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Review

Social Robots in Hospitals: A Systematic Review

Carina Soledad González-González [1,*], Verónica Violant-Holz [2] and Rosa Maria Gil-Iranzo [3]

1 Departamento de Ingeniería Informática y de Sistemas, Escuela de Ingeniería y Tecnología, Universidad de La Laguna, 38204 La Laguna, Spain
2 Department of Didactic and Educational Organization, Faculty of Education, International Observatory in Hospital Pedagogy, Universitat de Barcelona, 08035 Barcelona, Spain; vviolant@ub.edu
3 Departamento de Informática e Ingeniería Industrial, Escuela Politécnica Superior, Universitat de Lleida, 25001 LLeida, Spain; rosamaria.gil@udl.cat
* Correspondence: cjgonza@ull.edu.es

Abstract: Hospital environments are facing new challenges this century. One of the most important is the quality of services to patients. Social robots are gaining prominence due to the advantages they offer; in particular, several of their main uses have proven beneficial during the pandemic. This study aims to shed light on the current status of the design of social robots and their interaction with patients. To this end, a systematic review was conducted using WoS and MEDLINE, and the results were exhaustive analyzed. The authors found that most of the initiatives and projects serve the elderly and children, and specifically, that they helped these groups fight diseases such as dementia, autism spectrum disorder (ASD), cancer, and diabetes.

Keywords: social robot; design; interaction; hospital; healthcare

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1. Introduction

In recent times, the academic community has taken a growing interest in human–robot interaction (HRI), particularly with social robots [1]. This field is dedicated to identifying, creating, and assessing robots and their interactions with people [2]. HRI includes computer science, engineering, psychology, and other areas of study involving these systems and social behaviors [1].

Social robots can help with long-term healthcare services, such as rehabilitation [3] or school attendance [4]; however, access to this technology requires a regulatory and ethical framework in the area of robotics research [3]. Assistive Ambient Living (AAL) supports healthcare services at home with e-tools and projects like ULISSE or ENRICHME, although the use of an interactive robot raises privacy and ethical concerns [5].

During the COVID-19 pandemic, society saw social robots being implemented in real settings and different applications [6]. The lockdown and the various measures adopted in countries, such as physical distancing and isolation, provided an opportunity to apply social robots as assistive tools during the pandemic, specifically in healthcare services [7].

As a result, social robots were crucial in reducing the spread of COVID-19 by performing certain functions like monitoring and supporting patients and healthcare professionals [8]. Furthermore, research has provided evidence that isolation and lockdowns have negatively impacted mental health and wellbeing [9], meaning social robots might be effective in helping and promoting wellbeing during a pandemic [10].

However, there are many unanswered questions involving the design of social robots as concerns their safety and the ethical principles involved in using them in healthcare settings. The research into their main uses and applications in hospitals is also lacking. For these reasons, in this paper, we will try to answer the following questions:

RQ1. How are social robots designed? Are they ethically designed?
RQ2. What are the main uses and applications of social robots in healthcare?

Our first research question involves three perspectives: design, interaction, and ethical issues. It is essential to determine what studies exist on the design of the software and hardware of social robots, so RQ1 seeks to shed light on this issue. Additionally, interaction is an essential ingredient in the development of social robots because they communicate and interact with human beings. RQ2 analyzes only that, while RQ1 addresses concerns involving social robots, with interaction and intelligence aspects being critical [11].

Thus, in this paper, we conduct a systematic review to answer these questions, focusing on the design of social robots and their applications in hospitals. We also provide the context and use of social robots in healthcare, answering the questions of what is being done and how they are being used. In addition, we analyze the ethical component in the design of social robots.+

The paper is organized into several sections. Section 2 presents the methodology employed, and the results are presented in Section 3. Section 4 discusses the results in terms of the research questions. Finally, the conclusions are presented to provide a roadmap for designers of social robots for healthcare services.

2. Materials and Methods

2.1. Design

This article focuses on peer-reviewed journal articles and systematic reviews involving social robots and hospitals published between 1 January 1960 and 31 March 2021.

2.2. Databases and Search Strategy

The Web of Sciences WoS and MEDLINE were searched on 11 March 2021. This search was refined in terms of the document type (article or early access or meeting or clinical trial or case report or review), language (English), and research areas (computer science or robotics or automation control systems or engineering or health care sciences services or psychology or social sciences, other topics or geriatrics gerontology or behavioral sciences or medical informatics or oncology or communication or telecommunications or information science, library science or education, educational research or pediatrics or social issues or neurosciences, neurology, or experimental medicine or urology, nephrology). An advanced search was conducted using these terms: (Social Robot * AND hospital *). The flow diagram was created as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [12] (see Figure 1).

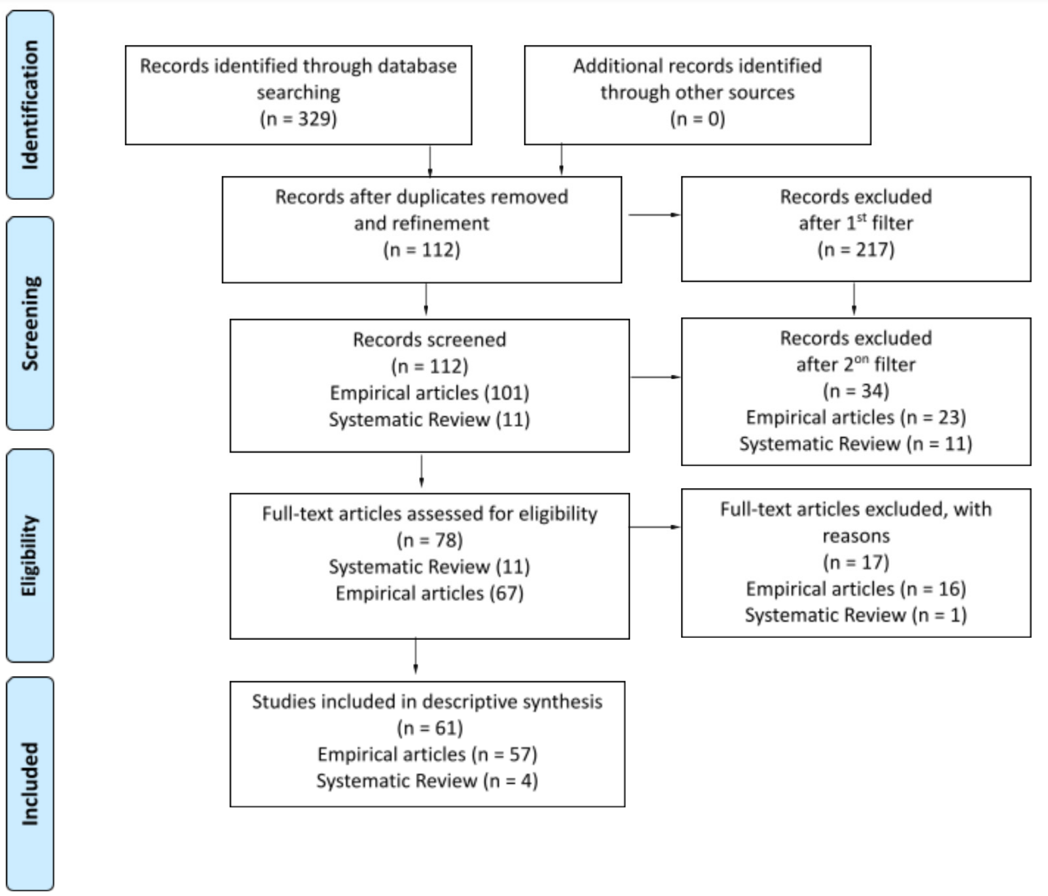

Figure 1. Flow diagram of the study selection process.

2.3. Inclusion/Exclusion Criteria for Selecting the Studies

Two filters were used to identify eligible studies and ensure the reliability of the systematic review in the first screening. In the first filter, the three authors, using the consensus agreement [13], applied the first filter by screening eligible articles based on their titles and abstracts. With the resulting articles, each author independently applied the second filter and completed an inclusion/exclusion checklist while screening the titles, keywords, and abstracts resulting from the primary search. A qualitative analysis was conducted using consensus agreement to settle a disagreement in one session [13].

The articles reviewed were screened by title, keyword, and abstract and then classified into three categories: (a) articles or systematic reviews excluded for meeting exclusion criteria; (b) articles or systematic reviews excluded for meeting exclusion criteria but related to the subject; or (c) articles included because they satisfy all the inclusion criteria (Table 1). The full texts of the latter group were analyzed to answer two research questions.

Table 1. Inclusion and Exclusion Criteria.

Inclusion Criteria	Exclusion Criteria
1. Type of publication: Empirical research and peer-reviewed articles and systematic reviews. 2. Study population: Participants of all ages. Participants with healthcare needs. 3. Keyword: hospitals. 4. Period: Published from 1 January 1960 to 31 March 2021. 5. Publication criterion: Written in English, any country.	1. Type of publication: No original data, such as reports, opinion studies, essays, or comments and no research. 2. No abstract available (first screening). 3. Study could not be retrieved (second screening).

3. Results

This search yielded 329 articles in two databases. After refinement involving document type, language, and research areas (Table 2), 112 articles passed the first screening. Based on the inclusion/exclusion criteria, we excluded 34 documents (23 empirical articles and 11 systematic reviews) with the second filter. Out of a total of 78 documents that were eligible to be read in full, 17 documents (16 empirical articles and 1 systematic review) were excluded after reading the full text for various reasons (13 studies could not be retrieved, 1 was written in a language other than English, 1 chapter, 1 collection of short, popular articles, 1 repeated). The total number of documents included in our review for analysis was 61 (57 empirical articles and 4 systematic reviews) (see Figure 1). Of all the papers analyzed, 22 were indexed in JCR (Q1 = 5; Q2 = 5; Q3 = 8; Q4 = 4), one in SJR (Q3), and 32 were published in proceedings.

Table 2. Search results by research area.

Research Area	Articles
Computer science	174
Robotics	134
Automation control system	127
Engineering	124
Health care sciences services	122
Psychology	51
Social sciences other topics	44
Geriatrics gerontology	30
Behavioral sciences	29
Medical informatics	25
Oncology	24
Communication	23
Telecommunication	23
Information science library science	22
Education educational research	18
Pediatrics	18
Social issues	18
Neurosciences, neurology	17
Research experimental medicine	17
Urology nephrology	17

A bibliometric analysis performed using Bibliometrix (an R-tool) and VOSViewer [14] was carried out on the 112 eligible documents after the first screening, that considered the importance of: 1. The annual occurrences vs. years, 2. Evolution in time of titles and abstract terms, 3. Details of the child cluster, 4. Details of clusters for older people, 5. Healthcare connections, and 6. Factorial analysis corresponding to Multiple Correspondence Analysis (MCA), which yielded four stable factors.

An analysis of the 3198 terms (titles + abstracts) revealed the evolution in time using full counting, with the restriction of a minimum of 10 occurrences per term. Sixty-nine met the threshold. The 60% most relevant terms are shown in Figure 2, a total of 41 terms. For instance, social robotic, information and healthcare appear as terms used more since 2018, Figure 3. A detailed view of the Children cluster allows us to identify specific social robots (i.e., Pleo) and applications in some diseases (i.e., cancer and depression). The same process was used to find another user profile (older adult) (Figure 4). In Figure 5, a binary count was carried out with a total of 323 links and 3 main clusters, one of them being healthcare context. This figure shows the main connections (social robot with study, human robot interaction and assistive robot) as different ways to address healthcare environments from an engineering perspective. Figure 6 also reveals that design and interaction are key topics in defining the areas of expertise of social robots and that the selection of papers can help us answer our research questions.

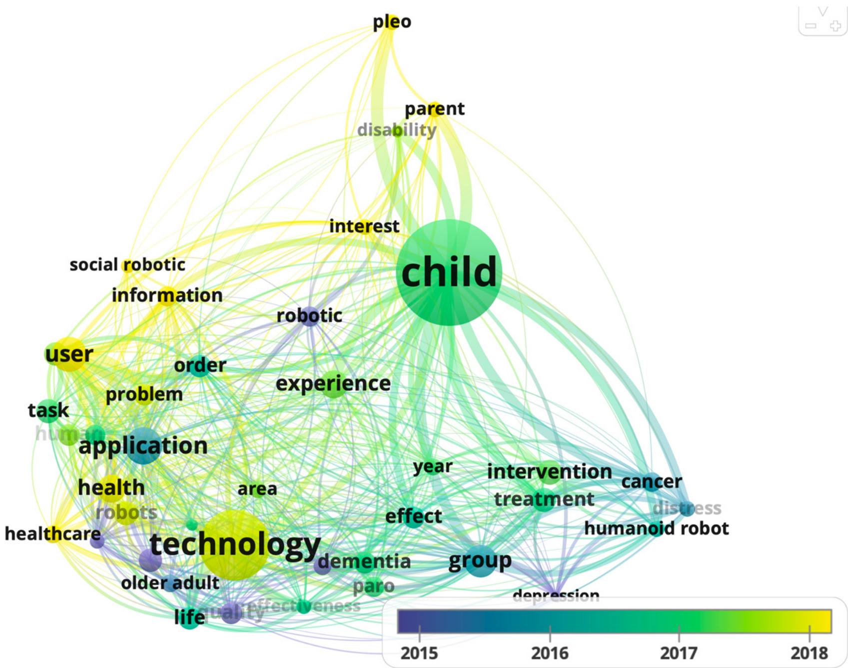

Figure 2. Evolution in time of titles and abstract terms.

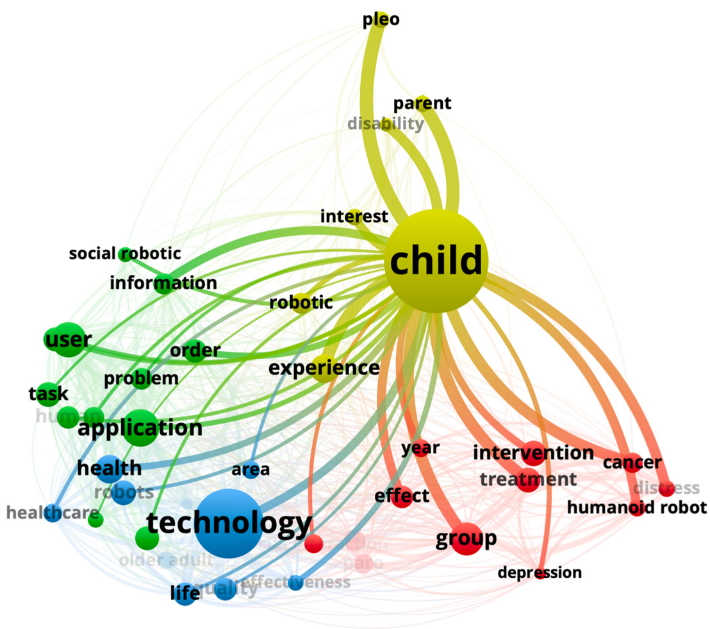

Figure 3. Details of the child cluster.

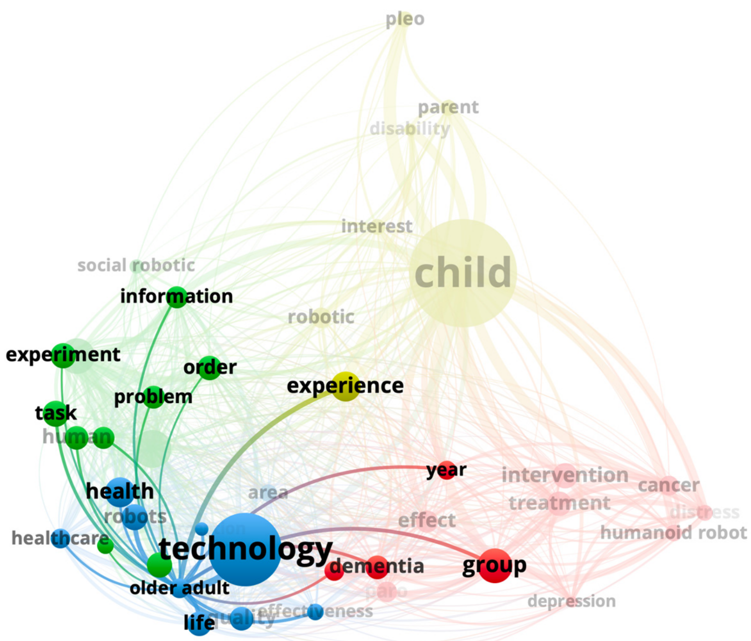

Figure 4. Details of the older adult cluster.

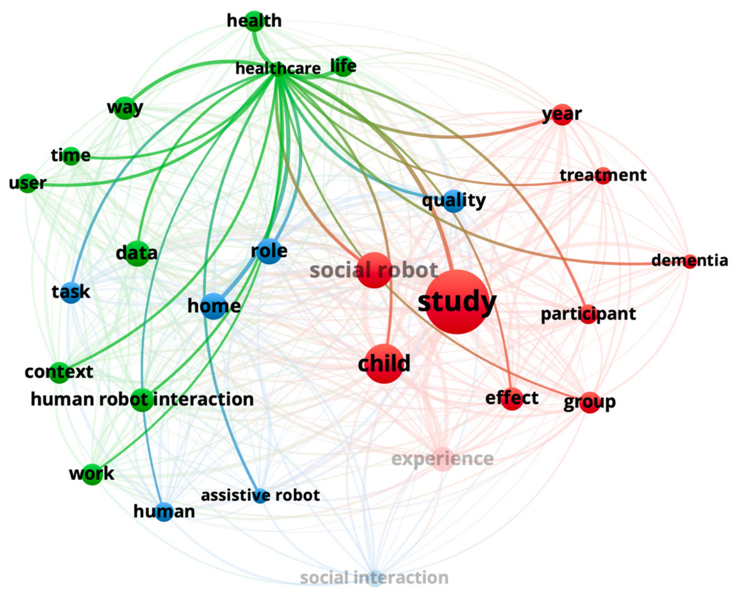

Figure 5. Healthcare cluster.

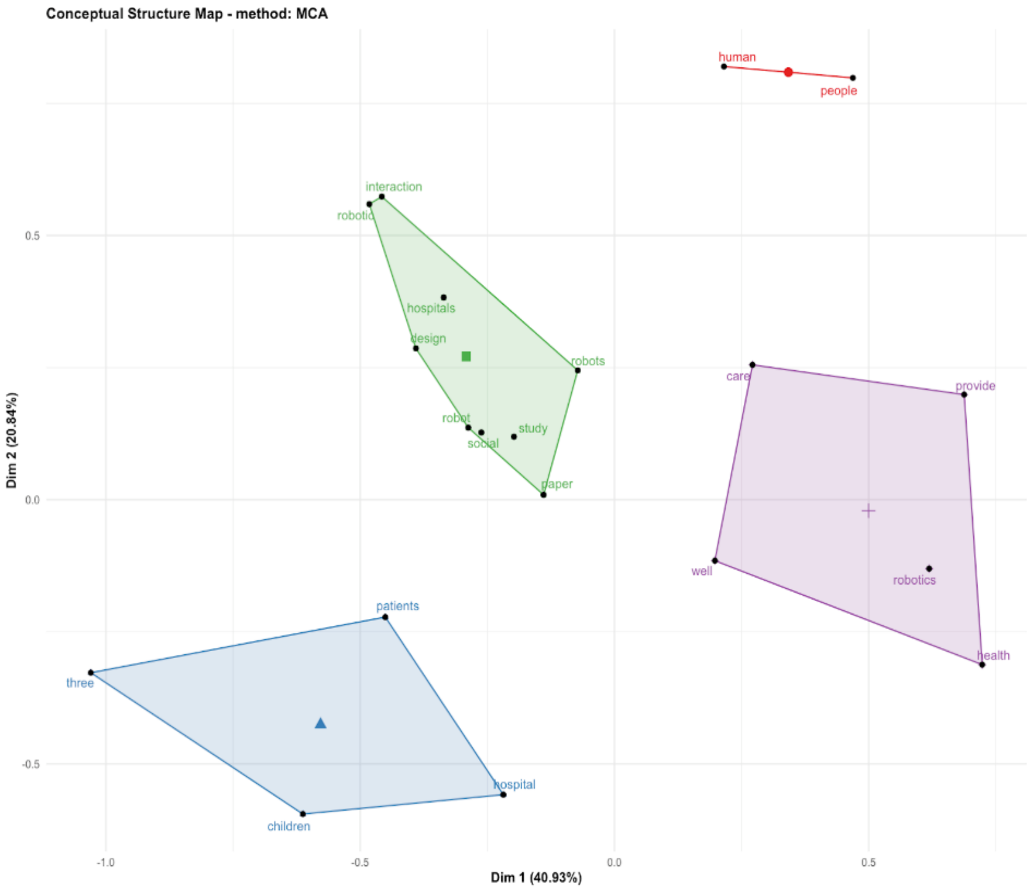

Figure 6. Factorial analysis corresponding to Multiple Correspondence Analysis (MCA). Four stable factors were found.

Two tables are presented below. Table 3 includes the articles identified that address the first research question, while Table 4 contains the articles that address the second research question. Later in the paper, reference is made to how these articles, in some cases, can answer both questions.

Table 3. Research question 1 (RQ1) on design approaches and main outcomes.

Authors	Goals	Population	Concept Origin	Main Outcomes
Cross, Emily S.; Ramsey,) Richard (2021) [15]	To provide a framework to classify all kinds of artificial systems.	Not applicable (technical paper)	Study/Survey.	A classification for artificial systems based on parameters and dimensions. Some factors can influence the design, such as expectations, cultural biases, and changing perceptions.
Sheridan, Thomas B. (2020) [16]	To categorize research into areas related to psychological aspects, engineering, assistance, and services.	Not applicable (technical paper)	Review to enhance psychology.	Psychology appears as the critical area for creating socially acceptable robots that are resourceful to human beings.
Ngo, Ha Quang Thinh; Le, Van Nghia; Thien, Vu Dao Nguyen; Nguyen, Thanh Phuong; Nguyen, Hung (2020) [17]	To contribute to children's wellbeing through interacting with the PLEO robot, connecting with	Children (hospitalized)	Contribution of PLEO to the children's wellbeing.	PLEO's interaction came with some behaviors (hugging, caring or technical exploration, calmness, activation, and/or

	parents or tutors in the interaction process, evolution of the interaction, and the child's psychological point of view.			making contact). Interaction with PLEO elicited positive emotions, like joy and curiosity. Negative outcomes when children did not observe the behavior they expected.
Moerman, Clara J.; Jansens, Rianne M. L. (2020) [18]	To address ethical issues coming to healthcare providers' attention involving AAL technologies in the elderly population.	Not applicable (addressed to elderly)	Assistive Ambient Living (AAL) in aging.	Factors that affect the elderly: the robot's role in caregiving, the interaction, the robot's physical appearance, ethics related to care, what the robot can or cannot do, and control over switching it off.
Bartlett, Madeleine E.; Costescu, Cristina; Baxter, Paul; Thill, Serge (2020) [19]	To characterize the questions that a social robot in the physical world must deal with to automate Autism Spectrum Disorder (ASD) diagnoses.	Children (ASD)	Social robot in the physical world.	Reliability and objectivity test of these definitions via Inter-Rater Agreement Information (IRA) using ADI-R and ADOS tools.
De Benedictis, Riccardo; Umbrico, Alessandro; Fracasso, Francesca; Cortellessa, Gabriella; Orlandini, Andrea; Cesta, Amedeo (2020) [20]	To create an expert structure able to provide a variety of assistive graphs evolving over time.	Adult patients (rehabilitation)	AI technologies: Automated Planning (AP), Knowledge Representation and Reasoning (KR), and Reinforcement Learning (RL).	The integration of model-based and model-free AI technologies can contextualize the robot's assistive behaviors and decide what to do and how, as well as the characteristics and needs of the people assisted.
Cooper, Sara; Di Fava, Alessandro; Vivas, Carlos; Marchionni, Luca; Ferro, Francesco (2020) [21]	To review how robots can assist older adults, people with mobility problems, hospital patients, and users who need healthcare.	Aging population and users with multiple chronic diseases (Review)	Socially Assistive Robots.	Research has shown that robots can lower the degree of stress and anxiety among older people with dementia, and that they can be adapted to be telepresence robots.
Turja, Tuuli; Parviainen, Jaana (2020) [22]	To expose and bring attention to our knowledge of robot acceptance and, concretely, to workers' concerns.	Nurses, Physiotherapists, Instructors, other professions	PARO and NAO.	There is a difference in the acceptance of robots in hospitals and homes, with this technology being more accepted in the workplace.
Beane, Matthew, I. (2020) [23]	To note that robots have not only a functional and instrumental value. The hospital services are enhanced.	Healthcare Professionals	RP-7 robotic telepresence system.	There are three outcomes: robots can add value, such as quality, status, or enhanced access to services; a collateral effect of using robots in hospitals was an increase in their revenue; marketing, fundraising, and business development activities can benefit from employing robots.

Moerman, Clara J.; van der Heide, Loek; Heerink, Marcel (2019) [24]	To provide a review to inventory the use of SAR in hospitals.	Children (Review)	SAR review.	The findings show that SAR have a positive impact on a child's emotional state.
Neerincx, Mark A.; van Vught, Willeke; Henkemans, Olivier Blanson; Oleari, Elettra; Broekens, Joost; Peters, Rifca; Kaptein, Frank; Demiris, Yiannis; Kiefer, Bernd; Fumagalli, Diego; Bierman, Bert (2019) [25]	To provide a socio-cognitive engineering (SCE) methodology. It conducts research and development for HRI.	Children	Socio-cognitive engineering (SCE) methodology.	Four outcomes appeared (joint objectives, agreements, experience sharing, and feedback and explanation) plus an information layer base and interaction design to consider the long-term regulation of children's diseases.
Logan, Deirdre E.; Breazeal, Cynthia; Goodwin, Matthew S.; Jeong, Sooyeon; O'Connell, Brianna; Smith-Freedman, Duncan; Heathers, James; Weinstock, Peter (2019) [26]	To introduce SR technology to pediatric patients.	Children	Introduction of SR technology to pediatric patients.	Joy and agreeable states achieved high levels, better than with other interventions.
Melo, Francisco S.; Sardinha, Alberto; Belo, David; Couto, Marta; Faria, Miguel; Farias, Anabela; Gamboa, Hugo; Jesus, Cada; Kinarullathil, Mithun; Lima, Pedro; Luz, Luis; Mateus, Andre; Melo, Isabel; Moreno, Plinio; Osorio, Daniel; Paiva, Ana; Pimentel, Jhielson; Rodrigues, Joao; Sequeira, Pedro; Solera-Urena, Ruben; Vasco, Miguel; Veloso, Manuela; Ventura, Rodrigo (2019) [27]	To illustrate the INSIDE system, where mobile robots are present during therapy for ASD.	Children (ASD)	INSIDE system.	Wizard of Oz helped to improve the perception and behavior modules in social interaction. The robot was able to be autonomous in the end.
Nguyen Dao Xuan Hai; Luong Huu Thanh Nam; Nguyen Truong Thinh) (2019) [28]	To design and implement a telepresence robot to allow communication and interaction in different environments.	Elderly	Telepresent robot design and development.	Telemedicine provided benefits, such as communication and interaction assistance, to elders.
Ahn, Ho Seok; Yep, Wesley; Lim, Jongyoon; Ahn, Byeong Kyu; Johanson, Deborah L.; Hwang, Eui Jun; Lee, Min Ho; Broadbent, Elizabeth; MacDonald, Bruce A. (2019) [29]	To update the receptionist system robot in a healthcare setting. HealthBots are divided into a receptionist robot, a nurse assistant robot system, and a server.	University students (Healthcare)	EveR4, Nao and ReceptionBot.	They developed different types of modules (perception, decision-making, and reaction modules) and organized two case studies to look for basic social features for receptionist robots in the hospital.
Sequeira, Joao S. (2019) [30]	Development of a social robot.	Children	Child interaction with an mbot.	Implement humanistic knowledge.
Meghdari, Ali; Shariati, Azadeh; Alemi, Minoo;	To design and develop a mobile social robot	Hospitalized Children (cancer)	Design of social robots	Design and construction phases of a social robot

Nobaveh, Ali Amoozandeh; Khamooshi, Mobin; Mozaffari, Behrad (2018) [31]	companion for use by children with cancer during healthcare.			and its specifications (mechanical, electronics, and control aspects of the robot).
Valles-Peris, Nuria; Angulo, Cecilio; Domenech, Miquel (2018) [32]	To analyze children's thoughts of Human–Robots Interaction in social robot environments in hospitals, taking into account ethical and social values when designing a SAR.	Hospitalized children	HRI- Child-Robot Interactions.	Potential of studying the imaginaries of HRI, and it concludes that their integration in the final design of robots provides a way to incorporate ethical values.
Burns, Rachael; Jeon, Myounghoon; Park, Chung Hyuk (2018) [33]	To provide a framework to improve human–robot interaction through robotic imitation of users' gestures.	University Students (addressed to children with autism)	Imitation in Robots.	A humanoid robotic agent fraternizes with and plays games with a user. Subjects exhibited positive emotional states, better mood contagion instances towards the robot, and improved autonomy.
Chen, Chaona; Garrod, Oliver G. B.; Zhan, Jiayu; Beskow, Jonas; Schyns, Philippe G.; Jack, Rachael E. (2018) [34]	To reverse engineer psychologically valid facial expressions of emotion into SAR.	Not applicable (technical paper)	Reverse engineering.	Reverse engineer methodologies updated for flexible facial expressions into a social robot head. Benefits of taking into account human users to derive facial expressions for SARs. Psychology is a relevant discipline in designing social robots.
Papadopoulos, Irena; Koulouglioti, Christina; Ali, Sheila (2018) [35]	To observe hospital staff's uses of SARs in the health and social care sector.	Nurses, Healthcare, Professionals, Social Care workers (Review)	Assistive humanoid utilizations and animal-like robots in the health and social care sector.	Hospital staff expressed mixed views regarding the use of robots in a healthcare context. They mainly thought of the challenge that robots may pose to patients and not to themselves. They included a tasks list for the robots; they bore in mind ethical values, such as safety or privacy.
Um, Dugan; Park, Jangwoon; Shin, Jeongsik; Lee, Woo Ho (2018) [36]	To capture people's images and social media content for social activities and/or health monitoring use. Image capturing processes were optimized using a visual servo.	Elderly	Social robotics—Navigation.	Autonomously capture users' images and feed pictures and live-motion clips to social media or hospitals for health monitoring purposes.
Dodds, Penny; Martyn, Katharine; Brown, Mary (2018) [37]	To prevent and avoid infection, prevention control standards.	Elderly (Dementia)	Therapeutic robot.	This paper presents an intelligent function to inform people around the elderly, like family or a

				care manager, of the dementia diagnosis results.
Larriba, Ferran; Raya, Cristobal; Angulo, Cecilio; Albo-Canals, Jordi; Diaz, Marta; Boldu, Roger (2016) [38]	To encourage PLEO uses in children with families.	Children, Families	PLEO is a robot that imitates a *Camarasaurus* dinosaur. It exhibits an appealing expressiveness and consists of a list of different behaviors and moods.	This paper describes how this technological point of view is being developed and tested. This technical improvement in Pleo involves maintaining the child's attention and engagement and recording the child's evolution for clinical purposes. Some improvements have been revealed involving the operation of the platform.
Shayan, Amir Mehdi; Sarmadi, Alireza; Pirastehzad, Armin; Moradi, Hadi; Soleiman, Pegah (2016) [39]	To address the development of RoboParrot 2.0 and discuss the potential values of deploying RoboParrot in different environments.	Not applicable (technical paper—involves autism, screening, elderly, children)	Portable and semi-autonomous SAR.	The RoboParrot 2.0 prototype is ready to be used in clinical centers for assisted ASD therapy, nursing homes, and in homes of autonomous older adults for companionship and entertainment.
Banthia, Vikram; Maddahi, Yaser; May, Morgan; Blakley, David; Chang, Zixin; Gbur, Amanda; Tu, Chi; Sepehri, Nariman (2016) [40]	To present the development of a GUI for a commercially available humanoid robot to explore its interaction with children.	Children	Humanoid Robot.	Results indicated that children and parents/staff expressed great interest in using the system developed and believed that such a robot could be a helpful therapy tool for child with ASD.
Yu, Ruby; Hui, Elsie; Lee, Jenny; Poon, Dawn; Ng, Ashley; Sit, Kitty; Ip, Kenny; Yeung, Fannie; Wong, Martin; Shibata, Takanori; Woo, Jean (2015) [41]	To investigate the use of PARO with people with dementia as a therapeutic SAR pet for improving mood and stimulating social interaction and communication.	Older adults (mild to moderate dementia)	Therapeutic treatment of dementia.	This study showcases a novel activity to improve mood and stimulate social interaction and communication in community care of older people with dementia, and provides an evidence base for using said SARs. Further research is warranted to examine the use of PARO to manage the behavioral and psychological symptoms of dementia using customized approaches.
Ono, Saika; Obo, Takenori; Kiong, Loo Chu; Kubota, Naoyuki (2015) [42]	To provide a functional structure for improving the daily lives of older adults to ensure their wellbeing, and to examine the effectiveness of relational trust for robot communication.	Elderly	Humanoid Robot: Robot Communication based on Relational Trust Model.	The article proposes a method of relational trust modeling based on reinforcement learning.

Goncalves, David; Arsenio, Artur (2015) [43]	This paper describes the construction, design, and early development process of an external structure for several MoNARCH mobile robots used in a healthcare context.	Children (specific needs).	YDR for conceiving the Monarch fleet of mobile, cognitive robots.	1. What to do and what to avoid in robot design 2. Multidisciplinary approach using functional and aesthetic features and economic factors combined with human factors.
Nergui, Myagmarbayar; Komekine, Keisuke; Nagai, Hiroki; Otake, Mihoko (2015) [44]	To ascertain correct motions in the laughter of robots based on human motions. To have a robot recognize a face, facial expression, speech (synthesis and some contents) to assist and influence older people in dialogues.	Young people (addressed to older people)	Conversational robot to support the rehabilitation of patients with dementia.	The sounds "fu-fu-fu" and "ha-ha-ha" coming from the robot were achieved using hand movements just in front of the mouth; meanwhile, another sound, "wa-ha-ha-ha", was produced when the hand's robots were moved.
Ferreira, Isabel; Sequeira, Joao (2014) [45]	To provide the MOnarCH Project with a fleet of networked robots (NRS) with cognitive skills to define the interaction context.	Children	Interactions between robots with children to improve quality of life.	The MOnarCH mission project's explanatory conclusions reveal an improvement in the quality of life of hospitalized children. The robots, by interacting with children in a hospital, keep them involved in socially exciting activities, play with them, and play the role of assisting schoolteachers.
Van Wynsberghe, Aimee (2013) [46]	To integrate ethics into robot development in healthcare, and illustrate it using an example.	Children (cancer)	CCVSD (Care-Centered Value-Sensitive Design) approach.	A "wee-bot" robot was used in urine tests with pediatric oncology patients following CCVSD. The requirements that need ethical consideration and the protocol to follow were integrated into this approach using different prototypes.
Lewis, Matthew; Canamero, Lola (2013) [47]	To develop an interacting SAR in order to help hospitalized children.	Professional dancer, actor Coached (by a director)	Social expressive human–robot interaction.	The clarity of interpretation is considered an advantage; however, believability and engagement can be negatively affected by continuous repetitions. Micro-expressions that are so rich in real life are not achieved by the robot and affect the children's interaction.

Elara, Mohan Rajesh; Rojas, Nicolas; Seah, Sue; Sosa, Ricardo (2013) [48]	To provide an approach to design social spaces for assistant robots with easy actions that enable robots to trespass their boundaries and achieve their planned missions.	Singapore hospital community	Robot for service and human–robot interaction.	A different approach from the classical bottom-up characterization. Five guidelines are suggested: observability, accessibility, manipulability, activity, and safety to assist the outstanding autonomous robotic systems in indoor and outdoor places.
Beer, Jenay M.; Takayama, Leila (2011) [49]	To obtain opinions from older adults on a mobile remote presence system; older adults' perceived benefits and concerns about the system, and their criteria to participate.	Older adults	Mobile remote presence (MRP) system.	Acceptance, Benefits, and Concerns are discussed: Social norms influence the design (it is difficult to refuse a call if you can see the interlocutor). Older adults prefer the mouse over a graphical user interface.
Rogozea, Liliana; Leasu, Florin; Repanovici, Angela; Baritz, Mihaela (2010) [11]	To diagnose the ethical scope used in medicine and enhance intelligence in robots.	Medicine context	Ethical approach.	Robo-Ethics is a guide for involving robots in medicine. Even for the university curriculum and bio-engineering fields.
Goris, Kristof; Saldien, Jelle; Vanderniepen, Innes; Lefeber, Dirk (2009) [50]	To provide background information on the Probo robot and present experimental results for a robot head prototype that exhibits facial expressions.	Children	The huggable robot Probo.	A robot with an actuated head that can be hugged and characterized by an animal shows expressions. It provides engagement using an interface.

Table 4. Research question 2 (RQ2) on the uses and applications of social robots.

Authors	Goals	Population	Concept Origin	Main Outcomes
Sutherland, Craig J.; Ahn, Byeong Kyu; Brown, Bianca; Lim, Jongyoon; Johanson, Deborah L.; Broadbent, Elizabeth; MacDonald, Bruce A.; Ahn, Ho Seok (2019) [51]	To study people's perception of a medical receptionist robot.	University	Friendliness of robots.	A robot can be a friendly receptionist.
van der Putte, Daisy; Boumans, Roel; Neerincx, Mark; Rikkert, Marcel Olde; de Mul, Marleen (2019) [52]	Investigate the ability of a social robot to autonomously take over the administration of a questionnaire.	Adult patients Nurses	Autonomous administration of questionnaires.	One could imagine scenarios in which the robot saves time on routine tasks with automatic storage in the patients' electronic medical records. There is a concern about using the robot at the expense of direct personal patient care.
Sarabia, Miguel; Young, Noel; Canavan, Kelly; Edginton, Trudi; Demiris, Yiannis; Vizcaychipi, Marcela P. (2018) [53]	To verify whether adult patients are happy interacting with social robots while hospitalized.	Adult patients (some with dementia)	Combating social isolation in hospitals with assistive robots.	Patients in the hospital enjoy socializing with robots.

Meghdari, Ali; Shariati, Azadeh; Alemi, Minoo; Vossoughi, Gholamreza R.; Eydi, Abdollah; Ahmadi, Ehsan; Mozafari, Behrad; Nobaveh, Ali Amoozandeh; Tahami, Reza (2018) [54]	To assess children's acceptance, feelings, and involvement with the robot and determine how much the robot resembled the sketch.	Child patients (cancer)	Designing social robots as a companion.	Pediatric patients with cancer engage with and are interested in this robot.
Eriksson, Yvonne (2018) [55]	To understand how the design (from appearance and socio-cultural aspects) of the robots influence older people, their relatives, caregivers, and decision-makers.	Elderly	Robot perception.	The influences of current and historical culture and media on both the perceptions and experiences of aging. The relations of the perceptions and experiences to the acceptance (or not) of robots as tools for nursing older adults.
Rouaix, Natacha; Retru-Chavastel, Laure; Rigaud, Anne-Sophie; Monnet, Clotilde; Lenoir, Hermine; Pino, Maribel (2017) [56]	To investigate the use of a humanoid robot in psychomotor therapy.	Elderly (dementia)	Assistive humanoid and animal-like robots.	Health and social care workers reported mixed views regarding the use of robots in a healthcare setting. The impact that robots have on patients related to safety and privacy.
Hebesberger, Denise; Koertner, Tobias; Gisinger, Christoph; Pripfl, Juergen (2017) [57]	To assess a long-term autonomous robot deployed in a real-world context in a care center for older adults.	Older adults/Elderly (Severe multimorbidity and dementia)	Robot-assisted therapy and care facility.	The interaction must meet the needs of specific end-user groups. The perceived utility of a robot is very much tied to its tasks and proper functioning. The social acceptance was ambivalent.
Shukla, Jainendra; Barreda-Angeles, Miguel; Oliver, Joan; Puig, Domenec (2017) [58]	To assess the effects of using robots during cognitive stimulation tasks during caregiver workloads.	Caregivers (Nursing home)	(SAR) Socially Assistive Robotics.	There was a significant reduction in caregiver burden. A concern was raised about the need for specific training of caregivers.
Jeong, Sooyeon; Breazeal, Cynthia; Logan, Deirdre; Weinstock, Peter (2018) [59]	To investigate how different interventions affect physical activity and social engagement in child patients.	Child patients	Interventions for pediatric care in child life program.	The children interacted longer and talked more when given a social robot than when given a virtual character or a plush toy. The family members, co-present but not directly engaged in the interaction during an intervention, were more likely to interact. A social robot could have a significant socio-emotional impact on children's hospitalization engagement, wellbeing, and general hospital experience.
Meghdari, Ali; Alemi, Minoo; Khamooshi, Mobin; Amoozandeh, Ali; Shariati, Azadeh; Mozafari, Behrad (2016) [60]	To demonstrate the conceptual design features of a mobile social robot ("Dr. Arash") for edutainment and therapeutic interventions in hospitalized children.	Children (cancer) Psychologists	Quality of life during the treatment process.	The design of robots (mobile social robot) intended to meet the needs of the population in question needs to consider: 1/ design factors, dimensions, and degrees of freedom, movement system, actuators and sensors, the physical appearance of the robot, design of the head, design of the face, communication modules.

Sequeira, Joao Silva; Ferreira, Isabel Aldinhas (2016) [61]	To assess the relationships that are established between humans and MOnarCH robots in a social environment.	Children Adults (team members, parents, and visitors, Staff)	Integration of the robot in a specific social environment.	MOnarCH social robots may play a highly positive role in socially difficult environments.
Diaz-Boladeras, Marta; Angulo, Cecilio; Domenech, Miquel; Albo-Canals, Jordi; Serrallonga, Nria; Raya, Cristobal; Barco, Alex (2016) [62]	To provide smart company to alleviate feelings of anxiety, loneliness, and stress in children patients and their companions.	Children	Design and deploy a robotic pet for pediatric care in the Child Life program.	Robotic pets had the effect of mediating and facilitating interaction and relationships between the different agents involved in the care process. The robot took on different roles: as a distractor, as a featured toy, as a companion.
Orejana, Josephine R.; MacDonald, Bruce A.; Ahn, Ho Seok; Peri, Kathryn; Broadbent, Elizabeth (2015) [63]	To test the feasibility and usefulness of robots in managing the medication of older patients living alone.	Older adults/Elderly (Chronic health conditions)	Medical care, utilization, quality of life, adherence, and robot acceptance.	The patients were primarily positive and accepting of the robot, acknowledging its benefits as a companion: reduced medical care utilization, increased quality of life, increased adherence, and companionship. More familiar games may be more accessible for older people to relate to and increase user confidence. It is feasible to use assistive healthcare robots in homes in this population.
Alemi, Minoo; Meghdari, Ali; Ghanbarzadeh, Ashkan; Moghadam, Leila Jafari; Ghanbarzadeh, Anooshe (2014) [64]	To propose a new approach that considers the effect of a humanoid robot as a therapy assistant in treating pediatric distress.	Children (Cancer)	Humanoid robot with different communication abilities.	A humanoid robot can be beneficial: by elevating the efficacy of interventions, encouraging kids to be more interactive, and it can be significantly helpful in teaching them their afflictions, instructing them on methods to confront their distress themselves and take control of their situation.
Alemi, Minoo; Meghdari, Ali; Ghanbarzadeh, Ashkan; Moghadam, Leila Jafari; Ghanbarzadeh, Anooshe (2014) [65]	To explore the impact of humanoid robots as a therapy assistant to deal with distress in child patients.	Children	Humanoid Robot as a Therapy-Assistant.	Feasibility of using social robots in psychological interventions for anger, anxiety, and depression in pediatric cancer.
Robinson, Hayley; MacDonald, Bruce; Kerse, Ngaire; Broadbent, Elizabeth (2013) [66]	To investigate the psychosocial effects of the companion robot to improve the quality of life, mood, and loneliness in elderly residents.	Older adults/Elderly (nursing home patients)	Robot to improve care (psychosocial effects).	The use of the seal robot was effective, with users exhibiting lower loneliness scores from baseline to follow-up compared to a control group.
Bartlett, Madeleine E.; Costescu, Cristina; Baxter, Paul; Thill, Serge (2020) [19]	To characterize the problems that a social robot faces in the real world when automating an Autism Spectrum Disorder (ASD) diagnosis.	Children (ASD)	Social robot in the real world.	1. It is feasible to incorporate technology-based means into the ASD diagnostic process. 2. Social robotics is explored in relation to technological issues (mostly solved) and understanding human–robot interactions from the

				Wizard of Oz studies (yet to be solved).
Boumans, Roel; van Meulen, Fokke; Hindriks, Koen; Neerincx, Mark; Rikkert, Marcel Olde (2020) [67]	To design a multi-modal dialogue for a social robot to acquire PROMs for older patients.	Elderly	Pepper robot from Softbank Robotics.	The effectiveness, efficiency, and usability perceived by older adults of acquiring PROMs from a social robot was positive, favorable, and appreciated.
Hung, Lillian; Gregorio, Mario; Mann, Jim; Wallsworth, Christine; Horne, Neil; Berndt, Annette; Liu, Cindy (2019) [68]	To analyze perceptions of experiences with PARO robots in a hospital setting.	Older people/Elderly (Dementia)	Human–robot and human–human interactions in a hospital.	The robot helps people with dementia maintain a sense of self in the world (friend), the baby seal facilitates social connection (conversation), and the robot transforms and humanizes the clinical environment (happiness).
Henry, Julie; Leprince, Tanguy; Robles, Sandra Garcia; Famery, Alexandra; Boyle, Helen; Gilis, Lila; Witz, Christine; Barland, Jean-Christophe; Blay, Jean-Yves; Marec-Berard, Perrine (2020) [69]	To evaluate the perceived benefits and difficulties encountered by users and their families (family dynamics).	Children, (Diabetes) Families (parents, siblings) Nursing staff	Benefits of telepresence robots.	Patients saw a benefit in maintaining a connection with their siblings and the retention of their role in the family. The contact with their child reassured parents. The nursing staff's professional relationship with the children was enhanced and they interacted with the children's extended family.
Jurdi, Sandra; Montaner, Jorge; Garcia-Sanjuan, Fernando; Jaen, Javier; Nacher, Vicente (2018) [70]	To analyze existing approaches in order to identify gaps for future research.	Child patients (Review)	Game Technologies.	Social robots as game technologies present physical and psychological benefits to hospitalized children. They motivate children in physical rehabilitation and different medical procedures.
Ali, Sara; Samad, Mohammad; Mehmood, Faisal; Ayaz, Yasar; Qazi, Wajahat Mehmood; Khan, Muhammad Jawad; Asgher, Umer (2020) [71]	To control NAO robot with an interface developed using the MyoArmband sensor.	Adults	NAO and MyoArmband targeted for patients with severe medical conditions	Interface in progress and as a future framework for robots targeted for users with severe medical conditions who cannot communicate using normal communication channels with the robot.
Hung, Lillian; Liu, Cindy; Woldum, Evan; Au-Yeung, Andy; Berndt, Annette; Wallsworth, Christine; Horne, Neil; Gregorio, Mario; Mann, Jim; Chaudhury, Habib (2019) [72]	To find key benefits and barriers using PARO.	Older people with dementia	Benefits and barriers in PARO use.	The key benefits identified were: decreased negative emotions and behavioral symptoms, as well as enhanced social engagement. Thus, mood and quality of experience augmented. The same happened with patients with anxiety and depression.
Kobayashi, Toru; Sameshima, Naohiro; Imai, Tetsuo; Arai, Kenichi; Watanabe, Tomoki;	To have a complete operational robot for	Elderly (dementia)	Conversational diagnosis method integrated in a robot for	Messages can be sent using the LINE app that the robot can execute.

Miyazaki, Teiichiro; Tsujino, Akira (2019) [73]	the elderly with dementia, an artificial intelligence diagnosis tool was added, which provides a conversational diagnosis method.	the elderly with dementia.

4. Discussion

We have found in the literature numerous terms related to social robots such as (1) chatbot, (2) bot, (3) virtual assistant, (4) robot companion, (5) artificial social, intelligent machine, (6) social assistive robots, (7) telepresence robot, (8) remotely operated robot, (9) personal assistant, and (10) autonomous robot. In a way, all of them fall within our scope; the difference among them comes from the fact that some of them combine software and hardware (4–10), while others are usually only software (1–3). [43,60] offer exhaustive and historical reviews of robots. Specifically, in a healthcare context, we found that the most accurate definition is related to the central care concept. Thus, a social robot aims to serve a person in a caring interaction rather than perform a mechanical task [16], and it usually has hardware and software components.

As if this were not enough, there are also other associated terms that are commonly used that range from small, handheld devices like smartphones, to thermostats and pet-like robots, such as Paro or MiRo, all the way to life-sized humanoid robots, such as Nadine or Moxie. This suggests that this undertaking represents a highly variable space [15]. This article provides a technology classification: objects (i.e., a chair), tools (i.e., hammer), machines (i.e., coffee machines), artificially intelligent machines (i.e., smartphone), and artificially socially intelligent machines (i.e., Paro). Our target is the last of these, and sometimes semantics are involved, as we saw in the first paragraph. A series of dimensions is proposed in [15] to describe all of them in more detail: Prior experience/expectations, Automated functionality, Functional Repertoire, Form-function mapping, Size, Human-like form or motion, Socialness, and Intelligence.

When technology is a means to an end, some adaptations involving Lego are used [74] in the robotics program. Cloud computing technology is present too; Google and Microsoft have released chatbot health-platform services that are usable in everyday life [75].

The control of one's actions and their consequences, or the sense of control, is called a sense of agency (SoA). Cozmo robots and Cozmo cubes reduce it, and in return, show that reduced SoA is not observed in the presence of a passive non-agent device [76].

In this work, we focused on the healthcare context. However, there are other reviews in other contexts, such as urban spaces and in artificially socially intelligent machines called social robots [47]. Next, we are going to discuss designing and interacting with social robots in healthcare contexts.

RQ1. How are social robots designed? Are they ethically designed?

The development of social robots includes several algorithms as well as different implementations, such as face recognition, speech recognition, cognitive and decision-making modules [29,39,40,42,44,60,61,66], emotional modules [47,50], and ergonomics [43], which must also be considered fundamental. Achieving new levels of conversational modeling and knowledge and providing intelligent interactive platforms that can interact with users is a promising field [75].

We found that 75% of HRI studies are laboratory-based [15], mainly intended to study certain aspects, such as prior experience/expectations, automated functionality, functional repertoire, form-function mapping, size, human-like form or motion, socialness, intelligence, and other bases for the development of robotic technology [34]. However, long-term interaction is a challenge for socially assistive and educational robots [23], and HRI research can be improved by studying the contexts [25].

Considerable research is being conducted in this regard to improve the navigation of social robots [27,28,30,48,61] in spaces where they must coexist with humans in accordance with subtle cultural rules [17] and taking into account certain disabilities, such as hearing impairment [77]. In [17], a model is proposed for the motion of a robot inside a hospital environment. Moreover, as a result of the COVID-19 pandemic, social interaction is restricted, and a minimum distance between robots and humans should be respected.

Regarding the appearance of robots or the features of robots intended for use by children or the elderly, pet-like SAR, like dinosaurs or animals (Pleo, Paro, Parrot, Aibo, Huggable, or iCat) are preferred [18,21,26,34,38]. People can also interpret affective non-verbal behavior in robots [21]. A stress-reducing effect on people who are ill in childhood and old age has been identified [24,62]. As concerns human-like robots, NAO is one of the most accepted robots in healthcare [65]. [16] found the main concern with social robots to be their cultural acceptance and skills. Additionally, feminine robots are preferred by users. Another concern found in this study was to understand what the human is doing; however, the robot's appearance depends on its application, the user's age, and several other factors [33,60,61].

As a method for designing and implementing AAL facilities, the person-centered process has been found to be the best design methodology, as it allows for conversations between participants and healthcare professionals [78]. However, [19] found that highly developed algorithms were needed to integrate more general cognitive aspects in the robot to enable it to diagnose certain illnesses, such as ASD. Another methodology that is useful in healthcare contexts (children with diabetes) is Socio-Cognitive Engineering (SCE) [25], as it enables the integration of different theories, models, and visions of patients and caregivers. More ingredients can be added to the interaction, such as prediction and feedback. Such is the case when using NAO in heart disease settings, which offers users a new way to understand the meaning of their vital signs through human–robot interaction [79].

Although social robots can promote fundamental values of care (i.e., patient safety, dignity, and wellbeing [22,32]), some researchers believe that doing experiments to test social robots with child patients is not ethical [80]. Besides, care services are highly regulated, and special legislation is required for care-work robotics [22].

According to the International Federation of Robotics (IFR), there is a framework of components of ethical importance, the CCVSD (Care-Centered Value-Sensitive Design) approach [46]. It consists of a framework of components of ethical importance that provides a list of components to take into consideration when evaluating a care robot: the use context, the care practice, the actors involved, the type of care robot (its capabilities, appearance, etc.) and the list of values involved for the practice in question in the stated context (i.e., the interpretation and prioritization of care values) [46].

We found some ethical principles applied to the design of social robot applications in healthcare, such as autonomy, beneficence, non-maleficence, fidelity, justice, utility, and independence [78]. The same authors noted certain ethical requirements in artificial intelligence algorithms for AAL and social robots, like (1) human agency, (2) robustness, (3) privacy, (4) transparency, (5) non-discrimination, (6) wellbeing, and (7) accountability to account for the negative impacts of the systems. Some social robots must comply with the three fundamental guidelines of the Policy Department for Economic, Scientific, and Quality of Life Policies (IPOL) (i) Hospitality and inclusiveness, (ii) Comprehension of individual needs, and (iii) Non-intrusiveness [65]. The ethical dilemma must reconcile the technical problems with patients' needs and rights, with health care services and hospital facilities, in keeping with the ethics in robotics used in medicine [11]. Ethical concerns in the design and use of social robots have been raised involving privacy, restraint, deception, accountability, and psychological damage [45].

Safety—both physical safety and psychological safety [16,17,43]—is another principle considered when designing social robots for healthcare. Security issues such as privacy violations and privacy protection for individuals have been considered in the design [47,65,81].

RQ2. What are the main uses and applications of social robots in healthcare?

Social robots can help with the global problem of the shortage of specialized medical personnel by doing several tasks [82], but their implementation in hospitals must be carried out conscientiously [23]. Robots have been used to quantify significant harm levels in autistic children, by professional caregivers of the elderly, to accompany the elderly while walking, to help persons with motor impairment (i.e., quadriplegia), to monitor and correct during rehabilitation for head, neck, and back pain [16,36], and as a mediator in the interaction with the physician or nurse who performed the treatment [18]. Additionally, social robots can be rehabilitation therapists at home [20] or do administrative tasks, such as reception [29,51] in hospitals [22,60]. They have also been used for edutainment purposes [30,70,80]. Moreover, robots can remind people to take medications, they offer entertainment and memory games, and can be used for videoconferencing [63]. They can be used remotely, connecting the hospital and a patient's home [28,69,70]. Moreover, robots have been used to administer automatic questionnaires [52].

During the pandemic, social robots were employed for various purposes, such as the use of drones to enforce quarantine restrictions, alerting individuals to return to their homes, delivering medicine to patients with Covid-19 in Wuhan, and transferring test samples or helping with hospital admissions [6,8,10]. Additionally, mobile robots have been used for hospital logistics by sterilizing surfaces with UV light. Robots have been used to take temperature automatically using a thermal sensor. Social robots have reduced the loneliness of people and improved their mental health [8,83].

In healthcare specifically, care workers reject the use of social robots due to their perceptions of their applications, which poses a challenge to the effective implementation of social robots in hospitals [22].

There are two groups where applications that rely on social robots are more widespread within the healthcare environment, namely the elderly and children.

(a) Elderly

The elderly can benefit from these assistive technologies. In [84], the researchers classify them as ICT (Information and Communication Technologies), Robotics, Telemedicine, Sensor Technology, Video games, and medication dispensing devices. They found that the studies targeted eight problems involving older adults: (1) dependent living (R), (2) fall risk, (3) chronic disease, (4) dementia, (5) social isolation (R), (6) depression (R), (7) poor wellbeing, and (8) poor medication management. (1), (5), and (6) were managed with help from social robots. Social robots have also been used for dementia rehabilitation in hospitals [37,41,44]. Robots have been used to improve quality of life and mood in the elderly, while reducing their loneliness [66].

Emotions are connected to social interactions [55]; this is the case for the elderly and (4) dementia patients [53,56]. It is a promising field for the PARO robot [68] and exhibits both benefits and barriers [71]. PARO can support the psychosocial needs of the elderly related to inclusion, identity, attachment, occupation, and comfort [68]. When it comes to expressing emotion and inducing empathy, ARI employs a few body cues simultaneously, mainly: facial displays, body movement, posture, and vocal cues [21]. AIBO, PARO, AIBO, and iCat are considered SAR (Social Assistive Robot and Companion). Six thousand, four hundred assisting robots were sold worldwide in health care contexts in 2017. The challenge is to clarify the role of robots in health care and regulate the services they provide through norms and codes of ethics [22].

Hospital personnel must take on arduous tasks that are often repetitive and burdensome, for which they do not have enough time. Here, social robots like Pepper also seem to have a chance to prove their usefulness with questionnaires [67].

Conditioning our home environments influences our wellbeing. They are a critical characteristic in the most vulnerable groups, as in the elderly, who routinely need health care assistance. For example, a virtual assistant and empathic coaches assisted older adults living independently at their homes [78].

For the elderly, robots are not just machines; they offer emotional support, much like a friend and companion who communicates and coexists [81].

(b) Children

Children are the other vulnerable group where social robots are most applied, specifically with children suffering from diseases such as cancer [54,64]. Such is the case of ARASH [60]. Project MOnarCH (MOnarCH (Multi-Robot Cognitive Systems Operating in Hospitals) is a well-documented European FP7 project for edutainment activities in the pediatric ward of an oncological hospital [30,43,45,61]. Robots can improve the quality of life of children by interacting with them in hospitals through social and play dynamics, and as school teaching assistants [18,45,50].

In long periods of isolation, telepresence is a practical tool, as we saw in the first section [69], to treat pediatric cancers [31]. Additionally, for long-term relationships and bonding, PLEO is used in the caring system [62], where the child's wellbeing is a priority. Because of its appearance, reminiscent of dinosaurs or an electronic toy, children found PLEO appealing [18]. Stress is a characteristic that is unfortunately also present during long periods of convalescence; interactive stuffed animals can positively influence a child's mood and improve their quality of life during hospitalization. They also provide support when confronting a disease and can serve as a distraction during a medical procedure [24]. Moreover, pain and isolation, along with stress, can be addressed with a table-based avatar and its interactive social robot teddy bear [26]. Positive effects in children were noted using social robots, such as positive mood, engagement, trust, less stress or pain, more relaxation, smiling and openness, better communication, or emotional bonds with users [24,38,85].

The topic of automatic diagnoses can be found in the literature. It is applied in ASD (Autism Spectrum Disorder), where predicting the outcome of actions remains a challenge [16,27]. Understanding internal mental states is not the same as observing kinematics [19]. Observable actions include completing a puzzle or finding a given number of balls hidden around a room [27].

The "in the wild" concept is normally used to describe real conditions. Many activities are performed in laboratory conditions or controlled environments, which are not realistic at all. Some works, such as those involving children with diabetes, address it with a methodology for a human–robot partnership framework for prolonged care [25]. For example, the Pleo robot, a baby dinosaur robotic pet, works differently to assist children during hospitalization [38].

Other social robots were used for storing therapy treatments in the database, observing and evaluating therapy processes, or testing urine in children with cancer [54,64,86].

Future work needs to address the problems identified in the current research on the use of social robots by carrying out studies with larger sample sizes, with different populations in different contexts and situations, and with different physical and cognitive skills [66].

5. Conclusions

This paper analyzed the state-of-the-art concerning social robots in hospitals, focusing on healthcare contexts, and using WoS and PUBMED as the principal sources of data. As the principal outcomes of this systematic study, we note the following:

- The interest in the use and real application of social robots in hospitals are relatively new: we observed that publications about this topic have increased from 2011. Although the review began in previous years, it was in 2011 when articles that met the inclusion criteria for this review began to appear with more frequency. Therefore, a growing interest in the use of assistive robots in the hospital setting can be observed from that year onwards.

- There is still no academic consensus around the term “social robots”.
- There are two central populations where social robots have been applied: children and the elderly.
- Despite the principal potential users (children and elderly) of social robots, some applications for diseases appear in the literature: dementia, cancer, diabetes, and ASD.
- The bibliometric study shows no consolidated research community around social robots in hospitals or for healthcare. Establishing a consolidated discipline around these topics would require an extensive collaboration network.
- There are many benefits to using social robots in healthcare contexts, such as in mental health, where robots promote a positive mood, engagement, trust, less stress or pain, more relaxation, smiling and openness, better communication, and other emotional positive effects. Some patients felt deep emotions towards the social robots. Negative experiences appeared only in children on rare occasions.
- Social robots are beneficial during long periods of isolation and were of help during the pandemic. Moreover, in different environments such as school or home, telepresence provided a good quality of service.
- Although there are several ethical approaches to use robots in medicine, there is a challenge in accepting their use with children and as care workers. Differences were found depending on the context (workplace or home).
- The main ethical concerns are privacy, restraint, deception, accountability, personal space, and psychological damage. Many researchers agree that more information and data must be gathered to improve their design and interaction to overcome ethical issues.
- There are several initiatives involving ethics in technology that should be taken into account in the design of social robots for healthcare.

Regarding the design of the robot, the influence of the media factor, such as films or series, has been identified; the cultural imaginary creates expectations and prejudices towards social robots. This influence should not be taken into account in the initial phases of the design prototypes.

As we have seen, the uses of social robots are diverse, and focus on two groups (children and elderly), and very specific contexts usually associated with diseases or disabilities. However, due to the positive influence that in most cases they have on patients, and to the growing amount of literature on the subject, we predict that robot interactions will increase (i.e., expansion of emotional accompaniment, forms of communication, the performance of more types of routines), as will use contexts in hospitals (i.e., expanding contact with more types of patients and new ways of receiving patients).

Still, a question remains that should be explored: why have social robots not been widely used already in hospitals? Some reasons can be attributed to the maturity of the field of social robots, but not others. For instance, many reasons not related directly to engineering can act as barrier to the adoption of technology, including the use of robots in healthcare: for example, economic aspects, the medical staff’s lack of technical knowledge, or the staff’s behavioral intention [87-88]. Thus, the effective adoption of social robots in healthcare provides an interesting area of research to expand in the future.

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References

1. Goodrich, M.A.; Schultz, A.C. *Human-Robot Interaction*, 1st ed.; now: Hanover, Germany, 2008; Volume 3; ISBN 1-60198-092-2.
2. González-González, C.S.; Gil-Iranzo, R.M.; Paderewski-Rodríguez, P. Human-Robot Interaction and Sexbots: A Systematic Literature Review. *Sensors* **2020**, *21*, 216, doi:10.3390/s21010216.
3. Jung, H.-T.; Yoo, D. *Towards Ethical Research Practice: Anticipating Social Consequences of Rehabilitation Robots*; IEEE. Chicago, USA; 2014; ISBN 978-1-4799-4992-2, doi: 10.1109/ETHICS.2014.6893422.
4. Fels, D.I.; Waalen, J.K.; Zhai, S.; Weiss, P.T. *Telepresence under Exceptional Circumstances: Enriching the Connection to School for Sick Children*; In INTERACT (pp. 617-624), Tokyo, Japan; 2001; ISBN 1-58603-188-0.
5. Vazquez-Santacruz, E.; Gamboa-Zuniga, M. *A Diagnosis Methodology For Assistive Technology Development Assistive Robotics for Elderly and Disabled Patients*; IEEE. Chicago, USA; 2013; ISBN 978-1-4799-1460-9.
6. Aymerich-Franch, L.; Ferrer, I. The Implementation of Social Robots during the COVID-19 Pandemic. *arXiv* **2020**, arXiv:2007.03941.
7. Aymerich-Franch, L. Why It Is Time to Stop Ostracizing Social Robots. *Nat. Mach. Intell.* **2020**, *2*, 364, doi:10.1038/s42256-020-0202-5.
8. Javaid, M.; Haleem, A.; Vaish, A.; Vaishya, R.; Iyengar, K.P. Robotics Applications in COVID-19: A Review. *J. Ind. Integr. Manag.-Innov. Entrep.* **2020**, *5*, 441–451, doi:10.1142/S2424862220300033.
9. Violant-Holz, V.; Gallego-Jiménez, M.G.; González-González, C.S.; Muñoz-Violant, S.; Rodríguez, M.J.; Sansano-Nadal, O.; Guerra-Balic, M. Psychological Health and Physical Activity Levels during the COVID-19 Pandemic: A Systematic Review. *Int. J. Environ. Res. Public. Health* **2020**, *17*, 9419, doi:10.3390/ijerph17249419.
10. Yang, G.-Z.; Nelson, B.J.; Murphy, R.R.; Choset, H.; Christensen, H.; Collins, S.H.; Dario, P.; Goldberg, K.; Ikuta, K.; Jacobstein, N.; et al. *Combating COVID-19—The Role of Robotics in Managing Public Health and Infectious Diseases*; 2020; Volume 5.
11. Rogozea, L.; Leasu, F.; Repanovici, A.; Baritz, M. Ethics, Robotics and Medicine Development. In Proceedings of the 9th WSEAS International Conference on Signal Processing, Robotics and Automation, University of Cambridge, Cambridge, UK; February 20-22 2010; pp. 264–268.
12. Page, M.J.; Mckenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. *The PRISMA 2020 Statement: An Updated Guideline for Reporting Systematic Reviews*; 2021.
13. Arana, J.; Lapresa, D.; Anguera, M.T.; Garzón, B. Ad Hoc Procedure for Optimising Agreement between Observational Records. *An. Psicol. Murcia Spain* **2016**, *32*, 589–595, doi:10.6018/analesps.32.2.213551.
14. Aria, M.; Cuccurullo, C. Bibliometrix: An R-Tool for Comprehensive Science Mapping Analysis. *J. Informetr.* **2017**, *11*, 959–975, doi:10.1016/j.joi.2017.08.007.
15. Cross, E.S.; Ramsey, R. Mind Meets Machine: Towards a Cognitive Science of Human-Machine Interactions. *Trends Cogn. Sci.* **2021**, *25*, 200–212, doi:10.1016/j.tics.2020.11.009.
16. Sheridan, T.B. A Review of Recent Research in Social Robotics. *Curr. Opin. Psychol.* **2020**, *36*, 7–12, doi:10.1016/j.copsyc.2020.01.003.
17. Ngo, H.Q.T.; Le, V.N.; Thien, V.D.N.; Nguyen, T.P.; Nguyen, H. Develop the Socially Human-Aware Navigation System Using Dynamic Window Approach and Optimize Cost Function for Autonomous Medical Robot. *Adv. Mech. Eng.* **2020**, *12*, 1687814020979430, doi:10.1177/1687814020979430.
18. Moerman, C.J.; Jansens, R.M.L. Using Social Robot PLEO to Enhance the Wellbeing of Hospitalised Children. *J. Child Health Care* **2020**, 1367493520947503, doi:10.1177/1367493520947503.
19. Bartlett, M.E.; Costescu, C.; Baxter, P.; Thill, S. Requirements for Robotic Interpretation of Social Signals "in the Wild": Insights from Diagnostic Criteria of Autism Spectrum Disorder. *Information* **2020**, *11*, 81, doi:10.3390/info11020081.
20. Benedictis, R.D.; Umbrico, A.; Fracasso, F.; Cortellessa, G.; Orlandini, A.; Cesta, A. A Two-Layered Approach to Adaptive Dialogues for Robotic Assistance. In Proceedings of the 2020 29th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), Naples, Italy, 31 August–4 September 2020; pp. 82–89.
21. Cooper, S.; Fava, A.D.; Vivas, C.; Marchionni, L.; Ferro, F. ARI: The Social Assistive Robot and Companion. In Proceedings of the 2020 29th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), Naples, Italy, 31 August–4 September 2020; pp. 745–751.
22. Turja, T.; Parviainen, J. The Use of Affective Care Robots Calls Forth Value-Based Consideration. In Proceedings of the 2020 29th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), Naples, Italy, 31 August–4 September 2020; pp. 950–955.
23. Beane, M.I. In Storage, Yet on Display An Empirical Investigation of Robots' Value as Social Signals. In Proceedings of the 2020 ACM/IEEE International Conference on Human-Robot Interaction, Cambridge Guild Hall, Cambridge, UK; March 23–26 2020; pp. 83–91, doi:10.1145/3319502.3374775.
24. Moerman, C.J.; van der Heide, L.; Heerink, M. Social Robots to Support Children's Wellbeing under Medical Treatment: A Systematic State-of-the-Art Review. *J. Child Health Care* **2019**, *23*, 596–612, doi:10.1177/1367493518803031.

25. Neerincx, M.A.; van Vught, W.; Blanson Henkemans, O.; Oleari, E.; Broekens, J.; Peters, R.; Kaptein, F.; Demiris, Y.; Kiefer, B.; Fumagalli, D.; et al. Socio-Cognitive Engineering of a Robotic Partner for Child's Diabetes Self-Management. *Front. Robot. AI* **2019**, *6*, 118, doi:10.3389/frobt.2019.00118.
26. Logan, D.E.; Breazeal, C.; Goodwin, M.S.; Jeong, S.; O'Connell, B.; Smith-Freedman, D.; Heathers, J.; Weinstock, P. Social Robots for Hospitalized Children. *Pediatrics* **2019**, *144*, e20181511, doi:10.1542/peds.2018-1511.
27. Melo, F.S.; Sardinha, A.; Belo, D.; Couto, M.; Faria, M.; Farias, A.; Gamboa, H.; Jesus, C.; Kinarullathil, M.; Lima, P.; et al. Project INSIDE: Towards Autonomous Semi-Unstructured Human Robot Social Interaction in Autism Therapy. *Artif. Intell. Med.* **2019**, *96*, 198–216, doi:10.1016/j.artmed.2018.12.003.
28. Hai, N.D.X.; Nam, L.H.T.; Thinh, N.T. Remote Healthcare for the Elderly, Patients by Tele-Presence Robot. In Proceedings of the 2019 International Conference on System Science and Engineering (ICSSE), Dong Hoi, Vietnam, 20–21 July 2019; pp. 506–510.
29. Ahn, H.S.; Yep, W.; Lim, J.; Ahn, B.K.; Johanson, D.L.; Hwang, E.J.; Lee, M.H.; Broadbent, E.; MacDonald, B.A. Hospital Receptionist Robot v2: Design for Enhancing Verbal Interaction with Social Skills. In Proceedings of the 2019 28th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), New Delhi, India, 14–18 October 2019.
30. Sequeira, J.S. Developing a Social Robot-A Case Study. *Robot. Healthc. Field Ex. Chall.* **2019**, *1170*, 103–125, doi:10.1007/978-3-030-24230-5_6.
31. Meghdari, A.; Shariati, A.; Alemi, M.; Nobaveh, A.A.; Khamooshi, M.; Mozaffari, B. Design Performance Characteristics of a Social Robot Companion "Arash" for Pediatric Hospitals. *Int. J. Humanoid Robot.* **2018**, *15*, 1850019, doi:10.1142/S0219843618500196.
32. Valles-Peris, N.; Angulo, C.; Domenech, M. Children's Imaginaries of Human-Robot Interaction in Healthcare. *Int. J. Environ. Res. Public. Health* **2018**, *15*, 970, doi:10.3390/ijerph15050970.
33. Burns, R.; Jeon, M.; Park, C.H. Robotic Motion Learning Framework to Promote Social Engagement. *Appl. Sci.-Basel.* **2018**, *8*, 241, doi:10.3390/app8020241.
34. Chen, C.; Garrod, O.G.B.; Zhan, J.; Beskow, J.; Schyns, P.G.; Jack, R.E. Reverse Engineering Psychologically Valid Facial Expressions of Emotion into Social Robots. In Proceedings of the 2018 13th IEEE International Conference on Automatic Face & Gesture Recognition, Xi'an, China, 15–19 May 2018; pp.448–452, doi:10.1109/FG.2018.00072.
35. Papadopoulos, I.; Koulouglioti, C.; Ali, S. Views of Nurses and Other Health and Social Care Workers on the Use of Assistive Humanoid and Animal-like Robots in Health and Social Care: A Scoping Review. *Contemp. Nurse* **2018**, *54*, 425–442, doi:10.1080/10376178.2018.1519374.
36. Um, D.; Park, J.; Shin, J.; Lee, W.H. A Social Robot, "Dali," for Aging in Place Technology. *J. Robot.* **2018**, *2018*, 6739652, doi:10.1155/2018/6739652.
37. Dodds, P.; Martyn, K.; Brown, M. Infection Prevention and Control Challenges of Using a Therapeutic Robot. *Nurs. Older People* **2018**, *30*, 34–40, doi:10.7748/nop.2018.e994.
38. Larriba, F.; Raya, C.; Angulo, C.; Albo-Canals, J.; Diaz, M.; Boldu, R. Externalising Moods and Psychological States in a Cloud Based System to Enhance a Pet-Robot and Child's Interaction. *Biomed. Eng. Online* **2016**, *15*, S72, doi:10.1186/s12938-016-0180-3.
39. Shayan, A.M.; Sarmadi, A.; Pirastehzad, A.; Moradi, H.; Soleiman, P. RoboParrot 2.0: A Multi-Purpose Social Robot. In Proceedings of the 2016 4th International Conference on Robotics and Mechatronics, Tehran, Iran, 26–28 October 2016; pp. 422–427.
40. Banthia, V.; Maddahi, Y.; May, M.; Blakley, D.; Chang, Z.; Gbur, A.; Tu, C.; Sepehri, N. *Development of a Graphical User Interface for a Socially Interactive Robot: A Case Study Evaluation*; IEEE : Piscatway, New Jersey, USA; 2016; ISBN 978-1-5090-0996-1, doi: 10.1109/IEMCON.2016.7746294.
41. Yu, R.; Hui, E.; Lee, J.; Poon, D.; Ng, A.; Sit, K.; Ip, K.; Yeung, F.; Wong, M.; Shibata, T.; et al. Use of a Therapeutic, Socially Assistive Pet Robot (PARO) in Improving Mood and Stimulating Social Interaction and Communication for People With Dementia: Study Protocol for a Randomized Controlled Trial. *Jmir Res. Protoc.* **2015**, *4*, e45, doi:10.2196/resprot.4189.
42. Ono, S.; Obo, T.; Kiong, L.C.; Kubota, N. Robot Communication Based on Relational Trust Model. In *IECON 2015-41st Annual Conference of the IEEE Industrial Electronics Society*; IEEE: Piscatway, New Jersey, USA; 2015; pp. 5335–5338.
43. Goncalves, D.; Arsenio, A. *Human-Driven Multi-Robot Design Process for Social Interactions with Children on Complex Environments*; IEEE : Piscatway, New Jersey, USA; 2015; ISBN 978-1-4799-6466-6.
44. Nergui, M.; Komekine, K.; Nagai, H.; Otake, M. *Development of Laughter Motion on the Cognitive Robot "Bono-02" Assisting Group Conversation*; IEEE : Piscatway, New Jersey, USA; 2014; ISBN 978-1-4799-4266-4.
45. Ferreira, I.; Sequeira, J. *When Children Interact with Robots: Ethics in the Monarch Project*; IEEE : Piscatway, New Jersey, USA; 2014; ISBN 978-981-4623-34-6.
46. Wynsberghe, A. van A Method for Integrating Ethics into the Design of Robots. *Ind. Robot. Int. J. Robot. Res. Appl.* **2013**, *40*, 433–440, doi:10.1108/IR-12-2012-451.
47. Lewis, M.; Canamero, L. Are Discrete Emotions Useful in Human-Robot Interaction? Feedback from Motion Capture Analysis. In Proceedings of the 2013 Humaine Association Conference on Affective Computing and Intelligent Interaction, Geneva, Switzerland, 2–5 September 2013; pp. 97–102, doi:10.1109/ACII.2013.23.
48. Elara, M.R.; Rojas, N.; Seah, S.; Sosa, R. Design Principles for Robot Inclusive Spaces. *Des. Harmon. Vol 4 Prod. Serv. Syst. Des.* **2013**, doi:10.1109/ICRA.2014.6907681.

49. Beer, J.M.; Takayama, L. Mobile Remote Presence Systems for Older Adults: Acceptance, Benefits, and Concerns. In Proceedings of the 6th international conference on Human-robot interaction, March 2011; pp. 19–26, doi:10.1145/1957656.1957665.
50. Goris, K.; Saldien, J.; Vanderniepen, I.; Lefeber, D. The Huggable Robot Probo, a Multi-Disciplinary Research Platform. In *International Conference on Research and Education in Robotics*; Springer: Berlin, Heidelberg, 2009; Volume 33, pp. 29–41.
51. Sutherland, C.J.; Ahn, B.K.; Brown, B.; Lim, J.; Johanson, D.L.; Broadbent, E.; MacDonald, B.A.; Ahn, H.S. The Doctor Will See You Now: Could a Robot Be a Medical Receptionist? In Proceedings of the 2019 International Conference on Robotics and Automation, Montreal, QC, Canada, 20–24 May 2019; pp. 4310–4316.
52. Van der Putte, D.; Boumans, R.; Neerincx, M.; Rikkert, M.O.; de Mul, M. A Social Robot for Autonomous Health Data Acquisition among Hospitalized Patients: An Exploratory Field Study. In Proceedings of the 2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), Daegu, Korea, 11–14 March 2019, 658–659.
53. Sarabia, M.; Young, N.; Canavan, K.; Edginton, T.; Demiris, Y.; Vizcaychipi, M.P. Assistive Robotic Technology to Combat Social Isolation in Acute Hospital Settings. *Int. J. Soc. Robot.* **2018**, *10*, 607–620, doi:10.1007/s12369-017-0421-z.
54. Meghdari, A.; Shariati, A.; Alemi, M.; Vossoughi, G.R.; Eydi, A.; Ahmadi, E.; Mozafari, B.; Nobaveh, A.A.; Tahami, R. Arash: A Social Robot Buddy to Support Children with Cancer in a Hospital Environment. *Proc. Inst. Mech. Eng. Part H-J. Eng. Med.* **2018**, *232*, 605–618, doi:10.1177/0954411918777520.
55. Eriksson, Y. The Perception of Aging and Use of Robots. *Hum. Asp. It Aged Popul. Accept. Commun. Particip. Pt I* **2018**, *10926*, 30–39, doi:10.1007/978-3-319-92034-4_3.
56. Rouaix, N.; Retru-Chavastel, L.; Rigaud, A.-S.; Monnet, C.; Lenoir, H.; Pino, M. Affective and Engagement Issues in the Conception and Assessment of a Robot-Assisted Psychomotor Therapy for Persons with Dementia. *Front. Psychol.* **2017**, *8*, 950, doi:10.3389/fpsyg.2017.00950.
57. Hebesberger, D.; Koertner, T.; Gisinger, C.; Pripfl, J. A Long-Term Autonomous Robot at a Care Hospital: A Mixed Methods Study on Social Acceptance and Experiences of Staff and Older Adults. *Int. J. Soc. Robot.* **2017**, *9*, 417–429, doi:10.1007/s12369-016-0391-6.
58. Shukla, J.; Barreda-Angeles, M.; Oliver, J.; Puig, D. Effectiveness of Socially Assistive Robotics during Cognitive Stimulation Interventions: Impact on Caregivers. In Proceedings of the 2017 26th IEEE International Symposium on Robot and Human Interactive Communication, Lisbon, Portugal, 28 August–1 September 2017; pp. 62–67.
59. Jeong, S.; Breazeal, C.; Logan, D.; Weinstock, P. *Huggable: The Impact of Embodiment on Promoting Socio-Emotional Interactions for Young Pediatric Inpatients*; IEEE : New York, NY, USA; 2018; ISBN 978-1-4503-5620-6.
60. Meghdari, A.; Alemi, M.; Khamooshi, M.; Amoozandeh, A.; Shariati, A.; Mozafari, B. Conceptual Design of a Social Robot for Pediatric Hospitals. In Proceedings of the 2016 4th International Conference on Robotics and Mechatronics (ICROM), Tehran, Iran , 26–28 October 2016; pp. 566–571.
61. Sequeira, J.S.; Ferreira, I.A. *Lessons from the MOnarCH Project*; IEEE : Piscatway, New Jersey, USA; 2016; ISBN 978-989-758-198-4.
62. Diaz-Boladeras, M.; Angulo, C.; Domenech, M.; Albo-Canals, J.; Serrallonga, N.; Raya, C.; Barco, A. Assessing Pediatrics Patients' Psychological States from Biomedical Signals in a Cloud of Social Robots. In *XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016*; Springer: Cham, Germany; Paphos, Cyprus; March 31st-April 2nd 2016; Volume 57, pp. 1179–1184, doi:10.1007/978-3-319-32703-7_229.
63. Orejana, J.R.; MacDonald, B.A.; Ahn, H.S.; Peri, K.; Broadbent, E. Healthcare Robots in Homes of Rural Older Adults. *Soc. Robot. Icsr 2015* **2015**, *9388*, 512–521, doi:10.1007/978-3-319-25554-5_51.
64. Alemi, M.; Meghdari, A.; Ghanbarzadeh, A.; Moghadam, L.J.; Ghanbarzadeh, A. Impact of a Social Humanoid Robot as a Therapy Assistant in Children Cancer Treatment. *Soc. Robot.* **2014**, *8755*, 11–22.
65. Alemi, M.; Meghdari, A.; Ghanbarzadeh, A.; Moghadam, L.J.; Ghanbarzadeh, A. Effect of Utilizing a Humanoid Robot as a Therapy-Assistant in Reducing Anger, Anxiety, and Depression. In Proceedings of the 2014 Second RSI/ISM International Conference on Robotics and Mechatronics, Tehran, Iran, 15–17 October 2014; pp. 748–753.
66. Robinson, H.; MacDonald, B.; Kerse, N.; Broadbent, E. The Psychosocial Effects of a Companion Robot: A Randomized Controlled Trial. *J. Am. Med. Dir. Assoc.* **2013**, *14*, 661–667, doi:10.1016/j.jamda.2013.02.007.
67. Boumans, R.; van Meulen, F.; Hindriks, K.; Neerincx, M.; Rikkert, M.O. A Feasibility Study of a Social Robot Collecting Patient Reported Outcome Measurements from Older Adults. *Int. J. Soc. Robot.* **2020**, *12*, 259–266, doi:10.1007/s12369-019-00561-8.
68. Hung, L.; Gregorio, M.; Mann, J.; Wallsworth, C.; Horne, N.; Berndt, A.; Liu, C. Exploring the Perceptions of People with Dementia about the Social Robot PARO in a Hospital Setting. *Dement.-Int. J. Soc. Res. Pract.* **2019**, 1471301219894141, doi:10.1177/1471301219894141.
69. Henry, J.; Leprince, T.; Robles, S.G.; Famery, A.; Boyle, H.; Gilis, L.; Witz, C.; Barland, J.-C.; Blay, J.-Y.; Marec-Berard, P. Qualitative, Exploratory, and Multidimensional Study of Telepresence Robots for Overcoming Social Isolation of Children and Adolescents Hospitalized in Onco-Hematology. *J. Adolesc. Young Adult Oncol.* **2020**, *9*, 90–95, doi:10.1089/jayao.2019.0059.
70. Jurdi, S.; Montaner, J.; Garcia-Sanjuan, F.; Jaen, J.; Nacher, V. A Systematic Review of Game Technologies for Pediatric Patients. *Comput. Biol. Med.* **2018**, *97*, 89–112, doi:10.1016/j.compbiomed.2018.04.019.
71. Ali, S.; Samad, M.; Mehmood, F.; Ayaz, Y.; Qazi, W.M.; Khan, M.J.; Asgher, U. Hand Gesture Based Control of NAO Robot Using Myo Armband. *Adv.Neuroergonomics Cogn. Eng.* **2020**, 953, 449–457, doi:10.1007/978-3-030-20473-0_44.

72. Hung, L.; Liu, C.; Woldum, E.; Au-Yeung, A.; Berndt, A.; Wallsworth, C.; Horne, N.; Gregorio, M.; Mann, J.; Chaudhury, H. The Benefits of and Barriers to Using a Social Robot PARO in Care Settings: A Scoping Review. *Bmc Geriatrics* **2019**, 19, 232, doi:10.1186/s12877-019-1244-6.
73. Kobayashi, T.; Sameshima, N.; Imai, T.; Arai, K.; Watanabe, T.; Miyazaki, T.; Tsujino, A. *Dementia Screening System Based on SNS Agency Robot*; **2019**; ISBN 978-1-72812-745-3.
74. Lindsay, S.; Hounsell, K.G. Adapting a Robotics Program to Enhance Participation and Interest in STEM among Children with Disabilities: A Pilot Study. *Disabil. Rehabil.-Assist. Technol.* **2017**, *12*, 694–704, doi:10.1080/17483107.2016.1229047.
75. Chung, K.; Park, R.C. Chatbot-Based Heathcare Service with a Knowledge Base for Cloud Computing. *Clust. Comput.-J. Netw. Softw. Tools Appl.* **2019**, *22*, 1925–1937, doi:10.1007/s10586-018-2334-5.
76. Ciardo, F.; Beyer, F.; Tommaso, D.D.; Wykowska, A. Attribution of Intentional Agency towards Robots Reduces One's Own Sense of Agency. *Cognition* **2020**, *194*, 104109, doi:10.1016/j.cognition.2019.104109.
77. Kivrak, H.; Uluer, P.; Kose, H.; Gumuslu, E.; Barkana, D.E.; Cakmak, F.; Yavuz, S. Physiological Data-Based Evaluation of a Social Robot Navigation System. In Proceedings of the 2020 29th IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), Naples, Italy, 31 August–4 September 2020;pp. 994–999.
78. Panico, F.; Cordasco, G.; Vogel, C.; Trojano, L.; Esposito, A. Ethical Issues in Assistive Ambient Living Technologies for Ageing Well. *Multimed. Tools Appl.* **2020**, *79*, 36077–36089, doi:10.1007/s11042-020-09313-7.
79. Sharif, M.S.; Alsibai, M.H. *Medical Data Analysis Based on Nao Robot: An Automated Approach Towards Robotic Real-Time Interaction with Human Body*; IEEE : Piscatway, New Jersey, USA; 2017; ISBN 978-1-5386-3897-2.
80. Beraldo, G.; Menegatti, E.; Tommasi, V.D.; Mancin, R.; Benini, F. A Preliminary Investigation of Using Humanoid Social Robots as Non-Pharmacological Techniques with Children. In Proceedings of the 2019 Ieee Int. Conf. Adv. Robot. Its Soc. Impacts Arso, Beijing, China, 31 October–2 November 2019; pp. 393–400.
81. Kang, S. A Study on Smart Homecare for Daily Living Ability and Safety Management of the Elderly. *Inf. Sci. Appl*. **2020**, 621, 707–710, doi:10.1007/978-981-15-1465-4_72.
82. Stollnberger, G.; Giuliani, M.; Mirnig, N.; Tscheligi, M.; Arent, K.; Kreczmer, B.; Grzeszczak, F.; Szczesniak-Stanczyk, D.; Zarczuk, R.; Wysokinski, A. Designing User Interfaces for Different User Groups: A Three-Way Teleconference System for Doctors, Patients and Assistants Using a Remote Medical Robot. In Proceedings of the 2019 IEEE International Conference on Advanced Robotics and its Social Impacts (ARSO), Beijing, China, 31 October–2 November 2019; pp. 612–617.
83. Dutra, C.C.D.; Rocha, H.S. Religious Support as a Contribution to Face the Effects of Social Isolation in Mental Health During the Pandemic of COVID-19. *J. Relig. Health* **2021**, *60*, 99–111, doi:10.1007/s10943-020-01140-2.
84. Khosravi, P.; Ghapanchi, A.H. Investigating the Effectiveness of Technologies Applied to Assist Seniors: A Systematic Literature Review. *Int. J. Med. Inf.* **2016**, *85*, 17–26, doi:10.1016/j.ijmedinf.2015.05.014.
85. Jeong, S.; Breazeal, C.; Logan, D.; Weinstock, P. Huggable: Impact of Embodiment on Promoting Verbal and Physical Engagement for Young Pediatric Inpatients. In Proceedings of the 2019 IEEE International Conference on Advanced Robotics and its Social Impacts (ARSO), New York, NY, USA, 26–31 August 2016; pp. 121–126.
86. Alemi, M.; Ghanbarzadeh, A.; Meghdari, A.; Moghadam, L.J. Clinical Application of a Humanoid Robot in Pediatric Cancer Interventions. *Int. J. Soc. Robot.* **2016**, *8*, 743–759, doi:10.1007/s12369-015-0294-y.
87. Vichitkraivin, P.; Naenna, T. Factors of healthcare robot adoption by medical staff in Thai government hospitals. *Health Technol.* **2021,** *11*, 139–151.
88. Breazeal, C. Social robots for health applications. In Proceedings of the 2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Boston, MA, USA, 30 August–3 September 2011; doi:10.1109/IEMBS.2011.6091328.