How should a robot caregiver for elderly people be?

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Abstract: - During the last few years, due to the aging of the population, many scientists have developed ICT tools to offer elderly people an independent life at home as long as possible. Most of these researchers focused their efforts on problem solving without adequate care to the agreeability and/or the acceptability of these ICT objects for their users. These resulting artifacts will hardly be used in real life by the users for which they have been developed. In this paper, we will present an experiment done on 202 elderly people over 65 on the acceptability and the likeness features a caregiver robot must have. Starting from a classification of 25 different real robot pictures and the associated questionnaire on the quality of seventeen adjectives describing the first and the last robot selected, our work tried to better understand the hidden and implicit motivations that lead to the acceptance or the rejection of a robot and found some interesting results for appealing or unpleasant features for caregiver robot design.

Key-Words: - Caregiver Robots, Robots for Elderly People, Robot Acceptability

1. Introduction

Populations around the world are rapidly aging and various sources point out this negative demographic transition. According to an estimation by the OECD by the middle of the 21st century more than 20% of the world's population will age 65 and over, and this trend will affect and cover not only industrialized nations but also developing nations [1].

Societies have to adapt to this demographic trend investing in healthy aging. The challenge is to prolong autonomous living of older people maintain their independence at home.

ICT solutions, and particularly AI, could be part of the solution to this problem, enhancing social inclusion and offering support for older adults with the difficulties and challenges associated with aging [2].

Robots could help prolong the time older people remain active and safe in their preferred environment by providing them with assistance in their own homes. And for this reason, the question about robot acceptance is particularly relevant for proper artifact design.

Various researches focused on the study of the functions that a caregiver robot should perform. Numerous attempts to create robotic tools, both in development and commercialization, have been created to carry out specific tasks to help the elderly live at home for longer by performing activities such as medication management, housekeeping, social entertainment and providing emergency monitoring.

However, as shown in literature, technology applications developed for senior users are often discarded due to factors that are specific to this age group of people. Acceptance of a robotic caregiver is a complex and multifaceted issue. Studies conducted on elderly people in usage of ICT tools showed how the reluctance to adopt new technological instruments is not only due to a lack of skills but, also, to the lack of perception of advantages and benefits of using these tools. To ensure acceptance of these new technological tools the age-related changes in perceptual, motor and cognitive abilities must be considered. Combined with these fundamental key aspects, it is necessary to recognize the importance of the compensatory process that older people develop to adapt to their changes and to understand the crucial role played by motivation, affection, and experience in every social interaction. In this context, if we want to increase the likelihood that people will utilize robot assistance, acceptance is a key factor. Indeed, if the development of these robots designed to solve pretended problems does not lead to agreeable and/or acceptable objects to the elderly, they will hardly be used.

As a result, we decided to focalize our attention on older adults' attitudes and preferences for robots, focusing on the aspects that are not functional but kinesthetic, because the acceptability of these tools, for this age group, depends heavily on empathetic factors. Keeping this in mind, we could be able to design robots capable of serving the needs of the elderly.

2. Caregiver Robot

This paper is part of the extensive research landscape that is being carried out today in the field of social robotics. Researches in eldercare proposed robots to be a form of assistive technology with a great potential to support older adults, to maintain their independence, and to enhance their well-being [3].

In literature, assistive robots are classified in two groups according to the function for which they were developed: rehabilitation robots and social robots [4].

Social robots, used in eldercare studies, can then be divided into two other categories: service type robots, developed to be used as assistive devices, and companion type robots, developed to enhance health and psychological wellbeing.

The research in this field is rich and fervid and the technology development in the homecare robotic field is developing faster and faster. Most likely, in the near future, robot caregivers will become feasible and affordable, but, currently, this technology development is largely technology driven. The question if the elderly would accept a robotic assistant at home has still to be more deeply investigated.

In literature, most of the studies measured the acceptance of specific robots with limited functionality [5]. Some papers cover the definition of the tasks that the elderly could delegate to robot assistants. In [6] for example, particular situations where elderly people can accept that some tasks are performed by a robot on behalf of humans are discussed, but this gives little information about general attitudes and perceptions of the elderly about robots because it is too related to the contingency of the performing task.

Other studies investigating the relationship between appearance and functionalities, stated that appearance influences the assumptions that people make of a robot and of the tasks correlated to it [7]. In this meaning, appearance must support the real expectations of the robot's skills. The more the user gets a clear idea of what the machine can do, the less he will be disappointed when using it [8]. Within this vision, functionalities of the robot lose importance and the appearance should be designed just to help users build a mental model of the robot usage [9].

On the other hand, researches also emphasized how the technologies for assistance, designed to facilitate autonomy, are often perceived as a handicap or aging signal and this realization can lead to their rejection. Therefore, the design of assistive ICT tools should be universal. It should aim at de-stigmatizing assistive robots making them appealing and useful for everyone and not just for the elderly or disabled [10].

Finally, as highlighted by Van der Heijden, in ‘hedonic systems’, the concept of enjoyment is crucial for the intention to use a technological tool [11]. Obviously, in eldercare, we can’t say that a robot is developed just for entertaining, but enjoyment needs to be part of the acceptance model for robotic technology.

Our research moves right from this assumption and seeks to understand in advance what the physical characteristics are that affect acceptability, making them the basis for future developments and functional studies.

3. Research question and purpose of the study

This paper examines the physical features that make a caregiver robot fit and usable in order to understand the peculiarities such device should have to be really used by the elderly at home. Caregiver robot have great potential in assisting older adults with activities required for independent living and social participation. However, it is a matter of fact that the acceptability of the tools, for this age group, depends heavily on empathetic factors. We decided to dig into this argument focalizing our attention especially on physical aspects.

This experiment was conducted on 202 Italian people aged over 65. We used a qualitative approach to try to explore and better understand empathetic features that, in some way, facilitate the acceptance and desirability of the robots by the elderly.

Table 1 shows the robots we selected to be evaluated within this experiment. These robots have been chosen among various artifacts developed in the world research scene. We did not limit our choice among social assistive robots, but we also took into account machines belonging to different fields of application like Kismet or ICube.

We created twenty-five cards, one for each selected robot. Each card contains two or more colored images. These images show, in an implicit way, the physical and functional characteristics of the robots and their dimensions. Each participant was asked to judge the robot based on their feelings while observing each card.

We chose our robots according to the class we decided they represent, and our classification can be partially conduced to the Broekens et al. paper [12].

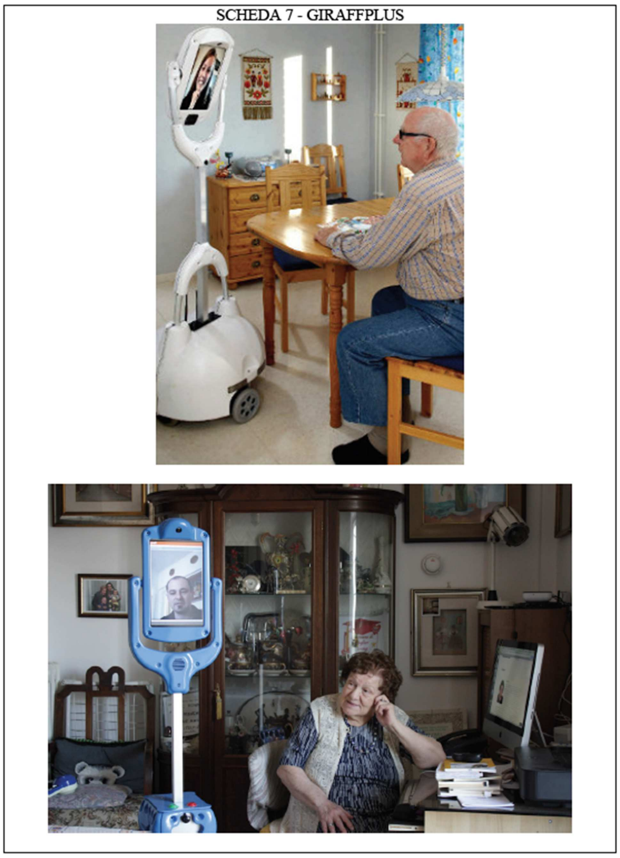

Figure 1: Experiment card example. The 2 pictures display the Giraffplus robot dimension and its possible social interactions.

We have three groups: a medical/rehabilitation class, a social class, where robots are divided in companion type and service type, and a general-purpose class where we put all robots that don't have specific functions.

In the medical/rehabilitation group, the emphasis is focused on the physical assistive technology and function (i.e. Riba II, a robot developed to perform patient-transfer tasks [13]).

The second group is representative of the social robots, systems that can be perceived as social entities with communication capacities. In this case, as stated in literature, we complied with the distinction between service robots and social robots. Service type robots typically investigate which social features can lead to the acceptance of a robotic device at home and how these same social features can facilitate the actual use of the device. Examples of these researches are the German Care-o-bot, a robotic assistant that supports people in their daily living at home performing common tasks like offering drinks, setting the table, switching on the TV or the radio and even calling for rescue service in case of emergency [14], or Giraffplus, a robot developed to check elderly health, ready to rescue in case of emergency and able to put users 'video calls through to their relatives and physicians [15].

Companion type robots focus on pet-like companionship, like the Japanese seal-shaped robot, Paro, [16], the Sony small robot dog, Aibo, or the robotic Japanese cat, Yume Neko Venus.

Medical/rehabilitation robots	iRobi Q	
	Riba II	
	Medical robot	
Social robots	Companion type	Aibo
		Yume Neko Venus
		NAO
		Paro
	Service type	Roomba
		Car-O-Bot
		Giraffplus
		Asimo
		Pepper
		Electronic Sourveillance
		Turtle Bot
		Romeo
		Chess Terminator
		Ramcip
		PR2
General purpose robots	CB2	
	ICube	
	Kismet	
	Mathilda	
	Albert Hubo	
	Wall-E	
	Kobian	

Table 1: List of the 25 robots evaluated within the experiment.

Finally, we added the general-purpose robots group where we put robots that are not classifiable within the two previous groups. They don't have a specific function clearly understandable by looking at the pictures.

3.1. Method

3.1.1. The sample

This experiment was conducted over 202 Italian people aged over 65, participation was voluntary and anonymity was guaranteed. Each participant signed a disclaimer sheet for privacy. Data was collected through personal interviews conducted by graduates in psychology. The duration of each experiment session was approximately 1 hour.

First of all, participants completed a questionnaire on demographics: age, gender, profession and education.

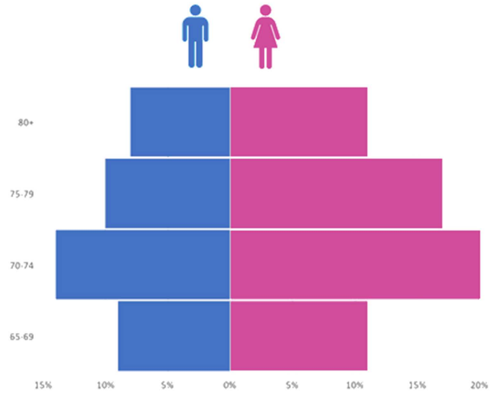

Figure 2: Sample distribution age by gender.

The response sample was composed of elderly Italian adults living independently (N = 202), aged 65 to 87 (M = 74 years; SD =5,5 years). 59% of the sample was composed by female and 41% by male. Participants varied in their educational background, with 39% having college or university education and with 61% having less than a formal college education (35% having only a first-grade education).

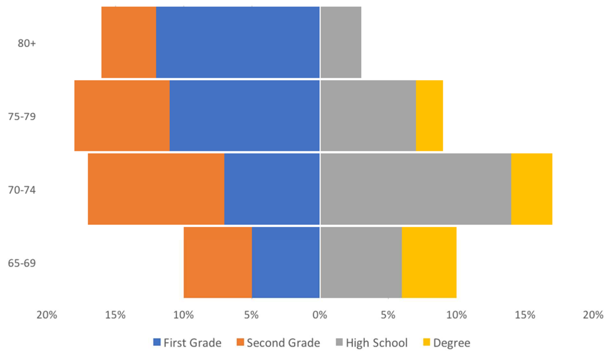

Figure 3: Participant education distribution.

3.1.2. The Experiment Process

The interview occurred in two steps: participants were asked, at first, to put cards in order of preferences. Then, only on first and last classified card, they were asked to assign a vote on a list of defined qualities. But let's analyze the process in detail.

Each participant was asked to judge the robot based on their feelings while observing each card.

Then the participants put the cards in order of preferences. To facilitate the carrying out of this task the conductor presented the cards in pairs.

No verbal information on the role or function of the robot was given to the participants. Conductors were instructed, if questioned about the robot, not to give direct answers, but to stimulate reflection letting the participants construct his own thought about the presented robot.

After that a deeper interview was carried out just for the first and the last card.

The scope was to derive the attitude towards some given characteristics. To do this, each participant was asked, for both cards, to give a value to eighteen quality pairs, using the Semantic Differential with a 5-point scale as the rating scale.

The qualities taken into account were divided in five macro categories and are presented below:

Anthropomorphism

1. False (1) – Natural (5)
2. Dead (1) – Alive (5)
3. Inanimate (1) – Animate (5)
4. Made up of mechanic components (1) – Made up of living components (5)
5. Unable to interact (1) – Able to interact (5)

Liking

6. Disagreeable (1) – Agreeable (5)
7. Friendly (1) – Unfriendly (5)
8. Ugly (1) – Pleasant (5)
9. Dreadful (1) – Pretty (5)
10. Threatening (1) – Harmless (5)

Perceived intelligence

11. Unqualified (1) – Expert (5)
12. Ignorant (1) – Cultured (5)
13. Stupid (1) – Intelligent (5)
14. Foolish (1) – Judicious (5)

Perceived safety

15. Evoking anxiety (1) – Reassuring (5)
16. Unsettling (1) – Comforting (5)
17. Surprising (1) – Normal (5)

Desirability

18. Desirable (1) – Undesirable (5)

4. Results

The results described in this paper will focus on the second part of this study.

A former investigation on the first part of the questionnaire, discussed in “The Acceptability of Caregiver Robots in Elderly People” [17], evaluated the classifying order with the following outcomes: a strong preference for robots similar to small animals or babies, in accordance with previous studies that highlighted a strong preference of older people for small robots in a home setting [18]. In our research, 40% of the sample chose robots with such features as a first robot.

By considering the median, more than 50% of the sample liked Giraffplus and put it within the top 8 positions, confirming the assumption that making home robots more socially intelligent can contribute to acceptance [19]. After Giraffplus we find small robots with characteristics similar to the ones highlighted above.

Moreover, testament to this, is the fact that the robots in the last position are all human-like robots with dimensions greater or equal to human dimensions [17]. The dimensions seem to be a critical factor together with the complexity of their function that could cause a feeling of technological inabilities.

Now, let's have a look at the Semantic Differential results.

We made the mean for each macro category, and then we added those means to have an overall view. To keep into account the fact that this interview part was done only for the first and the last card, we decided to multiply the coefficient of satisfaction of the individual qualities by the average positioning value of the card obtained in the first part of the questionnaire. In Fig. 4, total ratings outcomes are depicted.

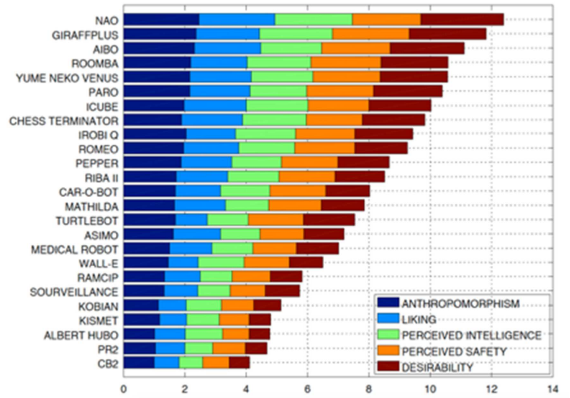

Figure 4: Total quality ratings

We observe that, even if NAO is the one with best grade here, the order is similar to that highlighted before. The ones with higher approval rating (total quality rating superior to 10) are the same we found in the first part of the research. The same consideration is valid for the less popular (total quality rating inferior to 6).

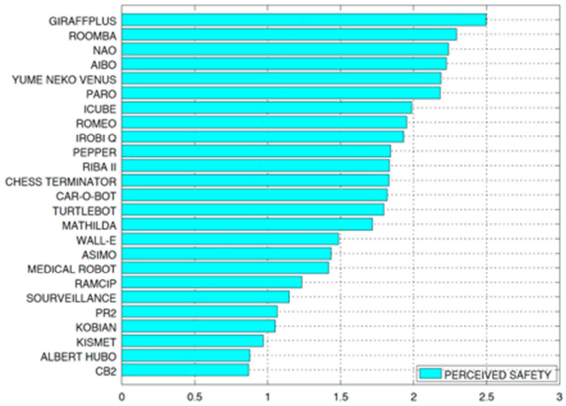

Figure 5: Perceived safety

Looking at the single macro categories we can see that the classification order is more or less the same for all categories, with NAO in the first position, except for the perceived intelligence (figure 5), where the first is Giraffplus followed closed by Roomba, and NAO is only in third position.

Because Roomba is a known robot, its result is hardly surprising. Giraffplus, instead, is a specific and unusual robot (see figure 1). Due to its particular aspect, it feels like it facilitates communication with other human beings. This leads us to reflect once again on the contribution of social intelligence in acceptance of such devices and how communication is a key factor to take into account.

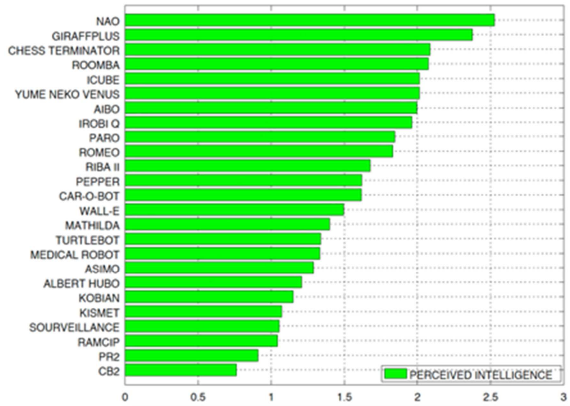

Figure 6: Perceived intelligence

Another thing we should notice is that perceived intelligence assessment leads to a general low performance, barely meeting the threshold of 2 point also for robots that have been found quite desirable.

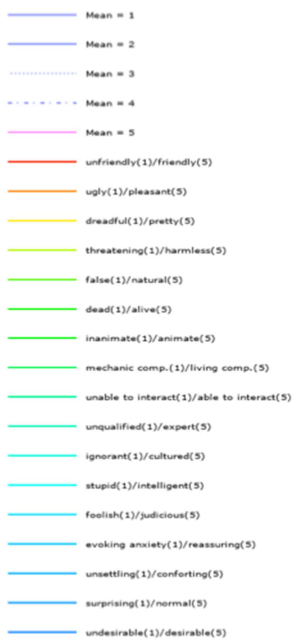

Figure 7: Radar chart legend

Going deeper in this analysis we can consider the single qualities. To do this, we plotted a radar graph for each card. The 5 graph circles indicate the mean score (from 1, the inner, to 5 the outer). The circumference radii represent the seventeen questionnaire adjective couples.

Looking at NAO's radar graph, the first robot in terms of qualities, and of CB2, the last one, one thing that stands out is the peaks reversal.

The worst qualities of NAO are the better of CB2.

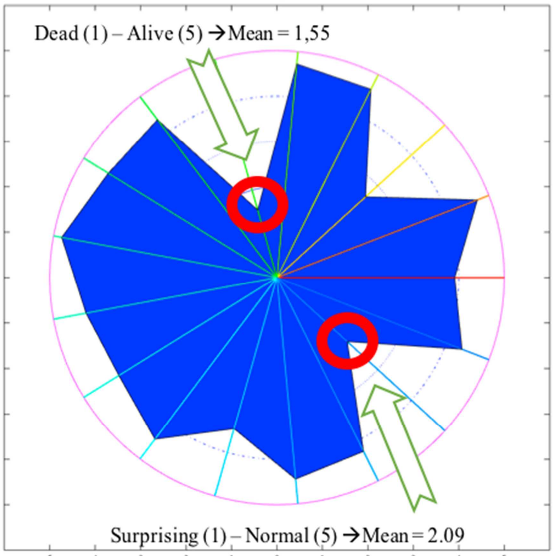

Figure 8: NAO quality radar

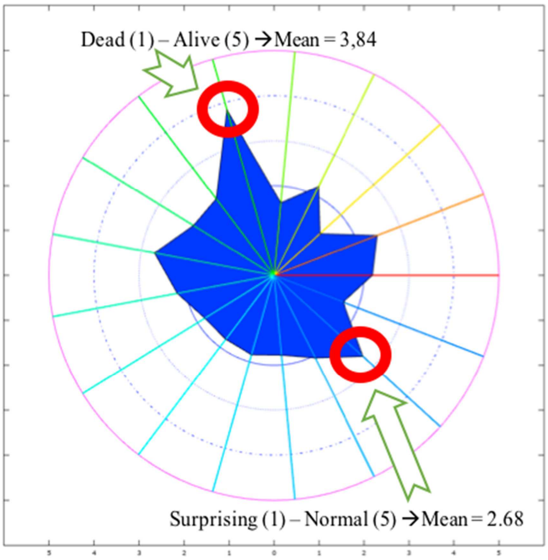

Figure 9: CB2 quality radar

The interviewees seem to sense CB2 alive, while NAO in their perception is dead.

The couple Surprising-Normal lead more or less to the same mean value but, contextualizing it, for NAO we can read it as surprising, as if its deadness appearance brings to something unexpected. While, for CB2, this value is higher than the others and make us interpret it closer to normality.

This trend can be observed, although to a lesser degree, in all the robots with more than 10 point totalized in the total quality ratings. Similar considerations can't be applied to the last positions. We can't identify a trend for the robots whose total quality rating is below five.

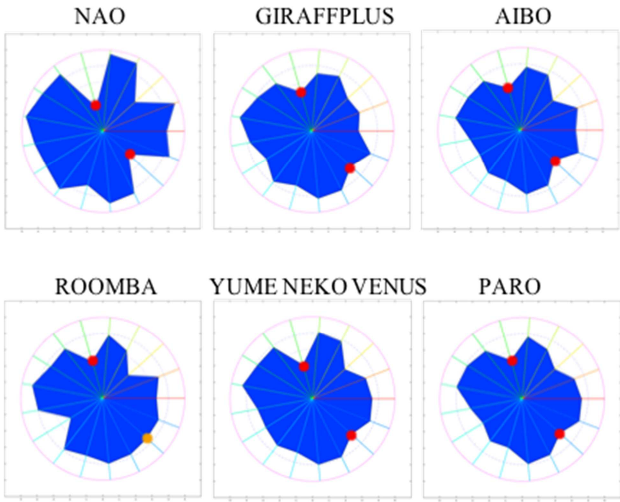

Figure 10: radar of the 6 first robots in the total quality ratings graph

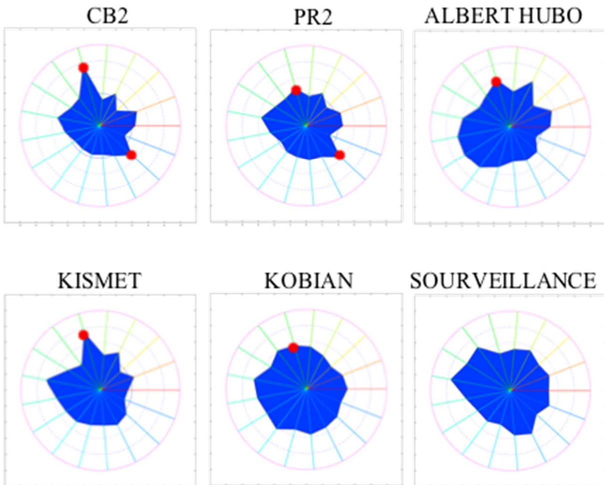

Figure 11: radar of the last robots in the total quality rating graph

5. Conclusions

In this paper, we presented an experiment on the acceptability of robot caregivers done with 202 elderly people as participants. We focalized our attention on the qualities that can help make robots most pleasing to older people.

Preliminary results suggest some important tips for designing a usable artefact.

In other researches, adults interviewed about their imagined home robot, responded in a way that suggested they consider robots as performance-directed machines, rather than social or non-productive devices [20]. Against these results, our study showed a strong preference to small robots that can be perceived as a toy or a puppy while the bigger and specializes ones did not receive good appreciation.

The most critical negative factors are large sizes, excess of human similarity, the feeling of low level of controllability or an overly mechanical aspect.

The most popular robots seem to be the ones that in some way maintain their robot likeness. They are small and can be perceived as a toy or a puppy. Even if the puppy likeness seems to elicit empathy, closeness, and confidence, robots resembling human babies is not sufficient enough to guarantee appeal. The robot should maintain its robot identity, clearly recognizable. Robot likeness, to a certain extent, provides a reassuring aspect of a dead or inanimate object.

Naturally, this suggestion is critical because it is difficult or impossible for small robots to perform some service tasks. Some solutions can probably be found in the direction of the distribution of services: many small robots performing different tasks. Other solutions can be reached by involving elderly people in new robot design.

Other factors to take into account are for sure social capabilities. A robot caregiver should help elderly people, but should also facilitate communication with other human beings, as demonstrated by Giraffpus good performance. In fact, even if Giraffplus is taller than human beings, its non-human like appearance, paired with video communication capabilities gives it the chance to be among the first positions.

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