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Understanding then modeling roboticists perceptions of assistive robots

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Abstract—**This study evaluates the level of acceptance of a robot within robot experts. Participants (N=30) were given a questionnaire in order to analyze their expectations of social robotic assistants. We got rich and interesting answers and the results show that from a robot expert point of view, for example, safety is the most important parameter to be considered when designing or dealing with a robot. In fact the overall results are quite different from the researches done previously on literature as these studies always focus on common people perception of robots and neglect the experts that are the best qualified to understand the factors that may increase social robots acceptance and adoption.**

Keywords—social robots; assistance; acceptance parameters; user expectations

I. Background and related work

Social robots are increasingly being applied to home, eldercare or healthcare settings in general, which means that a robot interacts socially with common users having little or no formal training about social robots usage and technology[1]. Several researches confirm that social assistive robots are expected to be an important part of people's daily life and that radical technology, such as robots, may not be as readily accepted as incremental technology[2][3]. Thus, it's very important to understand the factors that may increase robots acceptance and adoption among users.

Acceptance has been widely analyzed and studied for other aspects of technology. For example, in the information systems literature, a number of technology acceptance models have been developed, such as the Technology Acceptance Model[4], the Unified Theory of Acceptance and Use of Technology Model[5] and the Chain Model[6]. All these models differ in complexity and content, but, their goal   remains to understand, explain and model predictive variables that are strongly tied to user acceptance.

In fact the different acceptance models established help to understand the main factors that may influence the robot acceptance in general. This will help designers and developers or engineers be close as much as possible to the user's expectations from using a robot for domestic or health purposes for example.

In order to go into a deeper analysis, we have identified several researches in the literature that analyze all the influencing parameters that impact user's acceptance of social robots such as robot task, robot social capability and robot appearance.[26][27]

A. Robot task

Some robots are destined to accomplish a defined work or task, for eldercare or healthcare purpose. The home applications are being widely demanded and have a large market too. We can classify the robot task into different categories:

1) Rehabilitation robots [7] [8] [9] [10][11]

Mainly the wheelchair robots and other mobility aides [12] [13] [14] [15]. In fact robots are widely demanded in this kind of assistance. These assistive mobile robots aid stroke patient rehabilitation by providing monitoring, encouragement, and reminders. They navigate autonomously, monitor the patient's arm activity, and help the patient remember to follow a rehabilitation program.

2) Eldercare robots

There is a growing need for new technologies that can help the elderly in their daily living. In fact people seem to prefer more and more to live in their own instead of being in sheltered homes or nursery homes, when problems related to ageing start to prevent them from leading a normal life. Some of the robots developed for this kind of assistance have the main function of keeping users up to date with nursing home schedules [16] [17]. Other robots are designed to act like pet companions. In fact some results prove that pets at home can help reduce stress and depression [18]. In fact researchers attempt to recreate these results with a companion robot [19]. Some types of robots are used to assist senior citizens with disabilities [20].

3) Home assistance

Even for people of all ages without any physical disabilities, robots may play an important role in saving time and effort, mainly because people don't have enough time to take care of their houses due to professional engagement and responsibilities. These household activities can be vacuuming, cleaning etc.

Researchers are currently working on the design of this kind of robots and soon we expect them to be potentially able to take care of the house and assist with daily living tasks [21]. Ezer and al. [22][23][24] performed a survey destined to 60 young people and 117 old adults. The goal of this survey was to better understand the characteristics of an assistive robot at home.

The results, after analysis, show that both younger and older prefer to have robots perform critical tasks. Participants least preferred to use a robot for tasks that involved a lot of interaction with the robot, or to form friend-like relations with the robot [25]

B.   Social robot characteristics

The challenge when designing a socially interactive robot is to develop a robot with social skills and bond with the users and that can show empathy and true understanding. To reach these goals, the robots must have some specific characters.

1)   Autonomy

This is an important factor that researchers widely investigated in literature.

David F. and al [26] concluded that ideally a Socially Assistive Robot (SAR) is a system that requires no expert operator or extensive training for use. It should be self-explanatory and capable of being started, stopped, and configured by persons already providing care with a minimum burden placed upon them. It must also be conform to the changing routines and demands of the user and caretakers.

2)   Form and appearance

Major focus of research regarding social robots is on improving its interaction with humans in a certain context by studying the appearance of robots and how they can affect their perception as concluded by Kiesler et al [29]. Thus, there is a strong need to better understand the expectation of people regarding the robot shape and appearance.

As an assistive and interactive technology, a robot should have an appearance that is suitable for its target user group and the system should fit the expectations of the population it's destined to assist. Some researchers concluded that there may be differences among people in the acceptance of the robot appearance depending on their age, culture, health and personality [30]

C.   Goals of Current Research

User acceptance of robots is complex and influenced by many factors including the robot functionality, appearance and person factors like perceptions of ease of use and usefulness. Additionally, the type of task a robot performs can influence perceptions and acceptance of the robot.

The goals of the current study are to:

- Identify the tasks that robot experts would like to be assisted in using a robot.
- Determine the relevant parameters that will influence their choices regarding the robot's appearance.
- Mainly, know if experienced people in robotics such as researchers, future engineers and robot designers will suggest new ideas concerning the robot attitude and the parameters to take into account, when designing a robot, that a simple user can't perceive from his limited experience with robots.

II.   Method adopted in our research

There were total number 30 participants from 'Giorgia Tech' in Atalanta USA, including 10 participants from HRL laboratory with an average age of 26 years old and 20 participants from RIM laboratory with an average age of 30 years old.

The subjects are from both genders: males and females and had different occupations: graduate students, doctors, post doctors professors etc. Thus all the participants have a robot knowledge experience or at least familiar with robots.

A.   Open questions

We developed an open questionnaire that consists on the two following questions:

#Q1: According to you, what might be the most influencing parameters to consider when humans have to interact with robots?

#Q2: Please indicate the type(s) of situation(s) that you were thinking about while answering the #Q1 (examples: Entertainment robots, robots for rehabilitation, Assisting robots for elderly people, assisting robots for people with mobility impairment, etc) ?

The goal from suggesting open questions is to avoid guiding the participants in their responses, and to gather the maximum of suggestions especially for #Q1.

After answering #Q1 and #Q2 the subjects have the possibility to leave a comment such as a personal point of view or a proposition related to the questionnaire.

The idea is to gather data that reflects a user vision of the robot, starting from the application domain and the purpose from interacting with a robot to the different criteria that better fit his expectations and preferences regarding the appearance, shape, attitude etc.

B.   Hypothesis proposed

There are two hypothesis suggested

H_0: The results obtained by addressing robot experienced people will be different from the ones found in literature that aim to know end user's perception of assistive robots acceptance.

H_1: The results will show no real difference with what is suggested in literature, the robot expert expectations from an assistive robot are in line with a simple user opinion.

III.   Results analysis and interpretations

We gathered the answers and tried to classify them by putting together the similar answers in order to create groups with significant numbers that will help us convert the answers into percentages.

A.   Analysis of the questionnaire results

By examining the different answers for #Q2 from both laboratories we found that the most significant application domains from a user point of view can be split into two main categories.

- **Entertainment robots**

The robot is used in order to entertain people by its behaviors and interactions, it can be a playmate, a dancing robot etc.

In such case, the user is a spectator.

- **Assistive robots**

The robot is used for other purposes. The assistive context can be divided in subcategories:

a) Rehabilitation and mobility impairment
b) Specific risky tasks
c) Home assistance
d) Assistive robots for elderly
e) Manufacturing

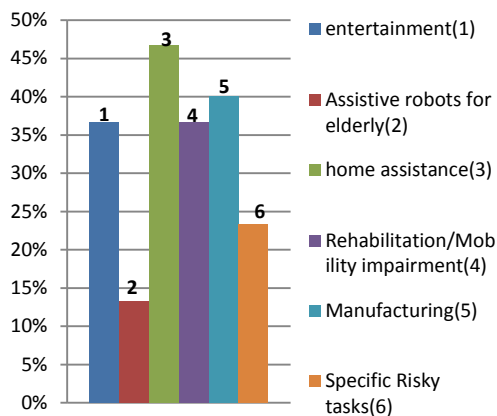Figure1 shows the percentage of the different results gathered.

Fig.1. Robot application domains chart

We used a professional statistics tool (SPSS) to provide us with the different results.

We can notice that a large percentage of participants (46.7%) would have preferred to use robots for home assistance purpose. We got several suggestions proposing a robot helping in daily life, doing home tasks, this is a relevant criterion when evaluating the user's acceptability of these technologies.

Results show also that people's preference in second place (40%) goes to manufacturing. In fact they seem to need robots the most in workplace, performing automated tasks for example. Thus, this robot category should be designed to accomplish this function taking into account the environment and the type of activity it will be performing.

In the previous list of potentially relevant robot application domains, we found that the lowest percentage went to assistive robots for elderly. This can be explained by the average age of the subjects (LAB1 ~ 26 years old & LAB2 30 years old) which represents a youth population.

The percentage would be different if this questionnaire were destined to an aging population as expectations from the use of this sophisticated technology would vary from a population category to another.

Rehabilitation and mobility impairment is another domain where socially assistive robots can provide therapeutic benefit. It's growing very fast and becoming a

source of interest of several researchers. This is very pertinent when examining the survey results, many participants (36.7%) proposed rehabilitation and mobility impairment as an interesting sector to work on and to improve.

In addition to the robot's application context study, another core factor to consider when studying social robots acceptance within a given population is to understand how a robot's appearance and behavior affect people's perception of robots.

The idea was to ask the participants what might be the most influencing parameters to consider when humans have to interact with robots (#Q1)

Gathering and analyzing the results, we found that all answers converge to five main categories with different percentages that reflect the importance of each category from a user point of view (figure2)
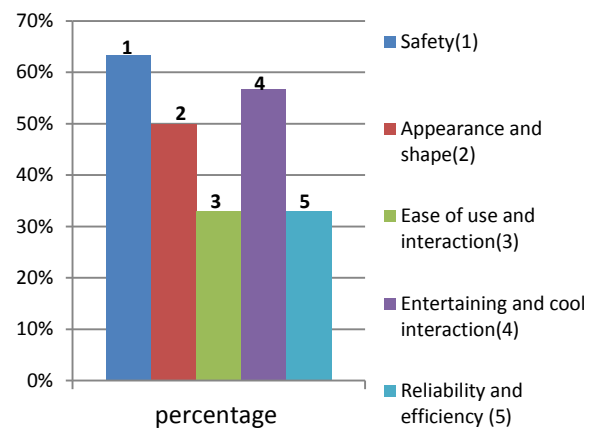

Fig.2. Human-Robot most influencing

parameters

It seems quite clear that the most influencing parameter is the safety with the highest percentage of 63.3%. In the second place after the safety factor, comes the entertaining factor between user and robots, in fact it should be diverting and delightful. Some participants (56, 7%) find that a robot is destined to entertain them while accomplishing the task it is destined to.

In this context we have many suggestions such as: dancing robots, performing funny reactions and having a playful personality. This percentage could be influenced by the youth population that answered the questionnaire, prioritizing the entertaining and funny behavior attitude of the robot.

After safety and the entertaining parameters we find the appearance and shape in third place with an important percentage that can't be neglected, in fact 50% of the participant prefer having a robot with an attractive and sophisticated design. Some participants suggest that the robot's size and dimensions should not exceed the user's one to facilitate the interaction. Others suggest a colorful robot or simply a human like appearance. Ease of use and interaction (33%), reliability and efficiency (33%) had the lowest percentages.

Some participants proposed the accuracy, the cost, the intelligence and speed but with a non-significant rate. In fact, for this question we had a wide variety of answers and

we tried to focus on the most appealing ones that can be classified in the same group.

B.   Interpretation of the results:

The aim of this study is to gain insight into how robot designers and programmers perceived a robot from a user point of view. The goal is to know if this research, by addressing a new category not addressed previously in literature can bring something new to the studies done on analyzing people's expectations from using an assistive robot.

The different answers revealed that the tasks suggested by the participants were mainly related to rehabilitation and mobility impairment (36,7%), home assistance(46,7%).These findings are similar with other researches [26] done previously and highlighting the different tasks driven by the needs of the user. In fact there is a growing necessity for having assistive robots aiding stroke patients with Constraint-Induced therapy and post-operative cardiac patients with spirometry exercises. Like stroke, cerebral palsy is another domain where repetitive exercise plays a key role in therapy. In the other hand many other researches also focus on the home assistance in daily activities aspect, especially for adults with age-related declines in certain physical abilities [31]. These studies show that robots may have the capabilities to support older adults in different activities like ambulation, housekeeping, social communication, dressing, and toileting.

A robot such as Secom's My Spoon[31][32]could assist by waiting for the person to indicate what food he or she would like to eat and then picking up the designated bite-sized morsel and bringing it gently to the mouth for example.

Alternatively, if a person has cognitive and motor impairments, the robot could assist with the whole process of eating: selecting the food, picking it up, and bringing it to the mouth.

Furthermore, the questionnaire data showed a considerable percentage of participants proposing robots for a manufacturing purpose (40%). This finding is consistent with many reviews done recently and proving the evolution of robots in automotive manufacturing. A recent Massachusetts Institute of Technology (MIT) review [33] shows how BMW started to take a huge step toward revolutionizing the role of robots in automotive manufacturing by having a handful of robots work side-by-side with human workers at its plant in Spartanburg, South Carolina. As new generation of safer, more user-friendly robots emerges, BMW's man-machine collaboration could be among the first of many examples of robots taking on new human tasks, and working more closely alongside humans. Proponents argue it will make employees more productive, relieving them of the most unpleasant and burdensome jobs.

The second part of our research aims to better understand the main parameters that influence the user acceptance of robots including appearance, embodiment, perceptions of ease of use and usefulness. As presented in this paper, participants reported that the most important parameter to consider when dealing with a robot is safety (63.3%). This finding differs with the most of the researches done on user acceptance of social robots[34][35][36] that commonly focus on other factors like autonomy, social intelligence, appearance and humain-likeness of the robot etc.

In fact the safety factor is neglected due to the fact that these studies target an ordinary user who can't be aware enough of the factors related to his safety. Most of these users will be interested in the preferred tasks to be performed.

As a conclusion, we can say that these results strongly support Hypothesis H_0 :

H_0: The results obtained by addressing robot experienced people will be different from the ones found in literature that aim to know end user's perception of assistive robots acceptance.

In the second place, comes the entertaining and cool interaction (56,7%) and then appearance and shape with a rate of 50%. This confirms that the appearance and the robot's attitude are mandatory in the robot design and that the user, whatever his education level is or whether he's a robot expert or not.

In fact, the user will always request a funny appearance and an entertaining behavior in addition to the task he must fulfill. That's why science and technology should always focus on this part of the robot as people's initial impressions of them are often influenced by the social ability and intelligence, the embodiment, physical attractiveness etc. [34]

Another recent research done recently by the European commission called "Public attitudes towards robots" [37] aims to measure public perceptions and acceptance levels among the European citizens located in 27 member states (figure3). We will try to make a comparative study mainly regarding the application fields in order to evaluate the differences between American and European perceptions of robots.

In this survey European citizens were asked about the areas of application for robots and the results showed that they have a well-defined view about the application context. In fact the highest rate of 52% was related to space exploration (52% priority), manufacturing (50%), military and security (41%) and search and rescue tasks (41%).
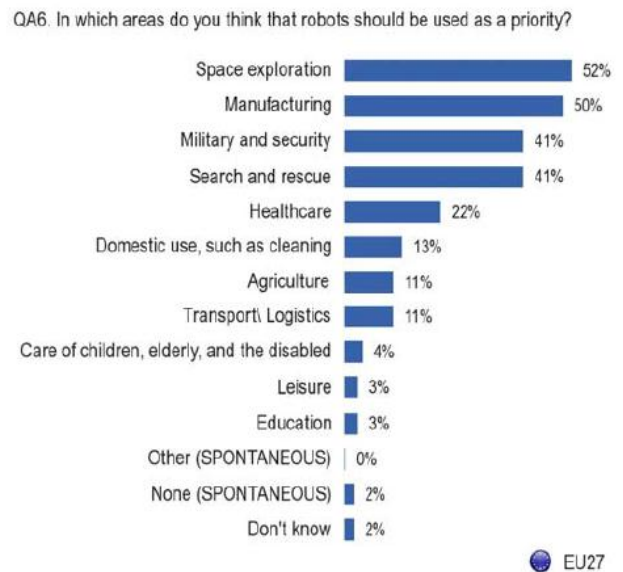

Fig.3. Assistive robots application areas

We notice that for European people, robots should be used as a priority for tasks that are too difficult or too

dangerous for humans. These results are quite different from our results, as the most mentioned priority from an American point of view goes for home assistance (46,7%).

But we can see that the second mentioned priority comes in the second place for both American (40%) and European (50%) participants. The Europoean research shows that domestic assistance comes in the 6th place with a percentage of 13%.

We can conclude that European and American citizens have a different perception toward robots: home assistance is the highest priority for American and comes in the 6th place for Europeans.

We obtained exactly the same conclusion regarding rehabilitation and healthcare. For people in Europe it is mentioned at 22% (5th place) so it doesn't seem a priority, but for American it reached 36,7% (2nd place right after home assistance)

Besides, we can notice that both surveys show that American and European would feel very uncomfortable if a robot were used to look after their elderly parents.

IV.   Conclusion

Through this study we tried to explore the level of acceptance of assistive and social robots from a different corner by targeting participants who have experience with robots design and engineering and who can enrich our studies by their deep studies and knowledge in robotics.

Although many findings were consistent with many results in literature, this study yielded interesting insights into how robot experts perceived assistive robots and enriched our findings with some topics that are neglected in literature.

Finally, although it is attractive to generalize these findings, statistical analysis would lead to more conclusive results if the amount of participants were much higher and if there were more diversity in participants ages, and this is what will try to work on for our future studies.

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