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Article

Artificial Intelligence of Things Applied to Assistive Technology: A Systematic Literature Review

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Abstract: According to the World Health Organization, about 15% of the world's population has some form of disability. Assistive Technology, in this context, contributes directly to the overcoming of difficulties encountered by people with disabilities in their daily lives, allowing them to receive education and become part of the labor market and society in a worthy manner. Assistive Technology has made great advances in its integration with Artificial Intelligence of Things (AIoT) devices. AIoT processes and analyzes the large amount of data generated by IoT devices and applies Artificial Intelligence models, specifically Machine Learning, to discover patterns for generating insights and assisting in decision making. Based on a systematic literature review, this article aims at identifying the Machine Learning models used in multiple different research about Artificial Intelligence of Things applied to Assistive Technology. The survey of the topics approached in this article also highlights the context of such research, their application, IoT devices used, and gaps and opportunities for further development. Survey results show that 50% of the analyzed research address visual impairment, and for this reason, most of the topics cover issues related to computational vision. Portable devices, wearables, and smartphones constituted the majority of IoT devices. Deep Neural Networks represent 81% of the Machine Learning models applied in the reviewed research.

Keywords: AIoT; Artificial Intelligence; Assistive Technology; Deep Learning; Machine Learning

1. Introduction

According to the World Health Organization, about 15% of the world population has some type of disability, totaling approximately 190 million people. This number continues to grow due to the increase in chronic health conditions and the aging of the world population. Taking into consideration that disabilities may be of temporary or permanent nature, they may encompass a wide range of special needs, restrictions, and health conditions. These disabilities could be represented by degenerative diseases such as Parkinson's, Amyotrophic Lateral Sclerosis (ALS), and Alzheimer's; physical, mental, visual, and hearing disabilities; chronic non-communicable diseases. Also, conditions resulting from aging, a period marked by the highest rates of development of some disabilities [1].

According to the United Nations Convention on the Rights of Persons with Disabilities (CRPD) disability is not an attribute of the person, but the result of environmental and behavioral barriers, arising from the interaction between people with disabilities and society, preventing them from participating equally, fully, and effectively as citizens in society. Therefore, dealing with the obstacles that affect people with disabilities contributes to the improvement of their social participation in general. Within this context, Assistive

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Technology (AT) contribute directly to the reduction of difficulties encountered by people with disabilities in their daily lives. Assistive Technology allows them to live independently, healthy, and productively, to receive education, and be participants in the labor market and society in a worthy manner [2].

Assistive Technology encompasses services, products, methodologies, strategies, and practices that aim to minimize and/or eliminate restrictions and limitations imposed on a person due to a disability or incapacity [3]. It focuses on providing independence, quality of life, and social inclusion to people with disabilities. Some examples of Assistive Technology are hearing aids, memory aids, eyeglasses, wheelchairs, hearing aids, pill organizers, and communication aids. Assistive Technology has made great advances in its integration with AIoT devices (Artificial Intelligence of Things) and Machine Learning [4–6]. AIoT processes and analyzes the large amount of data generated by IoT devices and applies Artificial Intelligence techniques, specifically Machine Learning, to discover patterns for generating insights and assisting in decision making [7].

When applied to AT, AIoT allows the conception of an array of disruptive solutions to address the disability issue. Some examples of such solutions are navigation systems for blind people, voice assistants for people with disabilities [8], remote monitoring of health conditions [9], telemedicine and telehealth [10], communication systems based on sign language [11], auxiliary memory for people with cognitive disabilities and a series of smart objects such as medicine dispensers, wheelchair [12], exoskeleton [13], etc. These are numerous applications of great value for those in need, quoting Mary Pat Radabaugh (former director of IBM's National Support Center for People with Disabilities in 1988) "For people without disabilities, technology makes life easier. For people with disabilities, technology makes life possible" [14].

Given the importance of the development of Artificial Intelligence of Things applied to Assistive Technology, this systematic literature review aims at identifying the Machine Learning models used in different research on this topic. The survey of the topics approached in this article also highlights the context of such research, their application, IoT devices used, and gaps and opportunities for further development.

This article is organized as follows. Section 2 presents the concepts related to the research. Section 3 presents the research methodology used, which includes: the research's objective and questions, the steps of the systematic literature review, and threats to the validity of the results. Section 4 presents the research results of this review. Section 5 presents the conclusion based on the study results and recommendations for future studies.

2. Assisted Technology, AIoT and Machine Learning

Aiming at minimizing and/or eliminating restrictions and limitations imposed on a person due to a disability or incapacity, The World Health Organization defines Assistive Technology as a wider term encompassing any system or service related to assistive products and services. The Assistive Technology Industry Association defines Assistive Technology's products and services, as any item, piece of equipment, hardware, or software, intended to assist people with some type of disability. Such products and services are a result of the combination of TA and AIoT (Artificial Intelligence of Things) [11].

Artificial Intelligence of Things is obtained by the combination of IoT (Internet of Things) [15] and Artificial Intelligence (AI) techniques [16]. IoT is defined as any device able to interconnect, such as sensors, and can collect relevant data in real time [17]. This relevance is revealed by processing the obtained data through Artificial Intelligence models, especially making use of Machine Learning (ML). Some cases also require the usage of Deep Learning (DL) to analyze the collected data to extract useful information for decision-making [18–20]. The application of ML techniques shows promise for the healthcare sector [21], improving efficiency in this segment [22].

The term AI was coined by John McCarthy [23], considered the father of AI, in 1956 during the first AI conference at Dartmouth College. McCarthy defines AI: It is the science and engineering of making intelligent machines, especially intelligent computer programs.

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It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable [24]. Several areas have been expanding faster recently and need dynamic solutions that can be solved with AI [25], such as sustainability [26], health [27] telecommunication systems [28?], data privacy [29,30], electric vehicles [31], and electrical power systems [32–34].

Alan Turing, however, proposed in 1950 the question "Can machines think?" The Turing test was then launched with the aim of determining whether a computer can demonstrate the same intelligence as a human being [35]. To pass this test the system would need to possess capabilities that are currently the subject of study in Machine Learning, such as Natural Language Processing [36], Knowledge Representation [37], and Automated Reasoning [38]. Given the advances in AI models, several applications are being used to improve the quality of life of people with physical disabilities, and applications for smart healthcare [39], such as using smart robots [40–42], or more specific applications such as in sign language [43–48].

Machine Learning is a subfield of AI that aims at developing models and computer programs able to learn automatically by extracting knowledge from data [49]. These programs must be able to improve and extend themselves from experience, without being explicitly programmed. In the IoT context, these models are used to process and analyze a large amount of data collected by devices, to automatically discover patterns and generate meaningful insights from this data. Such a task would be impossible for humans to perform manually. Some of these ML models are Echo state networks [50], ensemble learning methods [51–53], k-nearest neighbors (K-NN) [54], group method of data handling (GMDH) [55], long short-term memory (LSTM) [56], convolutional neural networks (CNNs) [57–60], and adaptive neuro-fuzzy inference system (ANFIS) [61].

Deep Learning is a subfield of Machine Learning. Deep Learning specifically studies Deep Neural Networks. Like ML, Deep Learning also uses data-based learning methods, however, computation and processing are done using multilayer neural networks [62]. The basic difference between a non-deep, also known as a Shallow Neural Network, and a Deep Neural Network is the number of layers. Shallow neural networks have three layers and deep ones have more than three layers, including the input layer and the output layer [63]. These models can be applied in prediction [64–66], classification [67–69], and optimization [70–72] problems.

3. Research Methodology

A Systematic Literature Review (SLR) was performed to achieve the objectives of the current study. SLR is a methodological review of research results that aims to aggregate existing evidence on a research problem, as well as identify, select, evaluate, and summarize primary articles considered relevant on the research topic in an unbiased and repeatable way. RSL is considered a secondary study for aggregating previous studies [73].

Banijamali et al. [74] implements these research steps: planning, this step includes the activities of identifying the research objective, defining the research questions, developing a review protocol and evaluating the review protocol, these activities can be done interactively; conducting, this step includes the activities of Identifying primary articles using search strategies, selecting studies using inclusion and exclusion selection criteria for studies, extracting data and synthesizing the data; publication, this step includes the activities of specifying the report, formatting the report and evaluating the report.

3.1. Research Purpose

The objective of this literature review is to identify the models of ML used in research of AI of Things Based Assistive Technology. Also, it aims at identifying the context of these models' applications through the survey of the topics of study, the IoT devices used, and identifying development gaps and opportunities. Due to the great magnitude of conditions characterized as disabilities, the scope of the study was defined for research that addresses the following disabilities: visual impairment, hearing impairment, cognitive impairment, and degenerative diseases such as ALS, Alzheimer's, and Parkinson's. Table 1 presents the research questions of this study.

Table 1. Research Questions.

ID	Question	Justification
QP1	What are the Machine Learning models used in AIoT applied to Assistive Technology?	Identification of ML models used in AIoT applied to AT.
QP2	What are the topics of study that have been researched in the context of AIoT applied to Assistive Technology?	Providing context related to research topics.
QP3	What are the IoT devices used in the context of AIoT applied to Assistive Technology?	Providing context related to the types of IoT devices used.
QP4	Is there a disparity in the number of studies found according to the problems selected in the research?	Identify gaps for research and development of solutions.

QP1 intends to identify the Machine Learning models applied in the development of AIoT applied to Assistive Technology. All models mentioned in the selected primary articles were identified for this purpose.

QP2 intends to provide a context related to the topics addressed in the development of AIoT applied to Assistance Technology. The study topics addressed by the selected primary articles were identified for this purpose.

QP3 intends to provide context related to the types of IoT devices that have been used for the development of AIoT applied to Assistance Technology. All IoT devices listed by the proposed solutions were identified for this analysis. The devices were also classified as Arduino, RaspberryPY or Nvidia Jetson based.

QP4 identifies gaps for AIoT applied to Assistive Technology research and development indicating for which disability or incapacity the study intends to develop a solution.

3.2. Research Process

This section aims at detailing the research process used in this RSL. Database Search or automatic search strategy was used for this study. It consists of searching digital libraries using a Search String [75]. A search string consists of combining keywords using logical operators such as OR and AND. Usually, synonyms of each keyword are grouped by the OR operator, and an AND operation is used to join these groups.

The keywords defined for this study were: Assistive Technology, AIoT, and Machine Learning. Interactive tests were carried out on each of the bases to identify the search strings, whose returns were the most significant in terms of scope and relevance of the studies. The selected libraries are justified for being among the most used in research in Computer Science [75]. Table 2 presents the bases used and the respective search strings defined after the iterative validation process.

The automatic database search was performed on 09/14/2021. Each database returned a set of articles as shown in Table 3. These articles were processed to remove duplicated entries, this task was performed automatically by the tool Parsifal. Initially, a total of two hundred and sixty-seven articles were selected, of which seventy-nine were duplicates, leaving one hundred and eighty-eight articles. The set of articles resulting from the research stage passed to the next stage of the RSL and Study Selection.

3.3. Study Selection Criteria

This section aims to present the selection and exclusion criteria used in this RSL. The presented criteria are preconditions for the acceptance or exclusion of an article in the RSL. This selection seeks to identify relevant studies that can answer the proposed

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Table 2. Database and Search Strings.

Data Base	ID	Search String	Url
El Compendex	EIC	("assistive technology" OR "impaired people") AND (AIoT OR IoT OR "internet of things") AND ("machine learning" OR "deep learning" OR "neural networks")	http://www.engineeringvillage.com
IEEE Digital Library	IEEE	("assistive technology" OR impaired OR parkinson OR alzheimer) AND (IoT OR AIoT OR "Internet of Things" OR "artificial intelligence or things") AND ("machine learning" OR "deep learning" OR "neural network")	http://ieeexplore.ieee.org
ISI Web of Science	WOS	("assistive technology" OR impaired OR parkinson OR alzheimer) AND (iot OR aiot OR "Internet of Things" OR "artificial intelligence or things") AND ("machine learning" OR "deep learning" OR "neural network")	http://www.isiknowledge.com
Science@Direct	SCD	("assistive technology") AND (IoT OR "internet of things") AND ("machine learning" OR "deep learning" OR "neural networks")	http://www.sciencedirect.com
Scopus	SCPS	("assistive technology" OR impaired OR parkinson OR alzheimer) AND (iot OR aiot OR "Internet of Things" OR "artificial intelligence or things") AND ("machine learning" OR "deep learning" OR "neural network")	http://www.scopus.com

Table 3. Number of selected articles from each database.

Database	Number of selected articles
El Compendex	37
IEEE Digital Library	63
ISI Web of Science	32
Science@Direct	67
Scopus	68
Number of Articles	267
Number of duplicated articles	79
Number of selected articles	188

research questions [73]. The criteria are applied to the set of articles resulting from the search process. Some of the criteria were applied directly to the databases, according to the available filters, with variations for each of the bases. Table 4 presents the inclusion criteria, and the indication of those applied directly to the bases. Table 5 lists the exclusion criteria.

It is worth mentioning that it is enough that one of the exclusion criteria is met for an article to be excluded. On the other hand, for an article to be selected it is necessary that all

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Table 4. Inclusion Criteria.

ID	Criteria	Applied directly to the databases:
CI1	Studies published between 2017 and 2021	EIC, IEEE, WOS, SCD, SCPS
CI2	Peer-reviewed primary articles	EIC, WOS, SCD, SCPS
CI3	Studies within the context of AIoT applied to AT, within the scope of deficiencies established	-
CI4	Articles published in English	EIC, IEEE, WOS, SCPS

Table 5. Exclusion Criteria.

ID	Criteria	Applied directly to the databases:
CE1	Secondary or tertiary studies	-
CE2	Studies within the context of AIoT applied to AT	-
CE3	Short articles, books, and gray literature (manuals, reports, theses, and dissertations)	EIC, WOS, SCD, SCPS
CE4	Not having access to the study	-
CE5	Duplicated study	-
CE6	Redundant studies by the same author	-
CE7	Studies prior to 2017	EIC, IEEE, WOS, SCD, SCPS

the inclusion criteria are satisfied. Initially, the title and abstract of each article were read and taken into consideration when applying the selection criteria and, in cases where the reading was insufficient for this, the article was read until the selection or exclusion could be confirmed. At the end of this stage, a total of 30 articles remained, this set passed to the next stage of the process, the Quality Assessment.

3.4. Quality Assessment

This section presents the quality assessment process used in this RSL. The previous step resulted in a set of pre-selected articles. However, for these articles to be considered accepted by the RSL, it is necessary to go through the quality assessment process. At this stage, each study is evaluated to ensure the quality of the data that will be extracted in the subsequent data extraction stage [73], meaning that it intends to identify studies that are relevant to answer the research questions.

Table 6 shows a questionnaire containing five questions prepared for this RSL to assess the quality of the articles. Each question has three options as answers, each option has its respective score. Options are "yes", "partially" and "no" scoring respectively 1.0, 0.5, and 0. The total score for each article is defined by the sum of the values obtained from five answers. A maximum value of 5.0 indicates a well-matched article for this RSL and a minimum of 0.0 indicates the article is not suitable for this RSL. A cutoff score of 2.0 was defined so only articles with a score greater than 2.0 will be effectively considered accepted for the RSL. This quality assessment method was implemented and applied using Parsifal.

The primary articles were read in their entirety for the attribution of grades. Table 7 shows the result of the quality assessment. The input set of this stage contained 30 articles, of which 3 articles received a score less than or equal to 2.0. Thus, 27 articles passed to the

Table 6. Questionnaire for quality evaluation.

ID	Question
AQ1	Are the study objectives clearly defined?
AQ2	Is the problem to be solved clearly described?
AQ3	Do the authors describe in detail the use of the ML models used in the solution?
AQ4	Did the study perform a well-described experiment to evaluate the proposal?
AQ5	Do the findings of the study indicate a validity relevant to it?

next stage, Data Extraction. The selected studies were submitted to the next stage of the RLS, Data Extraction.

Table 7. Quality evaluation selected articles.

ID	Subject	Author	Score
A01	Assistive Technology	Júnior *et al.* [76]	4.0
A02	Medicines Recognition	Chang *et al.* [77]	3.5
A03	Localized Assistive Scene	Ghazal *et al.* [78]	4.5
A04	Drug Pill Recognition	Chang *et al.* [79]	5.0
A05	Visually Impaired People	Rao and Singh [80]	2.5
A06	Visually Impaired Pedestrian	Chang *et al.* [81]	4.5
A07	Pattern Recognition	Bal *et al.* [82]	3.0
A08	Exploring Printed Text	Su *et al.* [83]	5.0
A09	Intelligent Navigation	Yadav *et al.* [84]	5.0
A10	Rehabilitation of People	Jacob *et al.* [13]	5.0
A11	Visually Impaired Users	Jiang *et al.* [85]	3.0
A12	Sign Language Recognition	Li *et al.* [86]	2.5
A13	Sign Language Recognition	Punsara *et al.* [87]	2.5
A14	Assistive Sign Language	Boppana *et al.* [88]	5.0
A15	Smart Wheelchair	Al Shabibi and Kesavan [89]	4.0
A16	Personal Assistant	Javed and Sarwar [90]	5.0
A17	Visual Aiding System	Kandoth *et al.* [91]	3.5
A18	Assistance of patients	Sharma *et al.* [92]	5.0
A19	Parkinson's Disease Assist	Baby *et al.* [93]	3.0
A20	Assistive Device	Wang *et al.* [94]	3.5
A21	Navigation system	Kumar *et al.* [95]	3.0
A22	Sign Language Interpretation	Lee *et al.* [96]	5.0
A23	Assistive for visually	M *et al.* [97]	4.0
A24	Assistant for the Visually	Hengle *et al.* [98]	5.0
A25	Zebra crossing detection	Akbari *et al.* [99]	5.0
A26	Scene-to-Speech Mobile	Karkar *et al.* [100]	4.5

3.5. Data Extraction

The data extraction process makes usage of a data extraction form generated specifically for this RSL using the Parsifal tool. Filling in the fields of this form after the reading of each selected article allows the recovery of data to answer the research questions raised by this RSL found on Table 1. This form also collects metadata used to identify the studies individually assisting the extraction process [73]. Table 8 presents the fields and the purpose of each field within the extraction form.

Table 8 brings ten data properties defined for this study where PD1 to PD3 are used to identify and locate articles. The other properties were defined to answer the research questions, where: PD4 answers QP1; PD5 and PD6 answer QP2; PD7 answers QP3; and

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Table 8. Data Extraction Form.

ID	Field	Values	Objective
PD1	ID	Incremental numeric value	Study Identification
PD2	Title	Textual Value	Study Identification
PD3	Doi	Textual Value	Study Location
PD4	ML model	Textual Value	Answer QP1
PD5	Topic	Textual Value	Answer QP2
PD6	Key Words	Textual Value	Answer QP2
PD7	IoT Device	Textual Value	Answer QP3
PD8	Adressed Issue	Multiple selection options: hearing impairment, cognitive impairment, motor impairment, visual impairment, and degenerative disease.	Answer QP4

PD8 answers QP4. Data was extracted and organized by the Parsifal tool after the complete reading of each of the selected articles, see Table 7, facilitating the extraction process.

3.6. Threats to the Validity of the Study

Biases in the identification of primary articles and in the extraction of data from the articles corroborated by the fact that each researcher was responsible for evaluating a set of disjointed articles, in the selection as well as in the quality assessment, with no peer validation is a threat to the validity of the study. Another threat is the small number of articles selected in this RSL, which implies the possibility that the sample is not representative to extract evidence that can effectively answer the research questions. The selection of databases, or digital libraries, can also be considered a threat, since these may not cover the completeness of the studies carried out in the context of the problem, which includes questions from different areas of sociology and medicine.

4. Obtained Result

This section summarizes the findings and results of the analyzes of the selected primary articles. The selection process conducted in the selected databases collected an initial amount of two hundred and sixty-seven articles. Of these articles, twenty-seven were considered for this RSL, see Table 7, for their contribution to the topic. Section 4.1 proposes to answer the research questions, Table 1, based on the data extracted by the form presented in Table 8. Section 4.2 aims at summarizing the research's findings.

4.1. Research Questions Answers

QP1. What are the Machine Learning models used in AIoT applied to Assistive Technology?

Out of the twenty-seven primary articles studied, 81% presented solutions based on ANN, 15% of them applied of other ML techniques, and 7% did not present the techniques used. As shown in Table 9, within the context of Neural Networks, the following ML techniques were addressed: ANN, CNN, use of Multiple-CNN, Clever CNN, R-CNN (Region-based CNN), Faster R-CNN, PNN (Probabilistic Neural Network), RNN (Recurrent Neural Network) and Multi-trained DL models. The models not based on neural networks were: Hoeffding Tree, Logistic regression, Naive Bayes, Random Forest, k-Means, Linear Regression, Independent Component Analysis, Support Vector Machines (SVM), and HOG (Histogram of Oriented Gradients).

QP2. What are the topics of study that have been researched in the context of AIoT applied to Assistive Technology?

Figure 1 presents a word cloud created using the keywords of each of these articles to provide a general idea about the topics being studied on the selected primary articles.

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Table 9. Algorithms and Machine Learning Techniques applied, and the respective deficiency addressed for each study.

Applied ML models	Articles	Impairments
ANN	A1, A10, A13, A21	Visual, motor coordination, hearing
CNN	A6, A8, A9, A11, A12, A14, A24	Visual, hearing, degenerative
RNN	A18, A22	Degenerative, auditory
Multiple CNN	A25	Visual
Clever CNN	A5, A17	Visual
R-CNN	A3, A4	Visual, elderly care
Faster R-CNN	A2, A23	Elderly care, visual
PNN	A7	hearing
Multi-trained DL models	A26	Visual
Linear Regression	A19	Degenerative
SVM	A20, A24	Motor coordination, visual
Independent Component Analysis	A20	Motor coordination
Naive Bayes	A16, A18	Cognitive, degenerative
Hoeffding Tree	A16	Cognitive
Logistic regression	A16	Cognitive
Random Forest	E16	Cognitive
k-Means	E16	Cognitive
HOG	E25	Visual

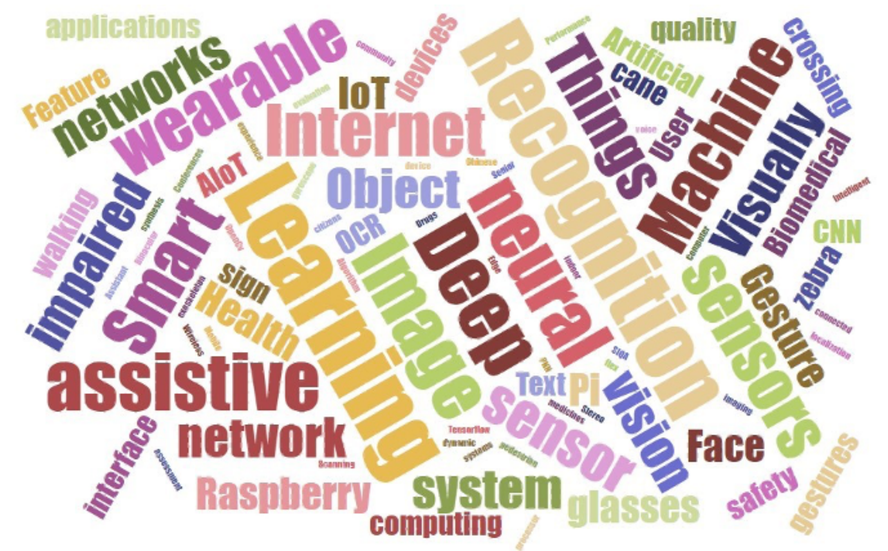

Figure 1. Word cloud.

The research topics discussed in the primary articles were: Assisted Locomotion, Assisted Navigation, Facial Recognition, Human Activity Recognition, Image Captioning, Object Detection, Object Recognition, OCR (Optical Character Recognition), Scene-to-speech, Self-Balancing Object, Smart Assistant, Speech recognition, Rehabilitation, Text-to-speech, and Text detection. Table 10 shows the articles where these topics occurred.

QP3. What are the IoT devices used in the context of AIoT applied to Assistive Technology?

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Table 10. Topics and occurrences in selected articles.

Topics	Primary article(s)
Scene-to-speech	A1, A3
Assisted Navigation	A3, A5, A6, A9, A17, A21, A25
Sign Recognition	A7, A12, A13, A14, A22
Object Recognition	A2, A4, A9
Object Detection	A11, A15, A23
Facial Recognition	A21, A24
OCR	A7, A24
Assisted Locomotion	A15
Speech recognition	A16
Text-to-speech	A24
Image Captioning	A24
Text detection	A24
Smart Assistant	A24
Human Activity Recognition	A16, A18
Rehabilitation	A10
Self-Balancing Object	A19

IoT devices used in the primary articles' proposed solutions: portable devices, wearables, various sensors, smartphones, cane, finger-worm, exoskeletons, wheelchairs, and others. Table 11 presents the articles where these devices were used.

Table 11. IoT devices and their occurrences in the selected articles.

IoT	Devices Primary Article
Portable device	A1, A2, A4, A5, A6, A7, A9, A13, A14, A17, A19, A23, A24
Wearable	A2, A4, A5, A6, A7, A11, A13, A20, A22, A24
Various sensors	A3, A9, A13, A15, A16, A18, A19, A21, A22
Smartphone	A3, A4, A5, A13, A16, A21, A26
Cane	A6, A17
Finger-worm	A8
Exoskeleton	A10
Wheelchair	A15
Other	A18
Non-defined	A12, A25

Out of the primary articles, 60% of them showed the use of RaspberryPY, Arduino, and Nvidia Jetson-based devices, respectively 41%, 15%, and 7% of the device total. Table 12 presents the articles that used RaspberryPY, Arduino, and Nvidia Jetson-based devices in their research.

Table 12. RaspberryPY, Arduino, and Nvidia Jetson-based IoT devices.

Board	Primary Article
RaspberryPY	A1, A4, A5, A7, A9, A13, A14, A17, A23, A24
Arduino	A8, A15, A21, A23
Nvidia Jetson	A2, A4

QP4. Is there a disparity in the number of studies found according to the problems selected in the research?

The selected articles point to a large disparity in the development of AIoT applied to Assistive Technology in relation to the impairments chosen for this study. 52% of the total number of articles addressed issues related to visual impairment, 19% of them hearing impairment and the rest distributed between 11% motor coordination impairments, 7%

degenerative diseases, and 4% cognitive impairment. This shows that most AIoT applied to Assistive Technology developments, within the selected articles, address visual impairment.

4.2. Threats to the Validity of the Study

Biases in the identification of primary articles and in the extraction of data from the articles corroborated by the fact that each researcher was responsible for evaluating a set of disjointed articles, in the selection as well as in the quality assessment, with no peer validation is a threat to the validity of the study. Another threat is the small number of articles selected in this RSL, which implies the possibility that the sample is not representative to extract evidence that can effectively answer the research questions. The selection of databases, or digital libraries, can also be considered a threat, since these may not cover the completeness of the studies carried out in the context of the problem, which includes questions from different areas of sociology and medicine.

5. Conclusions and Future Work

This article presented a Systematic Literature Review, which aimed to identify Machine Learning algorithms and techniques used in AIoT applied to Assistive Technology solutions as well as the context of its applications. These two hundred and sixty-seven articles were pre-selected using automatic search mechanisms on the previously selected database, or digital libraries. After applying selection criteria and the quality assessment process twenty-seven articles were considered from this initial set.

This final set of articles was submitted to the data extraction process, where after extracted, the data was organized, summarized, and analyzed to answer the research questions raised in this RSL. After surveying the findings, it was possible to conclude that 50% of the analyzed articles addressed visual impairment, identifying a gap and opportunity to develop Assistive Technology for all other disabilities. It was also possible to observe that most topics were influenced by a large number of research focused on visual impairment resulting in a majority of topics related to or based on Computer Vision.

It was possible to identify that 81% of the studies used Machine Learning algorithms and techniques based on neural networks and that only 15% of the studies used different techniques. This shows not only the interest of researchers in neural networks but also the great applicability of these learning techniques in the solution of Assistive Technology problems. Conversely, it also shows there is a gap waiting to be filled in relation to the other algorithms and techniques.

Some threats to the validity of the results were also raised, such as biases in the identification of primary articles and extraction of results, the selection of digital libraries, and the number of studies selected in the SLR. Future work, related to the first question, it is intended to adopt peer review in the SLR stages such as the application of selection criteria, quality assessment, and data extraction. For handling the second threat, including other digital libraries and databases not covered by this SLR can also significantly contribute to the scope of primary articles. Finally for the last one, adopting a hybrid search strategy, possibly using snowballing and a manual search in addition to an automated search.

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