts towards implementing and developing solutions based on these concepts.

The analysis of keyword frequency and validity provides valuable guidance for decision-making in designing and implementing technologies for smart homes. The discovery that concepts such as Smart Home and Ubiquitous Computing are declining, while the Internet of Things, Artificial Intelligence, Assisted Living, and Big Data are emerging, suggests the need to adjust strategies and approaches in research, development, and implementation. Professionals and companies in the smart home sector should focus their efforts on developing innovative solutions that address current demands and challenges. The areas of greatest relevance and growth potential should be prioritized.

Conclusion

The data suggests that the years of greatest interest were 2016 and 2015, indicating a prominent focus on the topic during those years. Similarly, the scientific literature in this field exhibits linear growth over time, indicating sustained interest and development in the investigation. The primary research references identified, including Cook DJ and Thomas BL, Crandall AS, and Krishnan NC, are notable for their impact on the field and their contribution to the advancement of knowledge.

Regarding thematic evolution, there has been a shift in focus from Ambient Intelligence to more current topics such as Automatic Resolution, Blockchain, Machine Learning, and Telemedicine. This change reflects an adaptation to current technological demands and advances. In addition, this study identifies emerging and growing keywords in the field of smart homes, such as Internet of Things, Artificial Intelligence, Assisted Living, and Big Data. These keywords reflect constantly evolving trends and research areas.

Finally, the classification of keywords based on their function reveals a research agenda focused on exploring key concepts for future studies in a context of increasing relevance. These findings provide a comprehensive overview of the current state and future directions of research on the integration of smart home technology.

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