What is a Robot Companion – Friend, Assistant or Butler?*

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Abstract – **The study presented in this paper explored people's perceptions and attitudes towards the idea of a future robot companion for the home. A *human-centred* approach was adopted using questionnaires and human-robot interaction trials to derive data from 28 adults. Results indicated that a large proportion of participants were in favour of a robot companion and saw the potential role as being an assistant, machine or servant. Few wanted a robot companion to be a friend. Household tasks were preferred to child/animal care tasks. Humanlike communication was desirable for a robot companion, whereas humanlike behaviour and appearance were less essential. Results are discussed in relation to future research directions for the development of robot companions.**

Index Terms – robot companion, robot-human interaction, social robotics, robot appearance, human perception and attitudes

I. INTRODUCTION

An autonomous robot companion might be viewed as a special kind of service robot that is specifically designed for personal use at home. Robot companions are expected to communicate with non-experts in a natural and intuitive way. Robots designed for the home are a growing industry from both a research and commercial perspective. A survey by the United Nations for example has reported that "robots are set to become increasingly familiar companions in the home by 2007." By 2007 it is predicted that there will be almost 2.5 million entertainment and "leisure" robots in homes which compares to 137,000 currently [1].

Human-robot interaction research is still relatively new in comparison to traditional service robotics where e.g. robots deliver hospital meals or provide security services, application domains that require relatively minimal human-robot interaction [2]. However, increasingly robots are meant to engage in social-human interaction including e.g. [3], [4], [5], [6]. Robot companions in the home should ideally be able to perform a wide array of tasks including educational functions, home security, diary duties, entertainment and message delivery services, etc. Currently, there are no robots that are able to perform a combination of these tasks efficiently, accurately and robustly. However, research is under way for developing such robots, e.g. [7]. More and more studies are investigating people's attitudes towards and perceptions of robots. For example, the Sony Aibo [3], an autonomous entertainment robot for the home designed to elicit emotions and show instincts, learning and growth abilities is often used in child-robot interaction studies. Aibo's design has been inspired by dog behaviour and appearance [8]. Research by Friedman et al. [9], and Kahn et al. [10] using unstructured play sessions for children and online discussion forums for adults, demonstrated that AIBO was psychologically engaging for both adults and children in terms of life-like essences, mental states and social rapports. However, participants rarely attributed moral standing to AIBO.

Pransky [11] has provided an interesting perspective for the different profiles a future robot companion could take providing the advantages and weaknesses of such a future companion. The 'Robotic Nanny' would on the one hand play with children and feed them but on the other hand could lead to a child not having any human interaction and viewing robot interaction as the 'norm'. A 'Robotic Assistant/homework companion' would be able to organise your meetings and research, and track documents, but could lead to the feeling that robot interaction is easier than human interaction. Finally, the 'Robotic Butler/Maid' could do all the housework, but may well cause relationship difficulties at home by being too efficient and making one feel redundant.

Investigating the design space of robots is a challenging task that needs to consider various factors [12]. For example, Goetz et al. [13, 14] revealed that people expect a robot to look and act appropriately for different tasks. A robot that performs in a playful manner is preferred for a fun carefree game, but a serious robot is preferred for a serious health related exercise regime. It seems that if a robot cannot comply with the user's expectations, they will be disappointed and unengaged with the robot. If a robot closely resembles a human in appearance but then does not behave like one, there is the danger of the human-robot interaction breaking down. It could even lead to feelings of revulsion against the robot as in the 'Uncanny Valley' proposed by Mashiro Mori [15, 16].

Methods used in psychology can provide a useful starting point for exploring a *human-centred* approach for a robot

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companion [16]. The studies by Khan [17] and Scopelliti, Giuliani, D'Amico and Fornara [18] are among the first to have used a psychological design framework using questionnaires to explore adults attitudes towards the design of a domestic robot. Khan [17] examined adults' attitudes towards an intelligent service robot, using a survey which included a variety of different concepts including what people thought robots should look like, how robots could be used for service purposes in the household, how the robots should behave, and how humans have conceived their ideas and images of robots. The survey revealed that most participants were positive towards the idea of an intelligent service robot. Scopelliti et al. [18] investigated people's representation of domestic robots across three different generations, taking into account gender and educational level, in an attempt to bridge the gap between technological capabilities and user expectations. Their results demonstrated that young people tend to have positive feelings towards domestic robots, whereas elderly people were more frightened of the prospect of a robot in the home.

The European project Cogniron (Cognitive Robot Companion, http://www.cogniron.org/) aims to study many of the above topics surrounding the development of robot-human interaction. One of the key aims of the project is to explore what having a robot companion in the home means to people. We adopted a *human-centred* approach to investigate what people's perceptions and desires for a robot companion are and explored the following research questions:

- Are people accepting of the idea of robot companions in the home?
- What are people's perceptions of a future robot companion?
  - o What specific tasks do people want a robot companion to perform?
  - o What appearance should a robot companion have?
  - o What are peoples' attitudes towards a socially interactive robot in terms of robot behaviour and character traits?
  - o What aspects of social robot-interaction do people find the most and least acceptable?

II. METHOD

The part of the methodology reported here is taken from a larger study where subjects participated in a human-robot interaction study within a simulated living room. The interaction trials and their analysis were the main purpose of the larger study, research questions and results will be reported in forthcoming papers. This paper's subject is the analysis and interpretation of questionnaire data regarding people's perceptions and attitudes towards a robot.

Design: A series of questionnaires were collected before and after an interaction session with a PeopleBot[TM] robot. These robots are used as a research platform for research into *future* robot companions by several research partners in the Cogniron project. It is a human-sized, non-humanoid robot of rather 'mechanical' appearance, specifically designed for HRI experiments. The questionnaires relevant to this part of the study were the Cogniron Introductory Questionnaire (providing demographic details), and the Cogniron Final Questionnaire (investigating people's attitudes and perceptions towards robots).

Sample: Table I illustrates the sample characteristics.

TABLE I: Sample Characteristics

Sample Characteristics (N: 28): Recruited from University of Hertfordshire	
Gender	
Male	50%
Female	50%
Age	
<25	7%
26-35	43%
36-45	29%
46-55	11%
Occupation	
Student	39%
Academic/faculty staff	43%
Researcher	18%
Educational/career background	
Technology related	50%
Non technological (e.g. law)	50%

Instruments:

Cogniron Introductory Questionnaire: This questionnaire enquired about participants' personal details (age, gender, occupation), level of familiarity with robots, prior experience with robots (at work, as toys, in movies/books, in TV shows, in museums or in schools), and level of technical knowledge of robots were rated according to a 5-point Likert scale.

Cogniron Final Questionnaire: Table II outlines the content of this questionnaire.

Procedure: All subjects completed consent forms before completing the Cogniron Questionnaires and robot interaction trials. After completing the introductory questionnaire, subjects were exposed to a series of human-robot interaction trials, cf. fig. 5. Finally, participants completed the Cogniron Final Questionnaire that enquired about future home robot companions and qualitative aspects of the robot interaction trials.

III. RESULTS

Acceptance of robot companions: Responses for acceptance of computers and computer related technology in the home were more positive compared to responses for the likeability of having a robot companion in the home. 82% of subjects liked or liked very much the concept of computing technology in the home compared to just under 40% for a robot companion (Fig. 1 for likeability of a robot companion in the home). No significant differences were found for gender, age or level of expertise with technology.

TABLE II Content of the Cogniron Final Questionnaire

Section 1 (rated using 5-point likert scale)

- What is a robot companion?
- Do you like the idea of having a robot companion at home?
- What role do you think a future robot companion in the home should have?
- What tasks would you like a future robot to be able to carry out?
- How controllable, predictable & considerate should a future robot be?
- How human-like should the robot appear, behave & communicate?
- What speed should a robot companion approach?
- How close should the robot come to you?
- Should the robot pay attention to what you are doing?
- Should the robot be polite and give way if people encounter it?
- Should the robot try to find out if you need help before it helps?

Section 2 (rated using 5-point likert scale)

- Questions about the subjects' feelings after robot interaction session
- Open-ended question about what participants found the most interesting & most annoying during the robot trials.
- Open-ended question about whether anything should be changed regarding the robot (appearance, speech, behavior).
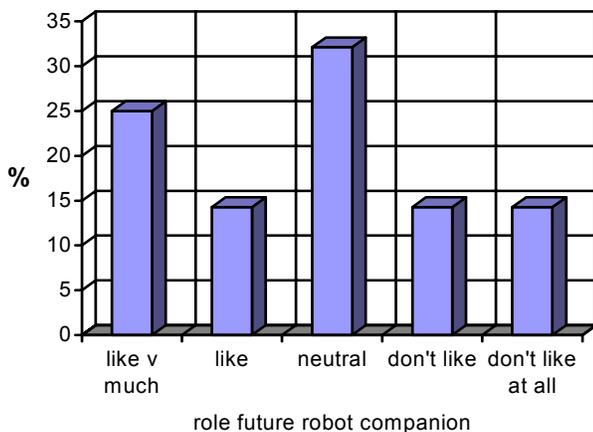

Fig. 1 Likeability of robot companion in the home

The potential role of a robot companion: When asked what role they thought a future 'robot companion in the home should have', the majority of participants wanted the robot as an assistant (79%), a machine/appliance (71%) followed by a servant (46%) (Fig. 2). Fewer people wanted the robot companion as a 'friend' or a 'mate'. [†] Younger subjects suggested that they would like to have a future robot companion in the home as a friend, compared to none of the older subjects (t (26) = 2.69, p = .01). No significant

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[†] Items in fig. 2 & 3 were scored dichotomously as yes/no answers

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differences were found for gender, or level of expertise with technology.

Task performance for a robot companion: When they were asked what tasks they would like this future robot to be able to carry out, the majority of the subjects wanted the robot to be able to do household (vacuuming) jobs (96.4%).
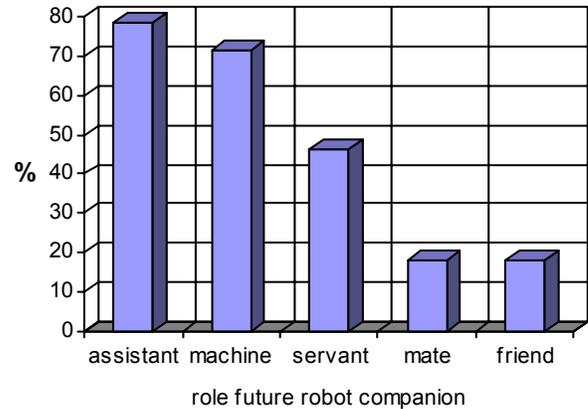

Fig. 2 Desired roles for a future robot companion

Only 10.7% of subjects wanted the robot to be able to look after their children. Guarding the house, entertainment and gardening were also popular choices for robot roles around the home (Fig. 3). No significant differences were found for gender, age or level of expertise with technology related disciplines.
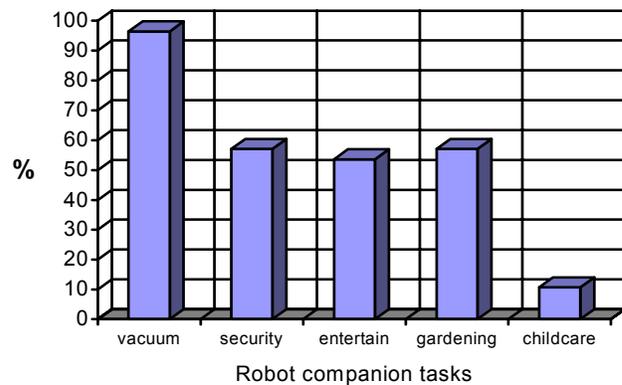

Fig. 3 Preferred tasks for robot companion in the home

Robot companion behaviour traits: Most participants expressed that they would want the behaviour of a robot companion to be highly predictable (54%) or predictable (36%). Only 11% were neutral about the potential predictability of the robot's behaviour. In line with requirements for predictable behaviour, 71% of subjects responded that they would want a robot companion to be highly controllable or controllable. Only one person (4%) stated that they robot should not be controllable. The expression of highly considerate behaviour by a robot companion was also desired by most subjects (86%), and 14% wanted the robot to be behave in considerate manner towards them and other family members. No significant differences were found for gender or level of expertise with technology

related disciplines compared to non-technology related subjects.

Robot companion movement: When asked about what speed a considerate robot should approach, the majority (56%) responded neither fast nor slow[‡]. 22% would want the robot to move at a very slow or slow speed. Regarding how close the robot should come to them, 63% said that it should come close to them. Only 4% wanted the robot to come very close to them. The majority of subjects stated that a considerate robot companion should pay attention to what they are doing (85%). Only 15% did not want the robot to pay them any attention. Most subjects noted that a considerate robot companion should be polite and give way to them (70%). With regards to the robot finding out if the subject would want help with a task, 37% of subjects stated that they would prefer the robot to try to find out if they needed help and 41% would want a robot to quietly wait to find out if they needed help. No significant gender or age differences were revealed. However, subjects who had no experience with robots wanted the robot to pay more attention to them compared to those subjects who had experience with robots (t (25) = 2.41, p = 0.02). Having no experience with robots was also related to how considerate a robot should be and the wish for the robot to find out if they wanted help more than those who had experience with robots (t (25) = 2.33, p = 0.03).

Desired appearance for a robot companion: Participants' responses about human-like appearance, behaviour and mode of communication for a robot companion were somewhat mixed. 71% of subjects would want a robot companion to communicate in a very human-like or human-like manner. However, human-like behaviour and appearance were less desirable. 36% thought that the robot should behave either very human-like or human like, and 29% stated that a robot in the home should appear human-like or very-human like (Fig. 4). Figure 5 illustrates a subject interacting with the PeopleBot[TM] robot.

Fig. 4 Subject preferences for how human-like a robot companion should be. Means and standard deviations are shown

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‡ We are aware that "fast" & "slow" are subjective terms. Since this questionnaire was given after the robot interactions, judgements were likely to have been based on the PeopleBot [TM] speeds which ranged from 200 mm/s – 800 mm/s.

Fig. 5 Subject interacting with PeopleBot[TM] robot in simulated living room

IV. DISCUSSION

The major aims of this study were to explore peoples' attitudes and perceptions towards the idea of having a future robot companion in the home. More specifically, we asked subjects about their level of acceptance of a robot companion in the home, and what types of roles and tasks they would envisage a robot in the home performing.

A summary of the main results indicate that:

- 40% of participants in the current study were in favour of the idea of having a robot companion in the home. This compared to 80% who stated that they liked having computer technology in the home.
- Most subjects saw the potential role of a robot companion in the home as being an assistant, machine or servant. Few were open to idea of having a robot as a friend or mate.
- In terms of specific tasks for a robot companion, 90% stated that it would be useful for the robot to do the vacuuming. This compared to only 10% who would want the robot to assist with child-care duties.
- A future robot companion would need to be predictable, controllable, considerable and polite (possibly based on the current responses of the PeopleBot[TM]).
- Human-like communication was desired for a robot companion. Human-like behaviour and appearance were less important.

It was an encouraging finding that 40% of subjects were in favour of the idea of robot companions in the home, although this figure was lower than the 80% who enjoyed having computer technology in the home. This figure was lower than the 70% of respondents who reported it was a positive idea to have a service robot in the home in the pilot study conducted by Khan [17]. However, this study was different to the current one as it was based on static images of robots and did not involve live interactions. A possible reason for the differences in liking a robot in the home and computer technology could relate to habituation and familiarity effects as computer technology is far more prevalent and accessible to the general public compared to robot companion technology. Also, few subjects were completely against the idea of robot companions
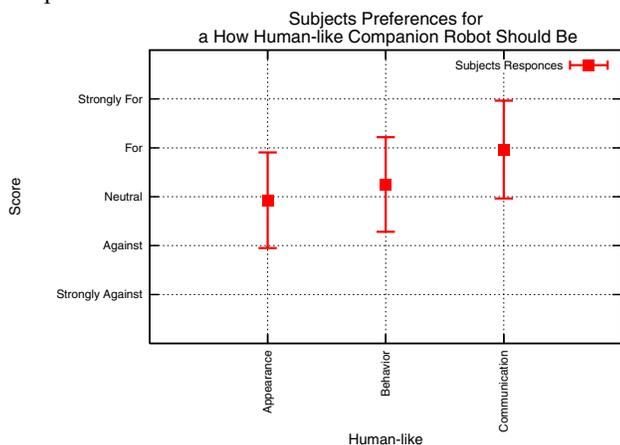
and most subjects appeared to enjoy interacting with the robot trials. Therefore, it is possible that the subjects felt uncomfortable with the idea of a robot companion rather than the reality of the interaction and as robot technology becomes more widely available the differences may become smaller. Dario et al. [19] reported that motor-disabled people were accepting and favourable towards a personal assistance robot in the home, in terms of robot appearance, helpfulness and behaviour. This is in line with our findings although assistive robots are different from more general-purpose robot companions that are relevant to our study.

When the subjects were questioned about the future roles and behaviours of robots in the home, a clear divide emerged. All of the roles which are already, traditionally associated with robots were selected as well as household assistant, gardener and security guard. More than fifty percent of the subjects selected these as roles to be performed in the future. However, roles such as looking after children, being a friend or being a mate were selected by less than eighteen percent of the group. These are all roles which are considered within the 'human domain' and which only a human is able to perform. Some individuals however, in other study can foresee a caretaking role for the robot, for example "I would like having a robot to help me to do something, like taking care of my baby in case he fell from bed" cf. [1]. This could relate to people's perceptions that robots do not possess humanlike personality or character traits. The human fear is sometimes held in the extreme case, that robots could take over the world and replace human abilities [11]. There are no robots currently available on the market able to fully perform the functions of being a child-care assistant or friend, comparable to a human. They are also roles which are the most difficult to prescribe specific actions to in advance, or to specify precisely. These findings are also echoed in a pilot study carried out by Khan [17], which reported that respondents most wanted the robot to perform cleaning tasks. The least cited tasks they wanted the robot to perform were baby sitting, cat/dog watching and reading aloud.

Throughout the study, no differences due to gender or level of technological experience were uncovered for perceptions and attitudes towards a robot companion. Only one age difference was revealed where some younger participants were more in favour of a robot companion taking the role of a friend, compared to none of the older subjects. Likewise, the study by Scopelliti et al. [18] did not find any gender or educational differences towards the idea of robots in the home. However, they found that elderly participants were the most frightened of the prospect of having a robot in the home and showed an element of distrust towards the concept.

Most subjects wanted a robot companion to be controllable and predictable. On one level, any technology for the home should be controllable, in that the user should be able to instruct the device to perform requested actions. However, at the same time, any device should not necessarily require constant supervision, or it ceases to be an aid and instead becomes at best an interface to a task, and at worst something which slows the user down. This finding could again relate to the unfamiliarity aspect and the possible difficulties in imagining the precise functions of a robot companion in the home. Most people want to be able to understand the logic behind technological devices; therefore it was not surprising that a predictable robot companion was desired. Khan [17] reported similar findings as people in their study did not want the robot to be too smart, but able to conduct limited actions according to its programs.

The fact that subjects wanted a robot companion to have humanlike communication was not a surprising one, as it is a natural human instinct to want to communicate using speech and gestures that are recognisable by humans. Somewhat surprising was that participants did not want the robot to behave and appear in a purely humanlike fashion. However, there is growing research evidence for the Uncanny Valley theory that as a robot approaches pure humanlike appearance, people generally exhibit discomfort and even revulsion towards it. This could also be true of humanlike behaviour for a robot and relates to a human perception of feeling threatened [15, 16].

The current study was exploratory in nature and has revealed many findings that could be relevant for future research ideas and robot companion design. However, a potential drawback of the study could be the self-selected university sample that was recruited to participate. Future studies should attempt to recruit a more representative population sample. Also, the cultural background of subjects, which was not accessed in the present study, is likely to have a significant impact on people's perception of robots. Moreover, none of the sample was older than 55 years, which means that the views of an elderly population are likely to be under represented in this study. This study also relied on subjects *imagining* the role of a possible robot companion in the home, although they interacted in two different trials with PeopleBot^{TM} robots before completing the final questionnaire. It is unclear to what extent these interactions might have influenced the subjects' opinions. Also, the trials were not run within a 'real' home and the scenarios did not cover all possible types of interactions and tasks that might occur in a home. In future trials we hope to explore different types of tasks in order to allow subjects to gain a greater understanding of possible robot capabilities. We are also aiming to use longitudinal experimental paradigms with the same sample of subjects, which will allow us to measure whether perceptions and attitudes towards a robot companion change over time as familiarity increases. A further aim is to change the behaviour and appearance of the robot to determine how these factors influence people's views long-term.

V. CONCLUSION

To conclude, the current study explored people's perceptions and attitudes towards the idea of a robot companion in the home. Interesting and positive results have emerged, indicating that a large proportion of people are

favourable to the idea of a robot companion. Results have highlighted the specific roles and tasks that people would prefer a robot companion to perform in addition to the desired behavioural and appearance characteristics. The finding that people frequently cited that they would like a future robot to perform the role of a servant is maybe similar to the human 'butler' role. Ogden & Dautenhahn [20] considered the concept of 'robotic etiquette' in relation to body movements and positioning to convey polite interactions to advance the social-interaction abilities of robots. A deeper exploration of the necessary training guidelines to become a competent butler could aid the design of future robot companions. For example, butlers need to know how to wait discreetly until given an order to perform a task, and to know when to speak to their employer. This requires great awareness and sensitivity to social situations. Other tasks that a competent butler should be able to perform include: supervising staff, ensuring safety and security, answering the door/phone, preparing meal services and social events, and valet duties etc. A mixed quantitative and qualitative approach taken was advantageous for this research program.

As a cautionary note, one has to be aware that in any HRI study it is practically and methodologically impossible to control for *all possibly relevant* factors that might influence an experiment, as well as providing a large and balanced sample size and rigorous analysis. Thus, exploratory studies like the one reported in this paper, while they often raise more questions they are able to answer conclusively (generalizable to all possible robot appearances, behaviours, contexts, tasks, human subjects etc.), serve an important role in HRI research: they can provide a starting point for identifying relevant future research directions that then need to be investigated in more depth in focussed studies.

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