Reviewing Assistive Human-Robot Experiences for Inclusive Human-Robot Interaction

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Abstract

Human-Robot Interaction (HRI) and collaboration have gained immense popularity recently, owing to the new mechanisms and advancements in the field of computing and the symbiotic nature of the involved processes. It relates to the ever-dynamic means of communication between humans and robots. Such interactions work both ways, i.e., inputs and commands from humans and the expression of the robot's interpretations. A significant amount of work has been done in this area; however, there are still challenges in assistive human-robot experiences. This study aims to review the literature on assistive robots to bring the current research together, identify persistent gaps and challenges, and recommend ways to enhance human-robot interaction. This paper covers critical aspects of assistive robots in social environments for socio-physical needs and assistance for children and the elderly with special needs. Given advancements in elements like sensor technologies, manufacturing materials, machine learning, control methodologies, and computer capacity, the subject of assistive robots is bound to see tremendous results. The findings in this paper present gaps, issues, and challenges in today's assistive robots that hinder human-robot interaction. The findings can be used to summarize the current works and provide a base for technological innovations to enhance the interactions between humans and their partner robots.

Keywords: Human-Robot Collaboration, Assistive Human-Robot Experiences, Inclusion.

1. INTRODUCTION

Assistive robots can be defined as devices that can process sensory information and perform actions that can help people with special needs (Vollmer, 2020). It includes assistive experiences for the physically and cognitively impaired, children with autism spectrum disorder (ASD) (Short et al., 2017), the elderly (Luperto et al., 2022), and others who may need assistance in terms of mobility and exercise. Such experiences can be extended to socializing, housework, shopping, and education, among others (Raigoso et al., 2021; Badawi et al., 2018; Leclair & Saunders, 2019; Kitt et al., 2021). Undoubtedly, assistive robots have extended their domain to various fields, and assistive strategies and collaborative experiences are being utilized in various research fields (Fitter et al., 2020; Newman et al., 2022a). The disparate domains of assistance can be traced back to a single theory of assistance that occurs in many domains and contexts

(Moon, Baker & Goughnour, 2019). Numerous pilot studies and controlled trials have tested the effectiveness of socially assistive robots, and the results have indicated great promise (Moyle et al., 2017; Marino et al., 2019). The ongoing work in this field focuses on assistance for medical professionals (Stone & Ganapathy, 2021;Dickstein-Fischer et al., 2018), stress-buffering robots in intense environments for children (Logan et al., 2019), long-term care for elderly patients (Getson & Nejat, 2022), and navigation frameworks for such environments (Kivrak et al., 2021).

In the field of human-robot interaction and collaboration, defining assistance can be challenging, but in a broad sense of view, aiding and facilitating people in their tasks for a better experience can be termed as assistance (Christoforou et al., 2020; Henschel, Hortensius & Cross, 2020). The devices that are developed and built to assist people are referred to as assistive (Tobis et al., 2022). There is no need to separate assistive systems from non-assistive systems, as it relates to the perspective of assistance through which we view such robots and related experiences (Newman et al., 2022a). Through this perspective, we can view robots as autonomous agents performing a subordinate goal for their human partner (Vitanza et al., 2019).Such goals may include intelligent environments for the elderly, wearable assistive devices, and training simulators for professionals in various fields (Raju, Ganapathy & McCarthy, 2021a; Stone & Ganapathy, 2021b; Thakur & Han, 2019).Hence, in theory, every robot is viewed as assistive to someone or something, which is why the scope of assistive robots and human-robot collaboration may not be limited (Pinney et al., 2022; Newman et al., 2022a; Martinez-Hernandez et al., 2021).

This paper reviews assistive robots in various fields to highlight the gaps and challenges in human-robot collaboration and related experiences. The review includes assistive robots for children with autism spectrum disorders, the elderly with cognitive challenges and limitations, individuals with special needs in a socio-physical context, and overall assistive experiences through time and space.

2. METHODOLOGY

This study aimed to identify the current issues in the field of human-robot interaction, with a specific focus on assistance. The objective was to provide theoretical groundwork for future research and technological innovations to focus on designing better and seamless interactions between humans and their partner robots. To achieve this objective, the following research question was formulated to set the scope of this paper:

RQ: What persistent gaps and challenges in human-robot social interaction need addressing for a more inclusive human-robot interaction?

We adopted a deductive approach for the systematic literature review to identify the persistent gaps and challenges. The search process employed various searches from Google Scholar and Academia.org, and Scopus to identify the literature. The research design followed the PRISMA methodology, which includes four primary steps; identification, screening, inclusion and exclusion criteria, and analysis of the results (Page et al., 2021). The keywords used to identify relevant articles were human-robot collaboration, assistive human-robot experiences, inclusion, assistive robots, and socially assistive robots.

A total of 8,460 full-text papers were identified and filtered out using the abovementioned keywords. The screening process ensured that the publications contained keywords and provided relevant and valuable insights. Following this, publications from 2016-2022 were considered, and the remaining 2,542 articles were included and subject to title and abstract screening. It narrowed down the dataset to 125 publications, which were screened one last time to identify duplicates, insufficient data, or redundant results. Once the title and abstract screening process were over, a total of 55 publications were considered eligible for the dataset and included in the systematic review.

- The inclusion criteria had three primary considerations, as presented below:

- The publication must focus on assistive robots, human-robot experiences, or the role of socially assistive robots.

- The article must be published after 2016.

- The article must be peer-reviewed or a conference paper published in English.

Figure 1 presents the PRISMA chart and summarizes the methodology for this paper.

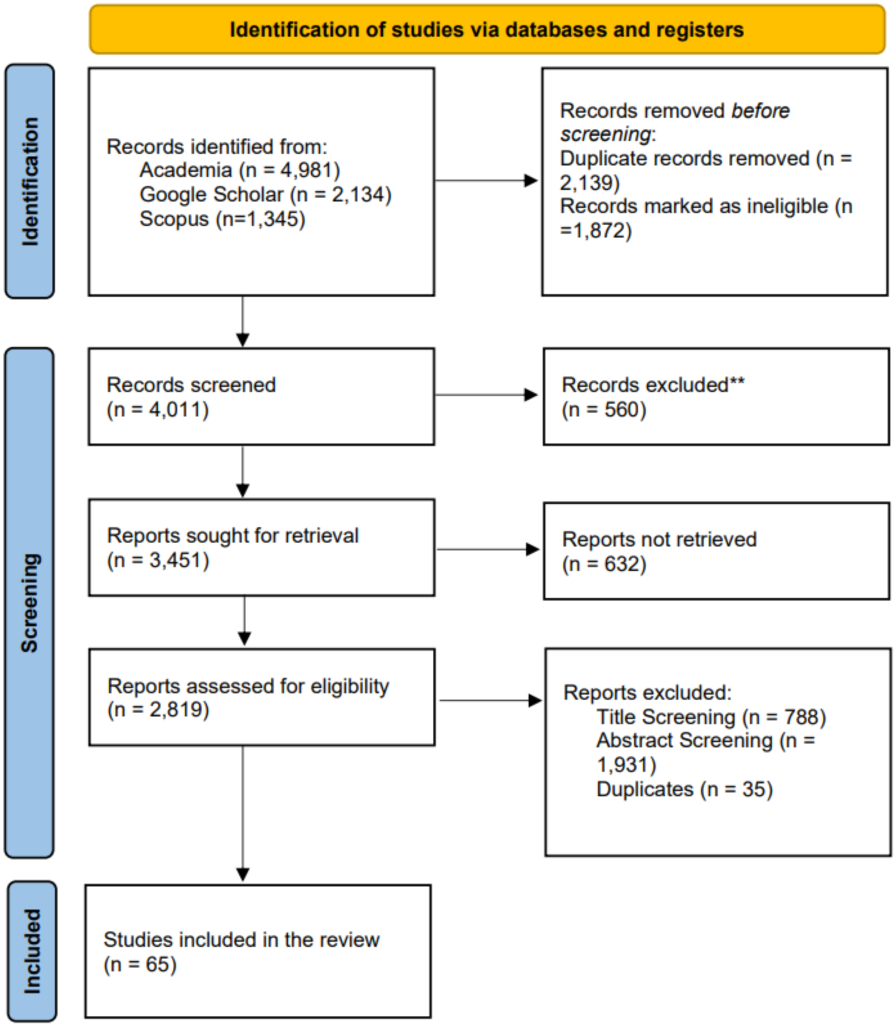

FIGURE 1: Research Methodology Flowchart.

The results of the systematic literature review are presented below.

3. LITERATURE REVIEW

Socially assistive robots (SAR) can provide efficient, affordable, and user-friendly experiences to children diagnosed with autistic spectrum disorder (ASD) (Kitt et al., 2018; Scassellati et al., 2018). Human-computer interaction (HRI) is still limited due to several factors, i.e., recognizing facial cues and detecting productivity; these tasks are challenging for children with minimal communication skills (Moon et al., 2019; Martinez-Hernandez et al., 2021).

It has been mentioned that the primary goal of an assistive robot is to act in a subordinate capacity to its human partner (Stavropoulos et al., 2020). The objective for these technologies is not to fit like gloves but be simple to use so that they do not demand additional cognitive load from their human partners (Lersilp et al., 2018). Currently, most assistive technologies are not very efficient and require considerable input to operate, which may be in a multimodal form that is accessible to non-impaired partners but can be a challenge for the impaired partner (Newmann et al., 2018b). Such interactions require input from the human partner, which can be a considerable challenge, given that the control signals are not in the same space (Broad & Argall, 2016). Still, new technologies like touch detectors, electromyographic sensors, strain gauges, pattern recognition, classification, and regression are slowly steering us in the right direction (Vitanza et al., 2019). The current paper explores the employability of assistive robots in various domains. In doing so, the upcoming literature review considers different themes based on which research has been found and critiqued leading to summing up the gaps that could be covered in future research.

3.1. Assistance in Human-Robot Interaction

Assistance refers to facilitating an individual to carry out their tasks. In human-robot interaction, the facility is provided by a device to the human partner (Desmond et al., 2018). Generally, all devices and robots are developed with specific goals in mind, including some sort of assistance (Haleem et al., 2022). However, in human-computer interaction and human-robot interaction, the assistance perspective primarily refers to supplementing human capabilities (Newman et al., 2022a). This perspective can be extended to explain the specific tradeoffs and patterns common in such assistive frameworks, regardless of the application area (Shi et al., 2022).

Assistive robots have become popular in many European countries as people become more aware of autistic spectrum disorder and the need for SAD becomes more vital for children with ASD (Alabdulkareem et al., 2022). People with disabilities often face difficulties accessing technology, limiting their ability to participate fully in society (Henschel, Hortensius, & Cross, 2020). Several assistive technologies can help people overcome these barriers and live more independent lives.

Some standard assistive technologies identified in the literature include (Senjam et al., 2021; Sankhi & Sandnes, 2020; Botelho, 2021; Harper et al., 2016):

- Screen readers, which convert text into speech or Braille, allow blind and visually impaired users to access electronic information. Specialized keyboards and mouse devices can be easier for people with limited dexterity.
- Voice recognition software allows people who cannot use a standard keyboard and mouse to control a computer using their voice.
- Text-to-speech software can read aloud text on a computer screen, making it easier for people with visual impairments or reading difficulties to access information.
- Video magnifiers enlarge text and images on a computer screen, making them easier to see for people with visual impairments.

In this regard, all the technologies mentioned above aid people in one way or the other. Assistive robots work on this principle and are designed to assist humans in their daily lives (Senjam et al., 2021). They can be used for tasks such as providing physical assistance, emotional support, or helping with cognitive tasks (Newman et al., 2022a). Assistive robots can be used by people of all ages and abilities and can help to improve their quality of life (Shen et al., 2018).

3.2. Assistance for Children with Special Needs

Children with Autism Spectrum Disorder (ASD) face developmental issues and often face challenges regarding behavior, communication, and learning (Alabdulkareem et al., 2022). There has been extensive research on this subject, and the findings have outlined various therapeutic interventions, game-based learning, and other forms of assistance to help children stay on track (Haleem et al., 2022). Jain et al. (2020) conducted a comprehensive study on children with AUD, and as part of the experiment, 17 participants were provided with socially assistive robots for one month. The role of the robot partner was to personalize feedback and instruction for each participant. By learning and adjusting to the participant's specific needs, the interaction's effectiveness in terms of engagement was measured. The results indicated that the robots could autonomously detect the learning patterns with 90% accuracy. Unfortunately, all present research ignores the crucial component of incorporating these students into society, as these approaches are solely used in educational institutions and are primarily focused on assessment rather than inclusion. Additionally, this study was conducted only on participants diagnosed with ASD, and the results indicated improved social and logical reasoning skills.

Children respond well to game progress, and data collection using this method has proven to be successful in many cases (Silva et al., 2017). Thus a similar approach can be taken to research participants with other mental deficiencies for real-world data. Real-world dataset collection and training produce a high level of variance (causing the algorithm modal to noise in the training set, i.e., overfitting) (Puli et al., 2021). It is due to several factors; the first is low levels of disengagement, and the second is the collection of data from atypical primary sources. These factors add a challenge, especially when dealing with accurate environment testing. For example, due to a high level of variance in a multimodal database created using audio, game performance did not provide adequate results compared to the visual feature modal. Due to this, the children diagnosed with ASD must only rely on visual means of engagement, affecting the overall experience and decreasing the effectiveness of individualized SAR performance.

Another case is related to chronic stress, especially in children. Studies have investigated exposure to chronic and normative stress (Svensson et al., 2019; American Psychological Association, 2017). The reason why it is an important area is that exposure to high levels of stress in early childhood can lead to poor academic performance, depression, anxiety, behavioral issues, and metabolic disorders, which can develop into other severe diseases (Balasubramanian, Beaney & Chambers, 2021).

According to Kitt et al. (2021), emotional support can be provided by emotional support animals; however, emotional support is insufficient when we talk about AUD, depression, learning disabilities, and cognitive impairments. Having an emotional support dog has been reported to reduce stress levels in children, but the impact of such an interaction is derived from the quality and quantity of the interactions (Kerns et al., 2018; Kertes et al., 2017). Hence, a foolproof interaction for stress relief is yet to be designed. Additionally, children diagnosed with dysgraphia (writing disability) and dyscalculia (difficulty solving math equations) should also be included in such studies as the current literature fails to provide a significant breakthrough in assistance research (Alabdulkareem et al., 2022).

3.3. Assistance for the Elderly

Socially assistive robots play a different category for the elderly because the goal here is to increase patient autonomy. Children need assistance with control and learning for the most part, but the elderly need assistance to perform day-to-day tasks independently (Thakur & Han, 2019). It has been stated that around 16% of the elderly in Switzerland find daily routine tasks challenging, especially the individuals staying in care homes (Aerschot & Parviainen, 2020). The goal is to enhance autonomy substantially (Fotteler et al., 2022).

Dementia is a general term for a decline in mental ability due to disease or injury. Dementia affects memory, thinking, and judgment. A person with dementia may have trouble with basic activities of daily living, such as bathing, dressing, and eating. The decline in mental ability may be due to disease or injury (Kawas et al., 2016; Łukasik et al., 2020; Afio et al., 2016). Symptoms can include memory loss, confusion, and changes in mood and behavior (Gale, 2018). According to the Alzheimer's Association, dementia affects an estimated 47 million people worldwide, which is expected to nearly triple to 131 million by 2050 (Alzheimer's Association, 2022). There is still much unknown about dementia; however, research has shown that it is a progressive disease that affects cognitive function and memory. Dementia affects people of all ages but is most common in older adults. There is no one cause of dementia, but it is believed to be caused by a combination of genetic, lifestyle, and environmental factors (Aerschot & Parviainen, 2020). There is no cure for dementia, but there are treatments available to help manage the symptoms. Some possible conditions that may be related to dementia include Alzheimer's disease, Lewy body dementia, frontotemporal dementia, vascular dementia, mixed dementia, and Normal Pressure Hydrocephalus (Halvorsrud et al., 2021; Demers et al., 2016).

In such cases, the reviews of doctors, nurses, and caregivers are essential. The study by Łukasik et al. (2020) reviewed assistive robots for the elderly and investigated the perceptions of doctors and nurses towards assistive robots. The findings indicated that the current need for assistive robots in this role is to act as guides and remind the patients of their safety, health status, and the medications they need to take regularly. Here, a robot must act like an assistant.

The study by Nishiura et al. (2021) was conducted in a nursing home with participants with and without cognitive impairment. The activities performed by participants were related to their day-to-day activities, i.e., taking medicine and taking a blood pressure test. However, two participants scored low in the first activity and had no cognitive impairment. The study concluded that this was the result of a lack of attention, further clarification on these findings was not provided. The activities the participants had to perform were to create verbal instruction according to different cognitive levels and characteristics of cognition. The assistive robot, PaPeRo could not function without an examiner, resulting in a lack of evidenceof real-world implications. Such interactions need to be refined further so that the communication between human and robot partners is clear and explicit for seamless experiences.

Fitter et al. (2020) studied if a well-designed socially assistive robot would increase the activity levels of the elderly. For this purpose, they employed game design for physical therapy and rehabilitation and utilized six games for the Baxter Research Robot. The study was conducted on 40 participants, of which 20 were young adults and 20 were elderly. The results indicated that such interactive games could elicit engagement and pleasure in the users. The cognitive challenge posed by the games leads to an increased energy level. It was also noted that the female participants reported more positively than the male participants. It further highlights the role of gamification. Games are fun for children and the elderly alike, and if used appropriately, they can add another layer of assistance in terms of emotion and energy alongside the designated role. It can also help the elderly face cognitive challenges more effectively by reducing stress and boosting positive emotions.

3.4. Socially Assistive Robots

Intelligent and wearable technologies have an upside over other assistive devices in that they are always close to the user and conform to the human body (Raju, Ganapathy & McCarthy, 2021). These features allow the systems to collect critical information to provide individualized help to people with various levels of physical, sensory, and cognitive limitations. The study by Tegmark & Scheutz (2021) covers wearable assistive technologies. These technologies are intended to help people with physical disabilities, notably with the body's upper and lower limbs and joints. However, these technologies tend to be rigid, bulky, and costly. Their rigidity and bulkiness make individuals uneasy and restrict the normal movement of human limbs in various positions (Martinez-Hernandez et al., 2021). When opposed to robots created with rigid components, assistive robots made of soft materials are typically lightweight and comfortable and do not constrain the movement of upper and lower limbs. Wearable sensors have primarily benefited from wireless communication technologies, lower power electronics, soft materials, and the internet of things (IoT), not only in terms of becoming relatively small, lightweight, and less burdensome (e.g., no/fewer wires), but also in terms of making sensor data accessible remotely for online processing, monitoring, and control.

Wearable assistive robotics is a new development that can help people with sensorimotor impairments carry out everyday tasks (Stavropoulos et al., 2020). It allows individuals to be socially and physically active, accomplish things independently, and regain their quality of life. The importance of wearable assistive robotics is highlighted when they are worn by people and interact with their bodies. Wearable robots must be reliable, safe, dependable, intelligent, responsive, lightweight, and pleasant to provide proper support, the user's safety, and the device's adoption and usability.

The study by Ashley (2021) elucidated that machine learning in wearable assistive technologies is also utilized to create intelligent wearable robots that can aid humans safely and precisely. Machine learning approaches can produce cutting-edge results, especially during training. Some the techniques such as Support Vector Machines (SVM), Random Forests (RF), Bayesian Inference, Decision Trees (DT), kNearest Neighbor (kNN), and logistic regression are some of the approaches used in this approach. Wearable sensors (bending and force sensors) and SVM, kNN, and DT techniques have been used to study hand gesture recognition. In real-time mode, SVM had the highest recognition accuracy, requiring the most training and prediction time compared to kNN and DT techniques (Chen et al., 2021). When compared to SVM, DT, NN, kNN, and Naive Bayes approaches, RF methods performed better (Badawi et al., 2018). Assistive learning robots have also been established alongside deep learning approaches, which are generally based on Neural Network (NN) designs. They have proved their capacity to recognize activities with convoluted datasets appropriately when other machine-learning methods have struggled (Hatcher & Yu, 2018).

Another study by Ridha & Shehieb (2021) introduced an intelligent software solution for low-cost augmented reality glasses. It aids students in their educational journey by providing real-time transcription, voice emotion detection, proper indication functions, and classroom assistance capabilities. While education is integral to a child's development, hearing-impaired and deaf (HID) students have higher rates of academic failure and require more educational support (LeClair & Saunders,2019). Virtual reality, augmented reality, and voice captioning are examples of modern assistive technologies being investigated and used to help HID (Hearing-impaired and deaf) students. Whereas most current research focuses on in-class assessment procedures and evaluation, incorporating mixed reality allowed them to enrich their perspective beyond what was previously possible.

Although the new designs are comfortable, they still lack the requisite assistive capabilities, including hybrid solutions incorporating energy-efficient actuation and control technologies (Martinez-Hernandez et al., 2021). Intelligent Assistive Technologies (IATs) must be both usable and inexpensive. Even though there are an increasing number of low-cost devices and free mobile apps ready to aid caregivers and dementia patients, most require a broadband connection or, at the very least, a smartphone. It continues to exclude many people living in remote areas whose socioeconomic background prevents them from accessing broadband or regular cellular service.

Table 1 below summarizes the gaps and challenges in human-robot interactions in recent years.

Author	Persistent Gaps and Challenges
Martinez-Hernandez et al., (2021)	New designs are comfortable, but they still lack the requisite assistive capabilities, which include hybrid solutions incorporating energy-efficient actuation and control technologies.
Ridha & Shehieb (2021)	Specific requirements like devices and connectivity make accessibility a challenge for the most marginalized communities who need assistance.
Jain et al. (2020)	Low levels of disengagement and data collection from atypical primary sources are challenging, especially when dealing with accurate environment testing. Children diagnosed with ASD rely on visual means of engagement, affecting the overall experience and decreasing the effectiveness of individualized SAR performance.
Nishiura et al. (2021)	Socially assistive robots like PaPeRo fail to perform without an examiner, which results in a lack of evidence according to real-world implications. For example, if the participant did not understand the AS instructions, did the examiner provide different instructions or not?
Fitter et al. (2020)	Using gamification can significantly improve activity levels; however, the related costs and expenses are far too significant to be considered an option for all.
Busse et al. (2021)	Lack of appropriate self-assistive training modules for users and making these training more effective and measurable.
Newman et al. (2022)	A significant challenge for robot designers is to enable assistive robots to make their own decisions. The need for a centralized action space for seamless human-robot interaction.
Van-Aerschot & Parviainen (2020)	Assistance in day-to-day activities is certainly a convenience, however, users develop a dependency on their robot partners, and an investigation into its influence on human partners is necessary.
Natale & Cooke (2020)	Lack of identified challenges in terms of web-based accessibility.
Kitt et al. (2021)	Limited emotions were studied, i.e., pleasure, arousal, and dominance. The age bracket of children chosen for the task(7-10 years), hence the results might be different for a different age group, i.e. 3-6 years

4. CHALLENGES

Given advancements in elements such as sensor technologies, manufacturing materials, machine learning, control methodologies, and computer capacity, the subject of wearable assistive robots has undoubtedly seen tremendous results. Despite all the progress in this sector, there is still a need to improve different sub-domains of ethical, legal, and implementation natures. In this connection, multiple challenges are posed in the way the use of assistive robots is for human betterment. Some of them deduced from the explored research are given here.

4.1 Safety and Dependability

Assistive technologies are bound to face many issues and challenges, and one such challenge is adaptivity. Safety, dependability, efficient robot support, and device acceptability remain current concerns. Adaptivity is frequently considered a machine learning issue, with much of the work on Human Activity Recognition (HAR) relying on supervised learning approaches to give crucial background knowledge (Martins et al., 2018). Sensor events are commonly compared to templates suited to specific ADLs over sliding time periods. These templates can be produced iteratively but are typically static and used to produce an ontological model (Smail et al., 2020).

These model-based techniques lack the flexibility needed for wearable assistive robots to deal with the quantity of variation that can be expected in outside settings. They may not adequately capture the intricacies or variety of many application cases.

4.2. Implementation

Although wearable assistive devices are perceived as tools that would revolutionize the lives of users, the gap between their testing in the labs and actual use in the real world remains a question mark. Under controlled conditions of a lab, devices would operate differently compared to the actual outdoor scenario where a user can use or misuse the tool leading to malfunctioning of the device (Berryman et al., 2011). Humans have been created on a pattern of variety and diversity, and in the case of wearable tools, exposure to different human conditions would threaten their survival. Robots perceive, make judgments, and regulate the assistance required by the user affected by the differences in testing situations.

This gap needs to be bridged to enhance the applicability of assistive tools, as it would be a giant leap to increase the acceptability of assistive robots. As a result, systems with methods capable of continuously learning from the status of the human body, robot, and environment are critical for safely and accurately adapting to common and unforeseen scenarios.

4.3. Acceptability

Acceptability is a significant and imperative concern; even with the technological advances in assistive technology, device abandonment remains one of the main challenges (Zipp et al., 2018). For instance, upper-limb prostheses are rejected by up to 75% of users because they are unpleasant and inadequately functional (Smail. et al., 2020). Acceptance studies reveal recurring topics across various assistive technology, with the reasons for device abandonment varying by the user but highlighting the imbalance between expectations and reality (Sugawara et al., 2018; Holloway & Dawes, 2016). These concerns have prompted researchers to focus on a more user-centered design method. It guarantees the involvement of various stakeholders to reduce the gap between user needs and generated product features and improve the effect. Users, healthcare professionals, industry representatives, and policymakers are among the stakeholders. Each stakeholder brings a unique perspective to the table. The designers may get empathy and learn from the consumers' lived experiences because they are at the center of the process.

4.4. Moravec's Paradox

One challenge for robot developers to overcome is Moravec's paradox, which is that machines can do difficult things for humans, such as playing chess but cannot learn psychomotor or perceptual skills. Reverse engineering is more difficult for tasks that humans do unconsciously, such as motor functions. The primary reason is that the systems require a lot of time and money: the capital these big technologies require can only be achieved by giant corporations or developed countries. Because they are software, they need constant updates, causing technological dependency (Kitt et al., 2021).

4.5. Increase in Unemployment of Medical Professionals

The automation of work and its replacement by intelligent machines will produce a decrease in a considerable number of medical jobs. This will bring with it a growing need for people to be professionally educated. For instance, it was declared in 2017 by the secretary general of the Organization for Economic Cooperation and Development (OECD) that approximately 9% of the jobs in member countries have the potential to be automated (OECD, 2017). Consequently, the risk of losing their jobs is more significant for people with low educational levels. According to research by the McKinsey Multinational Research Institute, in 2030, artificial intelligence technology will impact the global economy, mainly in the labor sector, which will lead to the replacement of 20% of the economically active population worldwide by intelligent machines (Aerschot & Parviainen, 2020).

5. A FUTURIST PERSPECTIVE FOR PUZZLING OUT THE CHALLENGES

The world population is aging, thus introducing a wide range of challenges. Most people require physical or cognitive assistance due to changes associated with aging, e.g., Traumatic Craniocerebral, Parkinson's disease (PD), Alzheimer's disease, and stroke, among others. For instance, more than 730,000 people in America and one million people in 22 European countries suffer a stroke, and almost 400,000 survive with some form of neurological disability annually. It places considerable pressure on the private and public sectors of the health of the nation concerned. The only comparable technology is human-computer interaction which could provide personalized care but without the physical embodiment of a robot. The research work proposed in this project defined a new niche of human-robot interaction for assistance requests. It included inclusive assistance and encouragement while being able to provide detailed reports on users' progress for everyone.

One of the proposed approach's main advantages is providing a more significant period for the supervision of a personalized exercise or activity accompanied by encouragement while saving the time of the therapist or caregiver. The purpose was to spotlight the principle of social assistance, which consists of using non-bulky physiological sensors and intelligent robotic agents to track real-time activity and determine user state. Combining these elements constitutes a personalized therapeutic tool that adapts to the user's personality, preferences, profile, internal state, and cognitive/physical disability to continue encouraging them to stay engaged in an activity (Busse et al., 2021). Thus, this research work's objective was to improve users' quality of life, which can be done in the future using a robotic agent that monitors, encourages, and engages users when performing tasks such as physical rehabilitation and cognitive stimulation. These robots' future emergence and development appear promising, with significant accomplishments and societal benefits expected in the following years.

When distributing functions between a human and a robot and organizing their interaction, one can proceed from various criteria for the effectiveness of the "human-robot" system. Which criteria preference depends on the overall approach to solving the problem. Thus, in the conditions of capitalist production, in the first place is the profit from the operation of "man-robot" systems. The other extreme is that some ergonomics experts see the role of robotization only in humanizing labor, in the maximum facilitation for the masses. At the same time, economic factors related to productivity and quality of labor, and the cost of production, have not been considered (Natale & Cooke, 2021).

Human-robot interaction and collaboration should be designed to ensure the maximum economic efficiency of the system. It may be subject to the obligatory observance of conditions that guarantee the protection of health, performance, and, even more so, the personal safety of a person. At the same time, it is necessary to proceed primarily from the interests of the person, from ensuring the maximum satisfaction of the needs of both societies as a whole and each person.

Based on the literature review, following are the essential requirements put forth that innovative applications must respect to be inclusive, reliable, and acceptable:

Human intervention and supervision: It must be achieved through governance mechanisms, such as human participation (human-in-the-loop), human supervision (human-on-the-loop), or human control (human-in-command).

Robustness and technical security: The algorithms must be secure enough to be resilient, reliable, and robust to resolve errors or inconsistencies during all phases of the life cycle of the intelligent system (Hatcher & Yu, 2018). Likewise, they must have the strength to repel open attacks, such as subtler attempts to manipulate data or the algorithms to guarantee a contingency plan in case of problems. Hence, our decisions must be accurate or, at a minimum, reflect our level of success, and our results must be reproducible.

Transparency: The traceability of the systems must be guaranteed; both the decisions made and the entire process that led to the decisions should be recorded and documented. It is important to properly communicate the capabilities and limitations of the system to the various affected stakeholders.

Diversity, non-discrimination, and equity: Aims to ensure accessibility through a universal design approach to achieve equal access for people with disabilities.

Social and environmental well-being: Its impact on the environment and other sensitive beings must be considered. All human beings, including future generations, should benefit from biodiversity. The sustainability and ecological responsibility of intelligent systems must be promoted, and the solutions they address must be considered the United Nations Sustainable Development Goals.

Accountability: the possibility of auditing these systems by internal and external auditors and the availability of evaluation reports is essential. The potential negative impacts of the systems must be identified, evaluated, documented, and minimized. In the event of unfair adverse effects, accessible mechanisms must be provided to guarantee adequate reparation.

These requirements are intended to be applied to all robotic assistive systems, but the intensity will depend on the specific application context. For example, the smart app that rates a reading book as unsuitable is far less dangerous than one that misdiagnoses cancer and thus may be subject to less stringent oversight. Further research can be conducted on the attitude of adults toward assistive tech and how it can impact their daily lives without the nurse's assistance. Real-world data collection is a real challenge. For assistive tools to work, we need to study the effects of SAR and other AS according to the dataset collected and trained. AR should be trained to create personalized instructions on a case-by-case basis, i.e., mental level and age.

6. DISCUSSION AND COMPARATIVE EVALUATION

Throughout this paper, assistive robotics have been conceptualized, as well as their applications have been considered to make interactions more inclusive. Currently, weare undergoing the Fourth Industrial Revolution, and like all change, it generates confusion, and some apocalyptic voices are raised. The collective unconscious often visualizes artificial intelligence as humanoid robots and identifies them with human-shaped machines and even with feelings, promoted by science fiction literature and movies. However, to date, scientists have not been able to create a machine that feels like a human being. According to anthropological philosophy, man is multidimensional, he has intellect, but he also has an emotional, volitional, and socio-political sphere. This new technology, until now, was nothing more than developed algorithms that allow a computer program to analyze and process a considerable amount of data, make automated decisions, and even predict certain events if certain variables occur. Nevertheless, it cannot go beyond what is scheduled. It is not just a new era or a new revolution that will bring about new technology, but something much bigger.

The concentration of revolutions at a rate so fast that humans will not be able to assimilate: the technological singularity, which is not a new concept.However, at the international level, different national legal systems derive from diverse anthropological conceptions. They arise because of different cultures, idiosyncrasies, and worldviews, a series of common considerations can be identified in the ways of carrying out this approach to the ethics and legality of assistive robotics, namely:

1) Diversity, non-discrimination, and equity must be carried out for the good of humanity and to benefit the most significant number of people, minimizing the risk of exclusion and discrimination. It must also ensure accessibility to achieve equal access for people with disabilities.

2) Safety standards must be extremely high. For this, ethical and finalist control of research, transparency, and cooperation in its development is necessary.

3) Researchers and designers have a fundamental responsibility. It relates to the development of assistive robots, characterized by transparency, reversibility, and the traceability of processes. The decisions and the entire process that led to the decisions should be recorded and documented.

4) Human control, intervention, and human supervision; it is humans who decide on the actions of robotic systems.

It is essential to mention the sanction of a voluntary code of ethical conduct, which is composed of a series of ethical norms that must guarantee the development of artificial intelligence centered on the human being. Hence, the accountability and transparency of algorithmic decision-making systems and clear rules on responsibility and fairness are always based on human control. The development of a framework that penalizes perception manipulation practices, profiles that classify people suffering discrimination based on such classification and their stigmatization, and emotional surveillance programs are also significant.Lastly, aspects like risk management must be considered for better control overall. Since advances in these fields are uncertain, cases are unimaginable. Regulations and frameworks must be continuously reviewed and reconsidered in the medium term when other advances have become a reality.

Such aspects must be considered for a more inclusive human-robot experience. The review has indicated that a significant amount of work has been done, and each year, new achievements are unlocked. Still, one of the key challenges in assistive robotics is the development of intelligent algorithms that can enable the robot to effectively and efficiently carry out tasks that are assigned to it. In many cases, the tasks that need to be carried out by assistive robots are highly complicated and require a high level of intelligence to be completed successfully. Similarly, another challenge is the development of robotic systems that can physically interact with their surroundings in a safe and effective manner. This is particularly important when considering tasks such as aiding elderly or disabled people.

Other challenges include cost, making it difficult for people to get the help they need. There can also be a need for more trained professionals to help people use assistive robots. It can make it difficult for people to get the most out of these devices. Additionally, assistive robots can sometimes be challenging, especially for people with limited mobility or dexterity. Lastly, assistive robots are only sometimes available when needed, which can be a problem for people who urgently need assistance. Hence, assistive technologies are beyond the reach of the public, especially marginalized groups based on socioeconomic backgrounds. The availability of internet services in the remotest of regions has made things easier, but assistive devices, let alone robots, are still a considerable challenge. Only if assistive robots and related technologies are available at a low cost and made commercially available will the goal of inclusion be achieved.

7. CONCLUSION

Socially assistive robots are designed to help people with various tasks and improve their quality of life. They can assist the elderly, disabled, or those with chronic illnesses alongside cognitive tasks such as memory, problem-solving, and decision-making. This paper aimed to identify persistent gaps and challenges in assistive human-robot experiences so that future work may consider them for a more inclusive and seamless collaboration.

The findings of this paper indicate that an assistive human-robot experience is one in which a robot assists a human in some way. It can be something as simple as a robotic arm helping to lift and move heavy objects, or it could be something more complex like a robot providing aid to a disabled person. In either case, the goal is to make human life easier and help them accomplish tasks they would otherwise be unable to do. There are many potential benefits of using assistive robots. For example, they can help to reduce the amount of time and effort required to complete a task, and they can also help to improve the safety of the task by reducing the possibility of human error. The goal is to provide autonomy for people who may not be able to care for themselves entirely.

One of the challenges of developing assistive human-robot experiences is ensuring that the robot understands and responds to human needs. It requires using sophisticated artificial intelligence algorithms to interpret human actions and intentions. Hence, the robot must be designed to be safe and reliable, as it will be working closely with humans and will need to be able to avoid causing any harm. Another challenge is ensuring that the assistive experience is positive for humans, which means considering factors such as the human's emotional state and ensuring that the robot can assist in a helpful and not intrusive way. It is essential to consider the social implications of using assistive robots, as they have the potential to change the way humans interact with each other.

The results presented in this study (Table 1) review advancements in assistive human-robot experiences in the last two years, which highlights the challenges and issues we face today. Despite significant progress in computational algorithms, assistive human-robot experiences cannot be extended to marginalized groups, and the reason is ingrained in various limitations like resources, costs, or availability of the interaction spaces. A lack of trained professionals and care personnel is also an issue that can only be resolved once the experiences are made more common. Overall, assistive human-robot experiences can improve humans' lives significantly, but some challenges still need to be addressed to ensure that these experiences are positive and beneficial for all involved. We hope this study provides a sound theoretical groundwork for future researchers working in this field and can serve as a base for future technological innovations.

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