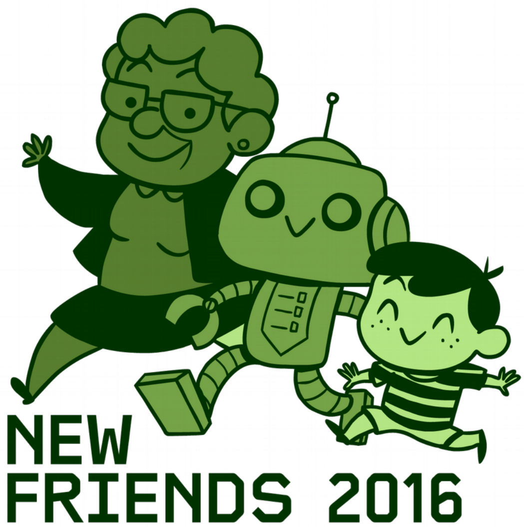
New Friends 2016

2nd International Conference on Social Robots in Therapy and Education



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A warm welcome to the New Friends 2016 Conference in Barcelona,

The application of social robots in therapy and education is an emerging field as these 'new friends' become more sophisticated, available and affordable. In recent years there has been an enormous increase of projects in which they are used successfully for groups with special needs, like people with dementia, hospitalized children and children with autism

This increases the demand for expertise from a wide range of disciplines, like psychology, education, nursing, occupational therapy, physiotherapy, engineering, technology, etc.

The conference draws regional, national and worldwide attention: it is the first major international event that gathers top researchers and practitioners in this specific field. They are dedicated to develop and apply the unique possibilities of a new technology that is positively changing our lives.

Being a part of this is to associate with compassionate experts and highly beneficial innovations. To enable this, the conference offers a wide range of customizable sponsoring opportunities, including exhibiting and advertising, official affiliation and award sponsorship: therapy, physiotherapy, AI, robotics and education to meet the technical opportunities with the development of therapeutic and educational practice.

To make this happen, the international and multidisciplinary conference New Friends 2016 brings together researchers, professionals, students from different disciplines of health, social welfare and education and developers in the fields of AI social robotics, ICT and business.

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What Do Roboticists Need to Know about the Future of Robot Law?

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Abstract. Europe is working towards a future Regulation on Robotics. This article ponders the 2015/2103 (INL) European Parliament Draft Report with Recommendations to the Commission on Civil Law Rules on Robotics and its impact on roboticists currently building social robots. This paper is informative and gives an overview of the latest legal discussion on social robots that will affect roboticists. The article covers the future design of robots, the responsibility of the creators and the perceived safety of users. The article will conclude highlighting the importance of the cognitive human-robot interaction and the demand for a personalized dynamic regulation at risk to overlook the particularities of each type of robot with one single regulation.

Keywords: Law and Robotics, Cognitive Human-Robot Interaction, Liability

INTRODUCTION

In May 2016, the European Parliament released a draft report with several recommendations to the European Commission on Civil Law Rules on Robotics [1]. While the Parliament expects the Commission to make a regulation in 10-15 years, current roboticists are left on the uncertainty about their creations: are they obliged to embed ethics into their design process? Where should be drawn the line on responsibility if the robot uses machine learning? How can robots be trustworthy [2]?

Apart from wondering whether by 2030 the robotics legislation will be obsolete (and full of dissonances between the Member States if the chosen instrument is the Directive), the robotic technology market grow (which not only covers schools but also universities [3] and largely cognitive and physical rehabilitation centers) questions which is the applicable legislation during the transition time. This paper summarizes the major discussions on the regulation of robotics at the highest European level to create awareness among roboticists of what will be probably expected from them in the future at this regard.

DESIGN

The design of the robot normally takes into consideration several aspects that go from perception to emotional attachment, embodiment, interaction or motivation design [4]. Future designers, however, will have to embed into the design privacy and ethics.

The Privacy-by-Design (PbD) is a concept developed by Cavoukian in the 1990s. PbD is born under the idea that the mere compliance with regulations cannot guarantee the protection of privacy, but the inclusion of this philosophy in the organization's modus operandi. Although lacking of concrete guidance to the data controller [5], this principle will enter in force in Europe after the art. 25 of the European 2016/679 Regulation on Data Protection (GDPR) [6]. This article will oblige the data controller (and in this case the roboticists as the draft report says) at the time of the determination of the means for processing and at the time of the processing itself, to implement appropriate measures for ensuring that all the requirements of the regulation are met. This implementation will need to be pro-active, as a default setting, embedded into the design, with a full functionality, offering a full lifecycle protection, open and user-centric [7]. Although not relieving from responsibility, a voluntarily certification issued by the National Data Protection Authority (art. 42 GDPR) is going to be able to be asked in order to demonstrate compliance with these requirements.

From the ethics viewpoint, the recent standard on the ethical design of robots [8] is the first initiative towards this regard. Although the legitimation of standard bodies is always questioned because they are business oriented and their arguments are based solely on interests and preferences [9], it seems that they go in the same direction as the future regulation of the EU will also incorporate this obligation.

PERCEIVED SAFETY

For the first time, it is highlighted in a report the possibility that robots might cause psychological harm. Until now it was known that robots could cause physical damage (because they are physical in the real world), but not much literature existed on the *cognitive* harm. This is a very logical step forward seen that social robots are used in therapy and in education where the main channel of interaction between user and the robot happens at the cognitive level.

According to the report, the users should use the robot without fear of physical or psychological harm. This is because certified safety (guaranteed by standards, CE) and perceived safety (perception of the subject/user of the device) are different [2]. This perceived safety should be at the physical level (e.g. the fear of falling during the rehabilitation with an exoskeleton) but also at the cognitive level (e.g. the fear that the use of social robots in cognitive rehabilitation will worsen children capabilities).

What the report does not make clear is whether it is solely the user that should feel this fear or if third parties, e.g. the parents of the child under treatment, or a friend that goes to your house, could also fear it: what rights are going to have third parties when the use of robots will be more generalized? In other cases the user might be unaware of the risk that at the physical or psychological level these robots might have (see liability). At this regard, the draft report adds that human frailty and the emotional needs of humans should be respected.

LIABILITY

According to the Draft Report, not only roboticists should remain accountable for the social, environmental, and human health impacts that their robots may pose to current and future generations, but also the strict liability rule for damaged caused by their creations should be applied. This means that it will only be necessary to proof a causal link between the harmful behavior of the robot and the damage suffered by the injured party.

Beyond the fact that this will also involve prospective liability scenarios, i.e. a damage that is only perceivable after the time goes by and as a consequence of the use of the robot, some scholars, however, have argued that because robots can learn as they operate they should not be held responsible for the future behavior of their robot [10]. This has been called "the responsibility gap". Although there has been a lot of discussion on it [11], and even it has been discussed the possibility that robots should be granted some sort of agenthood in order to allocate the responsibility (similar to animals, corporations [12] or to even a Roman law institution called *peculium* [13]), it seems that the European Parliament is clear at this regard: "the greater a robot's learning capability or autonomy is, the lower other parties' responsibility should be, and the longer a robot's "education" has lasted, the greater the responsibility should be".

As robots will be finally a *thing* within the Internet of Things, robots will reproduce themselves in the future, and given the fact that introducing the responsibility of the "teacher" of the robot, however, will not yet solve the problem of the self-learning process of social robots, we will have to wait to see how the responsibility will be articulated in the future piece of legislation.

CONCLUSIONS

Until now, industrial standards and available legislation (e.g. Machinery Directive 2006/42/EC) have focused solely on the technical aspects of robots. However, as robots can have moral implications, these legislations fall short in providing guidance on aspects that go beyond technicalities. The need for a legislation that can provide a full coverage for the users therefore has become a priority in the major European Institutions.

Indeed, at the same time that machinery safety regulations are being developed, supra-/national and state laws are needed to provide citizens a fully legal coverage [14]. This will provide users the capacity to enforcement, will fix consequences for violations, and will avoid self-serving auto-interpretation.

Although the efforts that the major European institutions are making to provide a response to the arisen legal questions of robots, not only the reality might look very different in 2030, the legislation risks at becoming obsolete. Furthermore, social robots in therapy and education are completely different than personal care robots, than self-driving cars or drones. At risk to overlook the particularities of each type of robot with one single regulation, therefore, there is the need for a personalized legislation (something that could go beyond to what the "Regulatory Robot" of the US Consumer Product Safety Commission is) that could be dynamic (i.e. timeless) and take into account not only the physical HRI but also the cognitive HRI.

In any case, and independently of how the future of legislation will look like, there is evidence that roboticists will have to pay attention to another side of the story, the legal one.

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The Market of Social and Educational Robots for Children with Autism Spectrum Disorder

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Abstract— There are several products available on the market of social and educational robots for children with Autism Spectrum Disorder, but none of them has ever sold more than a few thousands – and often hundreds – units. Why so little? How large is this market and what are its needs? This extended abstract sheds some light on these questions, which are crucial to achieve a commercial success in this yet largely unexplored market.

Keywords— Autism Spectrum Disorder, Robots, Business models

1. Introduction

In the past few decades, the number of diagnosed cases of Autism Spectrum Disorder (ASD) has skyrocketed: nowadays, in developed countries over 1% of the children has been identified with ASD, which implies that a large part of the population needs special social and education programmes. Without them, as recently a prestigious magazine said[1], "beautiful minds are wasted". The financial costs related to this disorder are enormous: a research led by the London School of Economics has showed that ASD costs more than heart disease, cancer and stroke combined [1]. Inclusion programmes – such as special education – account for a large part of such costs. Recent studies (e.g. [2]) have proved that robotics can play a crucial role in this field; yet, this market has been barely scratched. In the last few years several products have been launched to the market; yet, most of them have received little commercial success.

This extended abstract provides a first analysis of the market for this kind of technology and makes some business considerations about what aspects entrepreneurs should take into account when launching a new product. Of course, it does not aim at being a comprehensive analyses but rather a first insight into a complex problem.

2. What is the market size?

The main consideration of every business model is what is the potential size of the targeted market. Taking into account the European Union (EU) single market[2] is not enough because it excludes countries with a track record in assistive robotics such as Japan as well as developed non-EU countries. Therefore, as a market framework we will consider the Organisation for Economic Cooperation and Development (OECD), mostly composed by countries with high incomes and Human Development Index[3].

We will limit our study to the individuals below the age of 14: the symptoms of ASD are typically apparent before the age of three and most robots concerning ASD are targeted to children, probably because the digital divide with adult individuals suffering from ASD is already too wide to be bridged. The OECD statistics[4] find that there are about 230M children in the age range 0-14 in the OECD countries. How many of them suffer from ASD? Even though the estimates vary enormously in different studies, in recent years the ratio 1:68, first stated in [3], has been widely adopted. This implies that there are approximately 3.4M children with ASD in the OECD countries. Of course, this is an educated guess but it gives an idea of how extensive the phenomenon is. This amount can be further segmented by language and economic market (see Figs. 1 and 2, respectively).

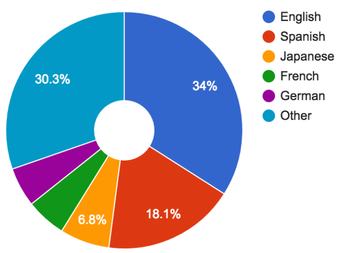

Fig. 1: Segmentation of the children with ASD by language.

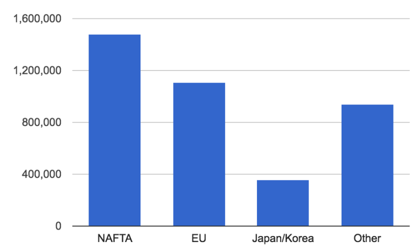

Fig. 2: Segmentation of the children with ASD by market.

Finally, what percentage of the market of children with ASD may be targeted by robotics solutions? This is impossible to

[1]Beautiful minds, wasted: How not to squander the potential of autistic people. The Economist, Apr 16th 2016.

[2]The EU single market includes the EU-28 countries and, with exceptions, Iceland, Liechtenstein, Norway and Switzerland.

[3]The OECD includes most of the EU countries as well Switzerland, Japan, South Korea, Canada, USA, and Australia, among others, for a total population of 1.25 billion citizens.

[4]OECD.Stat includes data and metadata for OECD countries. Available at http://stats.oecd.org/

say since ASD is a spectrum ranging from individuals with Asperger syndrome, who often have a satisfactory social life, to individuals almost incapable of any kind of interaction. The DSM-5 [4] distinguishes three kinds of severities: *1 – 'requiring support'*; *2 – 'requiring substantial support'*; *3 – 'requiring very substantial support'*. We can easily assume that developing robots for individuals with ASD severity 3 is too challenging for the current state of the art and it would require specific business models tailored to professionals care givers. We will then focus on the first two degrees of severity, which are realistically between half and 2/3 of the total.

The conclusion of this brief analysis is that the market of robots for children with ASD in countries ready to adopt such solutions is approximately of 2M individuals. Such market is fragmented among 35 countries, even though 10 of them (France, Germany, Italy, Japan, Korea, Mexico, Spain, Turkey, UK and USA) account for more than 80% of it. North America (NAFTA countries) and the EU accounts for 2/3 of the market; about the 10% is in Japan and South Korea, and the rest is dispersed across the other OECD countries. From the linguistic viewpoint, approximately one third of the market is for English speakers and one fifth for Spanish speakers; the other languages share the rest, with about 6% each for Japanese-, French-, and German-speakers.

3. What are the market needs?

The considerations made above show that the market is relatively large, though reaching it is quite hard. The most recent successful crowdfunding campaign – Leka – has received the support of about 300 backers, including associations [5]. Even a very popular product that has found applications beyond ASD such as NAO has sold only 9,000 units, in fact, many of them to companies[6]. Why successful robots are scarce on the market? Why does a non-ASD child have several electronic gadgets but an ASD child is missing the very one that would help him or her to make a huge leap in terms of quality of life?

Price is surely a factor. Most of these robots are targeted to families but they are actually unaffordable by them. NAO has a 4-digit price tag and the Keepon Pro, which has received a large media coverage, is sold for about $30,000. The crowdfunding campain of Leka exhausted quickly all the early bird packs, but it has sold only five kits at full price ($490). We can then infer than any product directly aimed at the customers should be available for about 400 if it wants to reach a massive audience. This can be only possible by using ready-made electronics, such as Arduino or Raspberry PI, and possibly 3D-printing technologies.

Customization is a key factor: each ASD child is a unique point in a complex spectrum. We cannot expect that families of 'special' children will buy a 'standard' toy. In fact, one of the keys to the success of NAO has been the high possibility of customization in terms of functionalities and branding.

[5]Leka: An Exceptional Toy for Exceptional Children, Indiegogo campaign: https://www.indiegogo.com/projects/leka-an-exceptional-toy-for-exceptional-children

[6]Source: https://www.ald.softbankrobotics.com/en/cool-robots/nao

Yet another aspect to be considered is that even though all the existing products have been developed in collaboration with ASD experts or with the associations of families with ASD children, practically none of them enjoys the endorsement of an official body working with ASD children. A notable exception is 'Brain in Hand'[7] that is supported by the "The National Autistic Society" of the UK.

As a matter of fact, the whole business model of selling the product should be rediscussed. The ownership of the objects has become less common and socially valuable than it used to be. The shared market for cars, tools, and even houses is now a reality so one could easily argue that the B2C approach in which the customer has to pay upfront for all the product costs does not work anymore. Offering a relationship based not only on the product but also on services that can be continuously updated (and billed) may create a bond between the manufacturer and the consumer, thus ensuring a higher product acceptance.

A last consideration concerns the use of such robots as therapeutic tools. Once that the appropriate security and privacy systems are in place, these robots will have the capability built-in to do remote and continuous observations. In the business model this aspect can become particularly important as this may save in trips to the clinic. Still, generally insurance companies do not see this technology as a valid means for therapy. This has to change, since we need to break through the valley of death that requires small technology companies to fund long pilots and clinical trials.

4. Conclusions

Thanks to the recent technology developments, we are at the turning point for the business of social robots for ASD children. There is a relatively large market formed by a couple of million individuals and their families, but it still largely unexplored. This extended abstract has tried to analyze why, despite the numerous solutions already available on the market, there is not yet a large penetration of this kind of products. At the same time, it has tried to provide an insight on the business aspects that should drive the development of future solutions. Price, customization, and acceptance are key factors to succeed, combined with the adoption of novel hybrid business models that yield profits not only with the hardware but also with the service attached.

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Privacy Concerns and Social Robots in Healthcare and Therapy: Presenting New Empirical Research

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Abstract. With the increasing adoption of robots in different social fields, the question of privacy concerns and challenges emerges. Conceptual research on the topic of robots and privacy has increased in the last few years but we lack detailed empirical evidence about the prevalence, antecedents and outcomes of privacy concerns. Our research provides results of a current survey (N=501) on privacy concerns around social robots and tests a model with a variety of antecedents grounded in trust, technology adoption and uses and gratifications scholarship.

Keywords: social robots, privacy, healthcare, therapy, education, empirical research, survey

INTRODUCTION

Artificial intelligence and robots reach higher and higher capacity levels every year [9, 16]. Soon, social robots – those that interact with us in some way – will be part of our daily environment and become our "new friends" as the title of this conference indicates. Social robots are already employed in industrial settings, in healthcare and therapy, and in households [4]. In healthcare settings, the employment of robots takes different forms. From surgery assistants, to patient carrier, to personal assistants, or therapy, the range of services robots perform is vast. The application of social robots in those fields comes with numerous benefits. For instance, therapy robots can alleviate daily tasks for older patients or help doctors monitor their patients' recovery. Beane and Orlikowski's [3] research shows that – under certain conditions – the introduction of PR-7 telepresence robots can help physicians and nurses in post-surgical intensive care units (SICU) coordinate themselves more efficiently. Other research shows that assistive robots in autism therapy facilitate the communication between physicians and patients [2] and provide promising results for patient wellbeing [5]. Yet, the diffusion of social robots in healthcare and therapy also triggers various concerns, one of them being privacy and its infringement.

PRIVACY CONCERNS & ROBOTS

Privacy is a concern because social robots have the ability to move around, monitor their environment, record their interactions with individuals, and register our daily routines as well as attitudes or preferences. In other words, they collect and process a lot of personal information about the individuals within their environment. In addition, they affect our sense of intimacy, surround us throughout day and night, and individuals bond with social robots [14]. Studies in the field of human-robot-interaction have shown that humans tend to anthropomorphize or zoomorphize social robots. This in turn increases the pervasiveness of social robots compared with other connected technology [15]. In fact, the real-life agency and limited autonomy that social robots typically possess, i.e., their ability to physically reach out into the world [4, 10], enables them to surveil individuals across places and gain access to personal rooms [6, 17]. Taken together, social robots affect the privacy of individuals in an unprecedented way when compared with other current technologies, such as smartphones [7, 8, 10, 14]. The attitudes and awareness of patients and consumers with respect to privacy issues and social robots needs to be assessed and documented if we want to take steps towards efficient privacy protection.

MEASURING INFLUENCE OF PRIVACY CONCERNS: NEW EMPIRICAL RESEARCH

In this contribution, we address the topic of social robots and privacy. The research questions we are interested in are in particular: are there any privacy concerns when it comes to the employment of social robots? If so, how pronounced are these concerns and how do they materialize?

While there has been an academic debate on how robots influence our privacy understanding, empirical research in this field is scare. An exemption is Alaiad and Zhou's work [1]. They conducted a survey among both professionals and patients to examine the use intention of home healthcare robots. The authors found that trust plays a key role [1]. Calo [6] and Lutz & Tamò [11] have similarly pointed out the importance of privacy when it comes to healthcare robots. Therefore, this contribution aims to fill the gap of missing empirical studies in the area of social robots, privacy, and trust. Our empirical research is based on an online survey that was conducted in late June 2016 via Amazon Mechanical Turk (N=501). The respondents had to fill out a series of closed and open-ended questions and we used established measures (for example from Eurobarometer studies or existing literature on privacy and trust) whenever available. We test a set of twelve hypotheses, derived from the privacy, trust and technology adoption literature [12, 13, 18]. The underlying research model is shown in Figure 1. In particular we are interested in understanding how the use intention of a social robot influences its adoption, whether privacy concerns influence the use intention of robots, and how privacy concerns influence the perception of benefits of robots.

PRELIMINARY SURVEY RESULTS

We will present final results of our research model at the New Friends 2016 Conference if the abstract is accepted. Preliminary results indicate that – out of four types of privacy concerns assessed – information privacy concerns about the robot manufacturer are most pronounced. The respondents scored arithmetic means of between 3.70 and 3.74 and median values of 4.0 on four 1-5 Likert scale items that measure informational privacy concerns related to the manufacturer (e.g., prompt: "*Please indicate your level of concern about the following potential privacy risks that arise when you share your personal information with a robot.*" item 1:*"The robot manufacturer insufficiently protecting personal data"*; item 3: *"The robot manufacturer selling personal data to third parties"*). Social privacy concerns (e.g., prompt: "*Please indicate your level of concern about the following potential privacy risks that arise when you share your personal information with a robot.*" item 2: *"Other users hacking into the robot."*; item 3: *"Other users stalking me via the robot."*) are second most pronounced, while physical privacy concerns (e.g., *"the robot entering areas it shouldn't access"*) and social bonding concerns (e.g., prompt: "*Please indicate your level of concern about the following potential privacy risks that arise when you have a robot at home.*" item 2: *"I develop intimate feelings towards the robot."*) are least pronounced.

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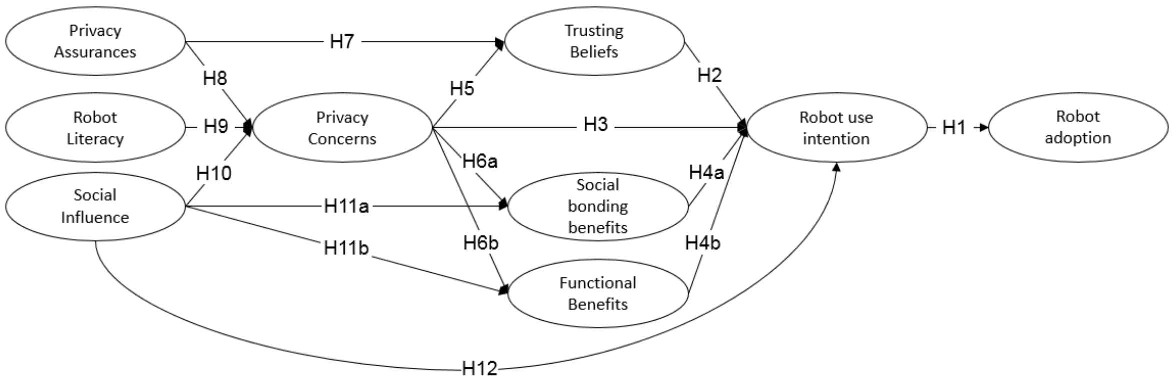

Figure 1. Model of Hypothesis and Testing.

Pet-Robots Assisted Therapy: Proposal For A New Standardized Nursing Intervention

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Abstract.

The use of assisted pet therapy in the population of hospitalized children has also been well documented with positive experiences in different fields. Our knowledge and experience on the functioning of the relationships between people and animals, especially those we consider as partners can serve as a starting point in understanding how the relationship between people and social robots. In the daily nursing work a care plan focused on the patient, family and community is set, this plan use a standardized language to facilitate the communication between health professionals and is registered in a international classification. The animal-assisted therapy is a nursing intervention included in this international classification and we propose the drafting and inclusion of a new intervention called "pet-robots assisted therapy". In this paper we discuss the relevance and necessity of this new intervention.

Keywords: Pet-Robots, Nursing, Care

INTRODUCTION

A nursing diagnosis is a clinical judgment about individual, family, or community experiences/responses to actual or potential health problems/life processes. The nursing diagnoses are classified by the North American Nursing Diagnosis Association (NANDA) with the objective of using a standardized terminology to guarantee the patients' safety through an evidence based practice [1].

The goals or outcomes set from the NANDA diagnosis are described by the Nursing Outcomes Classification (NOC) [2]; this classification has its own terminology and standardized indicators. Finally the nurse uses different interventions for the achievement of the goals set, these interventions have their own classification, the Nurse Intervention Classification (NIC) [3].

The nursing interventions

A nursing intervention is any treatment based on a clinical judgment or knowledge that a nurse performs to achieve the goals set. The intervention may be focused on the patient, the family or the community.

These interventions are developed using a global standard language to describe the actions of physiological, psychological and social aspects necessary to treat and / or prevent disease and promote health in line with the diagnosis nurse (NANDA).

Animal-assisted therapy

The animal-assisted therapy has been widely used by nurses in different care areas. Florence Nightingale, famous reformer of the modern nurse said in her book "notes on nursing" [4]:

> *"A small pet animal is often an excellent companion for the sick, for long chronic cases especially. A pet bird in a cage is sometimes the only pleasure of an invalid confined for years to the same room. If he can feed and clean the animal himself, he ought always to be encouraged to do so."*

The use of assisted pet therapy in the population of hospitalized children has also been well documented with positive experiences in different fields, from intensive care to oncology, although they have established some recommendations for cases in which therapy should be introduced carefully or cases where should not be performed, for example in patients with open wounds, immunocompromised or allergic [5].

The animal-assisted therapy is an intervention included in the NIC, defined as the intentional use of animals for affection, attention, fun, relaxation and learning facilitator. It describes 19 different activities related with the intervention from "encourage petting the animal (432012)" to "encourage the expression of emotions (432014)".

A NEW NURSING INTERVENTION?

Our experience with pet-robots

Our knowledge and experience on the functioning of the relationships between people and animals, especially those we consider as partners can serve as a starting point in understanding how the relationship between people and social robots [6].

So that the social and emotional bond established between the child and the pet, who will be the facilitator agent and producer of beneficial effects could be formed similarly between the child and the pet robot. This relationship has different facets, on the one hand is the interdependence between the "owner" and mascot, this relationship is based on hierarchy and bonding. The hierarchy means that the child has a superior status to pet. The social situations of interdependence naturally produce activities that encourage bonding, for example the child teach the robot new skills, name it, and feed it.

In our hospital we has been using the PLEO® pet-robot, a robot-like baby dinosaur that has different personalities and animals and primary behaviors such as hunger, fear , happiness , curiosity. The PLEO® generates affective behaviors in children aimed at satisfying the needs of the robot (F. E. give affection) and involves them in the care of it. In our previous experiences the children interpreted the internal responses of the robot as a result of intention and reasoning, and interpreted in the same way PLEO®´s responses as recognition of himself after repeated contacts [7].

Pet-robots assisted therapy

The new nursing intervention would be defined as the intentional use of pet robots for affection, attention, fun and relaxation, and it include different activities such as feeding the robot, petting it…

OBJECTIVES

The main objective of this work is to know the relevance of this new intervention for the achievement of certain goals.

METODOLOGY

The first stage of the validation aims to establish the relevance of the development of the "pet-robots assisted therapy" intervention. For this objective we use a qualitative methodology based on an open response survey.

For the second stage we use the animal-assisted therapy as a model and from the hypothesis that the new NIC could be use in the same situations that the previous one we select the interrelated nursing outcomes, that is to say the nursing outcomes that could be achieve with this new intervention. After the initial selection we make a second selection of indicators derived from the outcomes. These indicators are statements or description of situations that the patient may experience, these indicators includes a 5-points-liker scale to check the degree of compliance of the outcomes.

RESULTS

Nine nurses with experience in the use of PLEO® were surveyed about the relevance of the pet-robots therapy. They place the robots in medical areas such as daily hospital, emergency department, surgical ward and hospitalization ward (figure 1). About the clinical utility of the pet robots the nurses said that the robot could distract, make company, awaken imagination, facilitate the expression of feelings, stimulates the responsibility of caring, interact with children and are viewed as an alternative to videogames or TV.

We surveyed the nurses about the difficulties of handling the anxiety and which role could play the robot, the nurses said that the robot could be a facilitator of feelings expression; it could be a mediator or a nexus between health professionals and the children.

Figure 1. An adolescent and his mother playing with a PLEO® in the surgical waiting room, a smaller child observe the scene with curiosity.

After this relevance validation we select the nursing outcomes and the indicators that best fit in the described scenarios and situations. The initial selection is shown in the table 1.

Table 1. Pet-Robots assisted therapy related NOC and indicators.

NOC	Indicators	Scale
1204-Emotional balance	01-Shows affection adequate to the situation	m: from Never(1) to Always(5)
1212-Stress level	23-Distrust	n: from Serious(1) to Neither(5)
902-Communication	07-Directs the message appropriately	a: from Severely compromised(1) to Not compromised(5)
1502-Social interaction skills	11-Seems relaxed	m: from Never(1) to Always(5)
1214-Agitation level	01-Difficulty processing information	n: from Serious(1) to Neither(5)
1843-Knowledge: pain management	25-Effective distraction	u: from Any knowledge(1) to Extensive knowledge(5)
1302-Coping problems	16-Refers decreased physical symptoms of stress	m: from Never(1) to Always(5)
1301-Child adaptation to hospital	05-Fear	t: from Always(1) to Never(5)

For the next steps of our work we are going to conduct a quantitative research measuring these indicators before and after the robot intervention. We will conduct a statistical analysis of the results to know if the intervention has been useful for these outcomes.

DISCUSSION

The objective of this work is to know the relevance of this new intervention based on pet robots. After a qualitative survey on nurses we identify different areas and situation where the robot could be useful as well as different outcomes that could be achieve with this therapy.

We are carrying out the quantitative study and we expect to have concrete results to show in the new friends' congress.

The process of inclusion of a new NIC in the international classification is difficult because a wide number of evidences has to be exposed, and the new NIC has to have at least an 80% of unique or different activities in contrast with other NIC, so we have to describe no less than 15 activities that could be performed in the "pet-robots assisted therapy" and that they are not described in the actual NIC.

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A design of child-robot interaction in hospitals

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Abstract— This paper presents the design for the social behaviors of robots operating in the pediatric ward of an oncological hospital. In this scenario the robots interact with a varied number of people: children, staff, etc. We present an HRI architecture that is capable of managing the different situations the robots face while interacting with people. We model these interactions as multimodal dialogues, in which the robot perceives the current situation and expresses in a cohesive and coherent manner.

1. Introduction

This paper presents the Human-Robot Interaction approach of the MOnarCH Project[1] The aim of this project is to develop a networked system of social robots targeted to interact and to engage children who are hospitalized in the paediatrics ward of an oncological hospital in Lisbon, Portugal. The robots' social behaviors have to comply with the adopted norms of different contexts. In that way, the robots must be able to adapt their social behavior depending whether they are interacting with patients, parents, nurses, doctors, teachers, etc. Additionally, they must be able to identify the different spaces of the hospital and adapt their behavior accordingly.

The proposed HRI architecture is based on Communicative Acts (CAs) which we define as the minimum unit of communication between 2 entities (in this case, a robot and a human). CAs are inspired by the ideas of Searle [7] and others, but adapted to the MOnarCH scenarios. A CA is an interaction pattern that might be instantiated differently according to its parameters and the interaction context. In some way, CAs have some point in common to the interaction patterns proposed by Khan and colleagues in [4] but focusing not only on the socialization aspects of the interaction, but also in the functional and task aspects.

2. Description of the hospital environment

The MOnarhCH robots, MBots (Fig. 1), are designed to interact with the children hospitalized in the pediatrics ward of the hospital.

The robots operate in 3 areas of the paediatrics ward of the hospital: part of the main corridor, where the robots acts as a *Joyful Warden*; the paediatrics ward playroom, where the MBots tries to engage children in *Interactive Games*; and the paediatrics ward classroom, where the Mbots behave as *School Teaching Assistants*. In some of these scenarios, we continued the social interaction developments from previous work [2]. However, in the MOnarCH the robot's social behaviors must comply with different situations and social norms. Also, the robots must be able to interact with children, staff and bystanders. This means that the robots must behave in different manners depending on to whom they are interacting with and on the current interaction context. In this way, we divided people in three different categories: hospital staff, children, and other people. We model these roles using the roles proposed in the literature [6] in the following way: hospital Staff will act as Supervisors and as Peers; children will act as Peers; and other people will be considered as Bystanders.

Fig. 1: An MBot with a child. ©Miguel A. Lopes / LUSA

3. The MOnarCH HRI architecture

The MOnarCH HRI architecture (Fig. 2) consists of a Dialogue Manager (DM) and the Multimodal Fusion and Fission modules. The DM It receives the CA activations requests from the Socially Aware Planner (SAP). That is, the SAP knows which is the current storyboard and situation and decides which CAs might appropriate for such context.

The Dialogue Manager (DM) manages the execution of the MOnarCH HRI. That is, it does not executes the interaction directly but, rather, it orchestrates the actions that compose this interaction by sending the appropriate commands to the robot's Multimodal Fission (MFi) modules, which are actually in charge of the execution. In short, the DM decides *what to do* while the MFi knows *how to do it*. For instance, if the robot needs to ask something to a user, the DM decides which question is needed to ask, with which emotion, volume etc. Then, it sends this command to MFi, which knows *how* to perform the utterances of that phrase, and returns the response to the DM.

Our HRI Architecture allows multimodality, the use of several HRI interfaces at the same time. This means that an interaction can be executed, not only by voice, but with other interfaces such as gestures, LED expressions, images

[1] `http://monarch-fp7.eu/`

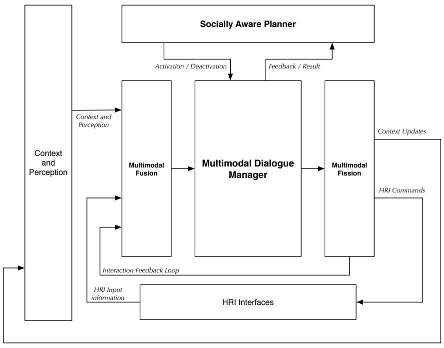

Fig. 2: Overview of the MOnarCH HRI architecture.

in the screen, etc. This multimodality applies as well to the inputs: besides of listening to what the user says, the robot also uses other sensors such as touch, RFID readings, cameras, etc. The multimodality is supported thanks to the use of the Multimodal Fusion (MFu) for inputs and the MFi for outputs (see Fig. 2). The MFu consists of a series of nodes that first, gather the information coming from the input HRI interfaces and the Perception, and second, aggregate and translate them into a format which is useful for the DM. With this information, the DM can decide what to do and send the appropriate commands to the MFi.

Our DM implementation is based on the *iwaki*[2] DM, a rule-based production system inspired by the COLLAGEN plan trees [5]. The rules of the production system, which are called recipes or dialogues, have aspects of finite-state, frame, and information-state-based approaches. These recipes are written in XML files, and define the preconditions that trigger the execution of a certain CA and the actions that should be executed in such CA. That is, these rules code what actions should be sent to the MFi when certain inputs are received from the MFu. For instance, consider the case of a give greetings CA. This CA waits for the input from the perception indicating that a user is in front of the robot. When this occurs, the recipe starts sending the different actions coded in the XML dialog file to the MFi, These might consist in, for instance, saying a random greeting utterance, expressing a big smile, etc.

4. Communicative Acts

A Communicative Act (CA) is the minimal interaction behavior that is performed by the robot to respond or to elicit a response by the receiver. The content of a CA is purposefully driven and is constrained by a set of parameters that include the robot's internal state and the situational context. Each CA is modulated by a series of input parameters that affect how the CA is conducted. For instance, all CAs have a "robot emotion" parameter, which modifies the execution of the CA depending on the emotion passed. For instance, MBots speak louder and faster when express happiness.

We categorized CAs according to their purpose following the ideas from [3], [7], [1] but adapted them to the needs of the project. Mainly, the CAs of our approach seek a functional perspective with the project objectives and the hospital scenarios in mind. Hence, we established 7 CA categories and defined a set of CAs that fit in each category. Each category has its own functional interaction purpose: *Referential CAs*, include the CAs that try to obtain certain information from someone such as the name of a child, the location of a doctor, etc.; *Informative CAs*, include the CAs used to provide information to a person (this category is similar to the previous one, but here is the robot who provides the information to a person); *Persuassive or Conative CAs*, where the robot attempts to persuade the user to perform a certain action (such as asking a child to play a game); *Commissive CAs*, where the robot accepts, refuses or delays an instruction of a command from a user such a doctor, etc.; *Phatic CAs*, which have the only purpose of social bonding (giving greetings, cheering up, etc.); *Affective CAs*, where the robot expresses attitudes to certain situations such as apologizing, giving thanks, etc.; and *Meta Interaction CAs*, which have the purpose of communicate information related to the interaction itself (for instance, telling the user that the robot cannot hear her well, etc.).

[2]https://github.com/maxipesfix/iwaki

5. Conclusions

We presented an HRI architecture that enables robots to establish social relations in different scenarios in an hospital scenario. Together with the architecture, we introduced the Communicative Acts (CAs), which are the minimum unit of communication between 2 entities (a robot and a human). CAs use ideas from the linguistics [3], [7], [1], and bring them to the hospital scenarios envisioned in the MOnarCH project. These CAs share some common concepts with the Interaction Patterns presented by Khan et al. [4], but they focus more on the functional aspects required by the MOnarCH scenarios. We introduced a set of CAs divided in 7 categories and provided some examples of them. We believe that CAs can be considered as a interaction patterns that are sufficiently generic for their use in a variety of situations other than social interaction in hospitals.

6. Acknowledgements

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Increasing the Robot's Level of Autonomy in Social Human-Robot Interaction through Interactive Reinforcement Learning

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Abstract. This paper introduces our approach for increasing the robot's level of autonomy by learning from the Wizard using interactive reinforcement learning. It describes interactive Q-learning and interactive SARSA modified for such purposes. The proposed mechanisms were tested on a simulated model of a child in a categorization task. The results show that these methods are suitable for creating a personalized robotic behavior while increasing the robot's level of autonomy.

Keywords: social human-robot interaction, interactive reinforcement learning, Wizard of Oz, autonomy

INTRODUCTION

In recent years social robotics and social human-robot interaction (HRI) became an interesting field in robotics research. Robots left the laboratories for real-world environments and interacted with people to help them in various aspects of their life [1] [2] [3]. Such studies proved the positive effect of using social robots in various therapies, but they also exposed their weak points. One of those is the fact, that most of HRI studies use the Wizard of Oz technique. In these scenarios the robot is not acting autonomously during the interaction, but is teleoperated by a human expert [4]. However, the number of publications with autonomous robot behavior is rising [5]. Another issue in HRI is the length of interactions. We argue that in order to enable long-term social HRI learning of the appropriate social behavior either from the user or from the Wizard is inevitable. Another aspect of the learnt behavior is its uniqueness and whether it is tailored to the user's preferences. As Dautenhahn pointed out the importance of personalization in [6], we believe that such a behavior can further enhance the interaction.

In our research we address the above mentioned issues. To solve them we designed two interactive reinforcement learning algorithms based on Q-learning [7] and SARSA [8]. This approach had been successfully used in various HRI scenarios to learn practical skills from demonstration [9] [10] [11] or adapt the robot's pre-programmed behavior [12]. However none of these studies dealt with learning a social behavior from the operator. The first mention of such a theory was in [13] by Knox et al. and it was tested in a simulated environment. Our approach combines the findings of the mentioned projects and creates a learning mechanism which is capable of creating a personalized social behavior of the robot while increasing the robot's level of autonomy.

THE EXPERIMENTAL SETUP

As a proof of concept we tested our approach on a modified version of the model published by Senft et al. [14]. The goal of this scenario is to increase the performance of a child with autism spectrum disorder in a categorization task. The internal state of the subject is described by three parameters: performance, motivation and engagement. Whenever the child is asked a question based on the current values of motivation and engagement, the performance is increased or decreased. To determine this, three different models were defined: highly reactive, asymmetrically reactive and low reactive child. Three different types of robot actions are used to set the values of the parameters: increasing motivation, increasing engagement and proposition for changing the performance. For more information on the model please refer to [14].

In our experiments we used a modified version of the described model. Instead of using just three possible actions of the robot, we worked with 12 (four for every action type), while each of those changed the internal state differently. Adding this feature enables the Wizard to create a more diverse and personalized action selection policy.

In our experiments we used the interactive versions of two commonly known reinforcement learning algorithms, Q-learning and SARSA [8]. In the case of Q-learning we are talking about an off-policy temporal-difference (TD) algorithm. "It directly approximates the optimal action-value function, independent on the policy being followed" [8]. Opposite to this, SARSA represents an on-policy TD algorithm. It continually estimates Q for the behavior policy. Since our method is based on learning from a human teleoperator the reward for each action is given by him/her. The pseudocode of our approach can be seen on Figure 2.

```
s_t = last state, a = action, r = reward
while not end of interaction do:
    a = ε - greedy action selection
    if Wizard accepts a:
        execute a, sense new state s_{t+1}
    else:
        a = action chosen by the Wizard
        execute a, sense new state s_{t+1}
    r = reward given by the Wizard
    update Q-value
    s_t = s_{t+1}
end while
```

Figure 1. Pseudocode of our approach based on interactive reinforcement learning

The only difference between the two algorithms is in step 10. In the case of Q-learning Q is updated according to (1), where α is the learning rate and γ the discount factor.

$$Q_{t+1}[s_t,a] = Q_t[s_t,a] + \alpha(r + \gamma\, max_a Q_t[s_{t+1},a] - Q_t[s_t,a]) \quad (1)$$

On the other hand, SARSA uses (2), where a_{t+1} is the next action using the policy derived from Q, in our case it is ε-greedy.

$$Q_{t+1}[s_t,a] = Q_t[s_t,a] + \alpha(r + \gamma\, Q_t[s_{t+1},a_{t+1}] - Q_t[s_t,a]) \quad (2)$$

PRELIMINARY RESULTS

In our experiments we wanted to determine whether our approach is suitable for acquiring a personalized robot behavior while increasing the robot's level of autonomy. To do so, we used the high reactive model, which was discussed in Section II. We used interactive Q-learning and interactive SARSA as learning algorithms. We defined the possible states of the subject by dividing the range of permitted values of the three parameters (performance by 20, motivation and engagement by 10). This resulted in 2541 states. When determining the subject's current state, the algorithm chooses the closest one from the pre-defined states based on the Euclidean distance.

As one session we considered 50 interventions whether they were chosen by the teleoperator or by the learning algorithm. One experiment consisted of 10 sessions, while at the beginning the Q-table was initialized with zeros and the consecutive sessions used the one from the previous session. In all cases the learning algorithms used α=0.3, γ=0.8 and ε=0.1. The results comparing the number of autonomous actions achieved by interactive Q-learning and SARSA can be seen on Figure 2.

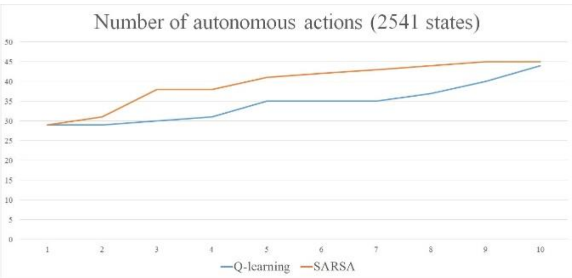

Figure 2. Number of autonomous actions achieved by interactive Q-learning and interactive SARSA during 10 sessions

From the figure it is evident, that interactive SARSA performed better, although interactive Q-learning also increased the robot's level of autonomy. Since both algorithms are storing the learnt policy as state-action pairs in a Q-table, we can say that a resulting table is containing a personalized behavior of the robot with the assumption that the Q-table is initialized with zeros for every unique subject.

CONCLUSION AND FUTURE WORK

In our work we focus on increasing the robot's level of autonomy while learning a personalized behavior. Testing the approach on a simulated model indicated that it can be used in a real-world HRI scenario. In our future work we are planning to create an interactive lecture using a NAO robot, where the subject will be taught about a chosen topic from artificial intelligence. The internal state of the subject will be described by his/her emotions. The robot will have at disposal various types of actions, such as explanation, encouragement, etc. and based on the subject's state and the help of a human Wizard it will learn a suitable behavior which can be used later in other sessions with the same subject in fully autonomous mode.

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Automated Audio Data Monitoring for a Social Robot in Ambient Assisted Living Environments

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Abstract— Human life expectancy has steadily grown over the last century, which has driven governments and institutions to increase the efforts on caring about the eldest segment of the population. Although this concern was initially addressed by building larger hospitals and retirement homes, these facilities have been rapidly overfilled and their associated maintenance costs are becoming far prohibitive. Therefore, modern trends attempt to take advantage of latest advances in technology and communications to remotely monitor those people with special needs at their own home, which boosts their life quality and has very few impact on their social lives. Nonetheless, this approach still requires a considerable amount of qualified medical personnel to track every patient at any time. The purpose of this paper is to present a social robot for assisted living that tracks patients status by automatically identifying and analyzing the acoustic events happening in a house. Specifically, we have taken benefit of the amazing capabilities of a Raspberry Pi together with a Nao robot to collect data inside a house and send it in realtime to the medical center. Conducted experiments verify the feasibility of our approach and open new research directions in this domain.

Keywords— Assisted living, human robot interaction, social robots, remote therapy, audio recognition

1. Introduction

Increasing the average human life expectancy is one of the greatest achievements of modern society [1]. This opens several challenges for the public (and private) health community since the number of patients to take care of has also raised accordingly. Additionally, the way of how those people who need special care are attended is changing significantly. In fact, despite the latest efforts of governments and institutions on building bigger and more modern medical facilities, they rapidly get overfilled due to the ever-raising number of people they have to serve. Nowadays, it is intended that the elderly stay at home for two reasons: on one hand, it is better for their health, while not suffering from severe deteriorations, and on the other hand, is much cheaper to health services.

Thankfully, technology can contribute to address this problem by enabling medic staff to monitor (and attend) patients when they are at home (also referred to as ambient assisted living [2]), which reduces the personnel costs and enhances their social interactions. From a general point of view, ambient assisted living consists of mining the preferred living environment of patients with intelligent devices able to track their status to improve their life quality. Nowadays, there are several social iniciatives to put robots to elderly people homes not only to cover certain routine tasks, but also with chatbot applications, to accompany them, to help them remember to take the tablets and also to make them use interactive games that help to keep their cognitive abilities.

This work further exploits the concept of social robots in ambient assisted living and presents an application, consisting of a hardware and a software, that infers the in-home context of a house using sound data. This platform is composed of a Raspberry Pi to work with any standard robot. Specifically, the Raspberry Pi acoustically analyzes all the sounds happening inside the patient's home using machine learning and data mining techniques. When the system determines that an event corresponds to an emergency (e.g., scream, silence for long periods of time, someone falling down) the robot itself activates an alarm. The social robot is also used to obtain information about what has happened in the tests, record it, and send it together with the activated alarm to the cloud to be evaluated. It is worth mentioning that this application has been designed in such a way that it is independent form the social robot used in the tests.

The remainder of this extended abstract is organized as follows. Section 2 reviews the related work on environmental sound recognition. Section 3 discusses the basics of the human robot interaction used. Section 4 elaborates on the technical details of the proposed platform. Section 5 discusses future work directions and concludes the paper.

2. Related Work

Environmental sound recognition is a hot topic today for several applications [3]; from bird sound detection to surveillance applications, several approaches can be found in literature to extract the features from the sound, and classify the source of the noise with previous training with a corpus.

One of the most popular applications nowadays of audio event recognition is its use in the smart home [4], especially when developing the system with the disabled people needs in mind. The challenges around the design of a health smart home [2] based on audio event classification: *i)* the degree of dependency of the disabled person, *ii)* the quality of life improval by means of automatization of processes and finally *iii)* the distress situations recognition and the activation of the preasigned protocols. In this paper we only adress the third of the challenges, despite in the literature [5] several solutions are given for all the others.

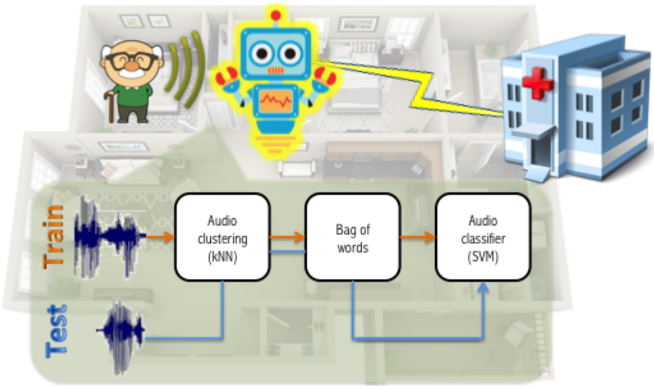

Fig. 1. Block diagram of the software modules that compose the proposed social robot for ambient assisted living

Interest in detecting in-home sounds was alive from the beginning of this technology; in 2005, Chen [6] was monitoring the bathroom activity only from the sound information. Afterwards, with research not detailed in this work, robust environment sound recognition motors were designed in 2008 [7]. Even audio scenes were classified evolving the same type of technology [8]. Finally, several works can be found about audio study in a smarthome to help doctors the early diagnose of dementia diseases for the elder [9].

3. Human Robot Interaction

Interaction between humans and robots applied is currently being used to fight loneliness in elderly people aging at home [10]. It is an instrument that can accompany them in routine daily tasks such as giving greetings in the morning, informing them of what is the weather like or reminding them to take the medication. In this regard, if there is no response in the proactive robot interaction, we get the first indicator of potential health problems. If we add the benefits of active listening of what happens at home, the patient's condition can be related with the acoustic context, and then activate the previously established protocol if necessary. In this regard, we have used Wilma, a Nao robot brought from the USA that La Salle R&D has at its disposal. It allows us to collect all the information about what happened at home and activate the alarms accordingly (e.g., when a fall is detected, the protocol is to first ask the person if everything is ok).

4. System Architecture

The social robot works with a Raspberry Pi model 3 which has wi-fi connectivity and an ARM quad-core architecture very suitable to conduct audio processing. We have connected a microphone to the Raspberry and programmed a data miming architecture to process audio data (see Fig. 1). Its behavior is detailed as follows.

First, the system splits the audio sample in subsamples of 20 ms. and extracts the relevant audio features for each subsample. One of the most used feature extraction algorithms in automatic sound recognition is Mel/Frequency Cepstal Coefficients [11]. Despite in literature they are widely used in speech technologies, most of the audio recognition systems settle the use of these coefficients as baseline in terms of feature extraction [12]. When all features are extracted, a k-Nearest Neighbors (kNN) system is run [13].

Next, we apply the bag of words technique to obtain a fixed size vector for each sample. Each component of the vector corresponds to the number of audio subsamples that match a cluster of the kNN. With this information, a Support Vector Machine is trained. We have built a training dataset composed by 2850 audio samples lasting a total number of 20 hours. On the test stage, this system is able to recognize the following events with an overall accuracy of 73%: someone falling down, steps, slice, screaming, rain, printer, people talking, frying food, filling water, door knocking, dog bark, car horn, glass breaking, baby crying, water boiling.

5. Conclusions

Preliminary results of our paper encourages us to keep on working on the human robot interaction and studying the information we obtain from the tests. This will conduct us to improve the definition of the protocols and the potential feedback that the robot can give to the elderly.

ACKNOWLEDGMENT

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Adaptation of Robot Behavior According to Human Speech

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Abstract— One of the areas of research that connect humans and robots is care for elderly. We propose a system which connects together two fields of research sentiment analysis and human-robot interaction. In the field of sentiment analysis, we are focusing on emotion detection. Information about emotion can be additional information for the robots to adapt its behavior to make elderly comfortable to be around them. As for emotion detection, we applied a hybrid of machine learning approach (i.e. Nave Bayess, SVM, k-nn, Kohonen network) and dictionary approach. The precision of emotion identification ranges between 54 % up to 80 % (highly depending on the chosen method). In the field of human-robot interaction, we are focusing our attention to move from Wizard of Oz technique to the at least semiautonomous system.

Keywords— sentiment analysis, emotion detection, human-robot interaction, dictionary, machine learning

1. INTRODUCTION

One of the areas of research that connect humans and robots is care for elderly. Its estimated that by 2050, the elderly will account for 16 percent of global population. That's 1.5 billion people over the age of 65, according to [1]. Caring for these seniors - physically, emotionally and mentally - will be an enormous undertaking, and experts say there will be a shortage of trained professionals and those willing to take on the job. Robots may fill the gap, taking care of older people.

Our goal is to utilize results from the field of sentiment analysis into the field of human-robot interaction. As we are not aware of any autonomous/semiautonomous system in social robotics that allows a robot to use information about emotion in a text we propose a system that will help the robot to make a decision based on the human textual input.

Generally, experiments in human-robot interaction are conducted using the Wizard of Oz technique, which means that the robots are not acting autonomously, but they are teleoperated by a human [2]. We are moving from robots that do not interact with humans, are programmed to do a specific task, and are unable to learn new things from humans to robots that interact with humans and are able to acquire new knowledge and use it productively.

In the next sections, we describe our achieved results in the field of identifying emotions in text and describe proposed scenario, and how such information can be utilized in human-robot interaction.

2. EMOTION DETECTION

Analyzing sentiment and detection of emotion in a text is still popular task these days. We can say that categorizing text into emotions category is a fine-grained classification in comparison with polarity detection. When we identify polarity we have at most three categories positive, negative, neutral. In the other hand when we identify emotions we can have up to eight categories. Number of emotions depends on emotional model we use e.g. Ekmans model [3] uses six distinct emotions - anger, disgust, fear, happiness, sadness, and surprise; Plutchiks wheel of emotions [4] uses eight basic emotions anger, fear, sadness, disgust, surprise, anticipation, trust, and joy. There are three approaches towards identifying polarity that applies to emotion detection in a text as well. The first one is a lexicon based approach, the second one is a machine learning approach, and the last one is a hybrid method which combines before mentioned methods [5].

A. Dictionary based approach

While using dictionary approach we focus on identifying seed words in a text. Seed words in a text are words that carry polarity/emotion. We are using dictionaries created by our students and also well-known dictionaries such as SentiWordNet 3.0 [6], WordNet [7], and NRC Emotion Lexicon [8]. Final emotion is calculated as the highest sum of each sum of emotions in given text. We are using unigram model.

B. Machine learning approach

The most used machine learning methods for polarity/emotion detection are Naïve Bayess, and Support Vector Machine (SVM) [5]. We also implemented others algorithms such as k-nearest neighbour and Kohonen network. We are not seeing the usage of these algorithms very often in the domain of sentiment analysis.

3. USAGE OF EMOTION IN HUMAN-ROBOT INTERACTION

We proposed a system, as depicted on figure 1, where robot interacts with elderly people. The Robot can maintain the role of the listener or the conversational agent. In both cases there is a need for the robot to understand spoken word, therefore, we are going to use existing systems for *speech to text* conversion. After converting speech stream into text data, we will apply our *emotion detection system*. The output of the system will be labeled text with emotion. This kind of information can be used further for the robot to adapt its behavior according to emotion discovered in the text. By adapting robot behavior we mean changing its hand gestures, face expression and voice characteristics.

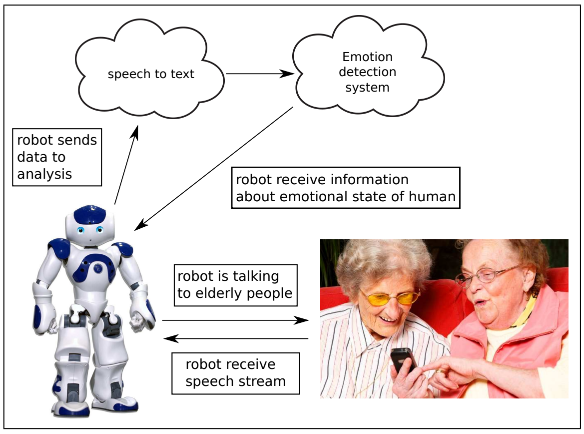

Fig. 1. Proposed scenario robot interacting with elderly

4. CONCLUSIONS

Exploration in the field of emotion detection is very popular recently and much research has been done in video and speech processing, along with some small progress in the field of text processing. We propose the utilization of detecting emotions in applications for human-robot interaction. We can see potential in implementing proposed system in facilities for elderly care. The robot can become a useful companion for old people as he can remind them to take their medicine but also can listen to them and talk with them anytime they feel the need. At the moment, we are in the process of negotiation such experiment in one of the elderly care facilities. We believe that in the near future we will obtain satisfactory results.

ACKNOWLEDGMENT

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Design of a robotics and IoT software platform for enhancing Early Childhood Education experience

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Abstract— Robots that interact with humans have become an important focus of robotics research. Composable service applications that can bring in the benefits of passive devices and active robots are going to play an important role in the future of education. This paper aims is to present the design and architecture of a distributed system that can be used for enhancing Early Childhood Education (ECE) experience. Key technologies involved in this research project are robotics, Internet of things, cloud computing and computational intelligence. The project will come under the umbrella of the Internet of things research foci at the Unitec Institute of Technology. The proposed design comprises child-friendly service robots, wireless networks, a cloud-based information portal, desktop and mobile software applications for teachers; parents, and software based learning tools, and intelligent tools for monitoring; interacting with children. The paper discusses the key element for software platform design and the engineering evaluation criterion for an enhanced user experience.

Keywords— Software and Architecture, IoT, Education Robotics, Robot Companions and Social Human-Robot Interaction, Personal Robots, Architectures Protocols And Middle-Ware

1. Introduction and related work

There's an emerging industry for interactive personal service robotics and Internet of Things (IoT) devices. The World Robotics report 2015 [1] stated that in 2014, about 4.7 million service robots for personal and domestic use were sold, 28% more than in 2013. The value of sales increased to USD 2.2 billion. There's been a simultaneous increase in IoT devices and integration with robotics. Grieco's survey article [2] discusses main topics related to IoT-aided robotics services: communication networks, robotics applications in distributed and pervasive environments, semantic-oriented approaches to consensus, and network security. Atzori's survey [3] gives a picture of the current state of the art on the IoT. The Springer Handbook chapter [4] provides an overview of the key ingredients that make successful education robots possible. Implementation of intelligent home robot based on smartphones with SKT manufactured robots and programming tools has been studied in [5].

2. Project Objectives

The project will come under the umbrella of the Internet of things research foci at the Unitec Institute of Technology. The proposed design comprises child-friendly service robots, wireless networks, a cloud-based information portal, desktop and mobile software applications for teachers; parents, and software based learning tools, and intelligent tools for monitoring; interacting with children.

3. Personal Service Robots in the project - Robot Nuri Atti

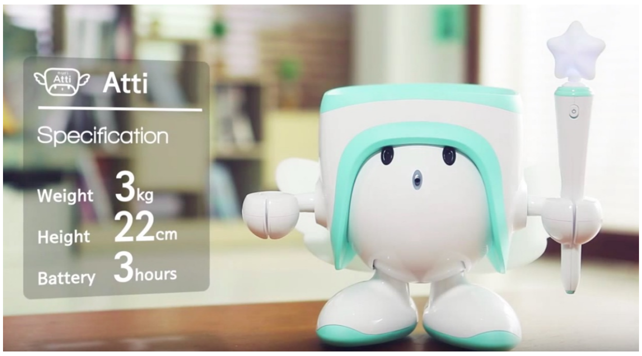

Fig. 1. Robot Nuri Atti

The proposed robots to be used in this project is manufactured and marketed globally by South Korean robotics company SK Telecom. Designed as an education tool for children aged 4-7, Atti offers a wide range of interactive features that make learning more interesting and effective. The cute little robot shown in Figure 1 begins working when the user inserts an Android smartphone i.e. all Android-based smartphones, regardless of model and carrier - to its cradle and runs the designated mobile application named 'Atti Home' on the handset [6]. Atti's interactive features are realized through various sensors e.g. optical sensor, proximity sensor, touch sensor, etc. embedded in its round-shaped body. Atti also comes with a Magic Wand that has an optical reader at the bottom (to function as an electronic pen), motion sensor and a microphone.

4. System components

The features of the proposed system as shown in Figure 2 are as follows:

- **Maintaining children profiles**: A profile is maintained for each child in the cloud-based information portal. In addition to basic personal information, a childs profile contains childs preferences, activities, educational levels, behaviour patterns etc. The profile is continuously updated when robots gather new information through interactions.
- **Teacher assistant role**: Robots function as teacher assistants by helping teachers to do certain daily activities.

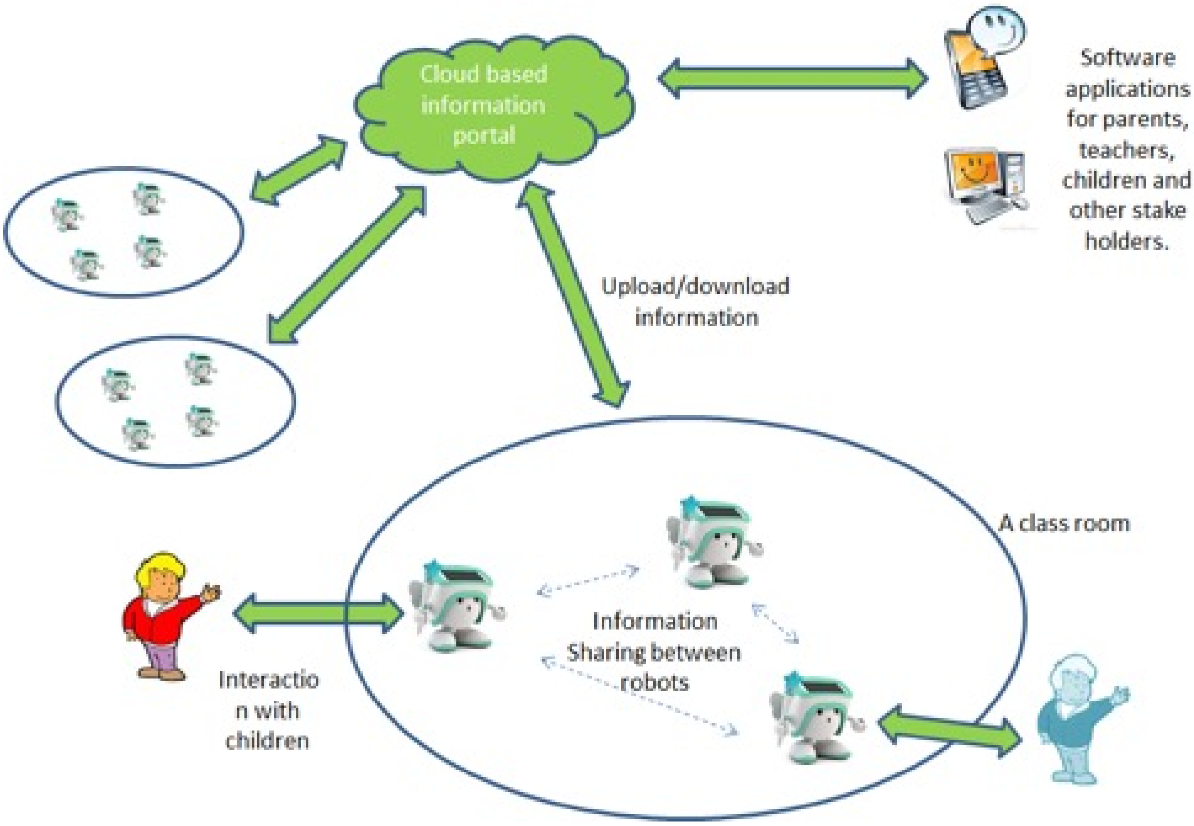

Fig. 2. Components of the proposed system

These could include taking attendance, spelling tests, drawing pictures, taking photos etc. depending on the capabilities of the robot.

- **Friendly interaction with children**: Robots function as companions to children. They will be able to greet, have simple dialogs, and play games with children. Robots will remember what they did in the past and change the behaviour accordingly.
- **Video monitoring**: Parents can monitor their children through the camera of the robot when needed.
- **Activity monitoring**: Robots monitors daily activities of children (both educational and other activities) and update profiles. If abnormal activity patterns are detected (e.g. due to sickness), those are reported to teachers and parents.
- **Therapeutic aids**: If required robots can provide therapeutic aids for needy children. e.g. Autistic children.
- **Educational games and activities**: Robots encourage children to play games and do activities that can contribute to their development. This will be done by identifying and tracking individual needs based on past activities and achievements.
- **Software tools for parents and teachers**: A range of software tools will be developed for teachers and parents, for monitoring child activities at various levels.
- **Report**: Regular reports are generated by the cloud-based information portal for teachers and parents, summarizing activities and suggestions for improvements.
- **Alert generation**: Whenever an abnormal activity, incident, or a behaviour is detected, alerts will be sent to mobile phones of teachers and parents.

5. Conclusion

In conclusion, this project aims to develop and a distributed system that can be used for enhancing Early Childhood Education (ECE) experience. The studies will build on existing research and find out the various advantages and disadvantages of using robotics and IoT technologies, followed by how to fill those gaps in the real world.

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Hookie: A Cloud Client Robot for Children with Autism Spectrum Disorder

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Abstract— In this paper we will explore and detail the implementation of the design of a new social assistive robotic platform based on cloud connectivity to be used to help autistic children improve their social skills. Although several solutions already exist in the market, we propose an alternative solution that optimises the robot design in terms of cost, expressively, usability, versatility, and technical specifications.

Keywords— Social Robotics, Learning, Robot, Education, Cloud

1. INTRODUCTION

Robots have become very popular and have an infinite range of applications and shapes. From machine-like mobile robots appeared in 1966 with Shakey the robot to the current concept of social robot companions, there is a great deal of new science and technology involved in their design.

In [1] we can find a sort of strategies to design robots. These strategies range from the biologically inspired design, based on the concept that evolution has found the best solution to perform complex tasks in real environments, to the functionality based robot design, where the robots are engineered according to certain effects and experiences with the users.

In this work we present a new assistive robotic platform, designed following the functionality-based strategy, that will be on the table as a helper, social mediator, and logger of whatever that happens during the sessions. Its functionality is based in a behavioral-based behavioral architecture similar to the one proposed in [8].

2. SOCIAL ROBOTS USED WITH AUTISTIC CHILDREN

In [2] the authors proposed a definition of social robotics as those robots that understand or mimic human activity, norms, and standards involved in the society and culture. In [7] the authors demonstrated that the robot behavior has a social impact on the child.

Into the wide range of solutions that we can find in the market, we have analyzed and studied the embodiment, mechanical structure, hardware, and software of the following robots: QUEBALL, AISOY, KEEPON, PARO, ICAT, KASPAR, PROBO, and NAO. Pictures of these robots are shown in Figure 1.

3. THE ROBOT DESIGN

In the first prototype, we have used 9 dynamixel motors [12] : 3 motors for the right arm, 1 motor for the left arm, 2 motors for the wheels, a motor to turn the robot in relation to its base from side to side, 1 motor to turn it up and down, and 1 motor to turn its face.

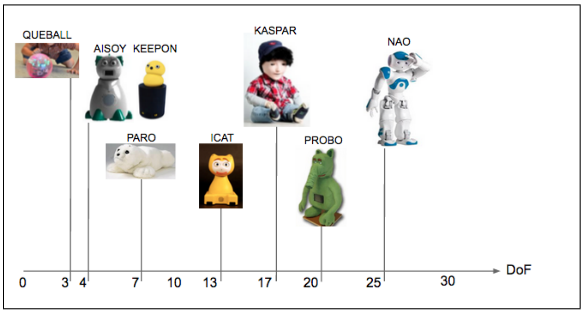

Fig. 1. Social Robots: A classification according to their DoF

Fig. 2. Hookie: The first prototype of the robot during one of the sessions

A. Hardware

From a technical point of view we would like to create a social assitive robot platform easy to evolve in terms of add-ons, software apps, and core hardware. Therefore, following the studies done in [3] we have decided to choose the Arduino board with the best and easiest connectivity. As a result from the previous classifications we are building a standard control board and a web client-based system. We considered the possibility to use a Raspberry Pi board instead, however we decided to use the Arduino board because according to [9], the differences between an Arduino board and a Raspberry Pi are small, and most of the work that our robot does can be performed by both. Some differences can be found if we compare the cost, security, functionality, expandability, and connectivity: (1) Cost: Although the cost is similar, because the Arduino is an open-source platform the variety and number of shields decreased the total solution cost if we plan to add extra hardware; (2) Security: Arduino has a clear advantage, as long as to access to the information programmed you need to know how the sketch was written, while in a Raspberry Pi only a SD card with a fresh OS loaded is needed; (3)Functionality: While a Raspberry Pi is a fully functional personal computer with easy access to peripherals as keyboard, camera, etc., the Arduino is able to host a much wider array of sensor options and even electronic circuits. This is because the Arduino has a more robust hardware interface than the GPIO of the Raspberry Pi. For example, the Arduino board provides 5V while the Raspberry Pi only supplies 3.3V in their outputs. Therefore, the circuit needed to connect the Raspberry Pi to the dynamixel motors (they require a 5V data control channel) is a lot more complex than the one needed with the Arduino, which adds extra complexity to the design; (4) Expandability: Because this is closely related to the functionality, Arduino is the clear winner in the availability of pluggable modules. Raspberry Pi is much better if you need to store a large quantity of data in local (hard drive), or use a complex display, but these are not relevant in our design; (5) Connectivity: Although Raspberry Pi is an optimal solution if you need connectivity to Ethernet or Bluetooth, Arduino has a more advanced interface to specialized hardware. In our robot design, we need WiFi and hardware connectivity, so Arduino Yun became the best option for us.

B. Human Factors Engineering and Mechanical Design

The embodiment and the mechanical components have been designed in order to achieve two major goals: optimization of resources and long-term acceptation. Taking into account the study done in [4], [7], [6], and [10] we have to be sure to get a low-cost platform without missing any key feature to engage the children with autism.

In [6] there is a wide study of robots used in autism and that looking at what it was published there is a inconsistency in the appearance of the robots used. Most of this is because the robots used in autism are general purpose robots.

The robot we present in this paper has a hybrid appearance between a humanoid and a machine-like robot. Together with the cartoon like face it becomes an optimal solution for children with ASD [10] and [6]. This kind of robot, also known as a nonbiometric robot, are usually used as a social mediator to engage children in a task or game with adults and other children [7].

Because customizing the robot can increase the rapport, cooperation, and engagement between the children and the robot [11] , we have designed a structure fully compatible with LEGO Technich and regular LEGO blocks.

4. RESULTS AND CONCLUSIONS

To test our design, we have made the robot go through various stress tests to check if the system remained stable after some time under continuous changes, and also to simulate the future behavior of the robot for the worst case. For that, we tested each module separately for an extended period of time, and finally we made a final check with all the modules working at the same time.

We used the robot in a total of eight weekly two-hours long sessions (See Fig.**??**). In this sessions, we also used the NAO Robot and the AISOY robot. We had a total of six students with ASD that worked on groups of two building LEGO Robotics challenges. The Robots (Hookie, NAO, and AISOY) assisted the students during the workshop.

During the first six sessions, the student chose between two different working stations, but with the same robotic platform as a facilitator (NAO, AISOY,or Hookie). For the last two sessions, they were able to choose which robot as social mediator they preferred.

From a technical point of view, the Hookie was the most stable platform in terms of connectivity to the cloud. During all sessions, Hookie Robot kept connected to the cloud all the time. NAO [16] and AISOY [17] lost connection a few times during the session. At the end of each session we asked the students about the quality of interaction with the robot: how they like the robot, how helpful or useful was the robot during the sessions, and if they perceived that the robot was intelligent. All students interact with all robots and we have taken two filled-out questionnaires per child and robot type. In Table I, We can see the results.

TABLE I
QUALITY OF HRI BETWEEN CHILDREN AND THE ROBOTS

About the Social Robot	Hookie	NAO	AISOY
How children like the robot	83%	100%	17%
How helpful/useful was the robot	30%	20%	0%
How intelligent was the robot	37%	30%	10%

All robots run the same algorithm. The smoothness of NAO movements achieved the best score about how children liked the robot, however, we saw that minimizing the DoF of the robot we got good results too. Most of the children pointed about AISOY that it does not have arms or legs to interact with. In addition AISOY actuators are slower than NAO or Hookie actuators. There is no significative difference between Hookie and NAO about how helpful or useful, and how intelligent they are. In fact, during the two sessions that the students were able to choose the social robot that was going to assist them, they do not show any preference between NAO and Hookie. We believe that AISOY low score was the result of missing a more interactive embodiment. AISOY strong point is that is a really good educational platform

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Mini: A Social Assistive Robot For People With Mild Cognitive Impairment

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Abstract— Robots have begun to assist people with some type of cognitive impairment, showing improvements in their quality of life. The goal of RobAlz project is the development of a robot to assist elders suffering Alzheimer's disease (AD), or other causes of cognitive impairment, and also their caregivers. The robot Mini has been designed and constructed within the frame of this project. This paper presents the main characteristics of the robot: its design, components and control architecture.

Keywords— Alzheimer, Cognitive Impairment, Social Assistive Robot, Social Robot, Assistive Robot.

1. INTRODUCTION

Nowadays, Alzheimer's disease is the most common cause of cognitive impairment. It has no cure and, eventually, renders people unable to tend to their own needs, depending completely on their caregivers. Social robots have already been applied to the assistance of elders and people with cognitive impairments, showing that they can improve their quality of life. RobaAlz project is aimed at designing and creating a social robot to assist these people, trying to take into consideration both the needs of the patients and their caregivers from the beginning. In this project collaborate the research group RoboticsLab at the Carlos III University of Madrid and the Spanish Alzheimer Foundation (FAE). This paper presents a first prototype, Mini, whose design and construction is based on the results obtained from a series of meetings of a team of subject-matter experts. In those meetings, the functionalities of the robot were discussed, obtaining a list of usage scenarios classified in the areas of: Safety, Personal Assistance, Entertainment and Stimulation. Those have served as a baseline to obtain the requirements for the construction of Mini. More detailed information about these scenarios and the resulted requirements can be found in [1].

2. MINIS DESIGN AND COMPONENTS

Considering the requirements obtained from the meetings, Mini has been designed to comply with all the functionalities. It is a desktop robot with an appearance similar to the robot Maggie [2], but with smaller proportions. Although different alternatives will be explored, this first prototype has been made with a soft material, trying to achieve a tender, friendly look which invites to touch it. Mini is approximately 50 cm tall, 30cm wide and weighs 3kg. It is conceived to be situated on top of a table and interact with a person sat in front of it. Fig.1 shows the main elements of robot Mini.

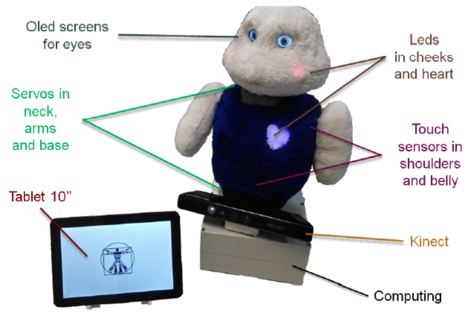

Fig. 1. Illustration of the main elements of robot *Mini*.

The robots torso is placed on top of a box which contains an Intel Core i5-3550 processor which does the majority of the computing, rechargeable batteries and other devices.

Mini has five degrees of freedom: one in the torso to rotate it with respect to a vertical axis, two in its head (pan and tilt movements) and one in each arm. This is achieved by means of five servomotors Dynamixel AX-12 situated in the different joints.

The visual perception device chosen has been a Kinect camera, situated in front of the robot and fixed to the same torso rotation. This permits widening the field of view of the camera with the robots movements. In addition, to allow voice interaction as required, the robot has a directional microphone and a speaker inside its belly.

Underneath its plush skin, Mini has three touch sensors situated right below its shoulders and its belly. Besides, Mini has various luminous devices situated in its eyes, cheeks, mouth and heart [3]. The eyes are implemented by a pair of Oled LCD 128x128 screens, connected to a PC via the RS 232 serial port. The screens displays different animated gifs corresponding to several expressions: joy, sadness, anger, surprise, etc. These animated gifs allow nine orientation and several blinking frequencies. The cheeks and heart consist of three RGB leds (one for each cheek and another for the heart), which can be turned on and off with different colors and frequencies. Besides, Mini has also an array of leds in its mouth, which are turned on from the center outwards proportionally to the volume of Minis voice, to emulate the movement of the lips. All these leds are controlled by an Arduino Mega board placed inside the base casing. which is also in charge of receiving the signals from the touch sensors.

Apart from that, Mini has also a Bq Edison 10 tablet with Android 4.1 Jelly Bean, which allows playing different multimedia content or interactive games. The tablet has been selected due mainly to its light weight, low cost and being wireless, with all the needed hardware onboard.

3. MINIS CONTROL ARQUITECTURE

Mini has a modular control architecture, organized in different levels and implemented using ROS (Robot Operating System). A general overview is presented in Fig.2 and each of the modules are described in subsequent sections.

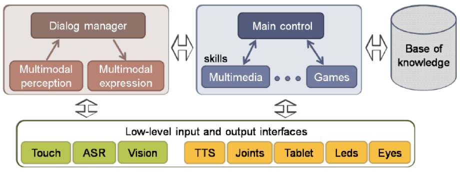

Fig. 2. Mini's software architecture.

A. Low-level interfaces

The module of Low-Level Interfaces represents the drivers to control the different devices devoted to allow a multimodal communication, including an ASR (Automatic Speech Recognition) and a TTS (Text-To-Speech) to synthesize text in several languages and voices.

B. Multimodal interaction system

The block of the left represents the multimodal interaction system of the robot and it is composed by the perception and expression modules by the dialog manager:

- Multimodal perception: This module provides abstraction to the dialog manager, processing the different inputs from the perception devices. For example, if a user comes and greets the robot by saying *hello*, two interfaces will react: the ASR will understand the greeting and the vision module will recognize the user.
- Multimodal expression: This module allows the coordination of all the output interfaces to create coherent and natural gestures.
- Dialog Manager: This is the module in charge of handling the multimodal interaction; depending on the context, it will generate different responses to the user inputs.

C. Base of knowledge

Mini has a database, implemented in MySQL, which stores the following information: Details of the people in the patients life and their relationship, information about the everyday object and locations of his house, routines and main events, stories, anecdotes and multimedia content preferred by the patient, etc.

D. Skills

Mini's skills are the modules in charge of the different functionalities required by the scenarios; that is, there is a skill to play games, another one to tell stories, to play multimedia content, another one that watches the position of the patient in order to detect if he leaves the room, an activity reminder for the patients routines, etc. Each of these skills makes use of different elements of the low-level interfaces depending on its functionality. Nevertheless, all of them need dialogs to interact with the user.

E. Main control

The decision of which skill has to be in execution at any time is made by Mini's main control, which is based on a state machine. If the robot is alone or it is not interacting for a long period of time, it will go to the sleeping state. This transition can also be requested by voice by the patient or the caregiver. Then, if it is touched, it will wake up and go to a waiting state, making a transition to an entertainment state depending the activity demanded: playing a game, watching photos or videos, telling stories, etc. The previously mentioned states (sleeping, waiting and entertainment) have the lowest priority. The medium level of priority is established for the activity reminder state. When it is time for the patient to do a preprogrammed routine (such as taking his medicines), the robot stops what it was doing (unless it was handling an alert) to remind the patient of his routine. Once the time established for the routine has finished, the robot can resume its normal activity. The highest priority is attending to a surveillance alert (handling state), i.e. if the robot detects that the patient leaves the room or enters in a dangerous area. The robot remains until the caregiver informs Mini that everything is fine.

4. CONCLUSIONS

This paper has presented the robot Mini, its hardware components and the control architecture. Although the design of Mini has been based on the results from a series of meetings with subject-matter experts, a complete study and experiments with people with cognitive impairment in their real environments must be performed in order to assess the usefulness of the robot. The results of these experiments will determine if new designs and features are included in subsequent prototypes.

ACKNOWLEDGMENT

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CASPER Project: Social Pet Robots facilitating tasks in Therapies with Children with ASD

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Abstract— In this paper, we present a Cognitive Assistive Social Pet Robot design and an early field study with it to facilitate learning with children with Autism Spectrum Disorder. The robotic platform is a low-cost robotic turtle based on a RaspberryPI and Arduino.

Keywords— Social Robotics, Pet, Austism, Therapy, Social Skills

1. INTRODUCTION

Through social robots, technology has begun to move from being a science fiction field to research laboratories and even into our society. These are autonomously acting, communicating, learning and self organizing robots which can also use spoken languages and mimic animal characteristics [1]. Animals are embodied, living beings, which creates strong constraints on what they can do and how humans can use them. Humans have always been attracted to animals; they are utilized partly as an outlet for increased social needs [2]. Furthermore, research has supported that animals play an important role in children‘ s healthy development offering comfort and companionship, and promoting the development of moral reciprocity and responsibility [3].

There is a lot of evidence in the literature that pet animals and wellbeing are correlated [4], [5], [6]. We know that the companionship provided by a pet can lead to a better health, mesured by survival rates [7].

Social pet robots are important for children with special needs such as developmental disorders or autism due to their assistive effectiveness. It is well established that people attribute intentions, goals, emotions, and personalities to even the simplest of machines with life-like movement or form [8]. Recently, social pet robots have been introduced to reproduce the social and emotional benefits associated with the interaction and the emotional bond between children and companion animals such as entertainment, relief, support and enjoyment [9].

In this paper we present the first working model of CASPER robot. CASPER, Cognitive Assistive Social PEt Robot, is a robotic platform that aims to improve quality of life of children that are visiting hospitals or have special needs. The design of this robot comes from what we learnt from previous experiences in the PATRICIA project and the social pet robot PLEO rb [10]. The objective is to develop a complete experience supported on added commercial technological tools, like tablets or bracelets, and gamified interventions in order to increase engagement and adherence to the treatment of people involved in the process and to extract information from the interaction to monitor the program and the caring process.

2. THE ROBOTIC PLATFORM

These strategies cover everything from the biologically-inspired to the functionality-based robot design. In this project we aim to conceive a new assistive robotic platform, designed following the functionality-based strategy. In this strategy the robot will be on the table as a helper, social mediator, and logger of whatever that happens during the interaction sessions. Its functionality is based in a behavioural architecture similar to the one proposed in [11]. From a technical point of view the two main constraints in the robot design are the connectivity required for the cloud-based platform, and keeping all elements affordable to achieve a low-cost solution..

The reduced processing power, storage capabilities, and number of sensors included in the current robots prevent them from going beyond their historically static and predefined behaviour [12]. In opposition to what has been achieved in other domains [13], it is still not feasible to codify the knowledge of the expert (i.e. medical staff) inside a single unit in a reliable and cost-efficient way.

In Figure 1 we can see our approach to the core design of the robot. We have divided the electronic controllers into two parts to expand the functionality of processing power: the high-level process unit with a RaspberryPI that is running ROS, and the low-level process unit based on an Arduino that manages all sensors and actuators except for the camera, screen, and microphones.

Regarding the embodiment, we developed a co-participatory design with a group of two hundred children from the Montserrat School of Barcelona, between 9 and 12 years old, who followed a Design Thinking process assisted by our the research team. From that participatory design, we

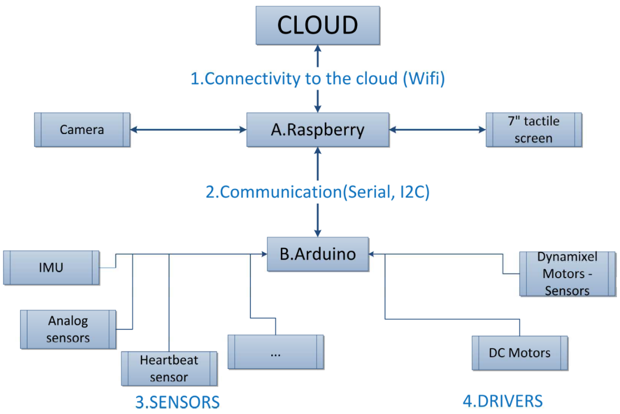

Fig. 1. Tasks in CASPER Project

extracted different types of morphisms for the embodiment, as well as playful functionalities of the robot. From all the possibilities we choose a turtle because it matches all of the characteristics of the real animal and the feasibility of implementation of the prototype.

Taking a look at the most relevant components, the shell provides an easy and safe interface to manipulate the turtle: the screen allows us to design more interactive and assistive activities, as well as non-verbal feedback to the children, and then we added a turnover sensor that triggers the scared mode in case the turtle is placed in up-down position 2.

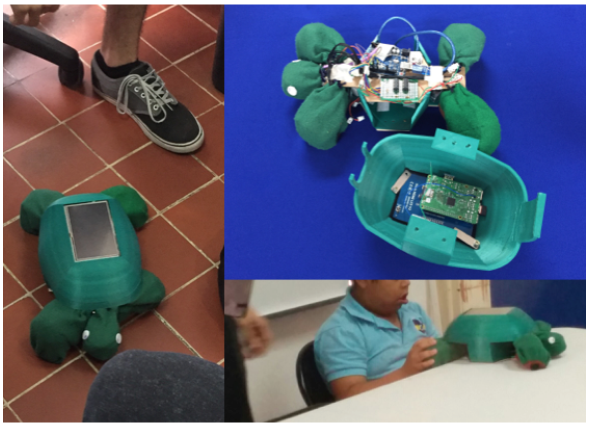

Fig. 2. First full-operative CASPER robot used in Panama with children with ASD

3. THE TEST OF THE ROBOTIC PLATFORM, CONCLUSIONS, AND FUTURE DIRECTIONS

In order to test the robustness of the system in a real environment, we used the robot during eight sessions with children with severe autism in the center CASPAN from Panama. In these sessions we used CASPER robot together with a Pleo rb robot and a LEGO-based dog-shaped robot. The robots were used in two different ways: 1) as the main agent during the session (count how many legs the robot has, what colors we can find in the robot, etc.); and 2) The robot was also used as a rewarding system (if you succeed with doing the activity you will be able to play with the robot). A total of twelve children played with CASPER.

In future work, we are going to present the data analysis of the comparison between the three platforms used in this study. But for CASPER, we observed that the platform was very well accepted by the children (none of them rejected to play with it), the platform was more robust that the LEGO-based dog, and, because of the screen, more playful that the Pleo rb. In addition, the processing power and the connectivity is higly improved because of the technology used.

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Social LSMaker: Educational Social Mobile Robot with an Arduino-based Audiovisual Interactive Platform

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Abstract— Social play scenarios and gaming activities stimulate students engagement in group work, and so helps the students reaching the competences they are expected in certaing subjects. LSMaker is used as an educational mobile robot since 2011 in the practical subjects of the Engineering Degrees at La Salle - Universitat Ramon Llull. In this paper we present an interactive audiovisual platform that leds the LSMaker to become a social robot, increasing the possibilities of engaging the students to develop the subjects and widening the type of practical work to implement on the robot.

Keywords— Social robot, interactive platform, engagement, face recognition, audio recognition

1. Introduction

Nowadays Robotics is a hot topic that can be found almost everywhere [1]. It is already observed by previous studies that young people humanise the technology and especially the robotics technology. This fact made this technology as catalyzers that empower the immersion effect. As a result of the immersion students are focused and due to the increase of interest and attention they learn better [2].

In [3] there is the suggestion that combining social play scenarios and engaging activities can stimulate the students to collaborate while working in groups. Its in such social interactive environment where a social robot can be a useful tool to stimulate social competence acquisition [4].

2. Related Work

LSMaker is an open source robot that La Salle - Universitat Ramon Llull has incorporated to all the Engineering degrees [5]. The platform was used for the first time in 2011, and was a design based on a PIC24FJ64GA006 by Microchip manufacturer, an accelerometer (MMA7660FC), an integrated transceiver of radio frequency using Zigbee protocol, drivers for the engines, and a USB interface and an LCD display. It carried an I2C communication bus to integrate all the sensors to improve the platform.

This robot has been used for five academic years to support practical studies for the Engineering students at La Salle. Furthermore, it has been used as mobile robot in a training group of children with autism [6], consisting in programming a mobile robot in order to complete a circuit on a game board inspired on previous studies [3], [4].

3. New LSMaker Platform & Design

The good reception among students but also among children with social impairments encourages us to design a new version of the mobile robot, enhancing its performance in order to add social-based computing algorithms, and increasing its general processing capabilities as well as standarization from previous versions [7]. We also focus on increasing their chances of interaction with people adding sense: of touch via touching through a new touch screen; of hearing via audio through the addition of a microphone to capture sounds that will later be processed; and finally of vision via image processing through a camera with in-built pre-processing algorithms, which recognize different users without prior training.

In order to reach this challenges, we propose a new LSMaker with interchangeable brain. The structure of the robot, motors for the wheels and other potential peripherial is part of a fixed structure, but the programability of the core can vary on Arduino, Raspberry Pi or an FPGA. This proposal aims to meet the technical needs in most of the engineering subjects, presenting a consensus solution. Also the design of the robot has changed into a more easy-to-use small robot; another interesting advance in terms of interaction is the new LCD touchscreen; see Fig. 1 for the scheme of the new design, and Fig. 2 for the new board connected to an Arduino. The new LSMaker can be both programmed to perform in an autonomous way, or can be driven from an application in any mobile phone.

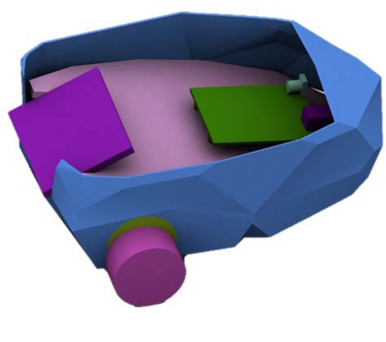

Fig. 1. Design for the new LSMaker

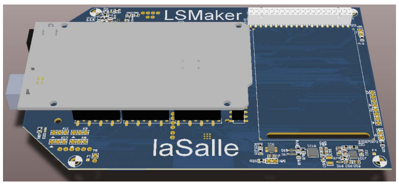

Fig. 2. New LSMaker board to be connected to an Arduino MEGA

4. LSMaker and Interaction

The new LSMaker using a Raspberry Pi core together with an Arduino Mega has been programmed using Python for two interactive procedures. The first one is face recognition and identification [8], and the second one is audio event recognition [9].

A. Face identification

The Raspberry Pi is equiped with a small camera (a Raspberry Pi NoIR Camera V2), looking front in the robot. The robot is trained to identify at least 5 different people using algorithms of image processing [8]. The goal of the face identification is that the robot can learn new faces and new names can be introduced in the platform, so that the robot can recognize them when they appear again at its sight.

B. Audio event recognition

The platform has been programmed to identify four audio event that the user can do to command the robot when it is working in an autonomous way. This is a group of four audio signals, corresponding to hand clapping, finger snapping, table tapping and walking. Each of the sounds is related to an order for the robot, e.g. hand clapping means stop, and finger snapping means start, as well as table tapping means right and walking means left. We have implemented there algorithms of audio event recognition based on feature extraction [10] and in machine learning.

5. Use cases where a more social LSMaker makes the difference

The new LSMaker with the audiovisual interactive platform led us to prepare practical applications of the Degree subjects for social robot implementations. The proposal is to design a pet robot after resolving three activities using the new platform. This pet robot has to be interactive as well as educative, with a age focus of 5 or 6-year-old children to play with it.

The first activity to reach the pet robot design is to improve and adapt the audio event recognition; the number of events can be widen, and the type of events should be changed to adapt to children's environment. The Arduino-based robot, together with the Raspberry Pi, can process and classify the audio signal and give the child an answer using the screen. Furthermore, the proposal can be to answer to the child using a small speaker connected to the platform.

The second activity consists on classifying previously trained faces into two groups: the children who can give orders to the robot, and the ones who can't. The core of this activity is face recognition, but afterwards, a hierarchy amongst the different children should be decided and programmed.

The third activity, oriented to advanced students, consists on programming the platform to recognize any other visual signal to give orders to the robot; gestures, written signals or even identify the vision of another robot working nearby. Furthermore, the students can implement an automatic speech recognition system (ASR), that, connected to the cloud via WiFi or Bluetooth, can be used to give orders to the robot, or even interact verbally with it using a dialog system after the ASR.

6. Conclusions

The new LSMaker platform, with its technical features already described, widens the possibilities of the design of social interactive activities, including the work in groups. Audio, speech and image recognition can be studied and implemented to increase the capabilities of the platform to become the center of social activities in the own subjects, or to be used in another environments to perform social playing games. Finally, preliminary tests of the audiovisual platform containing the camera and the microphone encourage us to improve the accuracy results of both the face and the audio recognition systems.

ACKNOWLEDGMENT

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Success factors for the implementation of Paro

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Abstract. The purposeful use of the socially assistive robot Paro has shown to be effective in psychogeriatric care. This study aimed to identify success factors for its implementation. A literature study was followed by a quantitative survey using an online questionnaire and qualitative semi-structured interviews. Overall, Paro is used frequently and organizations are satisfied about the product. Success factors related to the product itself, the professional and the organization. Recommendations for a structured process of implementation, which appeared to be lacking, were formulated and disseminated.

Keywords: Socially Assistive Robotics (SAR), intramural elderly care, behavioral change, implementation

BACKGROUND

The Dutch population is ageing [1]. In order to maintain high level quality in care, innovations are needed and can be observed, recently. They comprise services, products and technology which often have proven to be effective and to meet actual needs. However, many of those innovations are not used (optimally) in care practice, meaning a waste of resources and a missed chance to improve care and to keep it affordable. A promising new development is the application of robots in care. Robots can effectively support caregivers [e.g. 2]. Paro is a commercially available Socially Assistive Robot (SAR) [3] which has shown to be effective in the intramural elderly care, especially for clients with psychogeriatric problems [4-6].

Figure 1. Picture of elderly woman using Paro.

In this setting, many Paros have been acquired, and its use is also trialed within the care for persons with autism spectrum disorders, multiple complex disabilities, children with pain and within (controlled) multisensory environments ("Snoezelen"). It is unknown if the acquired Paros are actually used and which factors influenced their adoption.
Therefore, the aim of this study was to gain insight into the use of Paro and the success factors for implementation to be able to provide recommendations for further implementation and improvement of its application.

METHODS

The study was conducted using a mixed-methods phased approach. In phase 1 an extensive literature study on methods and conceptual models regarding behavioral change and implementation was performed. The 2nd phase comprised a survey using an online questionnaire on acquisition, implementation, and use of Paro, as well as user satisfaction among 84 care institutions which had acquired a Paro. It comprised multiple choice and standardized answers, and a valid and reliable instrument on user satisfaction (D-QUEST) [7]. Quantitative results were analyzed by using descriptive statistics. The nominal data were reported as modes. In the 3rd phase semi-structured qualitative interviews were conducted with caregivers, who already participated in the 2nd phase and were willing to provide more in-depth qualitative data, one expert, who conducted research about Paro, and Paro's supplier. Content analysis as described by Van der Velde and colleagues (2013) [8] was used to analyze the qualitative data. A member-check confirmed the results and formulated hypotheses. In the last phase recommendations for further implementation of Paro were communicated.

RESULTS

The 1st phase resulted in an overview of methods and conceptual models regarding behavioral change and implementation and informed the development of the online questionnaire and the interview guide. In the 2nd phase 44 participants completed the online questionnaire; that equals a 60% response rate. Most Paros (85%) were at least used once a week, about 25% even once or several times each day. The results obtained by the D-QUEST showed that furthermost organizations were at least satisfied with Paro in general (>80%); safety was rated highest (89%), dimensions (86%) followed by ease of use (82%), and effectiveness (82%). Overall, organizations were less satisfied with the related service delivery. Integration into care practice is in most cases achieved by describing specific Paro interventions in the personal care plans. The purchase of Paro is mostly sponsored. Results from the 2nd and 3rd phase indicate, that the implementation process to integrate Paro into daily care practice is quite divers, a specific pattern cannot be recognized. Most Paros are delivered by mail, without further instructions for use. Interview data gained in the 3rd phase (n=15) identified the following success factors: Paro's outer appearance, its sounds and utterances and high usability. Paro evokes feelings and compassion, even in persons who are no longer able to express their emotions in daily life (e.g. persons with dementia or profound intellectual disabilities). Being able to try out Paro in a specific setting prevents non-use and facilitates acceptance. For successful application a dedicated person needs to take responsibility for and ownership of Paro. Integration into daily care practice and a workshop with instructions for use and an overview of possible interventions foster optimal use. A robust construction and reliable technical functioning as well as a positive impression also play an important role. With purposeful use, Paro is perceived as complementary to care provided by a professional, not as a substitution.

Table 1. Factors influencing technology acceptance gathered from different theories, identified by literature search

Product	Professional	Organization
Visibility of the innovation Reliability technology Expected and experienced ease of use Expected and experienced gain Answer to perceived needs (clients, care givers, organization)	Comparative advantage Opportunity to try-out Compatible with actual behavior and values Extrinsic motivation Job-fit Performance expectations Effort expectations Prior experiences with technology	Compatible with work processes Obligatory or voluntary use Facilitating environment (e.g. training, helpdesk) Social factors Use of different communication channels for promotion of the innovation Opinion-leader's belief Financial feasibility Homogenous groups

DISCUSSION

This study envisioned to include all Dutch care organizations which had a Paro at their disposal. Although complete coverage could not be achieved, a response rate of 60% can be judged as high. Due to time constraints interviews were conducted by phone, which could have led to less in-depth information compared to face-to-face interviews, but nonetheless they yielded valuable data and saturation could be reached. However, detailed information on the implementation process appeared to be difficult to bring out. A member-check based on the interview transcripts improved the validity. Overall, the mixed-methods phased approach proved to be suitable to reach the study's aim.

RECOMMENDATIONS

Based on the ascertained positive effects of Paro health care insurance companies and care organizations should search for opportunities for structural reimbursement to make the acquisition of Paro less dependent from sponsoring. A community of practice around the purposeful use of Paro could improve the implementation process and make it more efficient by sharing experiences and best practices. Zuyd / EIZT as an independent center of expertise could host such a community. Some suggestions for improvement encompass the place of Paro's on/off button and the battery. Paro's supplier should communicate them to Paro's manufacturer. Recently, the supplier improved the service delivery related to Paro, but maintenance and support should be evaluated again to perform services in a less expensive and timely manner. Future research should explore whether Paro's success factors would also apply to other types of socially assistive robots, as for example Zora.

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Empowering Robots with Empathy for Cognitive Stimulations Therapy towards personal Autonomy

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Abstract— Recent advancements in the Socially Assistive Robotics (SAR) has shown a vital potential for the use of social robots to achieve cognitive rehabilitation among individuals with Intellectual Disability (ID). But lack of smart and adaptive interaction abilities, limits the capabilities of social robots to provide an efficient cognitive stimulation. The current research presents the architectural overview of the system abilities, required to empower the social robots with automated and online behavior adaptation ability during cognitive stimulation activities among individuals with ID. The proposed system can be used to provide an effective cognitive rehabilitation among individuals struggling with a wide range of clinical concerns, including kids with Autism Spectrum Order (ASD), individuals with ID and people with dementia.

Keywords— Socially Assistive Robotics, HRI, Cognitive Stimulation, Rehabilitation

1. INTRODUCTION

Socially Assistive Robotics (SAR) has already been widely used in mental health service and research [1], primarily among children with Autism Spectrum Disorder(ASD) and among older adults with dementia. Project REHABIBOTICS[1] is a holistic approach to extend the benefits of SAR to individuals with intellectual disability (ID) [2]. Project REHABIBOTICS will be deployed at Ave Maria Foundation, which is a residential care facility for individuals with ID[2]. A crucial step towards delivering an efficient cognitive stimulation to individuals with ID by robots is to make them able to perform an emotionally adaptive behavior; i.e., to be able to detect user's feelings and to adjust the experience to fit them [3][4]. However, empathetic robot behavior during robot interaction activities has been challenged by the absence of a comprehensive overview of architectural system abilities required to empower the social robots with automated and online behavior adaptation ability during cognitive stimulation. To assist in empowerment of the robots with the automated emotion recognition ability during human-robot interaction, project REHABIBOTICS created a first ever multi-modal dataset of individuals with ID in a *subject elicited, nearly real world* settings for the appropriate analysis of human affective state [5]. The aim of presented work is to introduce the architectural overview of the system abilities which will assist in empowering the robots with empathy for efficient cognitive stimulations during human-robot interaction.

[1]`http://www.institutorobotica.org/projects/rehabibotics`
[2]`http://www.avemariafundacio.org/inici.html`

2. SYSTEM ARCHITECTURE

Figure 1 provides a comprehensive system architectural overview which can help to achieve empathetic robot behavior during robot interaction activities. Project REHABIBOTICS categorizes different tasks in following three different layers:

- Perception
- Social Interaction & Cognition
- Action

A. Perception

Perception provides all the required data to be processed by project REHABIBOTICS to enable its social interaction and cognitive behavior. It has following components:

1) **Multimodal Sensors**: It consists of physiological sensors, eye-tracking solutions, RGB-D & video cameras and provides raw data to create understanding about scene & environment, user activity state and user emotional state.
2) **Scene Understanding**: It obtains RGB-D & video data from Multimodal Sensors and utilizes advanced algorithms on them to create understating about the involved objects and scene of the interaction environment such as, identification and placement of involved objects etc.
3) **User Activity Perception**: It obtains user body posture and head movements data from Multimodal Sensors and applies sophisticated algorithms to obtain activity state information of the user such as, user is moving an object etc.
4) **User Emotion/Engagement Perception**: It obtains user Heart Rate (HR), Galvanic Skin Response (GSR) and Electroencephalogram (EEG) biosignals, eye movements & behavior, facial features data from Multimodal Sensors and employs state-of-the-art algorithms to extract meaningful features for emotional/engagement state of the user such as, variability of heart-rate, eye-movements etc.

B. Social Interaction & Cognition

This layer is responsible to empower project REHABIBOTICS with advanced social interaction and cognitive abilities and has following components:

1) **Activity Model**: It is a database consisting of execution model for each intervention activity. It receives user

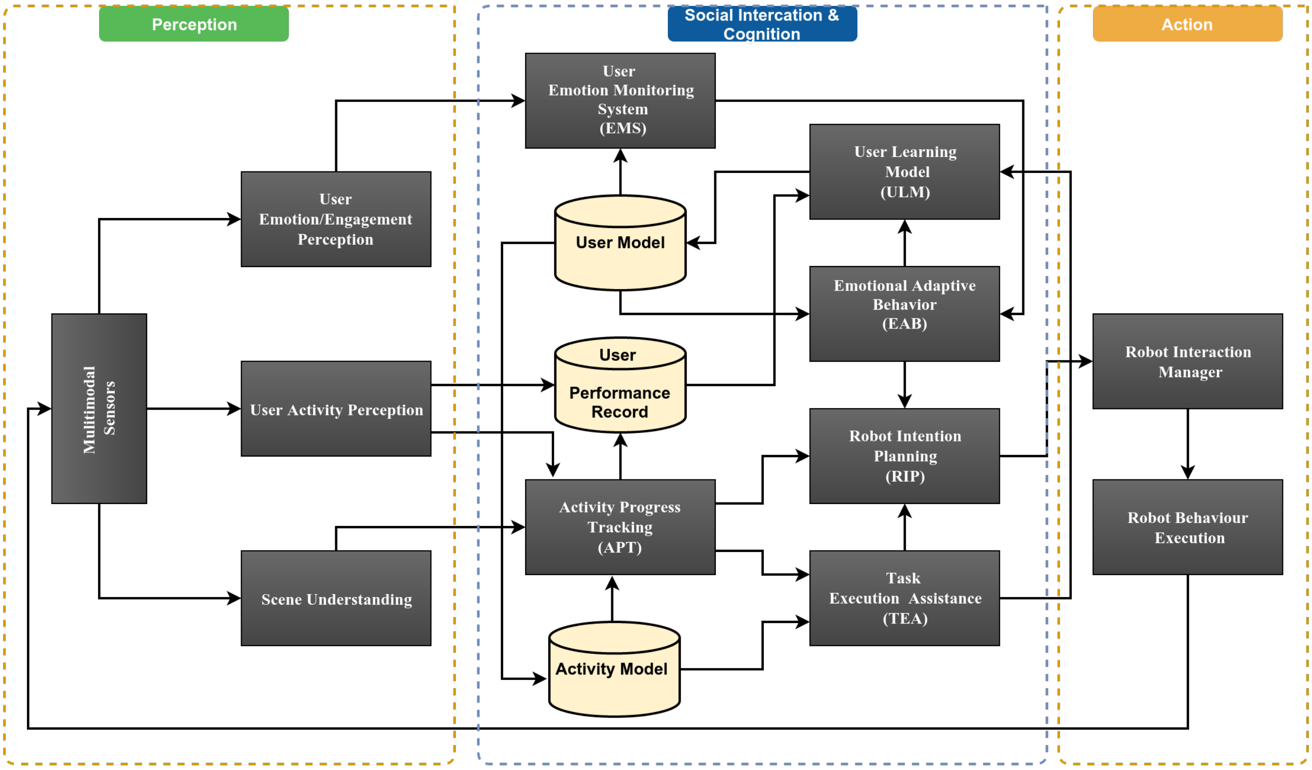

Fig. 1. System Architecture

profile information from User Model and applies customization for each activity in accordance to the above information.Customization on interaction activity can be of several different ways such as, employing user preferences for color of the objects involved in the activity etc.

2) **Activity Progress Tracking**: It receives information about user activity state from User Activity Perception, object & scene information from Scene Understanding and information about activity execution model from Activity Model and utilizes sophisticated artificial intelligence techniques to monitor and track the progress of the activity execution.
3) **User Performance Record**: It is a database consisting of performance record for each individual against each intervention activity over time. It receives information about user activity state from User Activity Perception and activity progress state information from Activity Progress Tracking. It stores performance information such as execution time, efficiency, effectiveness etc for each user against each participated intervention activity over large duration of time.
4) **User Model**: It is a database containing information about user preferences and his/her physical and mental abilities. This information is collected from those who are familiar with them such as care-takers, parents etc. It may contain information about user's likes/dislikes such as about food, color, music etc and also information about user's physical and mental abilities such as limited ability to engage verbally, limited manipulation ability etc. This information is further used in Activity Model to create execution model for activity, customized for every individual user and is also used in Emotional Adaptive Behavior to generate empathetic response towards the users during the interaction activities. This model is updated over time with learning obtained over time from User Learning Model.
5) **Emotion Monitoring System**: It receives meaningful information for emotional/engagement state of the user from User Emotion/Engagement Perception and information about user preferences and his/her physical & mental abilities from User Model and applies assorted machine learning & data mining algorithms on it to perform automated prediction of user's emotional state and engagement level during the intervention activity. It can provide objective evaluation regarding the effectiveness of the intervention activities by providing valuable information. For example, If during a particular intervention activity, user's emotional state can be classified as happy and his/her engagement level can be determined as active it positively indicates the effectiveness of the cognitive stimulation.
6) **User Learning Model**: It receives performance record for each individual from User Performance Record, empathetic responses generated for the users during the activity from Emotional Adaptive Behavior and information about planning assistance as required by

the users for the activity execution from Task Execution Assistance and applies state-of-the-art algorithms to acquire new information regarding the user in an automated fashion. It will produce valuable informations about user profile which would have been very difficult or impossible to gain otherwise such as, e.g. degradation in memory level of user can be identified by detecting a deterioration in user's ability to recite the things during a particular memory centric activity over time.

7) **Emotional Adaptive Behavior**: It obtains user profile information from User Model and information about user's emotional state & engagement level during the intervention activity from Emotion Monitoring System and employs sophisticated decision making to generate empathetic response towards the users during the intervention activities, e.g. upon identifying user as sad during the intervention activity, it may plan to cheer user up by offering his/her favorite candy etc.
8) **Robot Intention Planning**: It receives current state information of the the activity execution from Activity Progress Tracking, empathetic response actions to be taken from Emotional Adaptive Behavior and planned assistance as required by the user for the activity execution from Task Execution Assistance and utilizes advanced decision making tools to plan optimized course of action for the robot, e.g. upon knowing that user is happy, actively engaged and is able to progress as per natural order, it may generate the next step of actions as per the activity model. If any of the above conditions changes i.e. either the user is not happy or not engaged actively or requires assistance for activity execution, the robot may decide to assist user by verbal instructions or can even invite care-taker to intervene. This module is single entity to specify course of action for robot at any point of time which is then used by Robot Interaction Manager to generate specific course of actions for the robot.
9) **Task Execution Assistance**: It obtains current state information of the the activity execution from Activity Progress Tracking, execution model information for particular activity and applies advanced algorithms to decide if user requires any assistance at given time for activity execution. The assistance required could be as simple as reminding next steps of activity or it could be even assisting with a manipulative job. It then provides this information to Robot Intention Planning to plan optimized course of action for the robot.

C. Action

Action layer is responsible for generation and execution of actions for robot at motor level and consists for following modules:

1) **Robot Interaction Manager**: It receives information regarding optimized set of actions to be generated for the robot at given time by Robot Intention Planning and converts these actions to generate interactions as per the specifications of the robot. e.g. Robot needs to communicate next steps of activity to the user and hence can employ voice instructions and can display pictures associated with next steps on the user to simplify the understanding of the user.
2) **Robot Behavior Execution**: It obtains robot interaction information from Robot Interaction Manager and accordingly executes action at motor level in the robot to achieve desired robot interaction. This behavior is further used as a feedback to the whole system by providing input to Multimodal Sensors which updates the system as per the new action specifications.

3. CONCLUSIONS

This article presented the architectural overview of the system abilities, required to empower the social robots with automated and online behavior adaptation ability during cognitive stimulation activities. This architecture will be employed by project REHABIBOTICS for the advancement of social interaction & cognition abilities of Socially Assistive Robotics(SAR).

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How To Introduce A New Technology Into Existing Health Care Practices And Evaluate Its Potential: experiences from the New Pals project.

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Abstract Hospitalization is a stressful experience for children. In hospitals in the Netherlands child life specialists are appointed to support the wellbeing of these children by, amongst others, offering play and self-expression activities. In this paper, we report on a study, still in progress, to evaluate the potential of a new technology (pet robot PLEO) for supporting a child's wellbeing when offered as part of an existing health care practice. We pay attention to how we designed the study, which problems we did encounter so far and how we tried to overcome them. To conclude, we present some recommendations to conduct a study like this.

Keywords: Robotics, well-being, pediatrics, hospitals

INTRODUCTION

Hospitalization is a stressful experience for children. The children are ill, out of their familiar environment, away from their parents and family, and often subjected to medical procedures that may be unpleasant, painful and can raise fear. All of which may affect the children's well-being in a negative way [1]. Research has shown that if a child has to undergo a medical procedure, offering play material helps to distract and relax and in this way support their wellbeing. These positive outcomes have been observed for a great variety of play material, ranging from age-appropriate toys to video games [2].

Pet robots which are designed to interact with human beings might be a good device to provide distraction. PLEO is such a pet robot which has been deployed for several years in the children's hospital San Joan de Deú in Barcelona, Spain, to distract the children who are hospitalized. Reports on the experiences with the robot are very positive, yet anecdotal. This means that the potential of PLEO is promising, but needs factual underpinning.

The New Pals project is designed as a multiple case study [3] and has the objective to explore if and how pet robots could be used as a means to improve wellbeing of hospitalized children. The project is initiated and conducted in co creation with child life specialists (CLS) working in three hospitals in The Netherlands and one in Spain. A CLS is a pediatric professional who provides information as well as mental and practical support for the child and its family during hospitalization. S/he provides, inter alia, play and self-expression activities for the child [4] and is oriented towards the needs of the children and their family, practicing a client-centered approach.

This paper is about a study still in progress. We describe the project, the way in which we introduced the robot in the hospitals and evaluated its effects on a child's well-being and the problems we encountered.

DESIGNING THE STUDY

The study focuses on the CLSs and is conducted in two phases. In phase 1 the intention is on introducing the robot to the CLS and exploring the feasibility of the study. Phase 2 will be used to evaluate the robot's impact on the wellbeing of the children.

Phase 1:To familiarize with the new technology

The aims for CLSs in phase 1 are to meet with PLEO and get to know how it functions; how it can be offered to a child as part of their daily work, what kind of responses the children show. For the researchers the aims are to test if the data collection method works and how to find and select eligible children.

We, as the research team, designed the study protocol for field study 1 in the following manner:

- Consulted CLS teams in the hospitals on their views about possibilities to deploy PLEO in their work.
- Visited the hospitals to assess the context in which a CLS does her job. Helpful to make a list of possibilities and requirements to deploy PLEO in that setting.
- Based on the consultation with the CLS team and the hospital visit, a study protocol was drafted, taking ethical considerations into account.
- Because the children's needs and the client-centered approach of the CLS may vary from hospital to hospital, a separate protocol was drafted for each hospital.
- Research methods to register the interaction between robot and child were chosen on the basis of what was needed for answering the research questions and what was possible in the specific contexts.

- A number of key points were similar at every location to make sure that the results obtained would be comparable. In study 1 these key points included (1) age criteria: 4 to 10 years, (2) the instructions for offering PLEO to a child and (3) the observation form used by the CLS to record the child-robot interaction.

Problems encountered in field study 1:

- PLEO has relatively limited technical possibilities. Several children commented on its 'being too slow'.

• Only a limited number of children were available at the time of observation who met the inclusion criteria. Older and younger children were also included.

• A concluding meeting was organized to discuss the findings of study 1 with two of the CLS teams and to do a respondent validation. Combining the findings and the problems encountered the teams saw opportunities for deploying PLEO to support a child's wellbeing in a trajectory tailored to the child. Meaning that they would not use PLEO for each child, and that PLEO could be used at different moments/events for different wellbeing-related reasons. The reasons included: stress/anxiety reduction, distraction and relief of boredom. In the meeting a draft of study 2 was presented to take them along to the next phase.

Phase 2: To evaluate the effect of the new technology embedded in the work methods of the CLS.

Based on this meeting we defined three starting points for study 2:

(1) The pet robot is offered to support a particular aspect of the wellbeing of the child.
(2) The offer of PLEO is embedded within the work methods of the CLS.
(3) The study protocol fits in hospital policies, f.i. hygiene rules.

• To meet points 1 and 2 the CLS is bound to set well-being-related goals for the deployment of PLEO for each child separately and to draw up a Plan of Action.
• The inclusion criterion for the lower age limit of being 4 years of age was changed into being able to reflect on one's own experiences with PLEO.

• The aims of phase 2 for CLSs is to select the children and to define the situations in which using PLEO can be helpful for a child's wellbeing. For the research team the aims are to collect information on observed and expected effects of PLEO on a child's wellbeing through different sources of information (triangulation) and the ruling out of a novelty effect.
• In study 2 the key points, similar at every location, include (1) individual goal setting and drawing up a Plan of Action for a child by the CLS, (2) for each child 3 to 5 observations with PLEO done by an independent observer, (3) use of semi-structured observation forms with a focus on wellbeing (e.g. stress reduction, distraction, relief of boredom) and (4) use of different sources of information on the child's experience with the robot (CLS, child, parents).

Problems encountered in field study 2:
• Children on chemotherapy have frequently changing treatment schedules, resulting in many deviations from the planned observations in the Plan of Action.
• So far (mid July 2016) field study 2 is almost completed in one hospital, whereas a start is prevented in another hospital due to the unpredictability of duration of stay and related observation possibilities, and the reduced opportunities for the use of independent observers. So, the key points of study 2 cannot be met at that location. In hospital 3 and 4 a start is foreseen.

DISCUSSION

The New Pals project is intended to generate a list of recommendations for the use of pet robot PLEO as part of existing health practices for the support of the wellbeing of hospitalized children. To this end, we follow a practice-based evidence approach: start from the practice and collect growing evidence on the effectiveness of the use of the new technology.

We designed a multi-site multiple case study and made certain methodological choices to be able to present trustworthy outcomes [5]. F.i. we gather data on the child's interaction with and experiences of the robot, using different methods and sources, and we use think aloud techniques to let the CLS set wellbeing-related goals for each child and reflect on them later, so that we have a framework for evaluating a child's wellbeing.

Our approach is in accordance with the conduct of practice research as laid down in a recent report of the Netherlands Organization for Health Research and Development (ZonMW) on the topic [6]. One of the recommendations is to split the research project in separate stages and make small, consecutive steps instead of a larger study project. In our project it turned out to be important to let the CLSs first get familiar with the robot so they could envision ways to deploy PLEO in their daily work.

Another recommendation is to keep the study protocol flexible in case the practical situation confronts the researcher with problems. In preparing the study protocol it turned out to be difficult in one hospital to find children for whom we could plan a series of 3 to 5 sessions with an independent observer. Recently we started a more intense consultation to work out a protocol that meets the possibilities of the practice and key points of the research team.

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Does interacting with a robot reduce your physiological stress response?

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Abstract. The study was designed to investigate the effect of a Paro seal robot on temporarily induced stress in healthy adults by measuring their skin conductance responses (SCR). SCR was measured for 3 minutes at four time points. An initial measurement (*t1*) was followed by 3 minutes of noise (*t2*), a 3 minutes session with the robot (*t3*) and a final measurement (*t4*). There were four conditions (*C1 – C4*) for the robot session: in *C1* participants interacted with an active Paro by stroking and talking to it; in *C2* they interacted with an active Paro without touching it; in *C3* they stroked an inactive Paro; and in *C4* an inactive Paro was present but ignored. Listening to aversive noise was found to increase SCR at *t2*, but subsequent interaction with the Paro did not reduce it. Increased SCR was found in conditions *C1-3* during the Paro session (*t3*). Possible reasons for the increase include positive arousal and engagement, or a lack of familiarity with the robot. Final SCR (*t4*) was slightly elevated in *C1-3* compared to pre-measurement (*t4*) but not significantly different.

INTRODUCTION

Pet robot therapy has shown considerable potential for improving mental health in both older people and children [3][4]. For example, interactions with a Paro robot in medical settings resulted in reduced levels of stress and anxiety in both populations [3][4]. Paro is a cuddly companion robot, modeled after a baby harp seal. Okita [4] used Paro as a social mediator between child patients and their parents to help them to cope with their pain. Robinson et al. [2] investigated the effects of Paro using physiological measurements of emotional reactivity. They found significant reductions in blood pressure and heart rate in older people who spent time stroking and patting a Paro.

Most studies of Paro have focused on the measurement of its effects on stress levels among children with disabilities and elderly individuals with dementia [3][4]. But, according to WHO, the adult population is also susceptible to mental health problems such as stress, anxiety, cardiovascular diseases etc [5]. It is therefore important to also understand the effects that a therapeutic robot like Paro can have on healthy adults.

This study was designed to look at the effect of Paro on induced stress in healthy adults, and to increase our understanding of which aspects of the robot (its interactivity, or its passive features of soft fur and seal like appearance) and what kinds of interaction (talking to or stroking) with Paro might contribute to stress reduction. In previous studies of Paro, e.g. Wada et al. [3], improvements in health and mood were found but it was not clear which aspects of the robot were responsible for the improvement. The expectation in this study was that interaction with a Paro would reduce temporarily induced stress as compared to no such interaction.

There are various features of Paro that might reduce individuals' stress. Paro responds to and encourages human interaction by making seal-like cries and moving its head and flippers [3]. Human behaviors towards Paro such as stroking, smiling, talking, and eye gaze could influence stress reduction. The appearance of Paro might have a calming visual effect.

MATERIALS AND METHOD

Participants

74 participants (37 female, 37 male) were recruited based on a volunteer basis. Participants were healthy students studying at University of Sheffield, none of whom had interacted with Paro before. Their ages ranged from 18 to 44 with a mean of 23.95 (SD = 5.353).

Noise as Stressor

Participants were asked to listen through headphones to 3 minutes of noise, designed to elicit mild stress. The noises consisted of road traffic noise and crowd conversation with decibel levels between 60 and 80.

Skin conductance response

Skin conductance response (SCR) was recorded to measure participants' physiological responses. Participants wore the equipment on their non-dominant hand.

Subjective measures

Participants were asked to rate their current feelings after each measurements point using a 5-point Likert scale ("Not stressed at all" to "Extremely stressed") and a Positive and Negative affect questionnaire (PANAS) that measures positive and negative affect.

EXPERIMENTAL PROCEDURE

On arrival, participants filled out a consent form and their age and gender. The experimental procedures were explained to the participants by the experimenter before they were left alone in the room.

A baseline SCR was recorded as a pre-stress measurement (*t1*) for 3 minutes, and then they were asked to fill out questionnaires (*at1*). Then, they were required to listen to a noise for 3 minutes (*t2*) and after that to fill in the questionnaires again (*at2*). Then they took part in a session with the Paro robot for 3 minutes (*t3*). Participants were randomly allocated to Condition 1 to 4 for the robot session. In Condition 1 (*C1*), they were asked to interact with an active (switched on) Paro by stroking and talking to it. In Condition 2 (*C2*), participants were asked to interact with an active Paro without touching it. In Condition 3 (*C3*), Paro was inactive (switched off) and participants were asked to stroke it. In Condition 4 (*C4*), Paro was turned off and participants were asked to sit back and relax. The switched off Paro ensured this condition was the same as the others apart from the lack of any interaction between the Paro and the participants. After the 3-minute Paro session, participants completed the final questionnaires and rated their perception of the length of the session (*at3*). Their SCR was recorded for a further 3 minutes (*t4*). (Table I)

Table I. Experimental procedure

Time-point	*t1*	*at1*	*t2*	*at2*	*t3*	*at3*	*t4*
Measure	Pre SCR	PANAS, feelings	Noise SCR	PANAS, feelings	Paro SCR	PANAS, feelings	Post SCR

All their interactions with Paro were recorded using a video camera. However, in this paper, the results from the video observation and the PANAS will not be reported.

RESULTS

The normally distributed data were analyzed using parametric tests and non-normally distributed data were analyzed using non-parametric tests.

Skin conductance response

Mauchly's test indicated that the assumption of sphericity had been violated ($X^2(5)= 22.76$, $p = 0.000$). Therefore, degrees of freedom were corrected using Greenhouse-Geisser. Two-Way Mixed Analysis of variance (ANOVA) showed there was a significant effect of time, $F(2.5, 175) = 77.21$, $p = 0.000$ and a significant interaction between condition and time on SCR, $F(7.5, 175.01) = 10.26$, $p = 0.000$. There was no significant effect of condition, $F(1, 70) = 1.267$, $p = 0.292$.

Response to noise

Pairwise comparison for specific time points, *t1* vs *t2* and *at1* vs *at2* revealed a significant increase in SCR and subjective ratings for all conditions, $p < 0.05$.

Response to Paro

A one-way ANOVA was conducted to examine the effect of the robot session on participants' SCR. It was found there was a significant effect of robot condition (*t3*), $F(3, 70) = 11.44$, $p = 0.000$. Post hoc test (Bonferroni) revealed that pairwise comparisons for *C1* vs *C4*, *C2* vs *C4*, and *C3* vs *C4* at *t3* were significantly different, $p < 0.05$.

All mean scores for SCR were increased at *t3* from *t1*, and pairwise comparisons found those differences were significant for all conditions, $p < 0.05$ except for *C4*, $p = 0.458$. However, there were no significant differences between *t1* and *t4* for all conditions, $p > 0.05$.

Participants' self-reported feelings of stress

Friedman test showed a significant effect of time for all conditions, $X^2(2) = 78.70$, $p = 0.000$. However, there was no significant difference between conditions, $p > 0.05$.

Pairwise comparisons tests between specific pairs of time points for all conditions showed a significant difference between *at2* vs *at3*, $p < 0.05$, but not for *at1* vs *at3*, $p > 0.05$.

Table II. Descriptive statistics for: (i) SCR (ii) Current feelings

Mea-sures	Condition	1 N = 20	2 N = 18	3 N = 18	4 N =18	Total N = 74
	Timepoint	Mean and standard deviation				
(i)	*t1* Pre	14.35 (14.00)	17.22 (8.84)	12.11 (8.145)	15.83 (11.68)	14.86 (10.95)
	t2 Noise	17.65 (12.95)	20.83 (9.401)	15.22 (10.35)	18.83 (13.48)	18.18 (11.56)
	t3 Paro	38.70 (11.14)	29.67 (9.401)	32.17 (10.18)	17.22 (11.92)	29.69 (13.73)
	t4 Post	17.75 (11.64)	18.33 (10.26)	14.67 (9.54)	14.94 (10.29)	16.46 (10.41)
(ii)	*at1* Pre	1.2 (0.523)	1.56 (0.705)	1.28 (0.461)	1.78 (1.06)	1.43 (0.723)
	at2 Noise	2.5 (1.0)	2.22 (1.003)	3.11 (1.231)	2.44 (0.856)	2.57 (1.061)
	at3 Paro (Post)	1.10 (0.308)	1.33 (0.594)	1.44 (0.784)	1.44 (0.511)	1.32 (0.576)

DISCUSSION & FUTURE WORKS

This preliminary analysis of the data suggests that the noise temporarily induced mild stress, as indicated by elevated SCR and subjective ratings. However, there is no evidence that interacting with the Paro reduced the SCR. SCR increased during the noise session (*t2*) from the initial measurement (*t1*). It also increased further during the Paro session (*t3*) for all conditions except in *C4*. In addition, in the final measurement (*t4*) did not show reduced SCR compared to *t1*. There were no significant differences between *t1* and *t4* for all conditions, and all conditions except *C4* showed a small increase in SCR mean scores (Table II (i)).

SCR was significantly higher during the robot session (*t3*) than at pre-measurement (*t1*). Previous research suggested that interacting with the Paro would reduce rather than increase stress levels [3]. SCR measures are difficult to interpret and the increased SCR during the Paro sessions could be due to a number of reasons: (1) The participants may have found interacting with the Paro stressful because it was new to them. (2) The Paro session may not have been long enough to reduce the stress induced by the noise. (3) The increase in SCR could be related to the excitement and intensity of their interaction with Paro [4]. The averaged SCR results also indicate that interacting with either an active (*C1* and *C2*) or an inactive Paro (*C3*) showed higher mean SCR scores than no interaction with Paro (*C4*) (Table II (i)).

Mean scores for self-reported were better (lower) after the Paro session compared to initial ratings in *C1*, *C2* and *C4*. In *C3*, interacting with an inactive Paro showed an increase in participants' subjective ratings. The mean scores were also decreased after the Paro session compared to the noise session in all conditions (with a larger decrease in *C1* and *C3*, the conditions involving physical interaction). Although interacting with Paro did not reduce SCR, it seems to have reduced self-reported stress.

In future, other physiological measures could provide more clues about the meaning of the physiological response [1]. The effects of Paro could also be assessed at different time-points e.g. during or before the stressor to see if the presence of an active Paro helped to reduce the stress effect. Finally, participants could be explicitly taught how to interact with Paro, making sure that they were more comfortable playing with the Paro.

CONCLUSION

These results indicate that interacting with a Paro robot does not always reduce people's physiological stress responses. Against expectation, an increase in SCR was found during the Paro sessions, as compared to initial levels, and the levels during the noise. The increased SCR could indicate that participants found interacting with Paro was stress inducing. Alternatively, the increased levels could indicate that the participants were experiencing positive arousal as a result of their interaction and engagement with the Paro. However, no firm conclusion can be drawn at this point, as the research and the analysis of the data is still ongoing.

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What I want to do the robot? Identifying needs for social robots in a pediatric hospital

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Abstract.

Keywords: Pet-Robots, Nursing, Care, Design Thinking

INTRODUCTION

In our hospital have been using social robots since 2013 in the context of the collaboration between LaSalle university, Polytechnic university of Catalonia, Autonomous university of Barcelona and Saint John of God hospital, for the development of a social robot for therapeutic use in pediatrics.

After several test the selected robot for the deployment in the hospital was PLEO®, a robot-like baby dinosaur that has different personalities and animals and primary behaviors such as hunger, fear , happiness , curiosity. The PLEO® generates affective behaviors in children aimed at satisfying the needs of the robot.

After the deployment of the robots in the hospital a wide range of test and research have been done for to know the dynamics set between the different stakeholders, patients, families, health professionals and the robots.

OBJECTIVES

Know the requirements that social robots may have for its use in a pediatric hospital. Identify the needs of the health professionals related to what this kind of technology could offer to improve the quality of care.

METHODOLOGY

This work has been divided in two parts. The first was a survey with four open response questions administered over nurses of different departments in the hospital that have had contact with the PLEO® (table 1).

Table 1. Open response survey questions

Questions
1. What areas of the hospital would be more likely to have robot companions?
2. What do you expect from a companion interactive robot? What information and how would you like it give to you?
3. What difficulties faced doctors and nurses dealing with hospitalized children from a perspective of how the child is emotionally? How to manage their anxiety? Which of these difficulties could help solve a companion robot?
4. What features should have a robot: ability to show expressions, talking, interactive, customizable depending on the child, etc? Should the robot perform a role similar to a pet?

The second part of the research was a design thinking session with nurses to identify user needs.

RESULTS

Nine nurses of the oncology department with experience in the use of PLEO® were surveyed. The comments on the survey were analyzed following the content analysis method.

About the first question the nurses mainly include the daily hospital, ER department, surgical ward and hospitalization ward like places susceptible to offer robots like a therapy.

About the second question the nurses said that the robot could distract, make company, awaken imagination, facilitate the expression of feelings, stimulates the responsibility of caring, interact with children. It is viewed as an alternative to videogames or TV. About the information that a robot could give to the nurse we didn´t obtain any response, maybe because the nurses identified the PLEO® like the unique alternative and they didn't imagine the PLEO® like a clinical device.

About the third question they refer to a problem communicating with patients due to lack of knowledge of them and trust. It shows the robot as a facilitator of expression of feelings and as a mediator between professionals and children, because the robot is a toy.

Finally, about the forth question some people say it should be like a pet, other nuance it should have distinctive aspects facing animals and should not be able to confuse one with the other. They also granted the role of stimulating the child's caregiver role and no liability with caring for a pet. Should be able to speak and show expressions in terms of feelings. It mentioned that is an alternative to live animals, which cannot enter all areas of the hospital. It must be disinfected.

After the analysis of the survey we conducted a design thinking session for ideation with nurses. The nurses invited to join the session were different for the nurses that answered the survey and didn't have experience in the use of PLEO®. The reason of this selection was that we thought that a previous knowledge of PLEO® could induce the participants to think in PLEO® and no in a general robot or technology.

For the session we presented the participants the basic elements of the design thinking and asked them about things or aspects of the clinical assistance that the technology could take from the patient, family or environment, we divided these aspects in three initial challenges, clinical, emotional and social aspects.

In the first stage (divergence) of the session all participants, divided in three groups, proposed ideas about this three challenges, in the second stage (convergence) each group select one of the aspects and made a conceptualization of the ideas exposed.

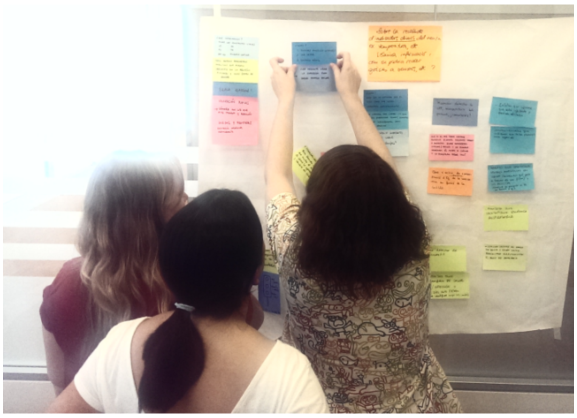

Figure 1. Nurses during the session.

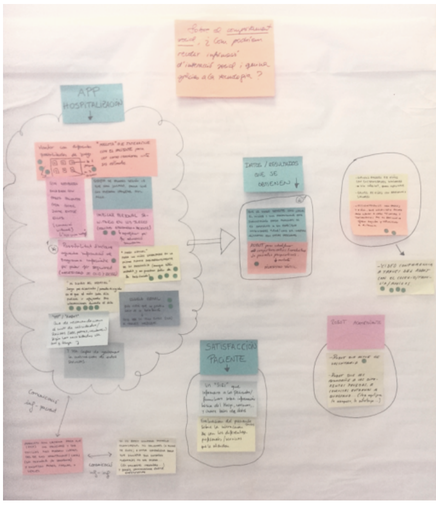

Figure 2. Social aspects identified during the design thinking session.

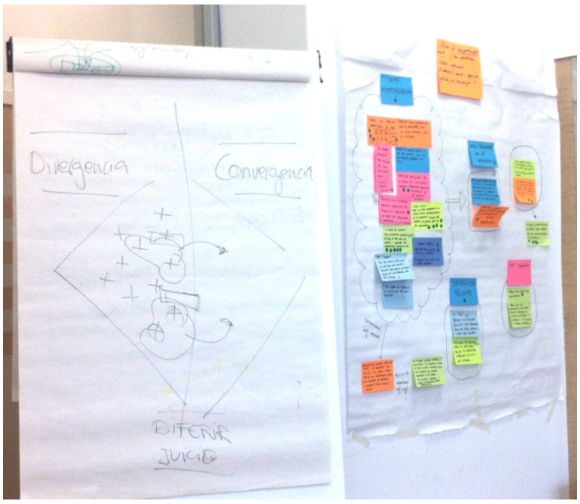

Figure 3. Social aspects identified during the design thinking session and explanation of the ideation phase of Design Thinking.

After the session the research team carried out an analysis of the results and a holistic conceptualization of the needs identified by the participants. This needs were grouped in a triangular pyramid model in which the clinical, emotional and social aspects form three hierarchical levels around all the model, in other level we use the three faces of the pyramid to classify the needs in "what", "how" and "why".

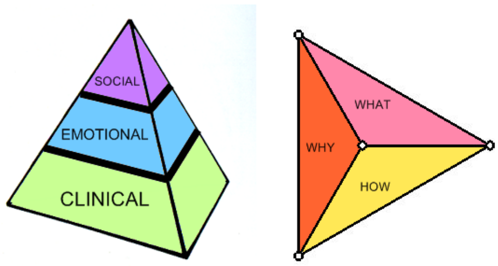

Figure 4. Pyramid model of needs

DISCUSSION

The nurses that participate in the session identify different needs in which the robot could we useful, against expected the clinical aspects weren´t the one in which the nurses identifies more needs. We interpret this fact because currently there are many devices that address these aspects such as vital signs and the nurses are familiar with them. The aspects where the nurses identified more needs were the emotional and social giving the robot the role of a mediator in the communication between different users for example between the hospitalized child and the school partners or between the family and the nurse.

After the design thinking session we have programmed a new session for solution conceptualization over the identified needs. We expect to show the results in the new friend´s congress.

After this work we concluded that is very important to incorporate the professionals that could benefit from the technology in the design phase.

Attentive Robot Listener Engages Children in Language Learning

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***Abstract*— Socially assistive robots have been used successfully to attract childrens attention, stimulate sustainable interactions and improve communication skills in young children. Many recent research studies propose various approaches for increasing the interaction effectiveness of such robots. Our research objective is to develop an autonomous social robot learning companion that, through contingent backchannel feedback, can successfully foster the development of early language skills of preschoolers over long-term interaction in an educational storytelling context. In this study we used Tega and we investigated the effect of the robot nonverbal behaviors during storytelling activities of young children. The findings of this study contribute to the effective use of interactive robots in education. Our results suggest we can build models that capture individual differences in backchannel style, captivate children's attention and enhance the whole storytelling and learning experience. In the near future we will possibly identify individual traits from observations of backchannel behavior and create autonomous and personalized activities so as to increase the children's curriculum in a social and engaging venue.**

I. INTRODUCTION

Early language ability (such as vocabulary skills and oral language knowledge during preschool) is one important predictor of children's academic success throughout their school years. Children who lack a rich vocabulary-building curricula suffer from language differences that may negatively affect the childs entire academic career [1]. The importance of social context to language learning is also well-established and just being surrounded by complex language does not seem to produce positive lexical growth [2]. Extensive research in young children and infants has verified the importance of social cues like backchanneling (BC), joint attention and shared gaze for language acquisition, thereby emphasizing the importance of the cooperative effort of the learner. Storytelling has been widely used as an effective means of improving language skills, (e.g., vocabulary, grammatical level, etc.), as well as cognitive and social understanding [3]. Furthermore, children enjoy telling stories they make up from their own imagination. Self-created stories provide a longer and richer speech sample than asking children questions about stories and children feel more relaxed when engaged in story-telling acts which promotes learning [4].

Social robot learning companions hold great promise in augmenting the language learning experience with parents and teachers. Such robots offer unique opportunities of guided, personalized, and controlled social interaction and delivery of a desired curriculum. Differently from tablets and smartphones, robots can play, learn and engage with children in the real world – physically, socially and emotionally. However, in order to serve as an effective long-term companion, social robots need to be far more autonomous, adaptive, personalized and able to model the corresponding cognitive capacities and language behaviors of child learners.

Still, no studies focus on developing an autonomous personalized social robot companion and assess its efficacy on the language development of pre-school children in the context of storytelling tasks. For this purpose, we developed a rule-based backchannel (BC) prediction model that will push the envelope of our understanding of childrens free form storytelling and eventually foster the development of early language skills in pre-school aged children. The objective of this study is to understand whether the type of feedback that the robot gives to children will influence their engagement and experience with the robot, and compare this with a robot that gives only random feedbacks.

II. RELATED WORK

A long-term interaction with social robots has been shown to have a positive effect on learning and behavioral outcomes for both adults and children beyond mere novelty effects [5]. The use of social robots as peers and tutors for children in educational settings has also been increasingly explored in recent years with promising results. Children have learned vocabulary from a tele-operated storytelling robot [6] and fostered curiosity-relevant behaviors [7]. Socially assistive robots have also been introduced in Kindergarten settings as teacher assistants to foster storytelling activities [8]. Taken together, findings such as these are highly suggestive of the ability of social robots to be perceived as engaging peers or to serve as instructors in learning.

Backchanneling (BC) is a component of conversation and verbalization that is naturally embedded in our everyday interaction and is the part a listener plays in a conversation. There are both verbal and nonverbal BC signals. Throughout a conversation, the listener may nod their head (nonverbal) periodically to show that they are paying attention and/or verbally acknowledge using fillers, such as *yeah, ok, uh huh, mhmm*. BC has been studied as a form of feedback, acknowledgment, and turn-taking in both the psychology field as well as in human-robot interaction.

III. OUR BACKCHANNELING MODEL

Since listener BC are generated rapidly and seem elicited by a variety of speaker verbal and nonverbal cues, generating appropriate BC is a difficult problem. There is evidence that people can generate such feedback without necessarily attending to the content of speech [9], and this has motivated

Fig. 1. Child and mum interacting with contingent Tega (left) and non-contingent Tega (right)

diverse approaches that generate BC using different features that are available in real-time (e.g. energy, prosody, pitch).

We generated autonomous nonverbal behaviors by using a broad range of real-time features. Based on the analysis of our existing corpus of child-robot tele-operated storytelling sessions from our prior study, we created a rule-based BC prediction model for children which, to our knowledge, does not exist at the moment. Commercial tools to extract prosody and timing in speech will be used to find differences in BC style and predict BC opportunities, which is an important milestone for building engaging [9] and natural [10] experiences.

IV. THE STUDY

The effects of our model were explored with 20 children (age $M = 6.25$, $SD = 1.33$; 45% female) who participated in a storytelling activity. Two Tega robots (Fig. 1) were randomly placed in front of the child. One of the robot provided contingent BC feedback with audio and gaze using our algorithm and the other robot provided random non-contingent BC feedback every 5 ± 1.5 seconds. Due to lack of space we can only share few results. Analysis of face expressiveness showed that children were more calm towards the contingent robot and felt the robot more attentive towards them (15 out of 20).

V. CONCLUSION

The proposed project can have a broad impact on bringing social robots into schools and peoples homes for the benefit of childrens development. In the past, the lack of affordable and commercially available social robot platforms had limited real-world impact of this kind of research. But this is no longer the case with recent commercial initiatives in social robotics [11]. By incorporating automatic assessment and personalized language into the child-robot interaction, autonomous social robots can become more believable, engaging, and efficacious to foster the positive development of children. The development of affordable personalized, autonomous social robots that can promote childrens vocabulary and language skills is an invaluable tool across many domains especially for children in under-served communities and with special needs [12], [13]. Having such robots in homes, community centers, and schools can augment parents, teachers and educators in facilitating an effective learning environment for children. As noted above, language is the basis for other cognitive, emotional and social skills, thus promoting it in an engaging and personalized interaction can have far reaching positive effects.

We will soon conduct a 6-month longitudinal study at multiple preschool sites to evaluate the impact of long-term interactions with the storytelling robot on childrens engagement and language skill development. The future work will increase our understanding of the impact of longitudinal interactions with social robot companions on childrens language development. This could inspire new tools and practices for early pre-literacy and language education (as well as other domains such as STEM) in the home, classroom, and beyond. Parenting groups and educators shall be engaged to facilitate the learning activities as well as to provide input and feedback.

Our dream is that these cumulative effects of the projects outcomes with social robots (and others like it) can lead to a more expressive, intelligent and pro-social oriented society.

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Considering students' confidence when building a synthetic tutoring system

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Abstract— Confidence, that is, how sure a person is about the accuracy of her performance, has been shown to have a positive in knowledge acquisition. It can influence the learner's behavior towards achievements, increasing the possibilities to complete them. In this experiment, we hypothesized that the amount of confidence reported by students when first approaching a task would be related with their improvement in performance.

Keywords— Learning, Education, HRI, Confidence

1. INTRODUCTION

The learners confidence in his ability has been shown to play an important role on improving his performance (among other requirements, as facing tasks aligned with their knowledge and being goal-oriented to improve). But what do we mean by confidence? Confidence can be defined as a judgement to express how sure an individual is about the accuracy of his performance [1];. These beliefs can influence the learners behavior towards achievements, like effort or persistence, such that people with higher confidence being more prone to get involved in tasks and, when presented with a difficult task, they consider it a challenge to master rather than a threat to be avoided, which increases the possibilities to complete it.

The confidence shown by learners on their capabilities has been found to correlate with the way they approach a learning task. On the one hand, confidence is positively correlated to deep learning, that is, the kind of learning focused on understanding and acquiring meaningful knowledge through the elaboration of ideas and the use of critical thinking. On the other hand, it is negatively correlated to surface learning, characterized by being based in mere memorization and with motives far from the purpose of the task [2].

Unfortunately, traditional educational methods like paper-based tests miss the possibility of getting that much into detail when assessing the characteristics of the student. It is for that reason that approaches like the use of Intelligent Tutoring Systems allow for a deeper retrieval of the data provided by a student. Apart from the influence that robots have on the performance and motivation of the student, Intelligent tutoring systems allow for an individual assistance to the learner, conveying the paradigm shift that is leaving behind the "one-size-fits-all approach [3].

Monitoring the learning process of the student through technology gives access to more detailed information hidden at first side and not available by traditional methods. This information allows us to create a model of the student able to predict the possible outcome of its actions and to adapt in the best way to the learner. Current models usually use the performance or the affective state of the student (via the analysis of facial expressions, physiological data, etc) to improve their learning, but miss the assessment of the confidence the student has on his performance.

2. METHODS

It is first needed to clarify that this study is framed in the validation of a platform (a hand-held device) that is part of a research on the development of an Intelligent Tutoring System, and the assessment of the optimal parameters to choose when modulating the performance of the robot to adapt to the learning process and the characteristics of the student.

This research is part of the development of the Synthetic Tutor Assistant (STA) [4], pursued in the European project entitled Expressive Agents for Symbiotic Education and Learning (EASEL). The STA is grounded in the Distributed Adaptive Control (DAC) theory of mind, brain and body nexus [5], [6] and will offer diverse tutoring strategies based in the performance and capabilities of the student .

A. Balance Beam Task

The setup used in this experiment comprises the Balance Beam task. This task, first designed by Piaget and Inhelder as part of their theory of childrens stages of cognitive development [7], was later divided by Siegler in four rules of increasing complexity [8], [9].

The main concept of the task focuses on the understanding of the relation between weights and distances on a balance beam. Given a distribution, children are asked to predict which would be its outcome (if the balance will fall to the right or the left or stay in equilibrium).

B. Experimental Design

There were 76 participants (39 female), coming from the fourth year (nine years old) of two primary schools in Barcelona. The experiment consisted in the performance of the balance beam task on a hand-held device (virtual reality and augmented reality conditions) or on a non-motorized balance (physical balance condition).

Before the beginning of the experiments, the participants were given a pretest to assess their previous knowledge about

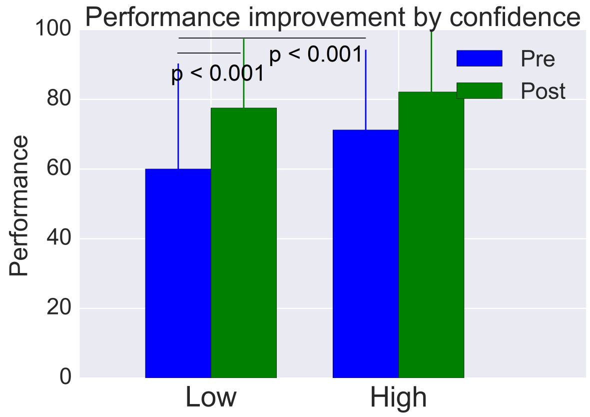

Fig. 1. Differences in improvement depending on the amount of confidence reported before the experiment.

the topic of the task and how confident they were on it. They received a similar posttest at the end of the experiment, to assess their performance improvement and changes in confidence.

3. RESULTS

In this experiment, we hypothesized that the confidence on the answers reported by students when first approaching a task would be related with their improvement in performance. To do so, we assessed the performance of the participants and the confidence on their answers before and after the task. The comparison between pre and post tests showed that there were statistically significant improvement in performance (p = 0.002) and confidence (p = 0.01).

We divided the data between the participants that reported less than the middle possible confidence (that is 5 out of 10) and the ones that reported more to look for differences between them in terms of improvements in performance and confidence. Highly significant differences could be found between the pre and post confidence reports of the participants who reported lower confidence; on the contrary, the differences for the ones who reported a higher confidence were not significant. Moreover, the differences in reported performance between the Low and High groups were significant at the beginning of the experiment but not at the end of it.

4. CONCLUSION AND DISCUSSION

In order to overcome an approach of learning as a mere knowledge transfer, current Synthetic Tutoring Systems should also consider other types of data among performance, like how confident the learner is about it. The assessment of confidence in a learning task permits for a better understanding of the learning process undergone by the student, and how much the self-perception of his own ability can be playing an effect on his knowledge acquisition.

In this article we have found significant results about how confidence and improvement in performance can be related. Further steps of this research will go in the direction of using learners' confidence to evaluate the kind of feedback the student should receive to guide him through the learning process.

Given the rapid development of the field and the previously presented importance of confidence in learning, further studies of robotic applications, including teaching assistants or learning companions, are needed to thoroughly consider the effect of the learners confidence in his abilities on the learning process.

ACKNOWLEDGMENT

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What do children in rural schools think and feel about companion robots?

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Abstract – Few studies have investigated the use of companion robots in rural schools and with older children. Children's perceptions of the companion robot iRobi have mainly been studied in early childhood education in Korea. This study aimed to investigate the potential usefulness of companion robots in rural schools in New Zealand from pre-school to high school. Participants were 211 children aged from 3-18 years from 11 different rural schools as well as home-schools, 19 teachers, and 5 parents of children. Groups of 5 participants were shown two robots, iRobi and Paro, and allowed to interact with them in half hour sessions. They were given questionnaires before and after the sessions. This paper reports the results of three questions regarding how the children thought and felt about the robots and if they wanted the robots at their school. Both robots were thought of as cute, cool, fun, young, and interactive. In addition, Paro was seen as fluffy, soft, cuddly and calming, while iRobi was seen as playful and smart, and as creepy by a small number of participants. Emotions included feeling happy, excited, good, child-like and strange. Additional emotions with Paro included feeling calm, loved, and warm; and with iRobi, feeling scared, engaged, and surprised. Over 80% of participants wanted to have the robots at their school. These results are very positive for the acceptability of companion robots in schools.

Keywords: Children, Companion robots, Rural, Schools, Thoughts, Emotions, Paro, iRobi.

BACKGROUND

Over the past ten years, researchers have become interested in using robots for teaching children in kindergartens and primary schools. It is thought that robot-assisted learning offers an interactive and engaging method of presenting educational content, which may be beneficial for learning [1, 2].

The home service robot, iRobi, is commercialized in Korea and used in early childhood education to teach English, entertain by singing and dancing, tell nursery rhymes, and deliver other educational content [3]. The robot was developed by Yujin Robot Co. Ltd, and can move its head and arms, and has touch sensors on its head, arms and wheels. It has speech and face recognition and can communicate with basic facial expressions using LEDs on its face and a text to speech module. It has a fall and collision function so it is suitable for kindergarten contexts.

Studies suggest that children in early educational settings enjoy interacting with iRobi even after novelty effects have worn off, and form friendships with it [4]. iRobi has benefits for motivation, interest, and achievement [1, 5]. To our knowledge, no research has investigated how older children in more senior schools respond to iRobi.

Paro is a Japanese companion robot that has also been commercialized and is primarily used for therapy with older adults in rest-homes or with dementia [e.g. 6]. Paro is built to resemble a baby harp seal and can move its head, flippers and tail with touch sensors in its body and light sensors in its eyes. It can respond to touch with movement and seal noises. To our knowledge, there is no research investigating how children in schools respond to Paro.

Rural schools are isolated from large cities and have fewer resources, so may especially benefit from exposure to robots that provide additional education resources.

AIM

The aim of this study was to investigate how children and teachers responded to both Paro and iRobi in educational settings. This exploratory study aimed to find out what participants thought and felt about the two robots, for what and for whom and what age groups they might be useful for, and how they might be improved for schools.

METHOD

This was a cross-sectional study conducted over a two week period. Ethics Approval was obtained from the University of Auckland Human Participants Ethics Committee. Eligibility criteria were children being home-schooled or attending pre-school, kindergarten, primary school, intermediate school, or high school. Teachers of these groups (including parent-teachers for home schooled children) were also eligible.

Rural education activities program coordinators in two regions in New Zealand (Central Plateau and Buller) contacted schools and arranged for researchers to visit. Central Plateau region has approximately 32000 residents over 13000 square kilometres, while Buller region has approximately 10000 residents over 8000 square kilometres. Participants took part in 30-minute group sessions of 5 participants (range 2-8) with a research assistant. The assistant demonstrated each robot in a counter-balanced order allowing the group to interact with each robot for up to 10 minutes (see Figure 1). An English menu screen for iRobi was made that included games, songs, a photo-taking application, and a speech recognition module for asking the robots to perform actions such as *lift arms*. iRobi was also demonstrated moving on the floor using its remote control. Paro was demonstrated being patted and held. The sessions were filmed and participants completed questionnaires before and after each session (children unable to complete questionnaires answered verbally).

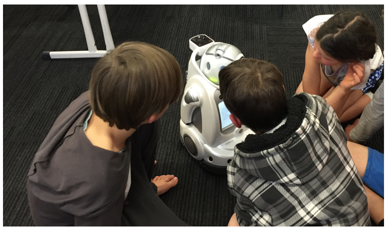

Figure 1. Children interacting with iRobi in the study.

Due to limited space, only three of the questions used in the study are presented here: *What did you think about the robot? How did you feel when you were using it? Would you like to have the robot in your school?* Answers were open-ended. Participants answered for each robot separately. Responses were coded into categories.

RESULTS

There were 235 participants from 11 different schools (36 participants from early childhood centres, 101 from primary schools, 23 from intermediate schools, 55 from high schools and 20 from home-schools). There were 211 students, 19 teachers, and 5 parents.

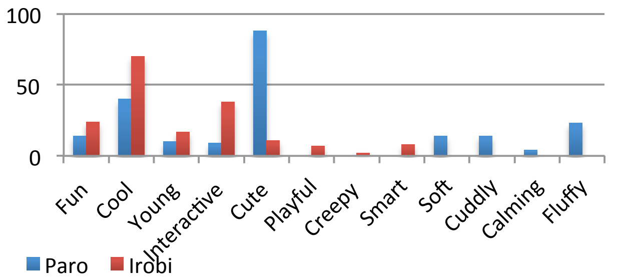

Figure 2. Responses to what people thought about the two robots.

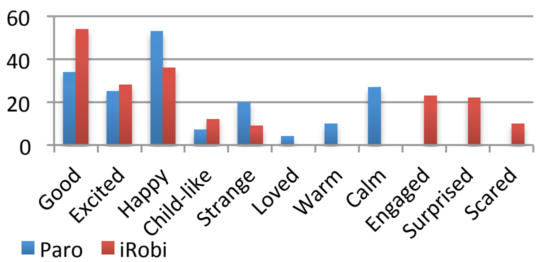

Figure 3. Responses to how people felt about the two robots.

Participants thought both robots were fun, cool, young, interactive and cute, although more people thought Paro was cute than iRobi, and more people thought iRobi was cool than Paro. Only Paro was thought of as soft, calming, fluffy and cuddly, and only iRobi was thought of as playful, smart and creepy (Figure 2). Accordingly, people felt good, excited, happy and child-like with both robots. More people felt happy with Paro and more felt good with iRobi. Some people felt loved, warm and calm with Paro and some people felt engaged, surprised and scared with iRobi (Figure 3). When asked if they would like to have Paro at their school, 86% (185/216) said yes, 9% said no, and 5% said possibly. With regards to iRobi, 83% (178/214) said yes, 11% (24/214) said no, and 6% (12/214) said possibly.

DISCUSSION

This is the first study to investigate the views of children of all ages and their teachers in rural areas with regards to two commercially availbale companion robots. Both robots were well received, with most thoughts and feelings being positive. This is the first time the participants had seen the robots so it's not surprising they were excited and happy. It is very positive that children thought the robots were cool, given the sophisticated games available on tablets and computers. Paro is designed to be like a pet, so it makes sense that it was seen as fluffy, cute, soft and cuddly and made people feel warm, loved and calm. iRobi has greater content relating to educational games, so it makes sense that it was seen as interactive, smart, and playful, and made people engaged and surprised – with only a very small number of participants feeling scared or seeing it as creepy. Over eighty percent of participants wanted the robots at their school. A follow-up study could investigate longer-term responses and use over time. Social presence is key to engaging children in long-term robot interactions [7]. The children's human-like perceptions about the robots suggest the robots did have social presence. More results will be presented in a longer paper elsewhere.

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Tutoring Informal Education CLOQQ online platform through SOTA Social Robot as Social Tangible Interface

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Abstract— In this paper we present technology developed for prove of concept of the use case of an on-desk social robot SOTA as a tangible social interface to, not only interact with the online informal learning CLOQQ platform, but also to collect useful information to understand the effecteviness of the tasks done by the user.

Keywords— Social Robotics, Learning, Robot, Education, Cloud

1. INTRODUCTION

It is well known that education system progress is far behind the needs of the society [1][2]. Even worse, there is a global warning about the Engineering skills of future generations required in today's society [3]. To address this gap, the NextGen-Disruptive Innovation Hub from everis-NTT Data developed an open on-line based educational platform named CLOQQ.

ClOQQ is the digital platform for kids and parents where they can enjoy unique experiences creating with the newest Cutting-edge technologies. CLOQQ allows users to create incredible projects, receive awards and share their creations with others, at the time they develop technical and personal abilities like self-confidence, mastering technologies and problem solving, among others. The platform offers a wide catalogue of very carefully selected activities, grouped in categories and guided in different ways, so that children can do them at home, in the school or at any other place.

On-line learning platforms are dealing with the challenge to keep participants engaged[4]. In this paper, we present a social robot as a social tangible interface that aims to engage participants. Published work like in [5] showed that physically embodied empathic robotic tutors have a better engage compared to paper notes or computers. Furthermore, we want to use this robotic platform as a monitoring device that extracts valuable information from the social interaction done during the execution of the activity.

2. DESCRIPTION

In Fig. 2 we show the schematic of the cloud-based implementation. There are three different parts in the robot-based tutoring system, the learning platform, the social robot, and the cloud services, in this case the speech to text and the natural language interpreter.

A. Sota Robot

Sota is a small, on-desktop type social robot [6]. It consist of 8 motors, as well as various leds on the face. Along with a camera and speaker it provides all the tools

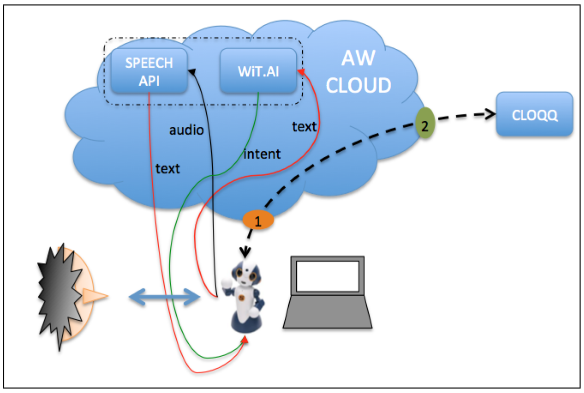

Fig. 1. Schematic of how data flow through the cloud until the model is obtained.

necessary for someone to create human like gestures in order to establish a human-robot interaction. Sota comes with WiFi and Bluetooth network functions that enable the use of IoT networks or cloud-based functionalities. Apart of the hardware capabilities, Sota comes with face and speech recognition capabilities. For the latter, since the robot is available only in Japan, it is restricted on the Japanese language only. Finally, Sota does not provide any text-to-speech capabilities but rather is using pre-defined recorded messages.

B. Speech recognition

The first obstacle to overcome was the speech recognition. As mentioned earlier, Sota can recognise only Japanes. In order to use the robot in English (or in Spanish) the *Google Speech API* was used. *"Google Cloud Speech API enables developers to convert audio to text by applying powerful neural network models in an easy to use API. The API recognizes over 80 languages and variants. Speech API can stream text results, returning partial recognition results as they become available, with the recognized text appearing immediately while speaking. Is not needed any advanced signal processing or noise cancellation before sending audio to Speech API. The service can successfully handle noisy audio from a variety of environments."*[1]

To use the Speech API we used the provided REST API. This process was maintained inside the robot's proccessor, as sending the audio file to the cloud would increase the latency. The resutl of this process, is a text of what the Speech API recognized.

C. Wit.ai

To get the context of the text that was returned from Speech API, the *wit.ai* platform was used.

“Wit.ai makes it easy for developers to build applications and devices that can talk or text to. THe vision is to empower developers with an open and extensible natural language platform. Wit.ai learns human language from every interaction, and leverages the community: whats learned is shared across developers.”[8]

The use of wit.ai platform is simple. The user provide voice or text and it gets back structured data. The user can learn the application that created in the platform with specific data. For example, in our case, wit.ai is trained such that when the input text (recignised by Speech API) is:

- Let’s go to the next step
- Go to the next step
- I’m ready, what’s next?
- Ok, what’s next?

the *intent* of these input is the same, *go-to-next-step*. The output of wit.ai is also a text that can be used by the developers. Wit.ai is also used usin the provided REST API. The proccess though is taking place inside the cloud.

3. IMPLEMENTATION

The idea, based on previous work [9], is to use Sota as the intermediate between the kid and the CLOQQ platform. The process can be summerised as followed:

1) The robot is constantly looking to recognize a speech. As soon as that happens, it sends the recorded audio to the Speech API.
2) Speech API is returning a text with the result of the recognition, and Sota is sending it to the cloud.
3) The cloud is sending this text to Wit.ai and the context of this text is returned back to the cloud and from there back to Sota.
4) Based on the context, Sota is interacting with the user and also sends a command to the cloud to interact with CLOQQ.
5) Cloud is passing this command to the CLOQQ platform. (As of now, the feedback from CLOQQ is not implemented yet).

Example of commands that Sota sends to CLOQQ through the cloud are:

- Go to the next/previous step (page is scrolled down/up to the next step
- Show the materials needed (a window pops up with the materials)
- Expand/Shrink the image of the current step
- Download the instructions (a pdf with the instruction is downloaded)
- Upload an image.

Apart of the commands, the user can also ask for some help, as for example to repeat the instruction of the current step or to ask for further explanation.

4. RESULTS AND CONCLUSIONS

In this paper we present a prove of concept of how a social robot can be a facilitator of a task such as navigate through an online-based learning platform. At the same time, the sota enagages the user with the activity and promote to keep working [10]. Sota rota combines the Java-based API provided by the manufacturer and its embedded functions like face-tracking, mood detector, or speech audio recording, with the python API we implemented to extend and enhance the capabilities with a Wit.ati natural processing language and Google speech recognition. However, these free tools require a better latency and are going to be improved with the services and apps in the in-company cloud.

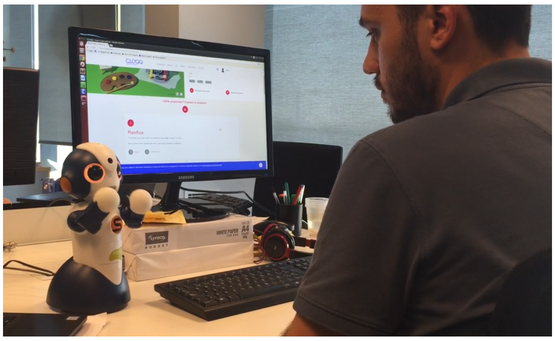

Fig. 2. The user can navigate with CLOQQ application though social interaction with Sota robot

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The future is Nao: Teaching Mathematics to young schoolchildren using humanoid robots

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***Abstract*—Research has shown that interaction with a robot is able to improve a childs learning rate in English, primarily due to children finding robots fascinating and fun to interact with. The study undertaken aims to achieve similar results, by using an Aldebaran Nao robot to teach primary school children novel Mathematical topics. The robot has been programmatically made interactive, and behaves in a human-like manner by effectively making use of speech fillers, pauses, behavioral animations, and facial tracking. The study aims to deduce the effectiveness of a robot as a Mathematics tutor, through the analysis of the childrens performance in a pre-test and post-test. A statistical comparison is made between childrens performances after being taught by either a robot or a human teacher (acting as a control), in identical teaching conditions.**

***Index Terms*—Mathematics teaching robots, human-robot interaction, visual feedback, human-like behaviour**

I. Introduction

The expansion of robotics into the niche field known as personal robotics is due to robots being able to perform tasks, such as teaching, without getting tired or frustrated like a human. Children find interacting with robots fun [1] , owing to an underlying design of a robots friendly persona providing a more comfortable presence, allowing the children to treat them as virtual friends. It is often found that a robot can assist a child in learning where an adult may fail. As a result, the study aims to achieve similar results by replicating the robots interactive learning in the field of mathematics. The goal of the project is to develop a mathematics tutor for children that interacts and behaves in a similar manner to a human. The Aldebaran Nao, with its diverse array of sensors for multimodal perception, provides an ideal platform to achieve such a complex task. The Nao will teach the participants algebra using examples, interactive speech and giving help when required. To endear the participant, the Nao will aim to learn the basic details of the participant, including the name, age and nationality. Further interaction with the user is to be achieved by using face detection and tracking. The robot utilizes the information about the location of the face to turn towards a participant attempting to keep the face in the centre of the visual frame, before switching to another. This enables the robot to feel more interactive, and therefore appears to be more human-like to the participant.

II. Hypotheses

The experiment aims to provide conclusive proof for or against the following hypotheses:

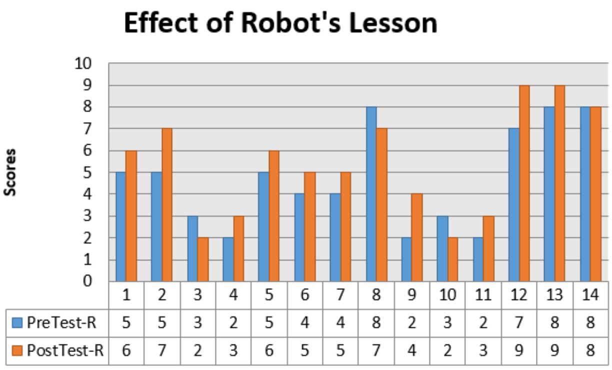
1) Robots are effective Mathematics teachers for children. A robot can teach a child an unknown topic and the child will grasp the concepts effectively. A humanoid robot interacting in a human-like way is equivalent or better to a human teacher for the purpose of teaching Algebra.
2) Children can accurately infer whether they learnt anything from a teacher (or in this case a robot).
3) A robot is equivalent or better than a human teacher for improving a child's ability in already learnt concepts as well as teaching new concepts.

The following assumptions are made with regards to the experiment:

1) The children taught by the robot and the teacher have mixed ability- no group is significantly better than the other.
2) The children comply to the robot's instructions
3) The environment is noise-free, and does not affect the speech recognition
4) The children solve both tests to the best of their ability

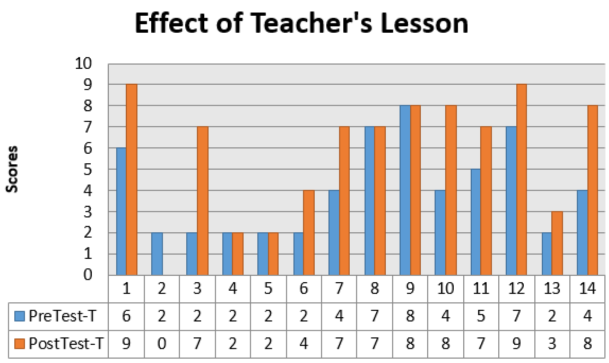
III. Score Improvements

The pre-test average and standard deviation for the group taught by the robot are found to be 4.71 and 2.18 respectively. The corresponding values for the group taught by the human teacher are found to be 4.07 and 2.12 respectively. Since the maximum score on the test was 10, it shows that the group taught by the robot was significantly better, as the group achieves a higher average score, and a similar standard deviation. This discrepancy in the data has to be accounted for when drawing the final inferences. Two ANOVAs were performed: one for the robot and one for the human teacher using pre and post-test data as dependent variable. The p value of 0.09 for the teacher suggests that the human teacher made a difference trending towards significance in the 15-minute session; however more data is required to confirm that this is statistically significant. The robot on the other hand has a p=0.42 which means that there is no statistically significant improvement in test scores. This is likely to have been influenced by speech recognition glitches in teaching, possibly leading to the children losing interest or being distracted.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PreTest-R	5	5	3	2	5	4	4	8	2	3	2	7	8	8
PostTest-R	6	7	2	3	6	5	5	7	4	2	3	9	9	8

Fig. 1: Effects of the Nao's lesson on scores



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PreTest-T	6	2	2	2	2	2	4	7	8	4	5	7	2	4
PostTest-T	9	0	7	2	2	4	7	7	8	8	7	9	3	8

Fig. 2: Effects of the human teacher's lesson on scores

observed that despite the pre-test average being higher for the group taught by the robot, the post-test average is higher for the group taught by the human teacher. This is reflected in the fact that the average improvement level for the group taught by the robot is 0.7 as compared to 1.7 for the group taught by the human teacher. However, this improvement level is not a sufficient criterion to deem that human teachers are better than the robot, as the group taught by the human teacher has increased room for improvement than the group taught by the robot.

To account for the discrepancy in the two sets of children, it is essential to level the field. For accurate analysis it is necessary to eliminate the effect of the averages as the group with a lower average has more room for improvement. A novel factor is thus introduced in this paper to account for this. It is called the Performance Unlock Index (PUI).

If the maximum score in a test is M and the score of an individual in the pre-test is S, scope for improvement (SFI) is defined as

$$SFI = M - S$$

Using SFI and improvement between pre- and post-tests, PUI can be defined as follows:

$$PUI = \frac{Improvement}{SFI} * 100$$

It is likely that the score will not always rise. Hence, there is a need to introduce another index, but for decrements. This index called as the Potential Hindrance Index (PHI) is defined as follows:

$$PHI = -\frac{Deterioration}{SFD} * 100$$

where scope for deterioration (SFD) is the initial test score itself. The negative sign expresses that the effect is undesirable.

Thus, PUI and PHI are expressed as a percentage of improvement. In case of a set of students having a scope for improvement of 3 and getting an improvement of 1.5, it will be treated as equivalent to a set of students with scope for improvement of 5 and a final improvement of 2.5. This will reduce the discrepancy in the initial set of averages. The PUI is calculated when the change is positive, and PHI when the change is negative. Note that PUI is always a greater than or equal to zero and PHI is always negative.

The PUI-PHI was calculated for both sets of children and analyzed using an ANOVA. The average PUI for the teacher was 26 % and for the robot was 14 %. Since, both are positive we can infer that both the teacher and the robot had a positive effect on learning in average. The p=0.42 from the ANOVA in between these PUIs suggests that there is no statistically significant difference between a teacher teaching the children algebra, and a robot doing the same.

IV. Conclusion

The study found that there is no statistically significant difference between a robot and a human teacher teaching a novel Maths topic to children aged around 8-9 years. This supports the first hypothesis although more data will be required to provide conclusive proof. Survey data compared with the actual score improvement support the second hypothesis-that the children can estimate their learning on their own at the age of 8-9 years. The improvement in section A in the test for the group taught by the robot and the teacher show no statistically significant difference. There is no statistically significant difference in the PUIs either. This supports the third hypothesis of the robot being equivalent to the teacher in reinforcing pre-learnt topics.

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9. **Social Robots in Education: Towards Versatility**
Wafa Johal, CHILI/LSRO, École Polytechnique Fédérale de Lausanne, Switzerland, **Gaëlle Calvary, Nadine Mandan, and Sylvie Pesty,** , Laboratoire d'Informatique de Grenoble, Grenoble-Alps University, France

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Social Robots in Education: Towards Versatility

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Abstract— This paper presents results from interviews of 16 children and their parents on robot's functionalities preferences. These interviews were realized after each child interacted individually with two humanoid robots in two different tasks. The first task was a mathematical quiz on multiplication and the second a dance session. After two times 15 minutes of interaction, children and parents were interviewed using some items from the *Children's Openness to Interacting with a Robot Scale* (COIRS). We report here results on expected versatility from the social robots for children. We also found that parents and children agreed on some tasks that robots should or should not perform as a social companion.

Keywords— Child-robot social interaction, Versatility, Social Robots, Education

1. INTRODUCTION & RELATED WORK

In the context of the MoCA project[1], we are investigated in the potential versatility of a social companion robot for children. We identified several social roles that the robot could play and aimed to propose a role-transition system and a personalisation system within these roles [1].

In the literature, quite often, social robots are restricted to one role or one task. The state of the art in robot tutoring reports research where the robot is often used to teach one and unique curricular subject such as languages [2], writing [3] or math [4]. However, sociability implies context adaptation. Humans endorse several social roles in their every day life to adapt to these context changes. One of the advantage of social robots in education is their ability to create a social bounding. They can empathize with the learners. But why won't they also be able to perform other tasks with the learner in other contexts.

Looking into how social robots could be versatile, we proposed an experiment with two tasks: a multiplication quiz and a dance. We tested two setups : a versatile and a specialist condition. In the versatile condition, one single robot was performing both dance and quiz with the child. In the specialist condition, the roles were split between two robots, one dancer and one math teacher.

This paper reports parents and children opinions on versatility and on roles/tasks to be given to a robot assistant for children.

2. EXPERIMENTAL CONTEXT

The experimental design was within subjects; each participant seeing the two conditions in a random order. Each session was 15 minutes long and was organized by the succession of 3 interactions. First the child takes a mathematics evaluation (*Math Quiz*), before being invited to *dance* and finally being a part of a second *Math Quiz*.

In order to test the **versatility** we proposed either one versatile robot (one robot performs the 3 interactions) or 2 specialists robots (one robot is assigned to the *Math Quiz* task and another to the *dance*). We used Nao robots for this experiment. During the interaction, parents could watch and hear their child from a control room a few meters away from the apartment where the child-robot interaction was taking place. Parents were invited to react during the interaction on what they were seeing. Figure 1, shows the parent ceiling view and the child's view through a wearable camera.

After each session parents and children were invited to answer to a questionnaire (twice the same) to collect data on acceptability, trust and credibility We expected for instance that specialists robots (dancer and teacher) would be perceived as more competent than the versatile robot. This evaluation allows us to do a comparison between conditions and between parents and children views.

The last part of the second questionnaire also contained some items from the Children's Openness to Interacting with a Robot Scale (COIRS) questionnaire [5]. This questionnaire included 5 items on the role/tasks that a companion robot for children should be able to perform. We asked these questions to both children and parents, adapting the utterance (see below : [child/parent]) :

- It is important for the robot to be able to help [you / your child] with *homework*.
- It is important for the robot to be able to be *taught new things*.
- It is important for the robot to be able to *play* with [you / your child].
- It is important for the robot to be able to be *used as a phone* by [you / your child].
- It is important for the robot to be able to be *used to browse the internet* [you / your child].

In order to recruit the participant, we advertised the experiment through the mailing-lists on Grenoble University Campus. Hence, most of the parents were researchers; others, being administrative staff members.

3. RESULTS

16 children and their relatives participated to the experiment. Most often, the relatives were parents, but 3 children came with their grand-parents. Figure 2, shows the average answers for each of the tasks and for parents and children. A first comment that we can make looking at this plot is

[1] http://moca.imag.fr/

(a) Parent's View - Ceiling Camera (b) Child's View - Wearable Camera

Fig. 1: Illustration of the experimental setup

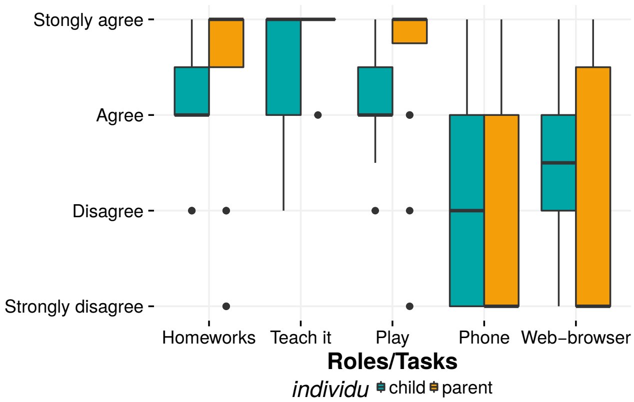

Fig. 2: Average preference of the robot in each role for parents and children

that some tasks are more consensually accepted than others. For instance homework, teach and play are mostly accepted by both parents and children. Parents are in general less agreeing on a phone or web-browser functionalities than children (although this difference is not significant).

It is also interesting to notice that parents are in favour of a robot that plays with their children. Results on perceived competency of the robots in the task did not show any difference between versatile and specialist robots as we would have expected. Finally, interviews showed that all parents and children would prefer one versatile robot rather and two specialists robots, cost and maintenance were given as main reasons.

4. CONCLUSIONS

To conclude, we learnt from parents and children than speciality of the robots was not affecting perceived competency in the task. Indeed, a versatile robot was perceived as competent as a math teacher than the Math specialist even-though it liked to dance sometimes.

From the COIRS questionnaire, we observed agreement on the fact that the robot should not be used as a phone or a web-browser. Entertainment, and educational roles were more positively viewed. Both parents and children strongly agreed on the fact that children should be able to teach their robot things.

Some limitations should however be mentioned. First, the recruitment of participants was not so randomized (as participants were from our university). We also believe that such a survey should be ran at a bigger scale in order to have significant and representative results. It also might have been interesting to run this questionnaire before and after the experiment. We believe that the fact that the tasks were falling into the homework and play category, it might have affected the perception of parents and children on importance of these tasks.

These results then to show that a good companion robot for children should perform educational tasks while still being entertaining. Versatility seems to be a requirement for social robots and educational role should be one of the many that a robot is expected to play.

ACKNOWLEDGEMENT

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Facial Expressions Interpretation for Human-Robot Interaction

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Abstract— **The main goal of this research is to classify human facial expressions in a human-robot interaction. The project used an existing robotic system, Socibot – a social robot developed by Engineered Arts, to implement the facial expression classifier. The target is to pick the visual cues and recognise the mental or emotional state of the user. This classifier can easily integrate into any of the existing Socibot platforms. The importance of this integration is to utilise the contextual cues from the classifier and enhance the human-robot interaction in the existing robotic system. In the experiment, a verifiable mapping between the facial expression and facial action units (FACS) was developed. The project utilised the CK+ database of images to train and test the classifier. The experiment incorporated four out of six basic expressions identified by Ekman and Friesen, eventually, expanded to a set of all six expressions. The classifier developed, successfully classifies the real human expressions using outputs from the Visage feature-tracking program.**

Keywords—Human-Robot Interaction, Artificial Neural Networks, Visage FaceTrack, Socibot, Radial-Basis Function.

I. INTRODUCTION

The main objective of the project is to classify human facial expressions for human-robot interaction. This helps the robot to utilise the user emotional state to build a mental model of the user. The user mental-model is essential to understand the interaction pattern of a user, inductively building a user-model interaction system.

Amongst the assorted divisions of robotics, human-robot interaction (HRI) is one of the most challenging fields that thrive on exploring a legion of avenues for robotic systems to achieve an interaction level similar to human-human interaction. Here, interaction is the communication between a human and a robot. The human-robot interaction has two broad classifications based on the proximity of the human user from the robot [1, 2]. The following research focuses on the close proximity face-to-face human-robot interaction.

This research aims to utilise the existing robotic system developed by Engineered Arts in UK, to work on tracking face(s), classifying facial expressions, and interpret the classified facial expressions for HRI. The primary goal is to pick the visual cues and recognise the human mental or emotional state of the user. Achieving this goal adds to the current functionality of the existing system, so that the contextual cues can be established, which makes the HRI smoother and smarter.

This project concentrates on working with a normalised radial basis neural network to develop the classifier because of its robustness and better generalisation property [8].

II. COMPONENTS

A. Work Station

The workstation consists of two monitors, a laptop, a webcam, and a depth sensor as shown below in figure 2. The Xtion depth Sensor, Microsoft HD webcam, and the monitor B (figure 2) displaying web GUI of SociBot are connected to Intel NUC. A laptop that is capable of running CORTEX is used for training and testing the ANN. An additional monitor is used as an extension of the laptop (figure 1). This monitor is used to display the training and testing images to the Webcam.

B. Socibot

The project development is on SociBot platform, a robotic platform by Engineered Arts. The SociBot is a compact, sociable robot, designed for human-robot interaction in a more intimate setting. The Socibot contains all the processing power compressed into a stand-alone kiosk or desktop device. The power of Socibot lies in its sociable qualities - the ability to detect faces, features, emotions, speech, and gestures. It also makes use of projective technology coupled with facial generation via parametric meshes to bring any character or image to life, in full 3D form [3].

Figure 1: WorkStation

C. SHORE: Sophisticated High-speed Object Recognition Engine

SHORE is a highly optimized software library that enables the detection of objects and faces, as well as extremely fine facial analysis. The foundation of the versatile SHORE solution lies in extensive experience with detection and analysis technologies and a large database for machine learning. The technology is trained by accessing a database of more than 10,000 annotated faces [4].

The SociBot has a free version of SHORE running alongside of Visage FaceTrack software. The free version of SHORE can classify only four expressions, namely, happy, sad, surprised, and anger. The role of SHORE usage in this project is to compare its results with the results of ANN using CORTEX.

D. Visage FaceTrack

Visage FaceTrack package is a powerful, accurate, and configurable face-tracking engine. It automatically finds and tracks the face and facial features in video sequences in real time and returns full 2D and 3D head pose (translation and rotation), gaze information, 2D and 3D facial features coordinates, and a wealth of other information [5].

One of the project requirement and a constraint mentioned by the company, Engineered Arts, was to use the Visage FaceTrack software as a descriptor. The role of Visage FaceTrack as a descriptor is to extract facial feature points and feed the data to artificial neural network in CORTEX.

E. CORTEX: A Neural Network Development and Simulation Environment

CORTEX-PRO is a neural network development and simulation environment that uses a scripting programming language called as cortex-language. CORTEX-PRO is, originally, a DOS program, but also runs in WIN98, WINXP, WIN7. The whole Cortex system requires a 1.44MB disk space. The cortex-language has standard programming components such as if-then, for-next loops, and subroutines. It also includes special commands and functions for designing and simulating the neural networks (Bugmann, 1994). The cortex-language can be extended by adding new functions or commands written in WATCOM C.

F. Artificial Neural Network

Artificial neural network is a distributed parallel processing network with simple processing units that has innate ability to store knowledge in synaptic weights through learning process [7]. The research uses Normalized Radial Basis Function (NRBF) neural network to train and test the best learning classifier for the given case study.

III. Methodology

The methodology explains two main aspects: a) Socibot workflow and b) ANN Classifier. The explanation involves step-by-step approach involved in these two aspects.

A. Socibot Workflow:

a) *Socibot* camera captures real-time video.
b) *SHORE* program outputs facial emotion analysis on the input video data.
c) *Visage FaceTrack* uses the data from video input and provides output of vector points of face captured.
d) The *ANN classifier* developed uses the output from Visage FaceTrack as input to the classifier (*Visage FaceTrack is the descriptor for the classifier developed*).
e) The *ANN classifier* outputs the emotion classification.

B. ANN Classifier:

a) The ANN classifier was developed and tested in CORTEX before its inclusion in SociBot.
b) The database of images is separated into two sets: training and testing.
c) Takes the 2-D vector input from the database of images (training) collected.
d) Runs the Normalised Radial Basis Neural Network to build the network with appropriate weights.
e) After a stable ANN is built, the input data of testing data set is passed to the network to test the network for new data.
f) The network with best testing result is used as a classifier in the SociBot.

IV. Analysis and Discussion of Results

Although, it is important to classify the emotions according to their definitive labels, it is also important that the system classify the data correctly into positive and negative labels with higher accuracy. The classifier currently has 70% or higher accuracy when the expression set used was 6 expressions. This indicates that more the expressions, the accuracy tends to decrease. Moreover, when dealing with such overlapping radial functions, one needs to train the network with more images.

Thus, as a future work, first, the network will train on more images to improve the existing CORTEX result. Second, the current CORTEX environment limits the input training data fed to the network, therefore, the focus will shift to another environment like CAFÉ from CORTEX to handle the computational constraint better. Lastly, the visual cue will integrate with voice cue to improve the understanding of human emotions, which eventually integrate non-spoke cues such as gestures and eye-gaze.

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Cloud robotics in therapy and education: possibilities and challenges

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Abstract. The technology of cloud robotics offers an opportunity for healthcare to increase availability and improve quality, even though the technology is still in its infancy. However, there are some context specific challenges to be met, concerning both technology and organization.

Keywords: Cloud robotics, sensor data, therapy, Pleo.

INTRODUCTION

Public healthcare costs are expected to increase significantly in the coming decades. Meanwhile, engineers are working on robots which will provide affordable care without the direct need of a medical professional. However, social robots that are rather used as instruments than as a replacement of human caregivers are already being used, providing novel means of treatment. For instance, robots will elicit social behaviour to a greater extent than an adult in children with ASD (Autism Spectrum Disorder) [1] which illustrates how they can be an addition when learning how to interact with the social environment.

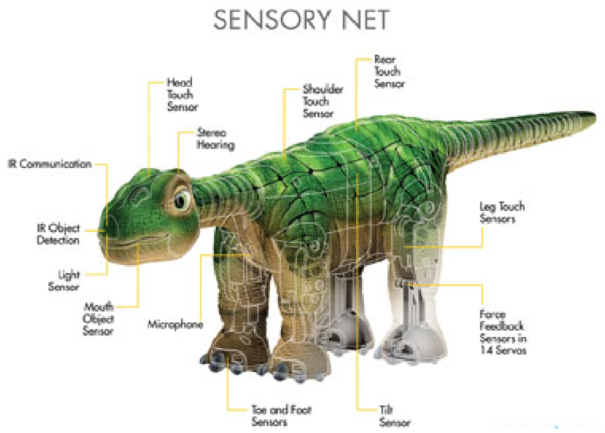

Figure 1 Sensors on a Pleo (retrieved from:http://science.howstuffworks.com/pleo4.htm)

An example of a social robot that is suitable for different forms of therapy is Pleo. Like many other social robots, it is able to 'feel' where it is touched through several sensor, it can track objects, react to being picked up and even develop a limp when it is not handled careful. After sustaining an injury, the recovery time varies depending on the level of nurture that is being provided. This way it can interact with the child as if it was real. Since Pleo collects different form of data from its sensors, these are suitable to be sent to and stored in a cloud. From the cloud these data can be read by therapists and reseachers, but also be shared among other robots.

This offers the opportunity to perceive a patient in a way that adds to observations of therapists and researchers. Moreover, it can provide possibilities for future robots that provide care, since such a robot can base its decisions on the exchange of data[2]. For example, a patient's health parameters can be monitored in real-time and measured against historic values, which are stored in a cloud. When a discrepancy is found, the robot is able to assess whether this falls within an acceptable margin of error or that immediate assistance is required. When needed, the robot signals a care centre or establishes a connection with a medical professional.

REQUIREMENTS

A robot that gathers, shares and retrieve data from a cloud needs a way of transferring data wirelessly without being bound by the facilities of a premises. A Wi-Fi connection would be useful, since it would avoid the costs of data roaming which come with a 3G or 4G modem. However, when there is no Wi-Fi connection available, the robot should still be able to connect to a cloud. For that reason, a robot should be equipped with a modem capable of using a 3G or 4G network.

In order to ensure safe storage and retrieval in real-time, a private cloud could be used [3] A private cloud will mean a faster way of communicating between the robots/devices and the cloud. The absence of a cloud gateway means the protocols do not need to be optimised. Furthermore, the most compelling reason for using a private cloud is that it is more secure than a public cloud.

CHALLENGES

In general, research regarding cloud robotics and smart robotics concerns recent projects. The technology is only just approaching the 'peak of inflated expectations' of the Gartner's Hype Curve (Figure 2.)[4]. If the hype cycle for emerging technologies is followed, assuming Gartner's predictions are correct, it will take at least 5 – 10 years before the plateau of productivity is reached. The examples stated in this paper are assumptions of what could be possible. Prototypes are currently being developed, but it may take at least a decade before we see a widespread usage of this technology. And that is, if the general public is ready for a world in which they are being looked after by a robot, instead of a human. General challenges developers might face include:

- what a robot should look like in order to be perceived as a natural part of their environment,
- how to make sure all the transmitted data are safely stored and shared,
- whether it is possible to make a personal care robot cost-effective.

Specific challenges concerning the context of therapy and education include:

- how to deal with privacy issues related to the collected data,
- how to have a non-intrusive form of technology,
- how to use this technology in a typical field setting that cannot or can hardly be adapted to this technology.

CONCLUSION

Cloud robotics will improve the quality of mental healthcare by allowing medical professionals to gain access to the patient's health parameters at any time.

Through the use of a cloud and sensors on board of the robot, the system will be able to assess whether medical assistance is needed at any time of day. The connection with a private cloud, for storing and retrieving data, is established using either Wi-Fi or 3G/4.

When social robots are used in the therapy of children with ASD, it will potentially be able to elicit greater verbalisation than the human control. This showcases the potential for using cloud robotics in using social robots for therapeutic and educational purposes.

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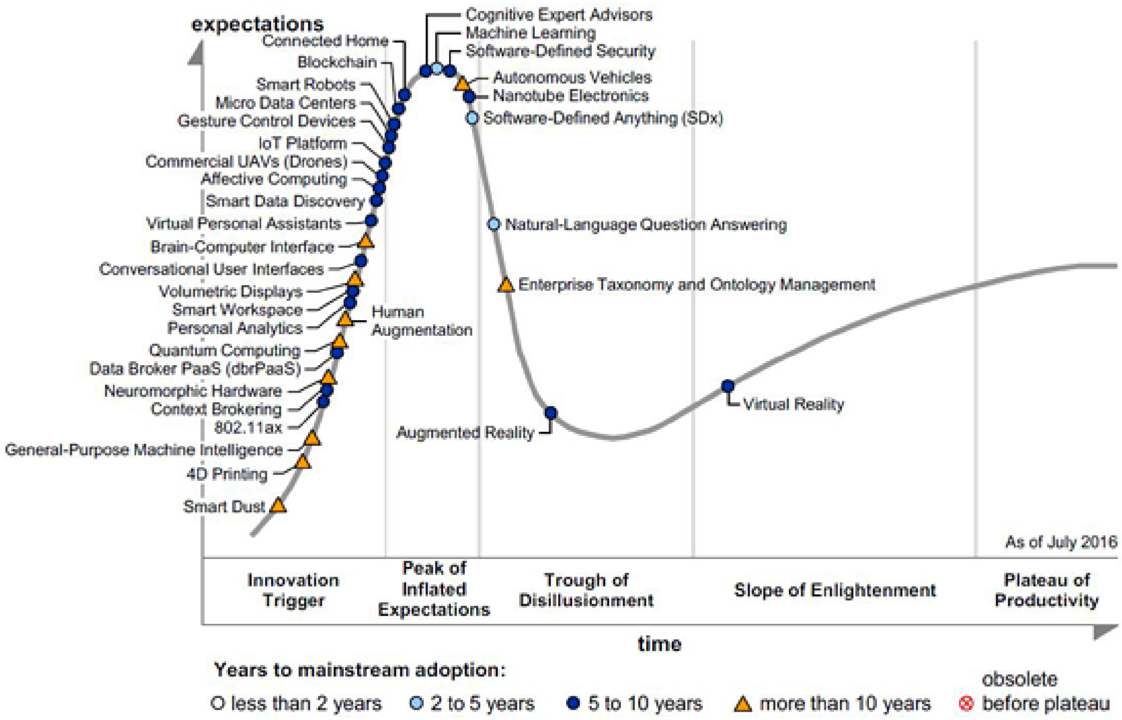

Figure 2. Gartner's Hype Cycle Curve (july 2016)

Provoking Pleo - Child Life Specialists' Reflections On The Use Of Robotic Playmates In Hospital Settings

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Abstract. This paper focusses on meaningful uses of dinosaur robot Pleo for children in hospitals, according to experiences and innovative ideas of Child Life Specialists at the Dutch Flevoland Hospital. They are participants in a research pilot on the usability of Pleo in several Dutch hospitals.

Keywords: Enter Keywords here.

INTRODUCTION

When you are a child under treatment in a hospital, what can be the use of having a dinosaur robot as a playmate? Can it make this distressing time of life more comfortable, can it alleviate your stress, anxiety or your boredom? These questions motivated to a series of pilots in several Dutch hospitals, among which the Flevoland Hospital, with accompanying research by the Universities of Applied Sciences of Windesheim Flevoland and The Research Centre for Technology in Care at Zuyd University.

This research is a part of the New Pals project [1,2], in which Dutch and Spanish universities and hospitals collaborate, explores the possible application of the robotic animal Pleo (a robot in the shape of a baby dinosaur) [3] to reduce anxiety and stress in hospitalized children, especially in pre and post-operative treatment.

This paper is not about the research as such, but about reflections of the three Child Life Specialists (CLS's) at Flevoland Hospital as participants in two consecutive pilots, the second of which is still ongoing. They determine which children could possibly benefit by the deployment of Pleo, introduce them to it, and use it in a series of their regular contacts with individual children, preferably while a parent is also present (parents have to authorize the deployment of Pleo beforehand).

For this paper, they were interviewed by a member of the research team in an open conversation about their experiences and ideas in the ongoing pilots. Their reflections here have a wider range than the research objectives concerning the alleviation of stress, anxiety or boredom.

From their point of few these are certainly relevant objectives, but to be seen as aspects of their more comprehensive interaction with the children. At the end, they also come up with innovative ideas for the further development of Pleo as a supporting tool in their interaction with the children.

REFLECTIONS ON PLEO'S VALUES AND SHORTCOMINGS

Child Life Specialists (CLS's) in Dutch hospitals are contact persons for children during their stay, or frequent visits, in the hospital. They assist the children to survive this uncomfortable time of their life, to process their experiences, to prepare them mentally for forthcoming treatments etcetera. Intensive communication with the children – and their parents – is necessary to find the best ways to assist them in developing coping strategies.

The CLS's use all kinds of toys and other materials, to start and to enrich their interaction with children, or in their own words 'to open up the child' when they perceive communication barriers: a common event in the alienating hospital surroundings. They try and identify children's individual distress and coping strategies, responding with types of play and conversation strategies. Play also as in: role play, representing and enacting situations and emotions. So play is not just about distraction from sorrows or boredom.

When asked to participate in the Pleo pilots, two CLS's reacted immediately positive. Having themselves been introduced to the robot, they found it totally endearing and were just keen to experiment with it. The third CLS had more cautious thoughts: we don't know yet what this Pleo can do, besides providing some distracting entertainment. Then, introducing Pleo to children, they all noticed at first the value of its mutual hugging capacity. Other toys you can hug, but this one hugs you back and asks for it.

Girls and boys seemed to swell by this toy 'that really crawls into you'. For a girl with eczema, Pleo was the only creature she could safely hug with. One shy girl that didn't touch the Pleo at all, nevertheless looked intensely at its maneuvers, eventually took her mother's hand to stroke it, and at last got the courage to stroke it herself.

In the first pilot, the children got to play with the robot only once, with a lot of other restrictions resulting from the controlled setting in this research stage.

In the second pilot CLSD's were happy to experiment more freely with Pleo in their sessions with the children, with an eye to individual goals planned for each child. Also, children proved to enjoy the Pleo better in more frequent acquaintance with it: you get to know him. For example, that he likes being kittled. And you can discover if he feels hungry or ill, by trying out what he wants to eat (there are several meal pieces at disposal to feed the Pleo, as well as some other attributes for playing with him). And a big attraction: you can give him commands to which he really listens: give paw! - and so he does time and time again. The CLS's saw this happenings occurring with small children (who perceived Pleo as a living creature, also if 'turned off'), up to a an eleven year old girl who by never ending questions showed an extreme interest in the technical intricacies of her Pleo.

Reflecting on these examples the CLS's concluded that Pleo, by its interactive quality, can be a positive enrichment in the toy area of the hospital. Children discover Pleo's reaction patterns, play with them and their predictability. So they can feel 'in control' and thereby regain (at least some of the) the confidence they tend to loose in a hospital situation, where they are otherwise mostly 'acted upon'.

These positive evaluations correspond however with the CLS's comments on liabilities and shortcomings of the Pleo (anyway in its actual state of development). For starters, it does not always work as expected. This is a serious problem since its predictability is the valued asset for children in regaining confidence and control, as argued above. If the expected result doesn't come up, this can enhance stress instead of alleviate it.

Reactions of parents can aggravate the negative response, as in the example of a boy with an eating problem, who tried to feed Pleo. When this didn't succeed, his mother angrily cried out, Pleo is just as troublesome as you! Secondly, corresponding with the initial doubt of one of the CLS's: although Pleo is a 'learning' robot, it tricks seems rather limited. When does it get boring to always hug, feed and command a paw? Then there is its lack of (easily recognizable) emotional expressions, except for its gladness in hugging. Couldn't he learn to shrink in some way, as an expression of grief, or discolour his head for shame or angriness?

Regarding these liabilities and shortcomings, the CLS's remark that may not know enough about Pleo's actual functioning and possibilities. The same, as to technological possibilities for further development.

Anyway in this last regard, they have some eager questions for those who are knowledgeable in the technology of social robotics. Besides the wish for more 'special tricks' as mentioned above, there are some more fundamental questions from the perspective of a CLS.

QUESTIONS AND SUGGESTIONS

A principal shortcoming, in the CLS's perspective, is that Pleo now only reacts on stimuli from others; in that way he is not really inter-active. If he could be developed in that direction, they see more use for him. For the children themselves as an engaging stimulus to cope with their hospitalization, but even more as a tool for their communicative actions and therapeutic strategies with children. Off hand, they come up with the following suggestions.

As a stimulating pal for the children, Pleo would become more useful if it could also provoke reactions in the children by actions of his own. Like (for a small example) kicking a ball away. Or take a playfully provoking attitude, like a dog with front legs down and ass up. Better still, if he could be interactive in a process like, for example, starting to cry along with a sad child - then proceed to comfort - and eventually alleviate the sorrows with some joking behavior. Maybe for processes like this, some kind of programming is needed in combination with a remote control for the CLS?

As to their own interactional strategies with the children, their gathering of ideas is anyway associated with a remote control. It would be great if children could do 'interventions' on the Pleo, with the CLS adjusting the programmed reactions of Pleo in service of a beneficial process and outcome for the child. So you could program Pleo on 'being ill' and 'getting better', with the children doctoring on him. Or, children with a forthcoming surgery could do the anesthesia on their Pleo and let it wake up again. With the helping remote control, and communicative interaction, of the CLS. These are all ideas that enrich the possibilities for enacting plays, and other stimulating interactions. The CLS's would very much like to know which perspectives there are for further development of Pleo - or any variety of a robotic playmate - in these ways.

Yet, to be noted: despite the limitations of the actual Pleo, these CLS's would love to have some of them as permanent playmates in their hospital.

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Social Robotics In Education Involving ASD Children: A Collaborative Design Project

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Abstract In a new project we want to develop an educational approach where the art of social robotics is used to enhance the development opportunities for students with a form of autism, which - by joining mainstream education attainment targets - creates a form of 'suitable education' in which pupils and without autism can work targeted forms of researching and designing learning..

Keywords: Robotics, Social Robots, Education, Autism, Collaborative Design

INTRODUCTION

Recently, much work and research has been done on the use of social robotics in special education for autistic children, in the belief that the predictable behavior of robots can help these children to practice social behavior [1, 2]. However, this has not yet resulted in programs that include working with social robotics at schools for special education for children with autism, or for regular schools where children with autism are integrated. Therefore, in the project presented here, we want to establish how design, application, construction and programming of social robots can be used in elementary school programs. In this context, we view social robotics as a means to support the social development of autistic children who are challenged when they need to perceive, recognize, interpret, and thus develop a social and communicative repertoire. We consider this essential, since these children often can only develop to a certain extent related skills by frequent, prolonged literal repetition with a high degree of predictability [3].

APPROACH

One of the underlying assumptions is that the condition of autistic children is not necessarily a disadvantage but possibly a positive starting point. It is typical for autistic children to have a need for clarity on the details of social interactions and expectations. By analyzing these processes and using technology to deploy a social sense of movement and sound production for the robot, autistic children can experience their condition as a deficiency in a learning context, but rather as a functional characteristic for activities focused on technological problems to be solved. The educational approach we aim to develop, bridges the gap between two ambitions that we have to live up to the future: strengthening Science and Technology in the educational curriculum, and appropriate education for all students including those with special needs.

PROJECT GOALS

The project has both an experimental and practical nature. We want to explore the possibilities to achieve the targeted approach using currently available robotics technology and associated structural fundings.

The goals are reflected in the following questions:

- What kind of learning activities and tasks are appropriate?
- What robotic equipment and software is suitable
- What are the established effects?
- What are the relevant differences between students in the respective school context?
- What are the possible forms of cooperation between students in regular education and special structure group and between younger and older students?
- What type of learning 'works' for children at their different levels of development: what appeals to them, when working on their own development in the social and/or technical field?
- What size of a module (in terms of weeks and hours per week) is possible and desirable?

With exploratory experiments, we first aim to establish the determinants of effectiveness with various groups of children; and which additional training for group teachers is needed and feasible. Based on these experiments, we can share a design for the intended educational approach. Subsequently we want to carry out a trial and, with accompanying research (through observation and reflective discussions with the various parties) to evaluate and adjust the approach.

Thus we develop an educational approach in co-creation with all parties, with differentiations, flexible for different learning contexts in schools that wholly or partially focus on teaching children with autism.

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Designing Socially Assistive Robot (SAR) for Cognitive Child-Robot Interaction (CCRI) with children with Autism Spectrum Disorder - The case of “+me”

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Designing socially assistive robots (SAR) is about designing social robots that work on the cognitive level and that can engage in social interactions, which are compelling and familiar to users, in this case, with Autism Spectrum Disorder (ASD). The stress and unpredictability caused by social interaction is largely removed during the interaction with a computer, a robot, or a mechatronic device [1]. In this case, therefore, not only the physical embodiment, but also the personality of the robot and its ability to model some of the patient’s motivational state are dimensions that are going to be crucial to effectively and positively impact on the user’s life [2]. For example, the “+me” prototype is a transitional wearable companion (TWC) which is an embedded social robot that responds to the user’s manipulations by emitting lights, sounds, or vibrations usable for multiple purposes such as to motivate children to engage and interact socially [3]. The social robot design key design dimensions (based on how we observe, engage and want robots to look like; what motivates us when we interact; as well as on the current legal requirements and the use of biofeedback) are defined below:

a) **Perception:** The lifelikeness of a robot has a strong role in HRI, especially if it is designed to work at the emotional level [4].

b) **Emotional attachment:** SAR are physical, can behave autonomously, and they social behavior – which can lead children to respond to cues even if they are not alive [5].

c) **Embodiment:** The embodiment affects users’ perceptions of the robot’s personality, mind [6] and intention [7] (see perception). SAR should be embedded with behaviors that enriched the interaction with humans, making such interaction natural. d)

d) **Motivation:** SAR may act intrinsically rewarding as sidekicks/social partners, especially for children with special needs. SAR reproduces the social and emotional benefits associated with the interaction and the emotional bond between children and companion animals such as entertainment, relief, support and enjoyment [8].

e) **Interaction:** Through social interactions, human are constantly responsive to social cues from others that make us how to behave in response to how the others are acting and feeling. SAR should be designed with similar social capabilities to be integrated into children’s life [9].

f) **Legal and Ethical:** As robots can have moral and ethical implications, the more and more there will be the need to accommodate the design of the robot to ethical and legal considerations. From what we have seen, several are the dimensions that need to be taken into account in order to accommodate the use of emotions in the cognitive HRI. As people perceive different robot designs, there is the need to help designers create appropriate robots for specific purposes – in this case, therapeutic contexts [10].

g) **The Use of Biofeedback:** Emotion regulation depends critically on the ability to adjust physiological arousal and this reflects the capacity to rapidly vary heart rate [11]. At the same time, increase in activity of the vagus nerve, measured by heart rate variability (HRV), is associated with social interaction skill and decreased stress [12].

SAR's mechatronic components could contain non-intrusive biosensors to detect the heart rate and the breathing rate of the ASD child. Biosensors collect online data, thanks implemented wearable devices worn by the ASD child [13]. Wearable devices could stream heart rate and breathing rate data wirelessly to SAR, that rapidly and accurately feed back HRV and breathing rate information to the ASD child, through SAR's actuators (e.g., visual and auditory feedbacks). The feedback from bio-signals could increase the ASD child’s capacity to maximize HRV by learning to increase the size of heart rate changes in phase with breathing, promoting social skill and Child-Robot Interaction.

Keywords: Social robot design dimensions, cognitive child-robot interaction, autism.

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Ethical and Legal Concerns when developing Social Robots for Care: Risks and Solutions extracted from co-participatory design of a Social Pet Robot

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Abstract— The purpose of this paper is to discuss what are the theoretical contributions that STS can provide to the ethical inquiries stemming from the human-computer interaction area when developing robots presence in people's lives.

Keywords— Social Robotics, Ethical, Design, Health, Care

1. INTRODUCTION

The presence of the robots in many spheres of life is something that has increased in recent decades, and its first inclusion in the labor field and gradually being present in homes and places of service [1]. Of course, for one of these fields in which it operates new questions are based around the very environment in which it is located. For example, the discussion in the industrial sector was mainly located on how these robots would affect the way of working and, specifically the number of vacancies in the labor market [2]. Later by entering in which constitutes the area of services the concern is not only focused on workers and their jobs, but on to customer/user who also interacts with the robot. The same kind of issues are present when these robots start to act inside people's house interacting more and more technological devices that are already stabilized in most of the population lives (the case of television, computers, and electricity).

2. CONCERNS REGARDING THE APPEARENCE OF ROBOTS IN THE HUMAN ENVIRONMENT

The robots trajectory, although arouse different questions around each place and historical moment it appears, it is always marked by ethical, moral and legal discussions about its existence and its use [3]. Some questions are hidden around these three pillars that hold such discussions as: What is the necessity of using this robot for this field? What is the limit of autonomy that the robot may have? What types of data you can collect from users and what use can make from it? What advantages do we get as a society with the existence of this robot? etc. Although the questions change substantially according to who does them, as is the case of companies that work on developing such robots and seek to sell a versatile and competitive product on the market, the government that can be their future clients trying to save time and money, or users who are interacting with these robots and wish to receive the best care they can get regardless from where it comes. And in the end, to be more thoroughly incorporated into society it will need to go through a profound discussion on these three lines: ethical, moral and legal.

The discussion of these axes assumes different aspects from the point of view of each area of study. Even though the STS field has not been prolifically working regarding to ethics, this theme has always been present in the moral field, especially in the morality of non-human devices that make up the network that sustains us as a society. Some classical areas concepts as the Latour's delegate [4] and the Akrichs script [5]serve as a starting point to see how the artifacts, from the most rudimentary ones, are inscribed arising from previous relationships and prescribing certain behaviors for those who work with it.

Although the Science and Technology Studies (STS) studies are not the only ones that have drawn attention to the lack of neutrality about the non-human elements, certainly this was one of its main contributions to empirically demonstrate how such objects moralization process happen. On the other hand, the ethical, moral and legal concerns awakened new ways of acting in other classical fields of knowledge, as the case of engineering and some newer fields like design. As occurred in the integration of computers in the factories, the solution was to dissolve the decisions in between more parties involved, and with that comes a participatory design as one of the answers, even partially, for such questions.

In this way, the discussion is no longer a priority done only by a group of experts in a particular area, but by professionals who have different knowledge and users/customers that in a final instance will occupy the role of those who will be part of the final users of the product. It is from this meeting between experts that this presentation will focus to understand what are the ethical, moral and legal contributions that circulate when a group of different professionals come together with the proposal to draw a social robot with children.

The first step that seems important is to clarify what we refer to when dealing with ethics, morality and legality. Ethics belongs to the branch of philosophy and its purpose is to study the moral issues concerning the given society. Thus the moral refers to the set of rules acquired through culture, education, tradition and daily life that guide behavior within a society. In its turn, the laws correspond to the precepts that should be pursued by a society, and it has the function to control the behavior and actions of individuals according with this same society. Although the ethics and morals are integrated into each other, not necessarily the laws have a direct correlation with the ethical principles, although in many cases are based on it.

3. STUDY

Our approach to the field of ethics is based on the perspective laid by Pols and it is called empirical ethics of care [6]. According to the author, this ethics becomes specific in relation to other branches of ethics by understanding that the studies in this field should take place based on empiricism found in the relationships between different elements in its environment, which are human or nonhuman. Another consideration made by Pols is about the non existence of good or bad ethics, dualities that are imposed primarily on discussions on the effectiveness of results-based ethics and another that puts the will of treatment by the user as the primary ethical element to be valued.

Following up with this theoretical basis we had eight meetings with different professionals over eight months project. These meetings had different work structures and during it was discussed the planning of participatory design, as well as what were the expectations and the points of view that each of the group members had in relation to what would be a social robot suitable for children in a hospital. Through this observation we will seek to answer the following questions: Does conducting work together between engineers, social scientists and medical staff make possible to build a common ethical path? How ethics is linked to methodologies adopted for the design of robots? Is it possible to coexist different ethical considerations in the same project? What legal concerns appear in the development of robots? The methodologies used during the meetings were mostly centered on discussions categorized from previously established issues by the team of social scientists.

Subsequent the meetings the material gathered was analyzed based on thematic content analysis, and the a priori categories used for the study were ethical level, moral context and legal framework.

4. RESULTS

Among the topics that raise discussion the image came up as something important regarding the development of the robot and also in the case of research with children. The presence of a camera on the robot was seen as something that could bring ethical difficulties, and at the same time as to collect other information such as vital signs and store it all in a cloud was perceived as something important and without major problems. The same situation occurred in relation to use of the image during the investigation, for those students who did not have the parents permission would not have captured images and sounds, but at the same time they developed the same activity along with the other students.

This concern about the image is something that arouses further questioning not only the need for its use in this hospital, but perhaps the moral convention to which it is linked, that is, the sight of it as a persons special property while the encoded biodata in binary code are somewhat open to the medical field and without the same sort of identification of themselves by the robot users.

On the other hand capturing and image transferring was one of the main elements brought by the students during the participatory design. The camera would use to assist in communicating with relatives, friends, classmates, teachers and even the external environment which they are barred of when hospitalized. The participation of children was also among the topics that awakened greater questioning by the whole team. In addition to debate about how the children would share their knowledge during the project also it was questioned what would be the areas where they could or not be able to participate actively. This discussion led to the own domains of each area that consists a prototype of a social robot. Thus each field of knowledge demonstrated how knowledge coming from them were inaccessible to the children due to the specialty that they required.

By analyzing the content discussed during the sessions with the professional group it is possible to notice that there is a transformation regarding to the participation of children. At first moment it was manifested the ideia that children would help particularly regarding the shape of the prototype, that is, elements such as color, design, texture and other external aspects summarized what was understood as possible for children to supply. However in the following meetings and with the start of classroom activities with the children it appears increasingly functional aspects brought by them to the design the robot as something that added ideas for a future prototype. Such transition from a limited view of children's contribution to this participatory design can be seen from many perspectives, but of course what we can put on the agenda is also a matter of the technical view that is passed gradually during training within each knowledge field. While part of the most groups connected to the humanities suggested that the process should be as participatory as possible, including that children could understand and talk about the he social robot hardware and software, the group connected the hard sciences could not visualized this possibility.

Here we should remember Pols proposal [6] saying that each one tries to give their best in a caring relationship, because this was an example where the different moral aspects that tell us even what we understand as participation and its limits was manifested and also it made the group to question how the process should be developed.

The transition of this impasse serve as a guide to answer some of the questions in which this work is based. The existence of a common ethic among different professionals composing a participatory design maybe is something that may occur as only when negotiated between the parties. In other words, this common ethics is not something that can be defined a priori, but only with the conflicts that occur in the course of the project that it will become possible.

When thinking about the process some lines showed how this process is negotiated and requires a relation of alterity to be carried forward. As one participant commented during one of the meetings it was only possible to establish new relations with the project because there is an opening within the group that allows everyone to put themselves in other members position. This flexibility of thinking condition is not necessarily consistent with a change in their beliefs, but promotes the emergence of new horizons within the project in which they participate and that perhaps later will take to other activities developing their careers as teachers and researchers.

These changes that happened in the course of the projects were also emphasized by another engineer who commented his case since it began participating in research with multidisciplinary teams. This way from a logic centered in the robot's operation to one where the importance is the children going well also shows that this interaction between a group of hard and social sciences can reverberate on new arrangements between morality from its areas with from other fields of knowledge.

Although these changes are points through where we can see the functionalist thought is something that remains. In other words, to think about the choices made during the process of developing a robot is seen as far from a moral debate because this would only happen a posteriori when it is already in contact with users and it would depend on this relationship to be understood. This distance happens especially when the topic of ethics was discussed in a more conventional way, that is, in the specific moment when dealing with the moral biases present in the project in which we are working and on the robot prototype.

Among the elements that made easier to think about the work in moral terms, out of a supposed neutrality, it was when the robot functions and to whom these attend were discussed. Even though this is directly thought for the interaction with the children it will have to relate with doctors, nurses, families and other hospital staff. This multiplicity of end users and the valence that each have on the developing of the robot is something that is directly linked with morality inscribed on this robot. Some examples, such as the time of surgical procedures in children, served to demonstrate how certain hospital routines are designed to better fit the schedule of doctors than the children themselves. Some examples, such as the time of surgical procedures in children, served to demonstrate how certain hospital routines are designed to better fit the schedule of doctors instead of the children themselves.

Regarding to legal issues concerning the robot it is clear that the main concern was linked to the interference in other areas of knowledge and its possible consequences in legal terms. Thus the medical field appeared in the comments as something to take into account, actuators or certain sensors may be planned, but only would be added to a prototype after projecting in which interactions it would have with this professional group. The area of law that deals with the relation between robots and its legal regulation is structured from a fixed base that would serve as the basis for all robots and others that would vary according to the specific attributes, the functions they perform and the location of use in which they are. This kind of concern with legal issues appears as a general theme which is still being developed by law professionals and even is part of the subjects handled by a researcher belonging to staff, but that didn't get more room for discussion within the project. In part, this lack of discussion of the laws in which the robot would fit is due to a field that is still in formation or due to the time in which the project took place. It is possible that after the first prototype it would take greater relevance in discussions between project participants.

Completing this work it is important to point out the circumstances that limits it. Among those we can mention so far the lack of prototype completely built to observe the functions that have been incorporated, so such comparison would be possible in a advanced stage of the project. Finally, a second step in this paper would observe the moral relations that link the robot in use and those that were discussed during the participatory design.

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LEGO Robotics Activities Feeder for Social Robotics through A Cloud-based Architecture

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Abstract— In this paper, we present a cloud-based architecture that facilitates the acquisition of information during LEGO-based activities with children with ASD to provide meaningful information to a social pet robot. The technology was designed and tested with a group of children with severe autism from CASPAN centre in Panama.

Keywords— Social Robotics, Pet, Austism, Therapy, Social Skills

1. INTRODUCTION

According to [1], Autism Spectrum Disorders are a set of neurodevelopmental disorders related to a lack of social interactions, communication and repetitive behaviours or interests. The low quality of social interactions, social relationships, or imaginative thought [2], are increasing the isolation of the individuals, causing a barrier to learning through collaboration and interaction in teamwork activities with others [3].

As it is stated in [11], [12], most of the research about children with ASD and the effects on families, life-long learning, economic impact in the economy of the country, services to get access to professional support, etc. are conducted in western countries. Communities in low-and-middle-income countries who have a child with ASD, access to professional support services will be limited. Thorugh the cloud architecture, that not only connects the multiple-device system to the cloud but also the different studies sites to an international group of experts, we hope to improve the services and the accessibility to better services. Inspired by [13], we believe that a system like the proposed in this work can approach the knowledge from developed countries through the on-line connectivity.

Since projects like IROMEC, AURORA, etc. [10] published good results about the benefits of using robotics technology with children with ASD, there is a lot of companies and institutions that provide full-time psychologist on staff to help researchers and schools use their NAO robot (Aldebaran human-like robot) as a method of supporting social skills learning [14].

Because of its repetitiveness and predictability, robotics is well accepted by children with ASD. The advantage of such a versatile tool is that robots can contribute to collaborative classroom work by helping to adapt the level of the intervention session to students' performance [15].

In [4] there is the suggestion that combining social play scenarios and engaging activities can stimulate the children to collaborate while working in groups. It's in such social play scenario where a social robot can be a useful tool to stimulate social competence acquisition [6]. Also, LEGO building activities and LEGO Robotics has been shown statistically significant increases in the number of positive social interactions with a correlation between enjoyment and cooperation [7], [8], [9], [3], [5]. Combining the mentioned factors about the use of social and educational robots, we can create a context of robot-based activities that enhance education through play, enjoyable, exploration and discovery, social interaction, collaboration and cooperative, competitive, (i.e. joint attention, sharing material, negotiating plans) and observation of learning challenges [16]..

To fulfill all the requirements and possibilities mentioned before, we propose the implementation of the cloud-based architecture presented in [17] and the validation of new technology as a new low-cost social robot for therapy and a new programming interface, both connected to the cloud, with the idea to accomplish the requirements to provide useful and affordable resources which are feasible to implement in different countries all over the world. At the same time, intended to create therapeutic activities aligned with the centre in Panama daily program to train social skills and problem-solving. These activities are based on previous work done in [18] and [5].

This implementation has been validated through workshops in Boston and Panama with children with ASD to test the technology implemented.

2. THE CLOUD-BASED ARCHITECTURE

We propose the use of robots as data loggers and social mediators facilitators connected to a cloud, combined with the traditional approach to educational robots. See Fig. 1.

This project is divided into two main parts:

1- With the cloud-based offering architecture, it is possible to measure the effect of robotic engineering and collaborative nature in the development of social skills in children and adolescents with ASD. We created a web-based interface to program the LEGO Mindstorm EV3 Robots. While using the interface, the system is recording the activity of the child and feeding the robotic social system to provide positive feedback to the children related to the progress of the activity.

2- We use a social robot companion as a social mediator to engage children in the activity and facilitate the task of the caregiver. At this time we have tested Nao Humanoid, AISOY Robot, and a prototype of a pet robot.

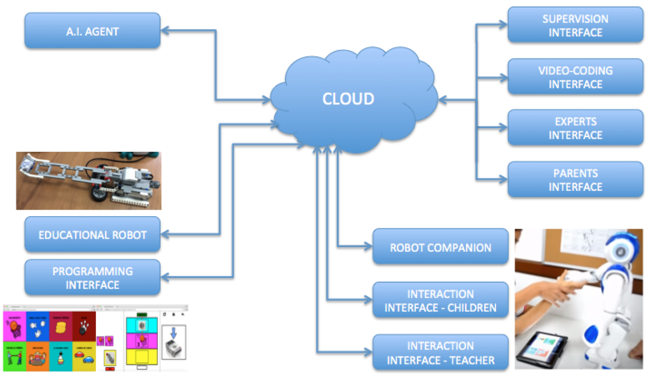

Fig. 1. The Cloud-based Architecture

The most important part in this implementation consists on transforming the LEGO Mindstorm EV3 robot in an Internet of Things Devices. To do so, we create a Lejos [19] API inside the mindstorm that connected the Robot with a SQL Database. The information from that SQL linked the EV3 with a tablet and a social robot.

To adapt the technology to the cognitive levels of the participants, children with severe autism, we create three levels of the programming tool. These three levels are represented in the Fig. 2, and are: touch, drag and drop, and drag, drop and connect.

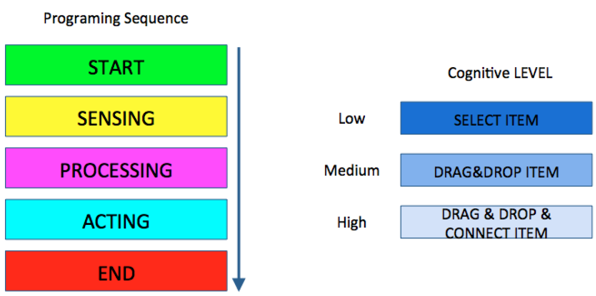

Fig. 2. The Cloud-based Architecture

3. CONCLUSIONS AND RESULTS

We tested the technology with the teachers and after with the children. We organised two sessions with a total of four children, three boys and one girl, working on the platform together and playing the game of Blind man buff and Basketball. They enjoyed the sessions as soon as they realised they were able to make the LEGO robot moves. 100% of the children understood the cause and effect.

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KNXBOT, A Social Robot Full Integrated To Smart Buildings

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Abstract— This work presents the design, Implementation and Test of a complete integration of Roomba, the most implanted Robot in the world, into a domestic environment. To accomplish this proposal, KNX Home Automation system has been chosen, as long as is a standard that has a major part of the market. The goal achieved in this paper is to demonstrate the fact that communicate a mobile device with a static automation environment is feasible using standards, and it contributes an improvement of applications of the robot and at the same time of the building, decreasing the overall costs. While Roomba is already considered as a facilitator of social engagement among users and itself, integrating it to the house control let a simple vacuum cleaner to become a house assistant.

Keywords— Social Robotics, Smart Home, Smart Building, Personal Robot, Home Automation, KNX.

1. INTRODUCTION

Since 2007, when Bill Gates predicted a Robotic revolution like had happened with the personal computers during the eighties [1], lots of companies, technological manufacturers and distributors have tried to implant Robots in everyday life, making them a basic tool as became the personal computers, cellphones or the internet. However, the increasing demand for domestic Robots is not as high as people, though. A poor standardisation, and a consequence of this, high costs, are considered as the obstacles to avoid to see what Bill Gates explained in [1].

The project presented in this paper begins with the starting point of assuming the Industry Automatization or the Home Automation Systems (HAS) as a kind of Robotic: Robotic Factory or Robotic Home. As long as all these environments are well integrated between all coexisting elements, designing a gateway between them and the Robot will extend this integration. Thus, this is the way to expand the application range with Robots, because of the distribution of sensors and actuators systems instead of having all of them directly connected to a non-standard expensive device.

Although this kind of robots are considered only service robots and not social, We consider the Roomba robot not only a vacuum cleaner but also a social agent at home as long as people interact with it as it was social [3][4][5].

2. HOME AUTOMATION AND KNX

Technology is getting deeper and deeper in our everyday living. It is a very long time since it was first heard about Domotics and (HAS. And today, with broadband internet access everywhere, it can be said that HAS are, more than ever, a reality.

HAS can be classified as proprietary systems and open systems [2]. Open systems are usually more flexible and capable of evolving and integrating new technological achievements than proprietary. Examples of this integration are the gateways to other systems such as EnOcean [6], ZigBee [7], Bluetooth, as well as other HAS like BACNet [8],Open Link Exchange for Process Control (OPC), IP [9] . This paper deals with one of the most deployed open HAS around KNX.

KNX trademark and system belongs to KNX Association which is a non-profit-oriented organisation governed by Belgian Law. Its members are manufacturers developing devices for several applications for home and building control based on KNX, together with service providers and also engineering and academic organisations. Nowadays there are more tan 240 members, 76 universities and scientific partners and more than 180 training centres around the world. A vast amount of KNX devices can be found: over 100 KNX member companies worldwide offer almost 7.000 KNX certified product groups in their catalogues, from different application domains.

3. I-ROBOT ROOMBA ROBOT DESCRIPTION

In 2007, Roomba was exploded into the market of Vacuum Cleaner Robots [10]. Four years later the number of units are upper 3 million. Roomba is a cheap robot (around 300$) that navigate around a human-scale indoor environment using a set of infrared sensors.

A differential driving system makes simple to control the robot using Left and Right Motors Speed and direction. The Serial Command Interface is described by [11].

4. INTEGRATION

To succeed in the integration of a robot in a domestic environment, it is essential for the robot to know two things: its position inside the home and what automated elements it can interact with.

A. Building structure representation

The navigation of a robot throughout a home is not only a matter of changing its physical or geographical position in it. As a building can have many different kinds of stays and “rules of behaviour” inside, the reasoning or context modelling that can be implemented in a robot is a step forward in home interaction intelligence, which can lead to providing automatic and proactive reactions of the robot.

This work presents an adaptation of the work done in [12] to abstract the building environment and hierarchically structure the architectural elements of a building through semantical relationships. Every building can contain different kinds of floors, which, at the same time, contain different types of rooms, every each of them can imply a different behaviour for the robot or a different pattern of rules.

As important as the semantical position of a robot inside a domestic environment is, it something crucial for a moving device to know where every one of the elements semantically described is. Many ontology models ([13],[14]) focus on the abstraction of a lot of parameters and rules models to describe every concept, in this case, though, this work adapts the building representation with the robot's restrictions.

The ruling model implemented for every different kind of stay is adapted to a robot's intended behaviour. Also, a complete simplification of the elements that can be contained by a stay have been drastically simplified as for navigation purposes; the robot only needs to know the immovable elements of a stay, other elements that it may find can be avoided using simpler and generic algorithms. Finally, due to hardware limitations and not being relevant, the only parameters describing each element has been reduced to its kind, its unique identifier, its physical position and the number of another kind of elements it contains.

B. Mapping of KNX devices

The integration of the Roomba robot in a KNX network is meant to allow the communication between automated devices and the moving robot; this would be meaningless if the robot won't know the Area of Influence of every one of the devices of the domotic network.

Even being KNX a distributed intelligence system, usually the devices of a KNX network are centralised in a very limited number of spots in the building, depending on its dimensions. So, if a mapping of the devices, considering just their position inside the building, were done, their physical position would be very similar and very different from the area these devices have real influence (AOI). Hence, even the robot would know its conceptual and physical position inside the building; it would be impossible for it to deduce what light, sensor or other device needs to be operated in that stay.

This work proposes an evolutionary mapping model of the components of the KNX network according to their Area Of Influence. Parallel to the architectural hierarchy of elements described in the previous section, a home automation layer, is described. This new layer, as it is describing a building, follows the same hierarchical structure than the architectural one. Its contribution is that inside every stay, aside architectural elements, KNX devices are included. These devices are represented by the following parameters: device id, physical area of influence, type of device, logical control address, unit semantics.

By including all the KNX controllable devices as described, the robot has a complete physical and semantical structure of the building. This mapping model allows the robot to navigate throughout the building, interacting with the home automation network to successfully perform the applications described in section 5.

C. Roomba to KNX Gateway

1) Hardware: On the one hand, the Roomba to KNX Gateway takes advantage of the Serial Command Interface (SCI) [15] that the robot has available on the center-right part of its top housing to communicate directly with the robot, allowing the full control of its motors, LEDs, buttons, brushes and sensors. On the other hand, the hardware uses the KNXnet/IP protocol, which is part of the KNX Specifications standard [16], detailing how the KNX protocol can operate through a standard IP network. The only requirements for this communication link to work are, a KNX to IP gateway on the KNX end, and a wireless TCP/IP compatible interface.

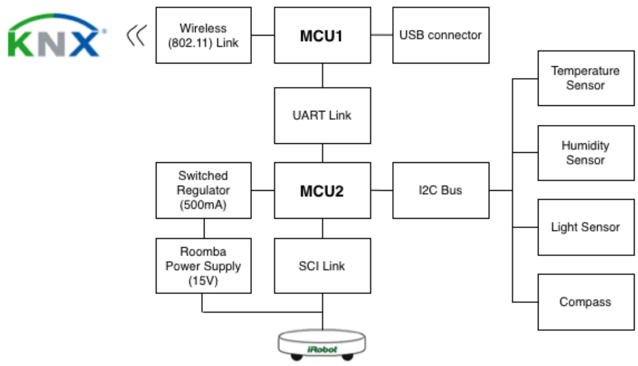

Fig. 1. Roomba to KNX Gateway Schematic

Besides from the direct interaction with the Roomba and the wireless link with the KNX IP gateway, the board incorporates four different sensors. A magnetometer, used as a digital compass, to facilitate the orientation task of the robot; as it's round, a number of degrees and direction is not a trivial matter. A temperature, humidity and light sensors, used to monitor environment parameters of the stay the robot is in; these sensors are used as a complement to the ones installed on the KNX network, providing a much more reliable measure. All the four sensors are accessed by the MCU2 through an I^2C bus.

2) Software: The first thing considered is the computational power that the two MCUs described in the previous section. Multithreading is impossible to implement in this kind of microcontrollers, so, the software has been split into two major parts, which work parallel to each other and, just when it is necessary, they exchange information.

The receiving MCU2 is responsible for the robot interaction, that includes, the motion of the robot, sensor monitoring and cleaning tasks. So, this MCU is in charge of the Artificial Intelligence that the gateway adds to the robot. It is also responsible for the monitoring of the four extra sensors that the gateway has.

5. APPLICATIONS

Once Roomba is fully integrated with the managing system of the HAS, the first application that customers can appreciate is to have a real-time monitor of the battery and the state of the cleaning process. Additional information like if it is working or not, which room is cleaning in that moment, working time, an average of rubbery found, speed and temperature can also be given.

Furthermore, we can give extra functionalities like send the Roomba robot to a particular room without using the Infrared barriers supplied by the manufacturer, play music while is cleaning, or permit a remote control from any interface connected to the KNX System. The Robot can also be controlled from any device with WiFi system. In figure**??** we can see the Roomba running with the prototype board.

In addition, the Roomba is converted to a mobile extension of the HAS system, so for example, it can run a presence simulation moving from one room to another, check if lights are all switched off, and send commands to have the light control, detect floods (using the rubbery sensor when is programmed in guardian mode) or fire (using the temperature sensor).

Because the Roomba to KNX Gateway supplies an IP address to the Roomba, we can create a swarm of Roombas that can cooperate to improve the cleaning process of big rooms or spaces, like can be a Supermarket, School or a garage.

6. CONCLUSIONS

In this work we have done the proof of concept that commercial robot systems can be integrated to HAS, adding a mobile device that enhances the number of functionalities and applications. The tests had been done with a prototyping board from Microchip manufacturer. Once the Robot has been successfully linked with the KNX System, a Roomba to KNX Gateway board has been designing as we can see in figure **??** . The custom design permits to save energy consumption that required of extra batteries in the Microchip prototyping board application.

An expected goal in a close future is to promote Robots into the residential environment as long as HAS systems are widely implanted, working, and, thank you to the Gateway board, the Vacuum Cleaner Robot is converted to a full of possibilities device integrated to the people domestic life.

ACKNOWLEDGMENT

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Pleo RB Social Pet Robot as Positive Emotional State Facilitator to Enhance Learning

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Abstract— Social robots have shown to be a good, engaging tool in therapy and education. In this work, we propose the use of Pleo rb robot as a facilitator of the learning process. Using a social robot we can conduct the behaviour and mood of the children in the classroom creating a positive context were children express curiosity, they are willing to share, and, in conclusion, they learn better. We combine prospective Rose-draw test with observation and questionnaires to evaluate the emotional state of children and validate the benefits of using the social robot.

Keywords— Social Robotics, Pet, Emotion, Learning, Social Skills, teamwork.

1. INTRODUCTION

Today's society is doing a big progress towards the use of robots in education. The approach followed by educators is now starting to be based on the fact that robotics can help to improve students' emotional and social skills.

The educational robotics like LEGO Mindstorms, promotes the curiosity of the students to experiment, to develop their creativity, to research for solutions through play-based activities. According to Piaget [1], playful activities help children to develop their perceptions, intelligence, experimentations, social skills, etc.

The mutual understanding between children and animals is much deeper than adults can imagine. Animals produce positive effects physical and mental health of people who live with them [2][3]. We can see this benefits applied in therapies like in [4].

When a child has a pet at home learn values such as respect for animals and other living things, friendship, promotes to take responsibilities by having to take care of another living being, promotes emotional contact, it facilitates the externalisation of their moods favouring communication with the adult subject by making intermediary. In cases of children with clinical pathology helps balance your stress level decreasing anxiety and aggressiveness gaining self-confidence. Interacting with pets favours psychological development, and increases accountability and social competence in children, according to German psychologist Dieter Krowatschek [5].

The emotional state of a child is changeable. It is very important to learn how to manage the emotional situations so the identification, recognition, and understanding of what is going on are done properly and what is happening makes sense. Emotional Intelligence is the set of skills that let us control our feelings and other's emotions [6].

A. The Pleo rb Pet Robot

Pleo rb is the second edition of a commercial robot dinosaur, a Camarasaurus dinosaur, equipped with sensors and actuators to understand the context that is surrounding itself. The robot is not learning from the experience, instead, is evolving its behaviour according to internal states that are modified like any regular video game. Pleo has been used in previous research works, and its social presence has been tested in [7].

2. STUDY DESIGN

We design a robotics learning activity, where children had to learn about how a robot works. Which sensors and actuators the used and for what purpose. We choose two groups of children, half of the children from a school that were attending to a regular robotics class, and the other half from a robotics academy.

A. Participants

We run the study with a total of 61 children, 33 boys and 28 girls, between 9 and 11 years old. The recruitment process was done in a school and a robotics academy. In both institutions, the children were attending to the robotics class. All students were neurotypical except two of them that were diagnosed with down syndrome.

B. Evaluation Tools

To evaluate the effectiveness of the study we have used three different tools:

- Adult observation of the children while they were doing the activity.
- We used the prospective Rose Test to identify the basic emotion of the child though the drawing, as well as unconscious aspects of their personality [8] [9].
- A questionnaire that the students are filling in at the end of the session.

C. Procedures

We introduce Pleo robot to the children and then they have free time to play with it. There are no instructions, except for a short guidelines about the robot's characteristics and skills. The children explore and discover what the Pleo robot can do through interaction based on [1]. See figure 1.

Fig. 1. Children interacting with Pleo rb robot

3. OBSERVATIONS

Thorugh observation there was a clear difference between boys and girls.

We realise that girls treat Pleo as it was a baby, holding on arms and cradling it. The use a delicate, direct contact with the robot while trying to protect it. They are doing their best to make it feel safe and comfortable. Girls showed difficulties to share the robot with others, like mothers with their children.

In the other side, boys tend to interact with the Pleo as a collective. Pleo uses to stay on a plane surface, table or floor, and several boys interact with the Pleo at the same time. They are discussing together what can happen to the pleo and multiple of them tried to solve it at the same time (like feeding it). If boys discovered something that stimulates the pleo, like making it angry, they repeated the action several times.

4. RESULTS AND CONCLUSIONS

91,8% of the participants expressed happiness and feel comfortable to play with Pleo. A 42,2% perceived the Pleo as a friend, and 32,2% consider it a pet. Only 9,8% defined it as a robot. For both genders, Pleo is an important member of the family, and it needs care and a nice play to stay.

32,8% of the children considered that Pleo was hungry, so they tried to feed it all the time. After feeding it, they put the Pleo to rest trying to make it sleep. 21,3% of the children pointed that the Pleo was missing care and they were trying to care it through hugs and whispers. 95,1% of the children wanted to repeat the activity, and the same percentage would like to work in teams again to play with Pleo.

In this study, we observed that creating the context of the activity was enough to work towards the learning objectives.

The Pleo rb robot has help children to expose their parasitic emotions, and show their true emotions instead [10]. In some cases, this emotion was related to the fear of the unknown things, and Pleo turned to be a facilitator to overcome this feeling. In some cases Pleo helps to regulate the aggressivity, reducing their level of anxiously. This behaviour has been seen in how they have treat Pleo.

Also, we have seen that children were behaving well in the classroom, learning together as long as the activity was of their interest. Children who normally have rage or aggressivity have projected their feelings to the robot, instead to the other children. Again, Pleo helped to discharge this negative behaviour. Most of this information has been observed through their facial expression, changing from relaxing to contractions. Non-verbal communications is much more significative than words.

ACKNOWLEDGMENT

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SOCIALLY ASSISTIVE ROBOTICS (SAR) DESIGN: DISCOVERING NEW TECHNIQUES IN THERAPY AND EDUCATION TO IMPROVE SOCIAL SKILLS OF CHILDREN

Organizers

Beste Ozcan, Institute of Cognitive Sciences and Technologies, National Research Council of Italy, **Mehmet Sinan Bermek**, University of Sapienza in Rome, **Maria Alejandra Garcia-Corretjer**, School of Engineering, La Salle Campus.

Description

Robotics & AI (Artificial Intelligence) is one of the most exciting areas of technology for the future enhancement of human existence. In recent years, innovators globally have developed an increasing range of applications for robotics and AI, and one of the most intriguing areas is the design ; development of SAR (Socially Assistive Robotics).

Research and testing in this field have already proved that these types of robots can augment certain types of educational ; therapeutic practices with children. To date, we know they can help with relieving tension, enhancing concentration and increasing psychological ; emotional engagement. However, what are the most effective types of social robots for different contexts and how we do design ; build those in the most human-centered; effective ways possible?

This workshop will be the first in a series that will aim to answer those questions and begin the process of developing a framework for SAR development in the future, ensuring that children are getting the best possible interactive SAR experiences in the fields of education and therapy.

WORKSHOPS

ETHICAL, LEGAL AND SOCIAL ISSUES REGARDING SOCIAL ROBOTS IN THERAPY AND EDUCATION (TWINNED WORKSHOP)

ELS of Social Robots in Therapy and Education at New Friends 2016, Barcelona, Spain, November 2, 2016
ELS of Social Robots in Therapy and Education at JSAI-isAI , Yokohama, Japan, November 14, 2016.

ORGANIZERSJo Bac, University of Aberdeen, **Eduard Fosch Villaronga**, School of Law bUniversity of Bologna, **Christoph Lutzc**, CIRSFID BI Norwegian Business School, **Aurelia Tamò**, University of Zurich

Description
Our aim is to conduct parallel research between Europe and Japan on the ethical, legal and social (ELS) issues concerning the adoption of social robots in the contexts of therapy and education.
The twinned workshop has multiple objectives:

- Collect all the ELS concerns, problems and difficulties concerning this type of technology – focusing on ethics, privacy and liability
- Enable discussions on the ELS aspects on an interdisciplinary and multicultural scale
- Provide a comprehensive roadmap for solving these issues

This twinned workshop brings together researchers from different disciplines, backgrounds and cultures to provide interdisciplinary insights into the current legal and ethical discussions about the impact of robots on society. This will serve to gather different scenarios on the topic. It will deepen our understanding of the real concerns and problems that researchers, teachers, therapists, and legal scholars are currently facing. It will also ensure an appropriate balance between innovation and user rights.

Framework
Social robots are increasingly utilized in therapy and education. The therapeutic robot seal Paro, for example, helps elderly patients by soothing their moods and giving them emotional support. While it has shown positive effects on patient wellbeing, Paro as well as other social robots in therapy and education raise a range of ELS concerns.
This twinned workshop aims at addressing such concerns in a constructive and proactive manner. It takes up important ELS challenges that come with the introduction of robots in therapy and education. Firstly, it deals with aspects of human dignity and the questions of whether and how social robots endanger individuals' dignities for example by implying an overly simplistic model of human agency or by discriminating against certain population groups. Secondly, the workshop revolves around the topic of privacy. In this context, social robots, especially those in therapy and education where vulnerable population groups are involved, come with various privacy challenges: surveillance, access to private rooms, excessive data collection, and complex design architectures which conceal robots' privacy-infringing behavior (black-boxing). Thirdly, social robots create tensions in society and in legal systems because questions such as

who or what should be liable for their autonomous acts remain unanswered. In seeking solutions to the problems encountered, we will consider how to allocate liability to different entities such as manufacturers, users, and robots themselves.

The three overarching ELS issues of dignity, privacy and liability shall be discussed in an open workshop format, with the focus on solutions. Researchers from all disciplines, as well as practitioners, are encouraged to submit abstracts stating the ELS problems to be discussed.

WORKSHOPS

SOCIAL ROBOTS IN EDUCATION

Organizers

Jordi Albo Canals, La Salle Ramon Llull University, **Jacqueline Kory Westlund,** MIT Media Lab, **Wafa Johal**, École Polytecnique Fédérale de Lausane amp & Rolex Learning Center, **Elizabeth Broadbent**, The University of Auckland

Description

Education research also often involves field work and long terminteractions, which bring their own unique challenges. This workshop is designed to bring together researchers, practitioners, and students who have social robots for education as their main focus, covering disciplines in childrobot and child computer interaction, social robots, computer science, psychology, child development, education, and more. Our goal is to facilitate connections between researchers, sharing of ideas and methods, and discussion of the challenges of social robots in education. To this end, this halfday workshop will include a keynote presentation, poster presentations or lightning talks from participants, and a group discussion.

Topics for workshop contributions include (but are not limited to) the following:

- Robots as educational o instructional agents
- Personalization and adaptation algorithms for learning with robots
- Design of autonomous systems for social robots for education
- Design and methodologies for social robots for education
- Theories and methods for evaluating social robots in education
- Childprivacy and ethical issues in educational robot applications
- Affect, social bonding, and learning with social robots
- Longterm user engagement with educational robots
- Effects of embodiment on children's learning with technology
- Challenges and guidelines for education field studies
- Impact of robot technology on children's cognitive and social development
- Robot enhancing collaboration

EXPERIENCES WITH SOCIAL ROBOTS IN CHILDREN

Organizers
Alex Barco, La Salle – Ramon Llull University, **Marcel Heerink**,Windesheim Flevoland University for Applied Sciences

Description

Social robots are emerging in our everyday life, and will in the near future become a part of our daily routines. And gradually, they emerge in therapy and education: practitioners are starting to use them for different purposes, like promoting social skills for children with ASD, helping children during their recovery process, distracting children in stress situations in a hospital environment, in amusement situations at home, etc.

This workshop is an opportunity to meet practitioners and researchers who are using social robots for different purposes with children and share their experiences.

A one or two page abstract is required describing the application of the social robot, the circumstances and goals, and the field in which the authors operate.

Advent of New Ethical, Legal and Social Challenge of Robotic Services in Cyber Physical Spaces

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Abstract.

This paper describes an important ethical, legal, social(ELS) challenge derived from a series of field experiments of robotic services in therapy using cyber and physical spaces and discusses several point of views in human dignity, privacy and liability. As shown in Figure 1, our previous works [1-2] show that semi-autonomous wheelchair robots with human robot interaction in nursing care home reduce not only the burden of care giver's workloads but also facilitate elderly to be socially active and promote their motivation to eagerly try things by themselves [1]. With the result of fall detection system using range sensors in a nursing home brought out the desirable monitoring of elderly's privacy and secure the safety of individual dignity [2]. On the other hand, the systems in cyber physical spaces are facing a new type of unexpected fatal and dangerous ELS issues in terms of liability such as spoofing GPS signals and fooling its directions or hacking the system to take over the actual control of everything. This complex design architecture is needed. One possible solution may come from the historical part of our machine civilization to the development of robotics application along the way of our life evolution and necessity to have common mind of revising our law in existence to match the unexpected and unprecedented situation dealing with human dignity, privacy and liability in robotics fields with speed. The discussion derives a few desirable and possible directions to tackle ELS challenges.

Keywords: ELS Issues, Cyber Physical Spaces, Social Robot Service, Autonomous Wheelchair Robot

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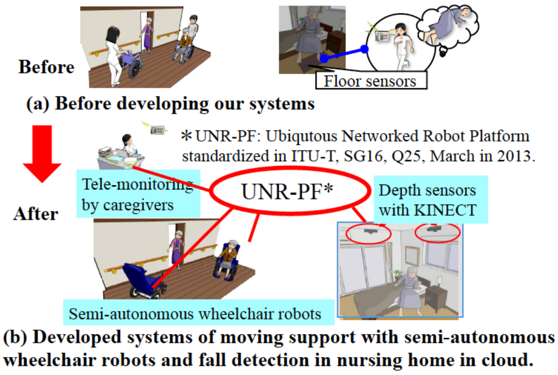

Figure 1. Developed robotic systems for elderly and caregivers in nursing home in cyber physical spaces.[1-2]

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Social Robots in Medicine and Education: An Alternative Perspective on the Threat to Privacy

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ABSTRACT

When we speak about social robotics—robots created to closely interact with humans, and in our case with the weakest and most defenceless part of our population, such as children, the elderly, and people recovering from serious injuries or illnesses—we, and in particular lawyers, are already quite used to raising a familiar set of questions: What about privacy? What about machines learning too much about us? What about sensitive data? Who holds this data? Who is managing it? Where does it go? Who uses it? What for? All these questions suggest that our privacy is under threat and that social robotics are putting it in great danger.

In this presentation I will argue that, while a serious privacy threat does exist and needs to be taken seriously, there are ways of looking at the problem that make it tractable. More to the point, I suggest that we imagine three different scenarios outlining what might happen depending on how the issue of privacy is tackled. The three scenarios I envision are as follows:

1) We (final users) permit robots (and the software houses behind them) to collect our data without any control on our side (Scenario 1: Permissive).
2) We clearly indicate which data can be collected and require robots to make these data anonymous (very much in line with the spirit of the current legislation on privacy in European Union) as soon as robots collect it (Scenario 2: Most Likely).
3) We prohibit social robots (and the software houses behind them) from collecting any kind of data (Scenario 3: Restrictive).

My overall argument is that in any of those three scenarios the problem of privacy can be solved.

In the case of the first scenario—Scenario 1: Permissive—we would literally give up on possession of our data, such that whatever robots (and the software houses behind them) decide to do with that data, that will be okay for us. To apply this scenario (prefiguring a sort of legal laissez-faire and anarchy in privacy law) we need to be sure that our data will not be used against us so as to for instance influence our behaviour. The software houses that build social robots should therefore be interested in making the whole process of data processing and use as transparent and legal as possible: The more software houses are transparent as concerns this matter, the more we as users will be willing to give our data to them. More data we give them, more data software houses have to work on and better social robots can offer thus gaining a bigger market share. Thus the software houses should be incentivized to collect and use our data in a transparent way. The threat to privacy is thus gone because we know how our data is used and we agree on that usage.

If we opt for the second scenario—Scenario 2: Most Likely—we would have to follow the spirit of the current data protection and privacy laws and explicitly state what data we allow to be collected, and what we prefer to keep to ourselves (this is what informed consent is for). Here, too, in order for that to happen, software houses would have to clearly explain what purposes the data is collected for (e.g., for research or to improve services) and how it is collected, in such a way that we could choose the purposes for which we agree to give our data and the purposes for which we do not give it. In this scenario we have control over our data: we decide whether the purposes of collection justifies the price of giving up the data. In this scenario the threat to privacy is relative because we decide the destiny of our data.

In the third scenario—Scenario 3: Restrictive—we would prohibit all data collection of any kind and require software houses to program robots in such a way that they would not even be able to collect data. This is quite an unlikely scenario, and yet it would not be impossible: Social robots in hospitals, universities, and schools would not gather any data which would also mean that their functionalities would be reduced and would not perform a enormous amount of tasks. Here again the problem of privacy would be solved in advance by design: Social machines would be just another set of tools, like VHS or radio. Of course in this case further questions would ensue, but as we are here concerned with the threat to privacy, and in this scenario this kind of threat is null, we should not take them into account.

What the conclusion can we draw? Reasoning from the three scenarios just briefly outlined, I will be arguing that the issue of privacy and data protection—and in particular our concerns about its collection and use by way of new technological advancements—is way too dramatized and does not reflect reality. We just have to choose the scenario we consider to be the best.

AI Educational Technologies: Connecting the Student by Emotional Proxy

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ABSTRACT

The idea for utilising intelligent agents in education is not new (Johnson, Rickel & Lester, 2000) [1], even using videogames (Malone & Lepper, 1987; Shute, 1993) [2-3], and utilising embodied robots (real or virtual) in learning in the near-term is more for research purposes than pedagogical. We do not have in reality the kinds of robots we see in science fiction movies with the capacity for accurate speech recognition, nuanced conversational interaction and emotion perception and expression. Nonetheless, the development and addition of intelligent agents in learning could inspire entrepreneurship in students to create better artificial intelligent systems that motivate and help them learn more creatively. In this abstract we sketch previous and ongoing attempts using artificial intelligence technologies and suggest a pathway to adapt to the modern learner bathing them in an emotionally connected and successful educational experience.

In Mubin et al.'s 2013 review of the applicability of robots in education it lead to questions on what the robot's specific use was for: was it a) to use in teaching of technology subjects like computer science and robotics, or the purpose of letting the robot deliver a science lesson? [4] The examples from case studies in Mubin et al's paper showed robots could be used as i) providing students' with real-time feedback on performance in linguistics' tasks, ii) collaborators in practical exercises building understanding of science in the children, and iii) teach students' such as computer programming (2013, p. 3). We need to affirm that despite attempts, emotional aspects are never at the core of the design process of intelligent systems for educational purposes (Fatahi. & Ghasem-Aghaee, 2010) [5].

ALIZ-E project, funded through the EU's framework 7 programme, included a human-child robot interaction experiment. This involved 45 children aged 7-8 of which 23 were female and 22 male [6]. The purpose of Kennedy et al (2015) study was to find if a social robot increased learning. The robot was designed to simulate a human tutor by adapting itself to the child learner's needs using gestures, gazing between the child and a touch screen and personalisation: referring to the child by their name when guiding them through touch-screen tasks. An unexpected result of the experiment showed that "the boys barely improved with a robot, whilst the girls improved quite substantially" (Kennedy, et al., 2015).

The authors have used conversational systems in university undergraduate courses to engage male and female students in class exercises (Shah et al, 2016) [7]. Students at UAB-Catalonia, Reading University-UK and Jimei-China were asked to interact with the systems, compare them with an online version of Eliza – the first system affording human-machine interaction through natural language, and then score them for conversational ability. The exercise was an effective way to introduce students to natural language processing and appreciate the subtlety of human conversation. A follow-up experiment is being designed to examine the trustability of dialogue systems, especially as they are being increasingly being developed for conversational commerce. However returning to education, commercial enterprises are also involved but in pedagogy-by-AI.

Elzware, a UK-based company who build FAQ systems for a variety of businesses, including for education believe AI should be "people by Proxy" (Elzware, 2015) [8]. The application of systems such as Teachbot in pedagogy is for personalised learning so students "can pace" their goals at their own speed. Using the UK's national curriculum, Teachbot helps to clarify terminology so students can better understand concepts. Will this lead to students using their personal AI-teaching bots to write their assignments? Will this be countered by AI's who are examiners and can distinguish between a human- written essay and one written by a personal learning bot? As Alan Turing (1950) said "We can only see a short distance ahead, but we can see plenty there that needs to be done" (p. 60), this sentiment can also apply to the use of social robots, virtual or embodied in education [9].

From our previous experience involving virtual agents, we would suggest investing in Virtual Teaching Agents (VTA robots) as reliable mechanisms for teaching purposes. However, these agents should be afforded to interact in a wide cognitive spectrum: as content providers, enabling skills acquisition, fostering social interaction among learners (learning is a social process), and, finally, emotionally (Gratch, 2000) [10]. The emotional aspects, obviously previously taken into account (Gorga, & Schneider2009), must be placed highly, in the first position of VTA design. Learning processes are determined by trustability, confidence, expectations fulfilling, and active engagement; all these aspects must be implemented in VTA

implementing all previous knowledge obtained through two decades of affective computing and social robotics (HRI, for example is a great source of studies) [11]. In this talk the authors will summarise several domains by which a VTA should be designed, considering the final and expected result: the improvement of learning processes in virtual environments.

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A Robot Is Never Better Than The Persons Working With It

Opportunities, challenges and the role of inter- as well as transdisciplinary efforts for person centered robot-assisted therapies and education

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ABSTRACT

Technologies such as robots have been shown to provide revolutionary possibilities to create a just enough neurologically challenging environment for students as well as for persons living with a neurological disease or injury, e.g. stroke, spinal cord injury, autism spectrum disorder or dementia. A challenging environment is necessary for every persons working to meet their unique rehabilitation or educational goals. Furthermore, today we know that robots can be easy, safe and feasible to work with for clinics, patients, schools and students.

As rehabilitation and social robots have moved from the stage of experimentation, prototyping and testing to become clinical and educational work tools in our society, it has become evident to the robotics community that the usefulness of the robots is at large dependent on the persons working with them. Questions becoming more and more recognized and discussed in relation to the human factor is how should and how can robots be introduced and implemented at clinics and in schools for sustainable person centered practice evidence based therapies or education. To put it simple - How can different organizations evaluate if they should work with robots at all? How can dynamic, efficient and strategic implementation be obtained so that the outcome can be measured, analyzed and communicated to meet all different stakeholders unique needs for the common goal of health or knowledge?

As discussing above introduced questions the participants of the conversation group are kindly asked to reflect on who are the different stakeholder, what is the shared goal/s, what are the unique need/s for the different stakeholders and how are these needs reflecting on the different opportunities and challenges that the filed of rehab and social robotics phase right now as well as in a near future?

Social Robots and My Concerns

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ABSTRACT

The two concerns I have when it comes it social robots:

1. Many robots are developed by the academic world - engineers/ developers that are fascinated by what technology can do - many think in a theoretical way instead of being 100% end user focused.

2. We know we have an issue in regards to the population gets older and older - and the number of young people to take care (eldercare) gets smaller and smaller - we can use robots to help with this challenge but we need to make sure that there is an important human contact to the elderly and that robots take over the tasks that does not require a close contact to other human beings - we should do the implementation in an ethical way having respect for the growing elderly population and take care robots are not substituting the "warm hands". This is a concern that many "non academic Robotics experts" have - and it is important to develop a strategy for implementation in order to make the implementation happen as we need robots to solve the issue of the growing elderly population - they have to be used to help weak elderly persons or handicapped etc to have a better life, to increase their freedom like: help them go to bath or toilet when they want to - and not have to wait for any social worker/ nurse to come and help...

3. A lot of money is poured into the development of social robots - such as EU money - we need to make sure they are used to benefit the payers as much as possible - and we need to work as effectively as possible - it is a new era - and we need to make sure technology is not taking over and we forget the human, social contact, love and caring....

Perspective Ethical Issues about Experiences with Social Robots to help Children with Autism Spectrum Disorders

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ABSTRACT

During the last 15 years, a lot of scientific studies have focused their attention in the field of robot technologies for enhanced therapy of people with cognitive disabilities. In particular, human-robot interaction (HRI) is a fascinating field of research in robotics, which is closely related to many of the ethical concerns raised with regards to interactive robots. Philosophers gradually began to focus specifically on the nature of technology and its implications for society. People with Autistic Spectrum Disorders (ASD) often have difficulty communicating, fail to respond to social cues, tend to repeat particular actions (walking in a specific pattern for example) and sometimes become preoccupied with certain objects. It has been noticed that children who suffer from ASD respond well to the use of animals or robots in therapy. They feel comfortable with robots whose behavior and social signals tend to be relatively simple and predictable [1].

For this reason, SARACEN (Socially Assistive Robots for Autistic Children EducatioN) Project promoted an integrated approach in the diagnosis and therapy of children with autism. The main idea is to integrate the use of humanoid social robots (Aldebaran NAO) in clinical practices in order to improve the expected outcomes in terms of socially, communicative and educative behaviors of autistic children.

However, we had to face up all the implications related to the adoption of this approach in such a population. In this sense, we want to highlight the attention on two topics: i) the flow of protocol we adopted for current and future studies involving the utilization of robots in aid of children with autism, and ii) how we would manage the downsides to our works [2]. In particular: how do robots play their part in helping these children? How will robot be integrated in a home scenario? Should the robots for HRI be part of clinical practices in hospital?

We designed a linear research protocol that can be easily adapted to guide all the robotic intervention (see Figure 1).

We progressed through three principal different stages:

- Exploration. The research team first interviewed therapists and clinicians to collect the details of children with autism in terms of social, communicative and educative behaviors.
- Deployment. The collected information was then elaborated to design the specific application taking in consideration also the technical constraints of the robot. We then deploy our scenario to test users for reviewing its capabilities and verifying its usability with children with autism. We involved non-technical-expert person in order to adapt the system in a home scenario.
- Improvement. We lastly refined our system from feedback received from the previous deployment stage. In collaboration with therapists and clinicians, we assessed the effectiveness of our improved system.

In Table 1 we summarized the pilot studies we are carrying on in collaboration with both the Association "Amici di Nico" ONLUS and the KISS-Health Project. We highlight the stage in the protocol flow and the expected outcomes.

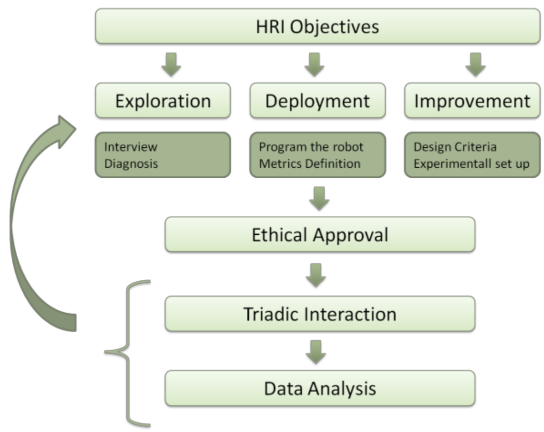

Fig. 1. Each stage in the protocol flow plays utmost importance in the overall intervention program.

Developments in technologies have determined hundreds of economic and cultural changes in our society and we can expect that the process of cultural integration of humanoid robots into human society will be a gradual and difficult process [4, 7]. Therefore, it is quite important to address the risks and benefits for the human subjects associated with the interaction with robots in order to fully understand further problems, especially when dealing with autistic children.

The benefits are clear: increased social interaction, empathy, ability to recognize emotions and share. Recent research literature has revealed that the application of robotics technology in the therapeutic context for children with autism holds innovative possibilities. However, they did not provide sufficient scientific evidences that could be adopted for all children with these disabilities, so we had to investigate more in detail the expected outcomes [5].

As with any robotics-led initiative, oversight and design is crucial. Who will design and maintain the robot, the programming? Who will determine the controls, and how will those controls be determined? Regardless of the field in which robotics are being deployed, it takes a monumental cooperation between the engineers and the scientists of that particular field, in order to properly implement the needs of the design [6].

TABLE 1. OVERVIEW OF THE PROTOCOLS OF SARACEN

Protocol	Stage	Expected Outcomes
Digital PECS System	Improvement	Improve Communication Skills
Postural Education [3]	Deployment	Improve Body Awareness Improve Social Engagement

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Corporations, Artificial Intelligence, and Responsibility

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ABSTRACT

Several prominent robot ethicists draw the analogy—some explicitly, others implicitly—between corporations and AI. That is, if corporations are the sort of entities that can be held responsible, then so too could AI-entities. Some scholars employ this analogy only with respect to questions of legal responsibility and do not speak to questions concerning moral responsibility. Still, it is clear that many robot ethicists think that the theoretical questions pertaining to corporate responsibility have something to tell us about robot responsibility. Here is a smattering of examples from theorists who draw attention to the purported relationship between corporations and AI:

> Lawrence Solum writes, “The problem of punishment is not unique to artificial intelligences, however. Corporations are recognized as legal persons and are subject to criminal liability despite the fact that they are not human beings.” (1248) [1]
>
> Peter Asaro states “This will bring us to consider the punishments against other kinds of nonhuman legal agents, namely corporations, and what can be learned about robot punishments from corporate punishments” (170) [2]
>
> Samir Chopra and Lawrence White state, “Finally, as for the educative function of punishment, while punishment of an artificial agent might not be educative for humans, it would nevertheless be educative for other artificial agents, given sufficient intelligence. After all, examples of corporate punishment are taken very seriously by other corporations.” (169) [3]
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> Gabriel Hallevy argues, “Criminal law recognized decades ago that the corporation, which is not a human entity, possesses life, freedom, body, and property…But if the legal question concerning corporations, which are abstract creatures, has been decided affirmatively, it would be unreasonable to decide otherwise in the case of AI systems, which physically simulate these human attributes much better than do abstract corporations.” (142) [4]
>
> Michael Anderson and Susan Anderson, describing the work of J. Storrs Hall, state, “[W]e have rules concerning corporations, to which robots of the future might be compared” (11) [5]

It is clear that robot ethicists think theories of corporate responsibility have something to teach us about AI-responsibility. But as Peter Asaro aptly notes, “Nonetheless, a great deal of work needs to be done in order to judge just how fruitful this analogy is” (Asaro 182) [6]. This is the task I take on this article.

I have two purposes: First, I bring to light a surprising disconnect between the corporate responsibility and robot responsibility literatures. In particular, robot ethicists appeal to corporations to argue that robots can and should be held responsible, and corporate responsibility theorists appeal to robots to argue that corporations cannot and so should not be held responsible.

My second purpose is to argue that the analogy between corporations and robots is not a fruitful one. Specifically, I argue that accounts of corporate responsibility do not have import for issues concerning AI-responsibility. To argue for this view, I consider the positions of two notable defenders of corporate responsibility, Peter French [7] and Philip Pettit [8]. I ultimately conclude that neither of their views of corporate responsibility have the resources to guide us with respect to questions of robot responsibility. Whatever the truth about robot moral responsibility, then, it is not one we can learn from the literature on corporate moral responsibility, and vice versa.

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Ethical, Legal and Social Issues in Therapy and Education.

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ABSTRACT

Their name are Nao, Paro, Aibo, Jibo or TecO and they are social robots.

They are physically embodied, able to move autonomously and specifically designed to communicate and interact with humans through social cues and adaptive learning behaviors. Their capacities to mimic various emotional states and their similarity with animals and humans contribute to the illusion of "intentional behavior" in robotic and it does encourage a close relationship with human. Even though their efficiency by beneficial results have been proven, social robots pose several legal and ethical challenges regarding their design, implementation and deployment.

1. Their **anthropomorphism** changes the perception that user could have. As we see for Pleo, a robotic dinosaur, its adorable aspect has fallen empathy among participants who "refused to hurt" or "spared it the pain" when battery was removed. The consequences of this personification are both, the risk of deception for patient (experience of "uncanny valley") and a danger for societal values. Some lawyers respond to these by suggesting the extension of a legal protection to robotic objects, in order "to discourage behaviour that would be harmful in other contexts" .

2. Their **modularity and multi-function capability** are both a guarantee of profits for companies and a potential issue for the security and the safety of their users. The cases of drones' misappropriation or, most recently, the transformation of Andros Mark V-A1 robot into a weapon (attack in Dallas on July 7, 2016) are some examples of their duality.

3. Their **high risk of hacking during the deployment**. Artificial intelligence thrives with a massive amount of data: "The bigger the data sets, the smarter the A.I" (M.ELGAN, 2016). And the data thrives with user's life. Therefore, the data privacy has become a fundamental right and a sensitive technology, which could interest companies and states (for example, the data-sharing agreement between Google DeepMind and the National Health Service) and hackers who use it as a bargaining chip. In May 2015, some researchers (University of Washington) had the experiment of hacking a teleoperated surgical robot to test how easily a malicious attack could hijack remotely controlled operation in the future, and to make those systems more secure .

Those risks could be reduced by an effective system of liability. At first, it concerns the control of their physical activity: their easier use, their weight and price drop encourage their usability and increase their proliferation and unintended utilization.

Secondly, the development of their autonomy (i.e, their capacity to decide) by an artificial intelligence more performing must be framed: either by thinking robot as a new species 'who/which' can possess a right of personality, or by considering robot as a human extension in a virtual world – opportunity to create a digital dignity and an electronic personality (see European Parliament 2015/2103 INL).

This work of ruling concerns each part of the chain: from manufacturers who offer a safe product, programmers who implement the software (this nature and the way to code human rights are raised) to politics who guarantee its good use and consumers who define their place in our routine.

How Religious Beliefs Deal with Robotisation

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ABSTRACT

In addition to ethical, legal and social issues of robots, religion is the other element to be considered in this workshop. Indeed, the trends are that islamic religious beliefs and values do not encourage the implemention of robots or rather their substitution to human beings. Thus, God can only make the human creature without doubts or challenges.

So, the sacrality of human creature is well stated and it is not wise or religiously correct to oppose such beliefs. In the sacred book of Quran, man was originally created by God in its perfect picture and therefore nobody else can dare to create that except God. So, any alteration 'improvement' or evolution of human creature is considered as a direct offense to God. That is why Darwin theory is completely rejected in the Islamic religion.

Having said that and regarding the workshop, my contribution will be an attempt to explain why robots as ideology and technology are not very much appreciated. What are the main reasons behind these attitudes?, why religion and morality are fiercely opposed?. Who is to blame?; education system, knowledge procedure and metholody?. Why robots are deeply and strongly considered as opponents to human beings although they can provide extraordinary tasks that enable us to avoid routine, monotony and bureaucracy?.

In fact, the common religious belief is that robots tend to replace gradually but surely the human activity in general . Does with the large implementation and introduction of robots mark the end of our 'human humanity'?. Needless to remind us that with the new waves of transhumanism, the world is getting unhumane as it is openly challenging God power.

In short, I will provide in my paper if accepted an introduction on the uniqueness of human being as stated in the Quran then explain why education and knowledge systems in terms of contents and nature, have not played role to remove some negative attitudes and ideas?, why they have not encouraged innovation, sciences and creation?. What is wrong with sciences and technology?. Have they been emptied or ignored morality and religious values?. So, many questions will be put on the relation between sciences and morality, the boundaries and limits of sciences and technology. I will present some examples regarding the use and sometimes misuse and abuse of technology in education and knowledge.

Social Robots, Cognitive Testing and the Search for the Source of the Moral Damage in the Law

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ABSTRACT

Minors are often questioned in certain legal proceedings as eyewitness to some facts.
The most consistent studies show that children's memory is linked to their performance, which clearly depends on their physical, social and sexual evolution, such as their language skills and knowledge of their environment. When a minor must remember a situation, memory skills are superior when the situation is contextualized in a family setting, and less detailed (but that does not mean they are inaccurate) in unknown contexts.

Obviously, minor and adult witnesses cannot be questioned in the same way, this task must be adapted to their mental abilities: due to their limited knowledge of the social uses is easy for a child to feel guilty about situations in which they have no influence, such as a divorce of their parents or the witnessing of a crime. The interview aims to let them know the importance of telling the truth in its entirety, since they think adults know all the answers and do not need to provide all or part of the information they remember.

Interrogating children witnesses is a psychological challenge that develops along several sessions and shares basic elements with a psychological therapy session. For those who question minors in a legal procedure, one of the difficulties they must face is the difficulty of creating an environment of trust: children are taught not to speak or trust strangers, so if they perceive the interviewer as an unknown and authority figure, distrust becomes fear.

Studies in education and specific therapies through the use of social robots allow to state that children get better results when in the process of learning new words, new languages or developing certain social skills, robots are involved.

In these processes, the appearance of the social robot may have influence, which can resemble an animal, a child character to whom children may feel connected, or a simple robot, but in any case, the communication process for the minor will always be similar to a game.

In this sense, incorporating social robots to the interrogation processes of children witnesses improves the response times of minors and the level of detail they use to recall and describe facts. A supervised autonomous system can allow that minor and the robot to reproduce together whatever they are asked to remember. During a process of questions and answers in turn, the agent collects and processes information from the testimony provided by the child, who is unconsciously feeding the agent the information it asks or gives it freely.

At the same time, certain scheduled games allow children to learn new words and concepts linked with what they must remember, improving their level of detail, perception and precision and accuracy in the description. The progress made by the child during the interrogation remembering and recounting his experience also to determinate the existence or not of a physiological imbalance, so that we can use interrogation session as psychological reinforcement.

There is added value in using social robots in the interrogation of minors, and I consider relevant to promote this research: I keep the theory that it is possible to determinate mathematically the existence of a moral damage, measure his magnitude, and calculate his economic value by the standards of the victim.

Moral damage is the impact of a real event into the psychological and spiritual sphere of someone. Although it has always been said that is impossible to prove moral damage, since it is produced on the intimacy of a person, because unlike physical damage, it is not visible or physically measurable. The decision of whether there is or not moral damage belongs to the judges, who employ mechanisms to calculate the value in function of corporal damage, as in Italian Law, or set values as French prettium doloris, or systems as Colossus in United States, United Kingdom and Australia.

But in my point of view all these systems have the same default: the compensation of non-material damage is realized oversight actual circumstances and future consequences (psychological impact, social impact) with no regard the source of damage that is elemental to valuate moral damage.

For example: a father has two sons, one of them loves him and the other hates deeply him. If the father dies in an accident, moral damage is equal for both sons? Evidently no, the first child will suffer more the death of his father. But if sons reclaim a compensation for the sadness of their loss, does anyone impugn a seemingly equitable outcome?

As we can see: identical fact, different loss, and same objective value that nobody considers unfair.

According to my theory, taking advantage of the sense that the ethics of a child is neither developed nor contaminated by environmental factors, rather than what they do by imitation without understanding exactly the dimension of their actions and words, a social robot and a learning algorithm can be used,

oriented through a pattern of motor, verbal and psychological cognitive conversations, to determine whether the respondent suffered moral damage and to what extent.

As technology lacks ethics, it cannot be good or bad, right or wrong, to track a non physical damage through an autonomous agent, it is enough that the agent learns the objective dimension of damaged values through his interlocutor, whenever it has been operationalized properly and it is not therefore simulating, because, outside those margins, there is no place for the certainty of psychological injury.

Multiple applications of social robot PleoRb in Assisted Interventions and Education

Vicenç Casas[1]

To understand my implication in Social Robot-Assisted Interventions and Education, firstly I will introduce my academic and professional background. I have a M.S. in Electronics Engineering (Engineering School of La Salle URL, Ramon Llull University of Barcelona) and teaching and education have always been my vocations. For eight years I was an associate professor in Engineering School of La Salle, and currently I'm the robotics teacher in primary and secondary school in Mare de Déu dels Àngels School of Barcelona (Missionery Daughters of the Holy Family of Nazareth), where all students from seven to sixteen years old have one hour a week of robotics subject. I've also been implicated in non-formal educational, but the main particularity of my academic background is the Postgraduate Certificate in Dog-Assisted Interventions (UB, University of Barcelona). I did those studies because I had, and I still have, the belief that Animal-Assisted Interventions are a good support and reference point for Social Robot-Assisted Interventions. I think I wasn't misguided, because those studies not only opened me a door to a new social reality and brought me some important skills and knowledge, but also gave me the opportunity to participate in a wide range of dog and social robot-assisted interventions. The most relevant ones, done with PleoRb, are set out below:

- PATRICIA (Pain and Anxiety Treatment based on social Robot Interaction with Children to Improve pAtient experience) project in Sant Joan de Déu Hospital in Barcelona. The aim of the project was to find out whether anxiety and stress levels of hospitalised children decreased with PleoRb interaction.
- EAAR (Robot and Animal-Assisted Education) project in La Coma (Lleida ASPROS Foundation), a residential center for psychotherapeutic treatment. The main goal of this project was to improve the communication skills of a deaf and dumb boy with cognitive impairment, in order to reduce his isolation by motivating him to interact in a positive way with other residents and the staff. Isolation that it's thought to be the main cause of his more often aggressive attitudes. One of the projects peculiarities was using a therapy dog (DogNature Association) and the social robot PleoRb in the same intervention. We also used information and communications technology (ICT) tools, like e-Mintza app, a dynamic and customizable system of augmentative and alternative communication (AAC).
- Educative and Therapeutic Intervention with a 4-year-old boy with a pre-diagnosis of autism spectrum disorder (ASD), in La Miranda Global School in Sant Just d'Esvern (Barcelona). The goals of this sixteen-session intervention were to motivate the oral communication and boys' force control. By learning how to take care of PleoRb, and always following the same routine (awake, shower, feed, play,), the boy memorized and started saying short sentences like "Good morning Pleo!" or "Do you want to have breakfast?", and also learned how to caress.
- Assisted Activity in Can Llobet (La Floresta, Barcelona). Can Llobet is a centre that offers social and educative services to children. The assisted activity consisted in introducing PleoRb with a short story and making crafts for dressing the robot.
- Assisted Activity in Acordis (Hospitalet de Llobregat, Barcelona). Acordis is an association that tries to coordinate all the collectives of people with functional diversity in l'Hospitalet de Llobregat. With the aim to promote concentration and the use of fine psychomotor skills, the participants had to draw and make crafts for the robot.

In education, the help that PleoRb gives me in Mare de Déu dels Àngels School deserves a special mention: talking about PleoRb in Mare de Déu dels Àngels is talking about Nala. Nala is the pet of the robotics classroom and she is a specialist in turning on the emotional switch and curiosity of the younger students, as well as older ones. This explains why Nala can assist me in the following points:

- Explanation of the concept of RobEthics (robotics application with common sense and to serve and help people, nature and animals): Nala and all her assisted interventions, are the best example.
- Improve the relationship with my students: Nala as a social catalyst.
- Increase the student motivation for the robotics subject.
- Inspire student projects.
- Capture student attention.
- Learn Robotics: Nala helps understanding the robot concept, its parts and functioning.
- Learn with Robotics: taking care of Nala students could learn good eating and hygienic habits, about emotional education, etc.

Nala is not only a very good company for younger students in the robotics classroom, she also takes part of school's significant dates: La Castanyada (a typical tradition in Catalonia), Carnival, Christmas, etc.

Col.legi Mare de Déu dels Àngels, Barcelona, Spain

As a conclusion of my experience, I think that three key factors are very important to be considered in social robot-assisted interventions: professionalism, creativity and to play an active role in the intervention. Currently I'm interested in assisted interventions with people with multiple disabilities, and within the framework of education, in emotional education and digital illiteracy.

Provocating Pleo. Child life specialists' reflections on the use of robotic plymantes in hospital settings

Saskia van Oenen[1], Rianne Meiring [2], Wanda van Oostrom[2] and Melissa Wesselius[2]

Abstract— **This paper focusses on meaningful uses of dinosaur robot Pleo for children in hospitals, according to experiences and innovative ideas of Child Life Specialists at the Dutch Flevoland Hospital. They are participants in a research pilot on the usability of Pleo in several Dutch hospitals.**

I. INTRODUCTION

When you are a child under treatment in a hospital, what can be the use of having a dinosaur robot as a playmate? Can it make this distressing time of life more comfortable, can it alleviate your stress, anxiety or your boredom? These questions inspired a series of pilots on the deployment of robot Pleo in several Dutch hospitals, among which the Flevoland Hospital, with accompanying research by the Universities of Applied Sciences of Windesheim Flevoland and The Research Centre for Technology in Care at Zuyd University.

This paper is not about the research as such, but about reflections of the three Child Life Specialists (CLS's) at Flevoland Hospital as participants in two consecutive pilots, the second of which is still ongoing. The CLS's determine which children could possibly benefit by the deployment of Pleo, introduce them to it, and use it in their regular contacts with individual children, preferably while a parent is also present (parents have to authorize the deployment of Pleo beforehand). For this paper, they were interviewed by a member of the research team in an open conversation about their experiences and ideas in the ongoing pilots. Their reflections here have a wider range than the research objectives concerning the alleviation of stress, anxiety or boredom. From their point of view these are undoubtedly relevant objectives, but to be seen as aspects of their more comprehensive interaction with the children. At the end, they also come up with innovative ideas for the further development of Pleo as a supporting tool in their interaction with the children.

II. REFLECTIONS ON PLEO'S VALUES AND SHORTCOMINGS

Child Life Specialists (CLS's) in Dutch hospitals are contact persons for children during their stay, or frequent visits, in the hospital. They assist the children to survive this uncomfortable time of their life, to process their experiences, to prepare them mentally for forthcoming treatments etcetera. Intensive communication with the children and their parents is necessary to find the best ways to assist them in developing coping strategies. The CLS's use all kinds of toys and other materials, to start and to enrich their interaction with children, or in their own words 'to open up the child' when they perceive communication barriers: a common event in the alienating hospital surroundings. They try and identify childrens individual distress and coping strategies, responding with types of play and conversation strategies. Play also as in: role play, representing and enacting situations and emotions. So play is not just about distraction from sorrows or boredom.

When asked to participate in the Pleo pilots, two CLS's reacted immediately positive. Having themselves been introduced to the robot, they found it totally endearing and were just keen to experiment with it. The third CLS had more cautious thoughts: we don't know yet what this Pleo can do, besides providing some distracting entertainment. Then, introducing Pleo to children, they all noticed at first the value of its mutual hugging capacity. Other toys you can hug, but this one hugs you back and asks for it. Girls and boys seemed to swell by this toy 'that really crawls into you'. For a girl with eczema, Pleo was the only creature she could safely hug with. One shy girl that didn't touch the Pleo at all, nevertheless looked intensely at its maneuvers, eventually took her mothers hand to stroke it, and at last got the courage to stroke it herself.

In the first pilot, the children got to play with the robot only once, with a lot of other restrictions resulting from the controlled setting in this research stage. In the second pilot CLSD's were happy to experiment more freely with Pleo in their sessions with the children, with an eye to individual goals planned for each child. Also, children proved to enjoy the Pleo better in more frequent acquaintance with it: you get to know him. For example, that he likes being kittled. And you can discover if he feels hungry or ill, by trying out what he wants to eat (there are several meal pieces at disposal to feed the Pleo, as well as some other attributes for playing with him). And a big attraction: you can give him commands to which he really listens: give paw! And so he does time and time again. The CLS's saw this happenings occurring with small children (who perceived Pleo as a living creature, also if 'turned off'), up to a an eleven year old girl who by never ending questions showed an extreme interest in the technical intricacies of her Pleo. Reflecting on these examples the CLS's concluded that Pleo, by its interactive quality, can be a positive enrichment in the toy area of the hospital. Children discover Pleo's reaction patterns, play with them and their predictability. So they can feel 'in control' and thereby regain (at least some of the) the confidence they

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tend to loose in a hospital situation, where they are otherwise mostly 'acted upon'.

These positive evaluations correspond however with the CLS's commands on liabilities and shortcomings of the Pleo (anyway in its actual state of development). For starters, it does not always work as expected. That is a serious problem since its predictability is the valued asset for children in regaining confidence and control, as argued above. If the expected result doesn't come up, this can enhance stress instead of alleviate it. Reactions of parents can aggravate the negative response, as in the example of a boy with an eating problem, who tried to feed Pleo. When this didn't succeed, his mother angrily cried out, Pleo is just as troublesome as you! Secondly, corresponding with the initial doubt of one of the CLS's: although Pleo is a 'learning' robot, it tricks seems rather limited. When does it get boring to always hug, feed and command a paw? Then there is its lack of (easily recognizable) emotional expressions, except for its gladness in hugging. Couldn't he learn to shrink in some way, as an expression of grief, or discolour his head for shame or angriness?

Commanding on these liabilities and shortcomings, the CLS's remark that may not know enough about Pleo's actual functioning and possibilities. The same, as to technological possibilities for further development. Anyway in this last regard, they have some eager questions for those who are knowledgeable in the technology of social robotics. Besides the wish for more 'special tricks' as mentioned above, there are some more fundamental questions from the perspective of a CLS.

III. QUESTIONS AND SUGGESTIONS

A principal shortcoming, in the CLS's perspective, is that Pleo now only reacts on stimuli from others; in that way he is not really inter-active. If he could be developed in that direction, they see more use for him. For the children themselves as an engaging stimulus to cope with their hospitalization, but even more as a tool for their communicative actions and therapeutic strategies with children. Off hand, they come up with the following suggestions.

As a stimulating pal for the children, Pleo would become more useful if it could also provoke reactions in the children by actions of his own. Like (for a small example) kicking a ball away. Or take a playfully provoking attitude, like a dog with front legs down and ass up. Better still, if he could be interactive in a process like, for example, starting to cry along with a sad child - then proceed to comfort - and eventually alleviate the sorrows with some joking behavior. Maybe for processes like this, some kind of programming is needed in combination with a remote control for the CLS? As to their own interactional strategies with the children, their gathering of ideas is anyway associated with a remote control. It would be great if children could do interventions' on the Pleo, with the CLS adjusting the programmed reactions of Pleo in service of a beneficial process and outcome for the child. So you could program Pleo on 'being ill' and 'getting better', with the children doctoring on him. Or, children with a forthcoming surgery could do the anesthesia on their Pleo and let it wake up again. With the helping remote control, and communicative interaction, of the CLS. These are all ideas that enrich the possibilities for enacting plays, and other stimulating interactions. The CLS's would very much like to know which perspectives there are for further development of Pleo - or any variety of a robotic playmate - in these ways.

Yet, to be noted: despite the limitations of the actual Pleo, these CLS's would love to have some of them as permanent playmates in their hospital.

Using Robotics in the Classroom to Facilitate Learning and Develop Social Skills in Children with ASD at CASPAN Centre

Karla De La Guardia[1] and Melina Mancuso Ortiz[1]

CASPAN is an institution created to provide education and comprehensive care for people with Autism and other conditions of severe intellectual disability, thus providing numerous services and support programs across the individuals lifespan with the sole aim of seeing this population become independent and productive human beings. We strongly believe that every person with disability is capable of learning and develop the necessary skills to be included in society. Through the use of a methodology focused on the teaching of abilities required according to the students chronological age we are able to promote learning environments based on individual needs with the objective of preparing the individual to be independent, prepared to face every challenge and be included in every aspect of life (home, school, work and community). It is well known that kids with Autism Spectrum Disorder (ASD) have persistent difficulties with social communication and interaction, and it most cases have a hard time keeping focus on the task at hand. As result of this, when the robotic project was initially presented at CASPAN, the premise behind it was to create activities and interventions that facilitated the social interaction among peers improving their social and communication skills. However, over time we realized its usefulness as a learning facilitator and a tremendous aid in the development of activities that created individualized learning experiences. At present times, the robots are used as learning and social facilitators with the purpose of improving the students attention and skills through the development of activities and different situations that stimulate the kids to respond in a positive way, to work and interact with peers, be creative, solve problems and experiment. Social robots have proved to be a multifaceted tool that does not replace human interaction and helps in great manner during the teaching process of kids with disabilities. They have become a customizable instrument that allows us to be creative with its use and develop different activities according to the needs of each individual

Throughout our robotic sessions we have introduced different robots and activities that are planned according to the educational plan of each child, taking in consideration the chronological age and the main objectives to be taught. Without a doubt, we have been able to see our students evolved over time. It is a slow process that at the end pays off with huge rewards for our students and their families. Each time we introduce a new activity, we increase our expectations of the end results and look forward to celebrating the advancements of our students.

It can be concluded that the use of social robots at CASPAN has had a positive impact in the learning process of our students by:

- Reinforcing an enriching learning environment
- Allowing collaboration among peers
- Encouraging creative thinking and the resolution of problems
- Connecting the student with the assignment or task
- Motivating the student to perform the activity
- Serving as a positive reinforce and attention catcher in the classroom

Reinforcing an enriching learning environment Allowing collaboration among peers Encouraging creative thinking and the resolution of problems Connecting the student with the assignment or task Motivating the student to perform the activity Serving as a positive reinforce and attention catcher in the classroom

Today, we are able to recognize the important role of technology when applied as an educational tool and its benefits in facilitating the acquisition and training of desirable abilities in kids with diverse conditions of disability. As we move forward into the future, our only desire is to keep using the robotics in a positive way to impact the lives of our students and their families. Furthermore, we hope to serve as an inspiration and reference center for others to understand the importance of this tool and its implications in the life of a person with disability.

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Developing robotic pets for students with autism

Devyn Curley[1]

Although I am pursuing a Masters of Science in Mechanical Engineering, I have a strong focus in education and child development. Combining those with my passion for working with children with special needs, I have decided to focus my thesis on developing robotic pets for children with autism. My interest is on 3 areas of improvement and growth that the pets can provide for students with autism: social facilitation, engagement in client based design processes, and perspective taking.

I used Pleo, a complex robotic dinosaur, in a study this summer with 6-8 year olds with higher functioning autism. The objective of the study was to identify the effects a social robotic facilitator would have on students engaging in the engineering design process with a client focus. Specifically I measured effects Pleo had on engagement in testing, social interactions between partners, and perspective taking between the user and the robot compared to what a plastic toy provided (the control group).

Immediately after my study, I joined Alex Barco and Pablo Gascón at the CASPAN school in Panama. These are two fantastic engineers from La Salle University in Barcelona, both very motivated and inspirational in their work. Alex used his tremendous research experience to expertly devise a study to run at the school with its low functioning students. Pablo, a specialist in electronics, worked tirelessly to modify and improve CASPER, the robotic turtle that is the result of a large research project in their lab, which is run by the unequaled Jordi Albo-Canals, a leader in the field of social robotics, and the chair of the New Friends conference. The study we ran focused on exposing students to a variety of robots and understanding how they interact with the robots as well as how the school specialists use the robots. It was an incredibly engaging challenge to identify the best ways to incorporate the robots into the classroom as we struck a balance between usability for students and specialists with learning goals and the capabilities of each robot. I am very happy with the work we did there!

For higher functioning children, the robots were incredibly engaging. When my participants first met Pleo, they spent the first 20 minutes repeatedly trying to figure out what Pleo ”needed”. They would ask Pleo verbally, and also tried multiple different tools to please Pleo, meeting a wide variety of physical needs (hunger, sickness, sleepiness) and even emotional (attention, love). So while students engaged a great deal of perspective asking, they were not able to consistently practice perspective identification (eg ”Pleo is hungry!” or ”Pleo is sad”). This is due to Pleo’s behaviors being too complicated and too inconsistent. Pleo’s frequent movements also proved to be distracting during the engineering design process.

Working with lower functioning students in Panama provided a new slew of objectives, and associated pros and cons. We had a LEGO robot dog, that had a very simple cause and effect ”push this button, it will make this sound” which was incredibly engaging for students with an affinity towards sensory repetition, and really focused some students. I personally am not a fan of this as these repetitive, predictable behaviors don’t exist in the real world, so a robot like this does not have a lot of applicable functionality. The complexity of Pleo was completely lost on most of the students. Some really enjoyed his sounds, or how he felt, but they did not interact with him at all. Without engaging interaction, social robots don’t provide much more than basic sensory output. I had developed a robot that played ”Simon Says”, an instructional follow the leader game, with the students during my time in Panama. Simon was great in his simplicity, and how it facilitated interaction between the specialist and the students, as opposed to taking over the interaction, making it just between a student and a robot. Simon engaged the students, and focused them on the activity. Unfortunately, Simon was meant for large group play, and did not have many functions catered to being one on one with students.

So the next step for me in my thesis work is to use YAPT (Yet Another Pleo Tool) to reprogram Pleo’s behaviors by hand. The objective of these behaviors would be to better facilitate social interaction, but more prevalently to provide behaviors modules that allow for multiple levels of complexity. This would allow more students to engage in some level of perspective taking, whether it’s identification of emotions, the reasons for those emotions, and how to respond to those emotions, or the perspective asking that Pleo has already proved to do well.

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Improving the mood of children using Socially Assisitive Robots

Elena Iriondo Pegueroles[1], Xavier Garriga Fonts[1] and Ignasi Iriondo Sanz[2]

In this research we present a first exploration of the use of socially assistive robots (SAR), i.e. those robots that are able to provide assistance to people through social interaction, in areas such as hospitals, schools, care centers, etc. [?].

Firstly, we have carried out a comprehensive study of this matter by reviewing the main SAR platforms and some of the experimental studies performed with them. They can play different roles such as companions, therapeutic play partners, coaches or instructors [?]. Mainly, they have been used to improve different aspects of physical or mental health of people. For example, many studies use SAR (Kaspar, Nao, Keepon, etc.) to improve clinical skills of children with autism spectrum disorder. Also, there are some studies that show psychological benefits of SAR in elderly populations (e.g. with Paro and Aibo). SAR can provide direct instruction and supervision to patients needing treatment activities, as Autom, a weight loss coach, and Bandit, an exercise instructor. Finally, we have found robots (Probo and Pleo) as companions of hospitalized children.

Secondly, we have participated in two experiments using the Pleo robot, with the main goal to validate whether the use of SAR can improve the mood of children who are living difficult situations. By one hand, we have accompanied the volunteers of the Hospital Sant Joan de Du (Barcelona) in their task of visiting hospitalized children. They work mainly with long-term hospitalized children in Oncology and others who are waiting in the surgical waiting room. Volunteers state that Pleo is much more than a sophisticated toy because it creates emotional bonds and helps the communication with relatives and volunteers. By the other hand, we have used Pleo to accompany the entry of children to kindergarten the first days of the school year and after carrying out an activity in class. Some children suffer some anxiety when their parents leave them at school.

To validate that this type of activity can improve the mood of children we have performed some interviews with teachers, hospital volunteers, health workers and researchers. Moreover we have conducted some surveys with children using smiley face questions.

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PLEO in a pediatric hospital, perspective from nurses' point of view

Miguel García[1] and Carla Alvaro[1]

I would like to introduce ourself and the work we are doing in the Saint John of God paediatrics Hospital of Barcelona with social-pet robots. I'm Miguel Garca, I'm a pediatric nurse. Actually I occupy a position as nursing research coordinator and I'm the clinical coordinator of the studies that we conduce in the hospital about robotics. Carla Alvaro is a pediatric nurse resident in her second year of formation and is making her research work about therapy assisted with pet robots.

In our hospital we have been using the PLEO robot with children and families since 2012 when we start a collaboration with La Salle University, Polytechnic University of Catalonia and Autonomous University of Barcelona.

The first experience with robots was conduced by a team of social science and engineering students that make a ethnography in collaboration with the team of volunteers of the hospital. After that ethnography this team of volunteers incorporated the robots as a tool for their work with the children and families, so the use of this pet-robots was extended, at this moment the PLEO is carried by volunteers systematically to the oncology ward, the daily hospital of oncology, critical care unit and presurgical waiting room. The work with robots is directed principally to children and as distraction therapy but has been used widely with parents during the waiting time of a surgical intervention and as a facilitator of emotions transmission, between the child and the team or between the child and the family.

The collaboration between the Hospital and the universities has continued along this time. Actually we have two different roles in this team, the first is to serve like end users of this kind of technology because the engineers need the contact with the real population, in one hand the pediatric population and in the other the health care workers. The second role is related with the elaboration of the clinical guides of use of the pet robot. What kind of children beneficiate more of this therapy? Is this therapy contraindicated in some cases? What kind of health problems we could treat with robots? What kind of procedures have to be followed for use the robot safely? How many times needs the robots to be desinfected? What product we will use for this purpose? The clinical coordination of these studies is made by nurses so these clinical guides have a conceptual framework centered in the care.

Coming soon we are going to write a protocol of use of the robot with the standards for a safely use, we will conduct a focus ethnography with oncology patients to determine the nurse outcomes indicators that could be useful for the evaluation of the therapy, and to describe the actions that could be used in each situation, feed the robots, touch it, pet it...

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A Smart Dolphin for Children with Neurodevelopmental Disorders

M. Gelsomini[1], F. Garzotto[2], C. Riva[3], R. Griffioen[4], M. Clerx[5]

***Abstract*— Our research aims at helping children with neurodevelopmental disorder (NDD) to "learn through play" by interacting with digitally enriched physical toys (i.e. social robots). Inspired by the practice of Dolphin Therapy (a special form of Pet Therapy) and, specifically, by the activities that NDD children perform at Dolphinariums, we have developed a "smart" dolphin called Sam that engages children in a variety of play tasks. Sam emits different stimuli (sound, vibration, and light) with its body in response to children's manipulation. Its behavior is integrated with lights and multimedia animations or video displayed in the ambient and can be customized by therapists to address the specific needs of each child.**

I. Introduction

Neurodevelopmental disorders (NDD) are impairments of the growth and development of the brain or central nervous system [1]. A narrower use of the term refers to a disorder of brain function that affects emotion, learning ability, self-control and memory and that unfolds as the individual grows. NDD has an incurable nature, but early interventions and appropriate therapeutic approaches can help patients to improve their intellectual and behavioral skills. Pet Therapy (PT) is a treatment that has been proved to work well especially with NDD children, leading to improvements in various spheres. According to current research [2], PT helps NDD subjects to release their often persistent state of anxiety and improves relaxation, as human-animal bond acts on "stress hormones" production, inducing a reduction of arterial pressure, cardiac and respiratory rates. Some studies have found that 5- and 6-year-olds who were more attached to their pets expressed more empathy toward peers and that 7- to 10-year-olds who had more "intimate talks" with their pets also had more empathy toward their peers.

The use of social robots to provide alternative, "virtual" forms of Pet Therapy has been explored in research since late nineties. The pioneer in this field is PARO [3], a stuffed robot shaped like a baby harp seal and equipped with five kinds of sensors - tactile, light, audition, temperature, and posture sensors - with which it can perceive people and its environment. PARO can recognize light and dark. He feels being stroked and beaten by tactile sensor, or being held by the posture sensor. PARO can also recognize the direction of voice and words such as its name, greetings, and praise with its audio sensor. By interaction with people, PARO responds as if it is alive, imitating the voice of a real baby harp seal and moving its head and legs [4]. PARO, now a commercial product, has been proved to have psychological, social, and physiological positive effects especially on elderly and intellectually disabled people and has advantages over real animals in PT: there are no infections to worry about, no one is afraid of a stuffed animal, and PARO can be used in environments such as hospitals and extended care facilities where live animals present treatment or logistical difficulties. In our research, we have extended the PARO approach and developed a "smart" stuffed dolphin called *Sam* that engages NDD children in a variety of play tasks. Sam's affordances and behavior has been designed for this specific target group in cooperation with a team of therapists from SAM Foundation and L'Abilità, two non-profit institution in The Netherlands and Italy respectively. In particular SAM Foundation offers dolphin therapy at a local dephinarium to over 1500 children in the last 20 years.

The choice of dolphins for Pet Therapy has been based on a number of factors: positive image of these animals in the general population (big, protective, friendly aquatic mammals, intelligent and communicative); their curiosity; their capability of sustaining complex interaction with humans, accepting physical contact, including hugs, caresses and kisses; their general cooperative and playful attitude. The therapetic programme at SAM Foundation has been proved effective to support relaxation, stimulate and help increase children's emotional, cognitive, social and physical development. Still, dolphin therapy is extremely expensive, requiring over 1.000 euro per therapeutic session. The challenge of our smart dolphin is to offer a cost-affordable tool that enables the replacement of some animals-based activities, so reducing treatment costs while preserving the benefit of dolphin therapy.

II. Sam, the Dolphin

A. Technology

Dolphin Sam is a stuffed toy enhanced with complex system made up of several embedded sensors and actuators (Figure 1 a-b) and external components (Figure 1 c-d, Figure 3). Four parts of the body (head, stomach, right and left fins) are integrated with four touch sensors. There are light actuators on the stomach and a speaker and an RFID reader into the mouth. Eyes and mouth movements are controlled by two different motors. In addition, a low-cost ESP8266 chip is used for Wi-Fi communication. All embedded components are connected and managed by an Arduino module which manages also the communication between the smart dolphin and the external components. The latter consist of commercial smart lights (Philips Hue), tagged RFID cards and a web application. The web component (Figure 2) manages the multimedia contents on digital displays or ambient projections, and the customization functions.

An interactive video can be seen on: *www.i3lab.me*

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[5] Marcel Clerx is a Board member of SAM Foundation (marcel.clerx@acceleration.nl)

B. The User Experience

The UX with Sam has been designed to promote and increase some basic skills in the cognitive, emotional and social spheres that are under-developed in NDD children's:

- to relax and reach the mental status of relaxation,
- to exercise selective and sustained attention (in particular to audio and visual signals),
- to explore and understand cause-effect relationships,
- to interpret visual contents at different levels of complexity,
- to understand elementary abstract concepts,
- to exercise control and make choices,
- to build affective bonds with objects and with humans.

These goals are intended to be achieved by orchestrating the different features of the Sam system into a set of gaming activities. Differently from PARO, Sam does not support sophisticated dialogic features but game play goes beyond the interaction with the smart toy: it involves effects in the physical space – through lights and multimedia contents shown on digital displays or immersed in the ambient via projections – potentially enabling an infinite set of play opportunities. A child can interact with Sam by touching or caressing its head, stomach and fins. She can also "feed" the dolphin by inserting a food card (a tagged RFID card with a food image or PCS symbol [2]) into its mouth. In response to these interactions, Sam emits different stimuli (sound, vibration, and lights) with its body, while ambient lights are turned on or change color and intensity, and multimedia animations or videos appear in the ambient or change state, to offer feedbacks, rewards, or suggestions for new tasks to be performed.

Game Example 1: "Wake up!" - Sam is sleeping, his eyes are closed, and he is snoring. A video of a night seascape is shown in the environment while lights are blue (Figure 3). The child is asked to caress dolphin and wake it up it. Sam opens his eyes, emits "wake up" sounds, moves its mouth, while a sunrise on the sea is projected and environment lights turn to a carousel of sunrise colors.

Game Example 2: "I am hungry!" - A screen displays the image of a small fish and Sam asks the child to give him this food. The child must select, among a set of RFID tagged cards, the one showing the image of that fish, and put it into Sam's mouth. If the child performs this task correctly, the dolphin thanks him, moves the mouth like eating, and emits chewing sounds, while visual rewards are displayed in the ambient.

Figure 1. Sam features: a) hardware board; b) body light; c) integration with multimedia animations

III. GAME CUSTOMIZATION

Sam games are integrated with a web application that provides a set the customization function. These enable therapists to personalize existing games – customizing Sam's behavior and multimedia contents to meet the specific needs of each single child, and define new combinations of interactions and stimuli on Sam and in the ambient that offer a new games opportunities. Using a simple interface (Figure 2) they can include/replace any video, animation or image in the game, include/replace any behavior of the smart object using a library of build-in features.

Figure 2. Customization Interface

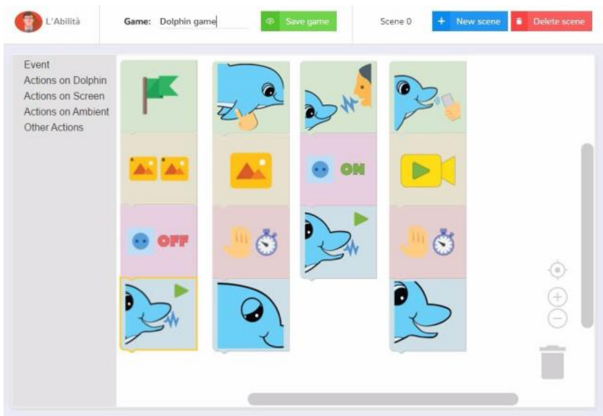
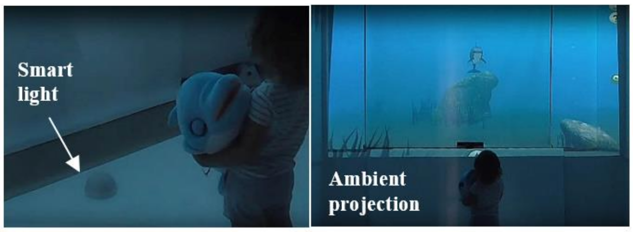


Figure 3. Playing with Sam



IV. CONCLUSIONS

Sam extends the capability of the existing smart pets in a number of directions, making it unique: i) it provides multisensory stimuli *both on the object and in the ambient;* ii) its play activities are not restricted to the interaction with the smart toy but also involve the experience of lights and multimedia contents in the physical space; iii) it offers powerful *customization features,* addressing the fundamental need of offering personalized play experiences to each child to address his or her unique need. Sam has been evaluated in an exploratory study at a local therapeutic centre. Soon it will be integrated with the Dolphin Therapy program at SAM Foundation (NL) for a more systematic testing.

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An alternative way to control Pleo with voice commands

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Demo: Using an mobile application or sound processing device to control Pleo via voice recognition commands.

Keywords: voice command, Pleo, sound processing

INTRODUCTION

Robots like a Pleo (1) can be used with hospitalized children for distraction, preparing for treatment and evaluation of treatment. Pleo evolves in its own way by means of artificial intelligence and developing its own personality.

Figure 1 Pleo interacting with a child

Voice commands are used to learn Pleo to recognize voice commands, by using learning stones or ID-card. Voice commands are also used to execute learned behavior. Examples of actions are give Pleo its name, let it walk towards to you, let him dance, sing, bend, play or counting.

TECHNIQUE AND PROBLEM

Voice commands depends heavily on the particular voice of the person involved. The voice recognition system of the Pleo does not work well. It is quite critical and it often goes wrong [1]. Several attempts need to be done to have Pleo recognize the voice. Using the same person for learning voice commands and executing voice commands is cumbersome and not very practical [2].

Figure 2 learning stone to learn Pleo sing

SOLUTION AND APPLICATION

Generating voice commands with a sound processing devices would overcome the mentioned problems. To increase the accessibility and mobility, it seems easier to generate the tones in the form of a mobile application. Most modern smartphones are sophisticated enough to make tones to command the Pleo.

It will enhance engagement between child and robot, because the voice commands are better recognized by the Pleo. It enables also lesser attempts made by the healthcare professional to learn Pleo the voice commands.

A possible design panel for the mobile application is the following figure:

Figure 3 Interface Design

CHALLENGES

The proposed interface design should be useful to healthcare researchers as well as healthcare professionals.

What are the experiences using voice recognition to command a Pleo, or another social robot? How useful is using a smartphone work in practice? How useful is the use of a mobile application in practice? What need a healthcare professional to see on the interface panel and how could this be tested?

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KEYNOTE SPEAKERS

ILLAH R. NOURBAKHSH

Former Robotics Group Lead at the Ames Research Center of the National Aeronautics and Space Administration, is currently, Professor of Robotics at The Robotics Institute, Carnegie Mellon University, Pittsburgh, USA

Professor of Robotics, **director of the Community Robotics, Education and Technology Empowerment (CREATE) Lab**, is associate director for faculty, and **head of the Robotics Master Program in The Robotics Institute at Carnegie Mellon University**. His current research projects explore community-based robotics, including educational and social robotics and ways to **use robotic technology to empower individuals and communities.**

The CREATE Lab's researchers lead **diverse projects**, from the application of GigaPan technology to scientific, citizen science and educational endeavours internationally to **Hear Me**, a project that uses technology to empower students to become leads in advocating for meaningful social change; **Arts and Bots**, a program for creative art and robotics fusion in middle school; **Message from Me**, a new system of communication between pre-K children and their parents to improve home-school consistency; Exprorables, interactive visualization **tools that empower communities of practice** to make sense of data and communicate to broad audiences, to many other programs.

The CREATE Lab's programs have already engaged more than 23,000 people globally, and the **CREATE Satellite program** is forging additional CREATE Lab partners in new geographic zones. While on leave from Carnegie Mellon in 2004, he served as **Robotics Group lead at NASA/Ames Research Center.** He was a founder and chief scientist of Blue Pumpkin Software, Inc., which was acquired by Witness Systems, Inc.

Illah earned his bachelor's, master's and PhD in computer science at **Stanford University** and has been a faculty member of Carnegie Mellon since 1997. In 2009, the National Academy of Sciences named him a **Kavli Fellow**. In 2013 he was inducted into the **June Harless West Virginia Hall of Fame.**

He is co-author of the second edition MIT Press textbook, **Introduction to Autonomous Mobile Robots**. He is author of the MIT Press book for general readership, **Robot Futures**. Most

recently he published **Parenting for Tecnology Futures**, as an Amazon paperback.
He is a trustee of the **Claude Worthington Benedum Foundation**, and he is Chairman of the **Board of Directors of the Southwestern Pennsylvania Environmetal Health Project** He is also CEO and Chairman of **Airviz Inc**. a company dedicated to empowering individuals regarding home air quality.

Keynote: Robotics and Technology Fluency

Illah R. Nourbakhsh Professor of Robotics The Robotics Institute Carnegie Mellon University, USA

Abstract:
As technology practitioners in health and education, **we care deeply about the impact of robotic technologies and social robots on individual persons that are frequently our focus.** In understanding these issues, it is also important to **consider future scale**, from how individuals could benefit from robotic technologies to how **whole communities can be impacted by these same technologies.**

In this talk, I **provide remarks concerning the ethics and ramifications of robotics on communities**: from problem-finding, citizen science, advocacy and change-making, we will discuss how robotics can shift the goal of technology literacy to a more intimate and powerful concept of technology fluency, whereby communities directly influence their future through the use of interactive robotics. **I will provide examples with behind-the-scenes views of projects at The CREATE Lab at Carnegie Mellon University.**

CARME TORRAS

Research Professor at the Spanish Scientific Research Council (CSIC). Head of the Perception and Manipulation group at the Robotics Institute in Barcelona

She holds M.Sc. degrees in Mathematics and Computer Science from the University of Barcelona and the University of Massachusetts, Amherst, respectively, and a Ph.D. degree in Computer Science from the Technical University of Catalonia (UPC).

In the scientific domain, Prof. Torras has **published five books and near three hundred papers** in the areas of **artificial intelligence, computer vision, neurocomputing and robotics**. She has led 11 European projects and supervised 18 PhD theses on these topics, and she **is currently Editor of the IEEE Transactions on Robotics**. She was Associate Vice-President for Publications of the IEEE Robotics and Automation Society (RAS), and has been elected to serve in the **governing board of IEEE RAS in the period 2016-2018.**

Prof. Torras was awarded the Narcís Monturiol Medal of the Generalitat de Catalunya in 2000, and became ECCAI Fellow in 2007, member of Academia Europaea in 2010, and Member of the Royal Academy of Sciences and Arts of Barcelona in 2013.

In the literary domain, her robotics novel, ***La mutació sentimental*** (*The Sentimental Mutation*), won the Manuel de Pedrolo Prize and the Ictineu Prize to **the best Catalan science-fiction book published in 2008**, and it was later translated into Spanish. She has contributed to several collective volumes, and her story ***La vita e-terna*** **won the 2014 Ictineu Prize to the best SF short story**. Her non-SF novels ***Pedres de toc*** (*Touchstones*) and ***Miracles perversos*** *(Perverse Miracles)* won the **Primera Columna** and the **Ferran Canyameres awards,** respectively**.**

Prof. Torras has participated in many activities to promote **Ethics in Robotics**: she has delivered talks at local, national and international venues (e.g., at **ICRA-13's forum "Robotics meets the Humanities**"), and she has written several essays on science fiction and ethics (e.g., in the Interaction Studies journal, the Mètode Science Studies journal, and periodicals like El

País). **She is currently developing some pedagogical materials to teach Roboethics based on her novel *The Sentimental Mutation.***

Keynote: Robotic assistants: research challenges, ethics, and the role of fiction

Carme Torras
Research Professor at the Spanish Scientific Research Council (CSIC). Head of the Perception and Manipulation group at the Robotics Institute in Barcelona

Abstract:
Robot assistants pose new, very attractive **research challenges.** They should be easy to command by non-expert users, intrinsically safe to people, able to manipulate not only rigid but also deformable objects, and highly adaptable to non-predefined and dynamic environments. A quick overview of research on these topics will be provided.Robot assistants pose also fundamental **ethic questions.** How will our increasing interaction with them affect individual identity, society and the future of humankind? Can this evolution be predicted? Can it somehow be guided? Philosophy, psychology and law are shedding principled light on these issues, while arts and **science-fiction** freely speculate about the role the human being and the machine may play in this “pas à deux” in which we are irremissibly engaged. We expect to trigger a stimulating interchange of views with the audience at the end of the talk.

ELIZABETH ANNE BROADBENT

Associate Professor in Psycological Medicine. School of Medicine, Faculty of Medical and Health Sciences, Auckland University, New Zealand

Elizabeth initially trained as an **electrical and electronic engineer at Canterbury University to pursue her interest in robotics.** She then worked at **Transpower, Électricité de Tahiti, and Robotechnology**. After becoming interested in the psychological aspects of robotics and in psychoneuroimmunology, she obtained her MSc and PhD in health psychology, supported by a **Bright Futures Top Achiever Doctoral Award.**

She received an **Early Career Award** from the International Society of Behavioural Medicine and **Early Career Research Excellence Award** from the University of Auckland. She was a visiting academic at the school of psychology at **Harvard University** and in the Program in Science, Technology, and Society at **Massachusetts Institute of Technology (MIT)** in Boston, USA.

Her current research interests include **how stress affects our health, how our body posture affects our mood**, interventions to help patients make sense of and cope with illness, and **human-robot interaction in health contexts**. Her work has been supported by grants from many agencies including the Health Research Council, Auckland Medical Research Foundation, Heart Foundation, Oakley Mental Health Research Foundation, Maurice and Phyllis Paykel Trust, and the Foundation of Research Science and Technology.

Keynote: The benefits of companion robots for patients with chronic illness

Elizabeth Anne Broadbent Associate Professor in Psychological Medicine. Aschool of Medicine, Faculty of Medical and Health Sciences. Auckland University, New Zealand

Abstract:

Over the last decade, the Cares group at the University of Auckland has developed and tested healthcare robots. These robots include i**Robi** and**Charlie**, which can support people to manage long-term conditions at home by providing functions such as medication management and symptom monitoring. The robots can also assist residents in rest homes and patients in general practice clinics to manage their health.

Elizabeth is the leader of human robot interaction research in this team and has lead **studies into the acceptability of these robots as well as their effects on health outcomes.** She has also lead randomised controlled trials with**Paro** a companion robot, to **investigate its effects**

on loneliness in rest home residents and on outcomes in people with dementia. The team has employed a range of methods **to study interactions with robots**, including focus groups, questionnaires, prospective observational studies, experiments, and randomised controlled trials in health settings. **These studies have shed light on which functions to develop for healthcare robots**; what people want robots to look, feel and sound like; how much mind and personality people attribute to robots; what makes robots seem creepy; **how acceptable robots are to patients and staff; as well as the benefits, harms, and cost-effectiveness of healthcare robots.**

In this talk Elizabeth will give **an overview of this research to date**. She will describe the team's most recent randomised controlled trial employing robots at home to support patients with chronic obstructive pulmonary disease and reduce hospitalisations. The implications of these results and recommendations for the future development of healthcare robots will be discussed.

DANIEL J. HANNON

Professor of the Practice in Human Factors Engineering (part-time), Department of Mechanical Engineering, Tufts University, Boston, USA

Research Interests

Dr. Hannon is both a **psychologist and an engineering professor with a research career that has been centered on studies of human interactions with complex socio-technical systems.** His engineering work has spanned a range of application areas, including transportation systems, team performance, education, and health care, and **has integrated engineering with psychology in his work with Autism Spectrum Disorders (ASDs)**. As a psychologist and professor of the practice in human factors engineering, much of his work has been conducted through **field-based studies, human-in-the-loop simulations, on-site system development, and through group workshop activities.**

Projects in transportation systems have included the development of airport surveillance technology for virtual air traffic control towers, and the development of simulation systems for driver training. **Work in team performance** has included understanding team member interaction with technology in co-located and distributed configurations. **His work in education** has focused on the development of educational technology, particularly with respect to classroom-based equipment that provides an **opportunity for students and teachers to work collaborativel**y. **In the area of health care,** Dr. Hannon's work has explored the creation of medical devices and decision support tools, and the use of technology in non-traditional approaches to providing care, including mental health. **Current work is exploring educational technology applications**, such as robotics and rapid prototyping equipment to support vocational and social skill development in adolescents with ASDs. In all of this work, the goal is to offer people new ways of interacting with each other through the use of information technology.

Much of Dr. Hannon's work is guided by an interest in perceptual control theory and cognitive systems engineering. Through these approaches, it is possible to focus on motivational and situational elements that influence the decisions people make while operating in a complex environment.

KEYNOTE SPEAKERS

Keynote: The Ties that Bind: Social Skills and the Theory of Mind

Daniel J. Hannon Professor of the Practice in Human Factors, Department of Mechanical Engineering TUFTs University, Boston, USA

KEYNOTE SPEAKERS

FUMIHIDE TANAKA

Faculty of Engineering, Information and Systems, University of Tsukuba, Japan

Fumihide Tanaka received a Ph.D. from Tokyo Institute of Technology in 2003. His dissertation was about **multitask (lifelong) reinforcement learning.** Then, he joined Sony Corporation as a research engineer for entertainment robots, AIBO/QRIO.

In 2004, he started a collaborative research project with the Machine Perception Laboratory in the University of California, San Diego where he and his colleagues conducted **a long-term field study of robots interacting with young children in a nursery school.**

Since then he has been actively working in the area of educational robots and child-robot interaction, and now is recognized as one of the pioneers in this research area. He moved to academia in 2008, the University of Tokyo (**ISI Lab** directed by Prof. Yasuo Kuniyoshi, -2014), and the University of Tsukuba (current).

Keynote: Title (TBC)

Fumihide Tanaka,

Faculty of Engineering, Information and Systems, University of Tsukuba, Japan

Aisoy

Building revolutionary emotional robots for making our lives more fun and easier, a social robot that has the power to engage like never before..

Aisoy1 V5, is a very affordable programmable social robot. It is not a toy. It is a powerful almost magical device, that enables people, of all ages, to explore social robotics, and learn how to program social robots in languages like Scratch, Blockly and Python. It is capable of doing most of the things you'd expect a social robot to do, from talking, to feeling if you touch it or move it and playing games. Education needs to adapt to current times and prepare our kids for the future, not giving the answers but promoting an attitude based on "learning to learn" and discovering how things work. Learning to enjoy to investigate, analyze, build, establish a hypothesis, experiment, discover, collaborate, share and communicate.

Kids need to touch, play and experiment with real things (not only multimedia things) by themselves **Kids need** something new that surprises and engages them – something magical **Kids need** a personal strategy with things going at their own speed because of different levels and types of intelligence in the classroom as well as at home.

Aisoy Social robots are real and magic, because they are interactive robots!

Pal Robotics

PAL Robotics is a worldwide leading company in biped humanoid robots based in Barcelona. The team is composed of about 30 people from different nationalities, mostly engineers in the fields of mechanics, electronics and software that design, craft and customize humanoid robots.

Founded in 2004 by four engineers, we have successfully built several robots for services and research, contributed to open-source projects and participated in several robotic competitions.

Our current robots are REEM, the event robot, REEM-C, an advanced humanoid biped robot, TIAGo, a mobile modular research robot and Stockbot, an autonomous 3D inventory robot.
PAL Robotics continues its R&D efforts on humanoid robots, for both commercial and non-commercial models, and thus keeps its original objective to supply robotic products and services that will **improve the daily work and quality of life for both its customers and users.**

Dynatech

Dyna Tech 2012 is a Spanish SME founded in 2012 **focused on creating innovative solutions and business cases on robotics, smart home and Internet of Things environment.** Dyna Tech delivers efficient, easy and tech-transparent cloud based solutions developing both, hardware and software, and, in consequence, **tailoring the solution to fit the client's needs and expectations.**
Robotics, more precisely, social robotics, is and has been the main research focus of the company, where a great impact and benefit on how people learn, recover and improve their social skills can be achieved. The Hookie robot project, for example, is meant to help high functioning authistic children improve their social and engagement skills. Mixing robotics with children is one of the big focus of the company, as it has been teaching robotics to children since its start.
Dyna Tech 2012 offers its expertise in developing cutting-edge software/hardware cloud (IoT) based solutions carefully tailored to any specific needs. Also, it makes available its robotics knowledge through training, consultancy and specific research.

Instituto de Robótica para la Dependencia

EXHIBITORS

Instituto de Robótica para la Dependencia (Robotics Institute for Dependency) is a non-profit private foundation in Sitges, Spain. It was created in 2014 by Fundació Ave Maria (Ave Maria Foundation) to separate caregiving activities from innovation activities, after 30 years of experience, to specialize the institute and make it an international reference.
The aim of the Institute is to improve quality of life among people with disabilities, their families and the care professionals providing them support, through the use of the most advanced technologies, obtaining innovative products that transform the way things are done today, transferring our knowledge, working efficiently, with quality, safety and sustainability. To that end, IRD has collaborates with the industry associations in Spain to collect and prioritize the needs of the dependency sector and also to start the projects that will provide solutions to most relevant needs.
Research Lines:

- Cognitive training for individuals with ID using robotics and assistive technologies.
- Socially assistive companion robot for transportation of individuals with ID.
- Mobile robots for meal and laundry transportation.
- Automated detection of individuals engagement and emotional state to facilitate feedback based treatment.

Ro-Botica

RO-BOTICA operates in the B2C and B2B space providing advanced, versatile and friendly solutions in robotics.Out goal is to bring robotics to education and encourage technological vocations among young people.
We work with the most innovative brands world wide to bring their products and services to individuals, education organisations, foundations and governments that are committed to technological and social change.
We carefully select our products achieving the widest offering in robotics for teachers and fans, from primary school to university, for each requirement and budget. We have proven experience in classroom equipment and support, training courses, workshops and competitions. **Our capacity to generate synergies translates in the biggest partners network is this filed, including vendors, institutions and organisations.**

VanPaz

VanPaz is a Dutch SME that aims at contributing the advancement of ICT with societal impact especially for frail people: the elderly, children with special needs, and chronic patients. Social robotics has been one of the early focus of the company also thanks to the collaboration with DynaTech 2012 and their Hookie robot. VanPaz bridges the gap between cutting-edge R&D and market by mentoring promising researchers on the business aspects of their work as well as searching for funding sources for their businesses.
The company was founded in April 2016 by two enthusiastic entrepreneurs with complementary expertise: Jan Geert van Hall, an experienced business developer with a track record as group controller in KPN first and CFO of a ICT holding later, and Giovanni Pazienza, a PhD researcher with a long international experience in academia and technology transfer.
VanPaz offers its expertise on public/private funding (within and beyond H2020) to international consortia. Also, it provides business and technology consultancy to SMEs and start-ups, in which it may participate as shareholder. Finally, it carries out its own research and development agenda in data science applied to the Health and Life Sciences domain in collaboration with numerous academic and industrial partners.

Everis

Everis Nextgen leads the next wave of digital revolution within everis and NTT Data, focusing on **disruptive assets and initiatives leveraging exponential technologies.**

SIMA

At SIMA Project we decide to build a personal, humanoid-robot for kids, to play teach and learn. We have developed a robotic body that when is merged with smartphones setup the SIMA Robot. A robot companion able to hear, communicate and interact by gestures and voice. We´ve decided to leverage on what we consider is a very common device, to give connection and sensor to our robots and in this way made it more accesible for everyone.