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Artificial Intelligence and the Internet of Things in Recreation: A Systematic Literature Review*

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Abstract

This study aimed to examine the literature on the use of artificial intelligence and the Internet of Things in the field of recreation and leisure and present the results within themes identified inductively from the data. We employed a systematic review methodology, consisting of determining appropriate selection criteria, choosing data sources, extracting data, categorizing the results, and reporting. Using the Web of Science database, we identified a total of 69 articles published between 2017 and 2024. After filtering and screening for keywords, 23 full-text articles related to artificial intelligence and the Internet of Things in the field of recreation and leisure were included in the analysis. Relevant studies were evaluated according to year, journal, focus, country, type of technology, recreation area, and results obtained. Findings from the reviewed articles are discussed under six themes: safety, ecosystem, personalized recreation experience, wearable technology, health, and potential recreation and leisure areas. We observed that the most frequently investigated topic in the studies was recreational tourism, with a general focus on outdoor recreation. The studies often referred to nature conservation and planned and safe personal leisure time. In conclusion, we determined that artificial intelligence and Internet of Things technologies have various applications in the field of recreation, but relevant studies are limited.
Keywords: Internet of things, Recreation, Artificial intelligence

Rekreasyon Alanında Yapay Zeka ve Nesnelerin İnterneti: Sistematik Literatür İncelemesi

Öz

Bu çalışmanın amacı rekreasyon ve serbest zaman alanında yapay zeka ve nesnelerin interneti kullanımı ile ilgili literatürün incelenmesi ve araştırmalardan elde edilen sonuçların oluşturulan temalara göre sınıflandırılmasıdır. Sistematik literatür taraması yönteminin kullanıldığı araştırma kapsamında amaca uygun seçim kriterlerinin belirlenmesi, veri kaynağının seçilmesi, veri çıkarma, sonuçların sınıflandırılması ve raporlama protokolü izlenmiştir. Rekreasyon ve serbest zaman alanında yapay zeka ve nesnelerin interneti kavramlarını konu alan 2017-2024 yılları arasında Web of Science (WOS) veri tabanında yer alan 69 makaleye ulaşılmış filtreleme işlemlerinin ardından anahtar kelimeler ışığında 23 tam metinli makale sistematik incelemeye tabi tutulmuştur. İlgili çalışmalar yıl, dergi, odak noktası, ülke, teknoloji türü, rekreasyon alanı ve elde edilen sonuçlara göre sınıflandırılmıştır. İlgili makalelerden elde edilen bulgular güvenlik, ekosistem, kişiselleştirilmiş rekreasyon deneyimi, giyilebilir teknoloji, sağlık, potansiyel rekreasyon ve serbest zaman alanları olmak üzere altı tema altında ele alınmıştır. Çalışmalarda en çok araştırılan rekreasyon alanları rekreasyonel turizm alanları olurken, genel olarak bakıldığında ise açık alan rekreasyon konusu üzerinde yoğunlaşıldığı görülmüştür. Çalışmalarda genellikle doğa koruma ile planlı ve güvenli kişisel serbest zamana atıfta bulunulduğu belirlenmiştir. Sonuç olarak rekreasyon alanında yapay zeka ve nesnelerin interneti teknolojilerinin farklı konseptlerde kullanıldığı belirlenmiş ve yapılan çalışma sayısının sınırlı olduğu tespit edilmiştir.
Anahtar kelimeler: Nesnelerin interneti, Rekreasyon, Yapay zeka

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INTRODUCTION

The digital age has transformed many areas of life. These transformations include the growing importance of innovative technologies such as artificial intelligence (AI) and the Internet of Things (IoT). AI and IoT have critical and complementary roles in the technology world (Zhu & Liu, 2022). Both technologies are related to big data usage and continuous communication. IoT devices collect data through various sensors and these data are analyzed by AI algorithms and converted into meaningful information. However, while AI focuses more on intelligence and learning, IoT focuses on device connectivity and data exchange (Sun et al., 2020).

The concept of IoT was first introduced by Kevin Ashton in 1999 in a presentation about how the benefits of inter-device communication based on radio frequency identification (RFID) technology could be reflected in business. According to Ashton, the IoT has an even greater potential to change the world than the internet (Hajjaji et al., 2021). The IoT is a technological concept in which physical devices exchange data by connecting and/or the internet (Borgia, 2014). This communication among various devices (e.g., smartphones, wearable technologies, household appliances, industrial machines, vehicles) enable users or systems to transfer data between devices, remotely control devices, analyze data, and perform various automated operations (Atzori et al., 2010). Common applications of IoT include smart home systems, industrial automation, health monitoring equipment, agricultural technology, transportation, and logistics (Farrokhi et al., 2021).

AI is generally defined as processes that require human intelligence and use computers and algorithms to perform tasks such as learning, reasoning, and problem solving (Bozkurt et al., 2021). AI is a rapidly developing field that has shown major advances in recent years. The concept of using computers to simulate intelligent behavior and critical thinking was first proposed by Alan Turing in 1950 (Ramesh et al., 2004). In his seminal 1950 paper “Computing Machinery and Intelligence”, Turing described a test known as the “Turing test”, which is used to determine whether a computer complies with the human definition of intelligence (Greenhill & Edmunds, 2020). Six years later, it is stated that John McCarthy defined the concept of AI as "the science and engineering of making intelligent machines" (Malik et al., 2019). AI began as a simple set of *if-then* rules and has evolved over the years to include more complex algorithms that perform similarly to the human brain. The term is now used to describe systems that can accurately interpret data, learn to make decisions and achieve certain objectives (Visvikis et al., 2019).

Today, AI and IoT play an important role in many areas. These technologies save people time and effort by automating various business and production processes, as well as reducing errors and contributing to more accurate results in decision-making processes. AI is used effectively in many areas, such as health, transportation, security, education, communication, agriculture, and industry (Altıntop, 2023).

It can be seen from the literature that these rapidly adopted new technologies are also being studied in the field of recreation. This research is especially concentrated in the international literature. Therefore, we believe that identifying in which areas IoT and AI use is most prevalent

will contribute to the field. Our aim in this study was to examine the literature on the use of AI and the IoT in the field of recreation and leisure and to classify the results obtained according to the themes generated from the data. To achieve this, articles on AI and the IoT in the field of recreation and leisure in the Web of Science database were examined through a systematic literature review.

METHODS

Systematic literature reviews aim to identify literature gaps by reviewing the relevant literature and determining the breadth and depth of existing studies (Xiao & Watson, 2019). This process comprises the steps of identifying, evaluating, and interpreting published studies related to a specific research question, topic, or phenomenon. Summarizing the literature data on the subject or phenomenon under investigation draws attention to the importance of previous studies (Kitchenham, 2004). In addition, systematic reviews contain more scientific information than traditional reviews and are recognized as a rigorous evidence-based method for several reasons: 1) they contain less bias and personal opinion, 2) they are more comprehensive because they follow systematic methodology, 3) they clearly specify the methods and selection criteria used for literature review, 4) the quality of the included studies is often evaluated, and 5) other investigators can repeat the systematic literature review and verify the results (Hemingway & Brereton, 2009).

In this study, the research questions, data sources, research strategy, selection criteria, data extraction, reporting protocol, and study limitations were taken into account during the systematic review process.

Research Questions

A systematic review was conducted to evaluate the relevant literature in four respects (years, journals, research foci, and themes). The basic research questions related to these four headings are shown in Table 1.

Table 1. Research questions

1.	In which years have research on AI and/or IoT intensified in the field of recreation and leisure?
2.	In which journals have studies on AI and/or IoT in the field of recreation and leisure been published?
3.	What was the focal point of studies on AI and/or IoT in the field of recreation and leisure?
4.	Which countries were focused on in studies on AI and/or IoT in the field of recreation and leisure?
5.	What type of technology was used in studies on AI and/or IoT in the field of recreation and leisure?
6.	In which recreation area(s) were studies conducted on AI and/or IoT in the field of recreation and leisure?
7.	Under what themes can the studies on AI and/or IoT in the field of recreation and leisure be examined?

Data Source

The international electronic Web of Science database was searched for articles on AI and the IoT in the field of recreation. The extensive coverage of English-language publications, the availability of unlimited access for authors, and the capability for comprehensive searches were significant criteria in the selection of this database. The date range for scanned articles was limited to between 2017 and 2024. The main factor determining this time period is that the first study was published in 2017.

Search Strategy

In addition to using the database filtering features, we searched for the relevant keywords in the titles and abstracts. The keywords used were [("internet of things") OR ("artificial intelligence") AND ("recreation") OR ("leisure")]. “Serious leisure” was also initially included in the search keywords but was not included in the concept search because no relevant studies were found.

Selection Criteria

Inclusion and exclusion criteria were defined for the selection of scientific articles to include in the systematic review (Table 2).

Table 2. Inclusion and exclusion criteria

Inclusion	Exclusion
• Published in international peer-reviewed journals • Full-text articles • Articles in English • Articles with relevant title and content	• Reports, theses, book or book chapters, news • Articles for which the full text was not accessible • Articles in languages other than English • Articles with irrelevant title and content • Repeated records

After applying the appropriate Web of Science database filters, 69 articles were obtained using search keywords. We excluded 44 articles that did not focus on AI or the IoT in recreation, 1 article for which the full text was not accessible, and 1 article that had been retracted. Therefore, the systematic review included 23 full-text articles published in international peer-reviewed journals which were relevant to the scope of this study.

Data Extraction

All articles selected for this review were classified according to the criteria of publication year, publishing journal, focal point, country, type of technology, and recreational area.

Reporting

Although in the social sciences there is no widely accepted standard protocol for reporting the data obtained by systematic literature review, many investigators utilize the 2009 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) criteria, which have been adopted in recent years as the gold standard in the health sciences. This guideline was developed according to the reporting criteria accepted by different researchers applying these research methods. The PRISMA reporting guidelines are designed to facilitate the presentation of systematic review and meta-analysis studies and enable researchers to critically evaluate previous systematic reviews and meta-analyses (Moher et al., 2010). The PRISMA diagram for the present study is shown in Figure 1.

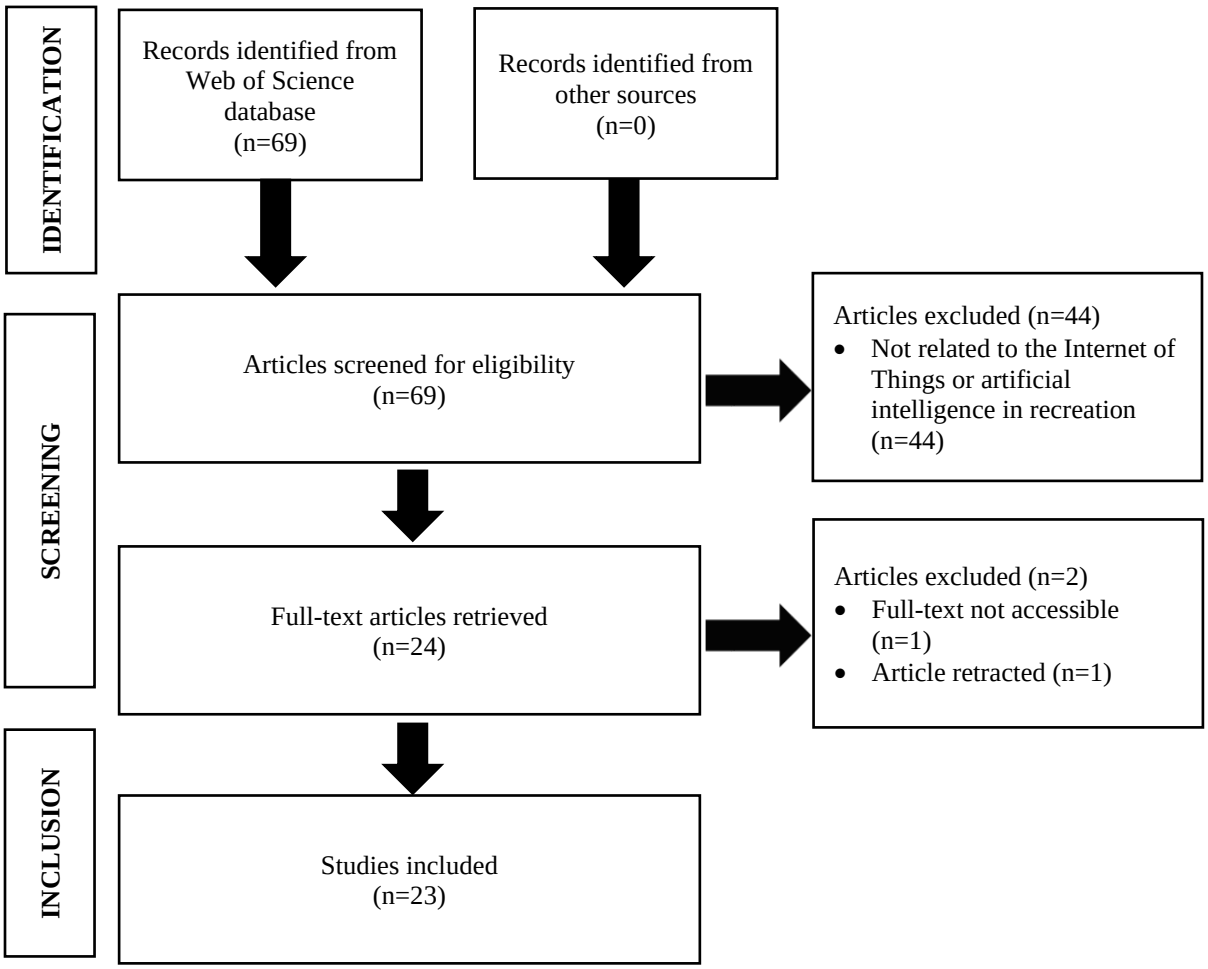

Figure 1. PRISMA diagram

Limitations

A systematic review has inherent limitations, especially the inclusion and exclusion criteria determined by the researchers. Limitations of the present study include our decision to focus on articles published in peer-reviewed journals included in the Web of Science database between 2017 and 2024 and exclude articles that were not published in English, did not have full text available, and whose title and content were outside the scope of the study.

Results

Our data source for this systematic review was the Web of Science database. The articles selected for analysis are summarized in Table 3.

Table 3. Summary of the studies included in the systematic review

Author (Year)	Journal	Focal Point	Country	IoT/AI	Recreation Area
Abang-Abdurahman et al., (2022)	Sustainability	Visitor classification	Malaysia	AI	Tourism
Baalbaki et al., (2022)	EURASIP Journal on Wireless Communications and Networking	Energy conservation	Lebanon	IoT	Water-based recreation
Binesh & Baloglu (2023)	Computers in Human Behavior	Service robots	USA	AI	Tourism
Cao (2023)	IEEE Access	Ecological safety	China	IoT	Tourism
Capriolo et al., (2020)	Ecosystem Services	Ecosystem	Spain	AI	Outdoor recreation
Cepeda-Pacheco & Domingo (2022)	Neural Computing & Applications	Tourist attraction recommendation	Spain	IoT	Tourism
Coman et al., (2023)	IEEE Access	Safety	Romania	IoT	Forest recreation
Ding et al., (2023)	Journal of Heritage Tourism	Time-space analysis	China	AI	Tourism
Eskerod et al., (2019)	Sustainability	Sustainability	Austria	IoT	Tourism
Feng et al., (2022)	Mobile Information System	Smart forest tourism	China	IoT	Tourism
Fennell et al., (2022)	Global Ecology and Conservation	Ecological efficiency	Canada	AI	Outdoor recreation
Hämäläinen et al., (2020)	IEEE Access	Ban standardization	Finland	IoT	Leisure
Ko & Choi (2017)	International Journal of Grid and Distributed Computing	Forest navigation	North Korea	IoT	Forest recreation
Leonidis et al., (2019)	Sensors	Smart home	Greece	AI	Leisure
Lin & Chen (2022)	Digital Health	Nature destinations	Taiwan	AI	Nature recreation
Lin et al., (2019)	IEEE Access	Assistance and safety provision	Taiwan	IoT	Forest recreation
Marin et al., (2017)	Sensors	Wearable devices	Spain	IoT	Health recreation
Miller et al., (2023)	PEERJ	Health	Australia	AI	Outdoor recreation
Riboni (2019)	CCF Transactions on Pervasive Computing and Interaction	Daily life	Italy	AI	Leisure
Sabbioni et al., (2022)	Sensors	Smart tourism	Italy	IoT	Tourism
Sun (2020)	Symmetry-Basel	Image perception of winter tourism	China	AI	Tourism
Winder et al., (2022)	People and Nature	Cultural ecosystem	USA	AI	Activity recreation
Zhou & Wu (2023)	IEEE Access	Sports and leisure-themed cities	China	AI	Urban recreation

Publication year and journal types

Figure 2 shows the distribution of articles by year of publication. The first relevant journal article was published in 2017. There were no publications in 2018, 2021, or 2024 (as of the date of this review), while most records were published in 2022 (8 articles). This demonstrates considerable fluctuation in the number of articles published per year.

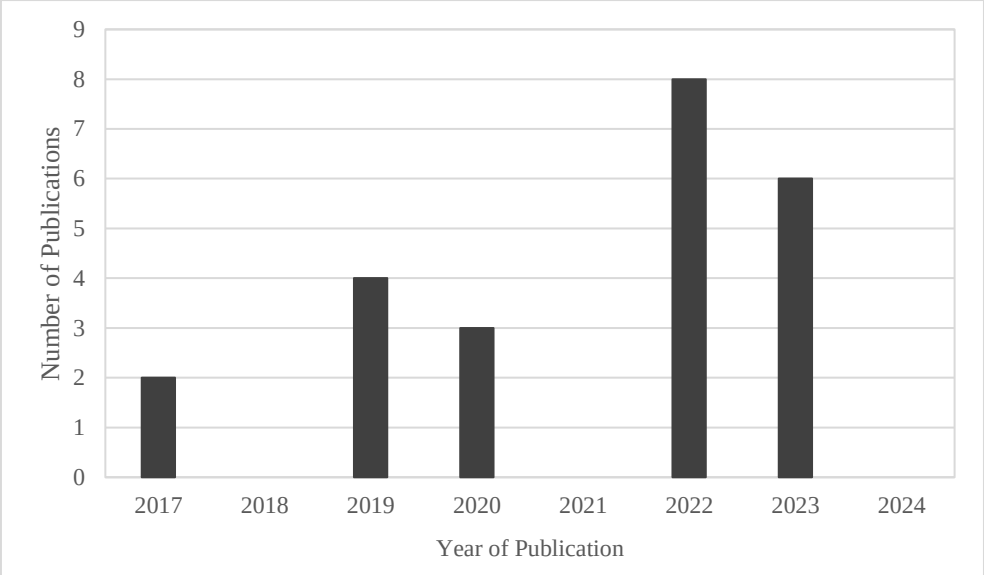

Figure 2. Distribution of articles by year

When the articles on AI and/or IoT in the field of recreation were examined in terms of publishing journals, we noted that the highest number of articles were in the journals *IEEE Access* (5 articles), *Sensors* (3 articles), and *Sustainability* (2 articles). The articles included in the review were published in a total of 17 different journals (Figure 3). However, it is noteworthy that none of these journals' main scope is recreation.

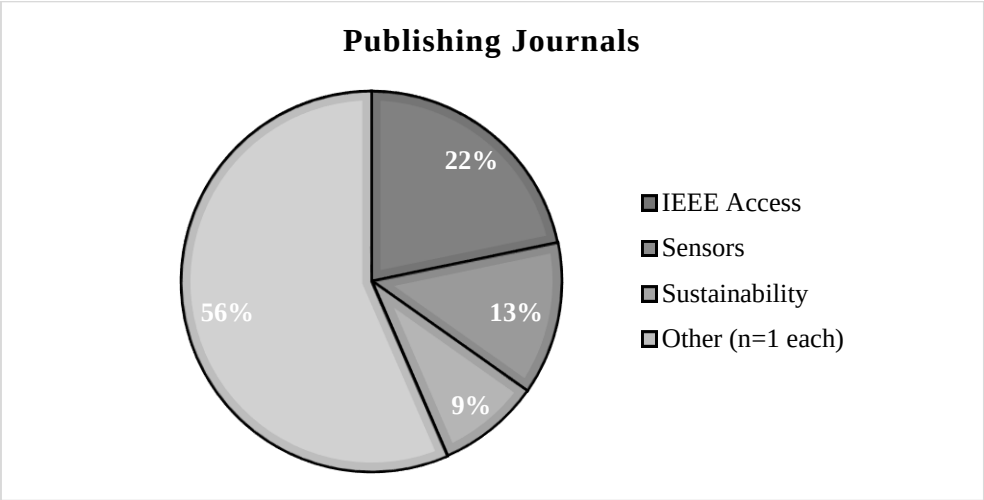

Figure 3. Journals in which the articles were published

Focal points of the articles

The articles on AI and IoT in the field of recreation focused on various points. As seen in Table 3, these focal points included visitor classification, energy conservation, robot use, ecological safety, ecosystem services, tourist attractions, model recommendation, time-space analysis, sustainability, distribution of tourism resources, smart forest tourism, ecological efficiency, body area network (BAN) standardization, forest navigation, smart home, nature destinations, safety and assistance provision, wearable devices, health, daily life, smart tourism, winter tourism, ecosystem culture, and sports- and leisure-characteristic towns.

Focal countries of the articles

Studies on AI and the IoT in the field of recreation mostly focused on China (5 articles) and Spain (3 articles). The United States, Taiwan, and Italy each had 2 articles, while Romania,

Austria, Canada, Finland, North Korea, Lebanon, Malaysia, and Greece had 1 article each (Figure 4).

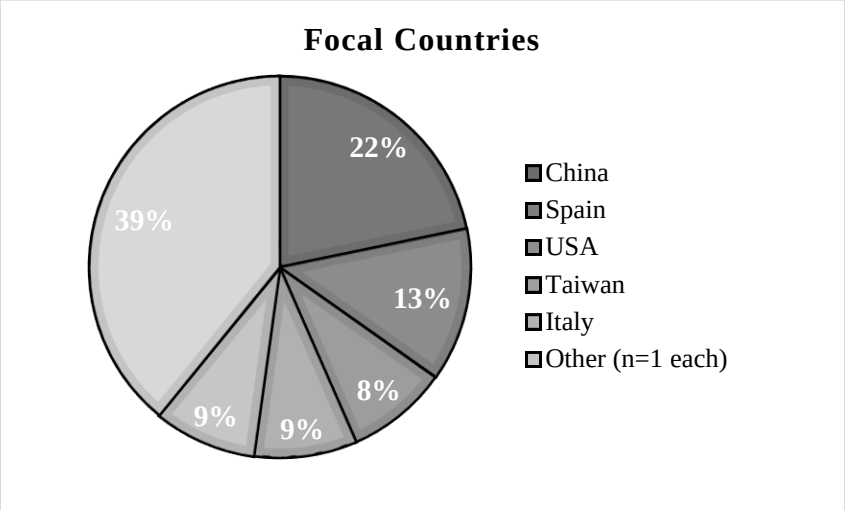

Figure 4. Countries of focus

Technology Type

Articles on AI and the IoT in the field of recreation were fairly evenly divided between those about artificial intelligence (12 articles) and those focused on the IoT (11 articles).

Themes related to the research findings

Studies on AI and the IoT in the field of recreation and leisure addressed six different themes: safety, ecosystem, personalized recreation experience, wearable technology, health, and potential recreation and leisure areas. We also observed that some articles encompassed more than one theme.

Safety

Under the theme of safety, IoT technology and advanced navigation systems play an important role in emergency assistance for visitors lost in recreational forests. A navigation system proposed by Ko and Choi (2017) verifies visitors' location through smartphones and beacons running on Bluetooth 4.0. The system aims to guide users to their targets quickly and easily with a route search algorithm based on direction information used in recreational forests. It was noted that this algorithm is more effective than traditional depth- and breadth-first search (DFS/BFS) methods, which provides a critical advantage in emergency situations, especially. A study by Lin et al., (2019) describes a system framework for deploying IoT technology in a recreational forest park. In their system, data is collected from visitors through wearable devices and used for physiological detection and positioning, which can facilitate the provision of emergency assistance to sick or lost visitors. Fennell et al., (2022) showed that the use of object detection models such as MegaDetector in the analysis of data obtained from camera traps helped to detect humans and animals with high sensitivity, thereby increasing forest safety. The authors suggested this technology could also significantly increase processing speed to improve efficiency in complex ecological studies. Furthermore, the expert system presented by Coman et al., (2023) utilized light detection and ranging (LiDAR) sensors to ensure the effective analysis of data obtained from the forest environment and improve conservation efforts.

Ecosystem

Ecosystem-oriented approaches using various technologies play an important role in the management of recreational areas. Winder et al., (2022) proposed a convolutional neural network model that combines social media analysis and AI technologies to enable the effective identification of recreational activities. They stated that this model has potential applications in environmental management and may contribute to the sustainable use of natural resources. Capriolo et al., (2020) recommended the evaluation of four ecosystem services (agricultural pollination, outdoor recreation, flood regulation, and water provision) in Italy with the use of the Artificial Intelligence for Ecosystem Services (ARIES) technology. This provides a systematic approach that utilizes extent, supply, and use accounting tables to facilitate the management of ecosystem services at the national level, thereby aiming to increase the sustainability of ecosystems and improve environmental performance. Baalbaki et al., (2022) proposed a data collection mechanism called LOGO for remote monitoring of water bodies used for recreational purposes against factors such as climate change using IoT technology. This approach is critical for the effective management and protection of water resources, and the authors noted that such systems supported by remote sensing technologies can help protect the health of ecosystems. Cao (2023) highlighted the importance of the use of technologies such as IoT and deep learning to assess the ecological safety of ice and snow tourism destinations. Using these technologies as remote sensing and data analysis tools has a critical role in protecting natural environments and ensuring the sustainability of touristic destinations.

Personalized Recreation Experience

Within the theme of personalized recreation experience, it can be said that the integration of common technologies and AI tools has led to substantial enrichment. The hybrid AI model proposed by Riboni (2019) highlights how mainstream information technologies can change human life and reveals the need for these technologies to be able to personalize services and interfaces by taking into account the user context. Cepeda-Pacheco and Domingo (2022) enabled the personalization of tourist activities through an IoT-supported deep learning-based recommendation system for tourists. The system analyzes users' travel profiles and preferences and suggests optimal attractions and activities based on real-time data. Sabbioni et al. (2022), on the other hand, proposed the holistic integration of tourism services with IoT technologies and the provision of personalized services for tourists by introducing an innovative architecture called APERTO5.0. This approach aims to increase customer satisfaction while promoting digital transformation in the tourism industry. The smart living room concept proposed by Leonidis et al., (2019) supports the leisure activities of home residents by using Ambient Intelligence and IoT devices, allowing users to personalize their living room experiences.

Wearable Technology

Studies on how wearable technologies can be used in the field of recreation and tourism provide important information. As mentioned above, Lin et al., (2019) described a system for forest recreation that uses IoT technology and wearable devices to collect data from visitors, which can then be used to detect visitors' location and physiological state. In another study, Marin et al., (2017) developed a design methodology called Octopus to increase the integration and utility of the human motion capture (MoCap) technology in wearable devices. Octopus aims to identify design requirements, create a common framework, and facilitate communication between multidisciplinary teams.

Health

The studies related to this theme provide different perspectives on how technology can be used in the field of health. Hämäläinen et al., (2020) aimed to create a standard framework to facilitate the widespread use of wireless BAN technology in health, medicine, sports, leisure, and IoT markets. Their goal with the SmartBAN system is to form the basis of future smart health coordination systems by providing solutions in areas such as data transmission, security, and semantic interaction compatibility. Miller et al., (2023) reported the performance of commercial AI-supported software to evaluate the skin cancer and melanoma risks of individuals participating in outdoor leisure activities. Their study shows how technology can be used in dermatological health assessments, playing an important role as a potential tool for the monitoring and early detection of individuals' health conditions. From another angle, Binesh & Baloglu (2023) examined the use of service robots as a contactless solution in hotel tourism during the COVID-19 pandemic, evaluating how the pandemic accelerated technology-driven changes in the sector and the effects of these technologies on guest satisfaction and operational efficiency. Their findings reveal demographic factors that determine guests' attitudes towards this technology but highlight the potential of robots to offer contactless solutions in the service industry.

Potential Recreation Areas

The studies examined under this theme demonstrate how advanced technologies such as AI, robotics, video analysis, and machine learning can be used in potential recreation areas and especially in the tourism sector. Sun (2020) analyzed online travel journals and reviews about ice-snow tourism using AI technologies, examining the frequency, classification, word cloud, and concordance of frequently used words. The author analyzed the public image of ice-snow tourism in the Jilin province under five main categories and identified elements such as tourism attractions, events, facilities, features, and service environment. This analysis presented a comprehensive approach to determine the perceived image of ice-snow tourism and provided examples of how data analysis with AI can be used in the tourism sector. Zhou & Wu (2023) investigated how AI and robot technologies can be used in the intelligent construction of sports- and leisure-characteristic towns. By developing a MobilNetV2-based image recognition system, they integrated tasks such as face recognition and automatic license plate recognition. The study proposed hardware acceleration schemes to improve the performance of the image recognition system, showing how AI-powered solutions can be optimized in sports fields. Ding et al., (2023) analyzed tourist density at world heritage sites using video-based computer vision technology to address the problems of overcrowding caused by tourism. In the case of the Master-of-Nets Garden, they examined the spatial-temporal distribution of tourists and emphasized the effects of local crowding on sustainable development. In another study, Abang-Abdurahman et al., (2022) used machine learning techniques to identify the personal preferences of domestic and foreign tourists according to the distance to recreation areas. They predicted park classification using visitor data and showed how the potential of machine learning in tourism planning could be evaluated.

DISCUSSION

Our aim in this systematic review was to examine the literature on the use of AI and IoT technologies in the field of recreation and leisure and to classify the results obtained from the analyzed studies according to inductively identified themes.

The articles examined in this review address various applications of advanced technology involving the IoT and AI in recreation areas. Studies under the theme of safety demonstrate how IoT and advanced navigation systems play a critical role in emergency responses for visitors lost in recreational environments (Ko & Choi, 2017; Lin et al., 2019). This research shows how IoT technologies and advanced object detection systems can be integrated to increase safety in recreational forests.

Under the ecosystem theme, there is a strong focus on the contribution of AI integration and social media analysis to sustainable environmental management (Capriolo et al., 2020; Winder et al., 2022). These studies highlight how technology can be used in the management and conservation of various ecosystems.

The theme of personalized recreation experience focuses on AI models and deep learning systems that increase the capacity to provide customized services based on user preferences (Riboni, 2019; Sabbioni et al., 2022). The potential of wearable technologies in recreation and tourism is emphasized through functions such as monitoring the physiological status of visitors and determining their location (Lin et al., 2019; Marin et al., 2017). These studies show how the use of these technologies can contribute both to improving the user experience and increasing operational efficiency. The study by Lin et al., (2019) emphasized key functions of IoT such as location detection and safety, whereas Marin et al., (2017) described how wearable technologies can optimize the design process.

The health theme emphasizes how wireless BAN technologies can be used in the fields of health services and sport (Hämäläinen et al., 2020; Miller et al., 2023). Studies conducted in this context demonstrate potential applications of these technologies in the health sector and highlight the steps to be taken for their dissemination. Both wireless communication technologies and AI-powered health applications can increase the accessibility of health services and provide more effective health management.

Under the theme of potential recreation areas, studies focused on how AI and robot technologies can be integrated into the tourism sector and contribute to the sustainability of touristic destinations (Sun, 2020; Zhou & Wu, 2023). This research can enhance the sustainability of touristic spaces by showing how video analysis technologies can be used for tourism management. The articles related to this theme also reveal how technology can contribute to different areas such as tourism management, sustainable tourism development, and improving tourist experiences.

In summary, the articles examined in this review show that IoT and AI technologies can play important roles in the field of recreation and leisure. The research being conducted in this area offers various technological solutions and innovations in myriad applications ranging from safety measures to personalized services and environmental sustainability to health management.

Recommendations

The use of IoT and AI in the field of recreation is growing in importance. Directions for future research include further diversifying studies related to technology use in recreation and more comprehensively evaluating the effects of IoT and AI-based solutions in areas such as different types of tourism, natural area management, and sports activities. Additionally, systematic reviews utilizing different databases will contribute to the knowledge on this topic. Finally, future studies should also encompass new technological approaches and explore how technologies such as augmented reality, virtual reality, and advanced wearable devices can be integrated into recreational experiences. These recommendations may make significant contributions to the advancement and effective use of technology in the field of recreation.

Conflict of Interest: There is no financial or personal conflict of interest among the authors of the article within the scope of the study.

Authors' Contribution: Study Design-SP, SKA, Data Collection- SP, SKA, Analysis- SP, SKA, Manuscript Preparation- SP, SKA.

Ethical Approval: Not applicable, because this article does not contain any studies with human or animal subjects.

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