Designing Robot Applications For Everyday Environments

Sara Ljungblad(1) *& Lars Erik Holmquist*(2)

Viktoria Institute
Hörselgången, 4, 417 56 Gothenburg, Sweden
saral@viktoria.se(1), leh@viktoria.se(2)

Abstract

We report from the workshop "Designing robot applications for everyday use". This event gathered robot researchers and interaction designers from several countries in order to push robot application domains in novel directions. This article presents the methods we used for breaking out of limited views of robots, and our process for refining ideas to more realistic product opportunities. Based on the results of the workshop, we discuss current challenges of extending the design space of novel robot product ideas.

1. Introduction

The notion of ambient intelligence involves intelligent computation in daily life, with intuitive, sensitive, adaptive and responsive interfaces [4,12]. Future everyday environments could consist of smart objects, providing information services, personal assistance, entertainment and soon more. Such objects may have robot like properties – for instance being embodied in the world, with the capability to act autonomously.

More than one million robots already provide a variety of services in households around the world [5]. This includes robots like Roomba [10] (developed by iRobot) for automatic floor vacuuming, and robots for entertainment such as Sony's Aibo [11]. Another example is the Paro robot [8] (developed by AIST) stimulating elderly at nursing homes, and enhancing physical rehabilitation of children. Research focusing mainly on issues of social interaction with robots is already a field in itself [3].

The goal of the workshop reported in this paper was to go directly to the core of human-robot interaction – to find out reasons for robots to exist around us in our everyday life. Rather than working on robots that are inspired by visions from science fiction or purely technically motivated research, we wanted to try to generate novel thoughts about robot applications.

2. Workshop Activities

The overall goal with the workshop was to investigate possible robot applications for domestic and other everyday environments. 14 participants and three student volunteers came from Italy, the UK, the US, France, the Netherlands, Australia and Sweden. The group was an interesting mix of robot researchers and interaction designers, from industry and academia, all presenting many different perspectives on robot applications. The workshop lasted two days, and consisted of presentations from all the participants, of a demo session, and of brainstorming sessions. Presentations and personal statements can be found at the workshop website [2].

Figure 1. One workshop participant presented entertainment robots such as the Sony Aibo as an example of robots for everyday environments.

2.1. Participants' Views of Robots

The participants' presentations provided many different views on robots and challenges for designing robotic applications. Several kinds of animal-inspired entertainment robots were presented. The robot-dog *Aibo* and the robot-seal *Paro* are two examples of commercial, autonomous robots. Both are entertaining and amusing in their own right, but were presented from different views. People interact with Aibo for the pleasure of playing, watching him do tricks etc. From a designer's perspective, the challenge with such robots is to keep the users interests. With self-reinforcing dynamics, the more the user interacts with his or her robot, the more the robot's behavior changes, which can create a positive feedback loop. It also introduces challenges to design for users who prefer to be less active with their robot and still want to have an exciting toy.

Several participants in the workshop had experience or were interested in designing applications for people with disabilities. Such robots were used as a tool in cognitive rehabilitation therapy or carried out tasks as a supporting companion. Paro, the cuddly robotic seal baby with sensors and actuators, encouraged children in therapy to engage and interact physically. Another participant presented a service robot on wheels, which provided transport aid (fetching and carrying for example coffee), for a person with motion disability. One participant had experience with assistance dogs, and was interested in how robots could perform similar tasks. Dogs can be trained to sense and predict for example epileptic seizures. Perhaps similar abilities could be embodied in a robot?

The participants were working with different platforms as starting points, raising different perspectives of application prototyping. Some were advanced commercial robots, such as the robotdog Aibo, where researchers and hobbyist owners are modifying mainly the software rather than the hardware. The so-called *Robosapien* humanoid robot [9] is a much less expensive alternative, but it has no sensors – only a number of actuators. Several attendees had experience from prototyping with *Lego Mindstorm* [6] (which is a hobbyist platform), designing simple robots from scratch. Some were also developing their own low-cost platforms, such as a PC on wheels with added sensors. Another potential approach was to let the user breed software robots in a simulated environment, i.e. let the robot-behavior emerge. When the behaviors have developed to a satisfactory level, it would be downloaded to a physical robot. Another view came from a participant working with a virtual conversational agent, interested in the challenge of transforming this to an embodied agent.

Several of the robots presented where designed explicitly to serve humans in social settings. A different perspective came from a participant describing swarm-intelligence and self-reconfiguration. Robots with such properties (e.g. emergence of behaviors, self-assembly, and sensing and communication abilities [7]) are currently used mostly in basic research, but can inspire human-robot and robot-robot interaction.

Understanding a specific usage situation can help to generate application ideas. One participant presented ethnographic studies of peoples' homes as an approach to gain this understanding. He had for instance investigated what kind of items in the home people already think "are like robots". He stressed that what people associate robots and robot properties with is highly cultural and affected by the view media give of robots. It is a challenge to come beyond imaginary constraints, when developing new applications.

Figure 2. The second brainstorm activity involved to randomly pick and attach notes from each category on a paper, and discuss the combination as an application.

Overall the participant came with many different experiences from robots. From entertainment robots like Aibo and a wearable robot responding to body movements, to applications for therapy and human assistance. The presentations provided a good foundation for the brainstorm activities, highlighting various robots and views on applications.

2.2. Application Brainstorming

The overall goal with the brainstorm activities was to make the participants think beyond their own robot research as well as popular visions from science fiction and other sources, and to move beyond existing robot applications. We designed the method to break with potentially limiting views of robots. The brainstorming involved both methods for generating ideas (the first day) and methods for refining them (the second day). Before it started, the participants were divided into three groups with five to six people in each group.

2.2.1. First brainstorm.

The first brainstorm consisted of four different sessions. Each session involved generating content for one of the following categories:

1. Robot type (e.g. humanoid, robotic arm)
2. Robot properties (e.g. emergence, emotional)
3. Place/activity (e.g. on the bus, birthday party)
4. Users (e.g. taxi driver, rock star)

To start off the participants in each session, pre-made paper-notes illustrating examples of possible content were provided. Each category was represented with a specific color of the notes. The participants had exactly ten minutes to generate as many paper-notes (instances of the category) as possible in each session. The aim of exact time constraints was to make people as active as possible. When generating ideas, each example was spoken out loud first, or written directly on a colored piece of paper, put visible on the table.

2.2.2. Second brainstorm.

In the second brainstorm activity the participants engaged in combining one note from each of the four categories to form a concept (see Figure 2). This was intended to be a very playful and open-minded activity: No thoughts or ideas would be viewed critically or turned down, at this point. Before the activity, the participants were told to choose example notes randomly from each category and discuss the combination as an application a maximum of 5 minutes. The goal of the activity was to create as many combinations as possible, and elaborate around each concept only briefly.

The randomly chosen notes created many unexpected combinations and this sometimes suggested extreme application concepts. For example, one randomly generated combination was "toy robot", "softness-sensor", "flea-market", "drug addicts". This generated ideas of a cheap and reusable robot application providing drugs into the body, suitable for people with diabetes. Another combination was "Sony Aibo", "nervous system", "skiing" and "cab driver". This inspired thoughts on a "dog-like" rescue-robot, able to ski and look for injured people in the snow. The robot could act as a taxi, transport injured people to the closest hospital. A third example was "self assembling robot", "multi-user", "library" and "plumber". This created ideas around a robot as a book, or a library caretaker sorting physical books. The envisioned robot could also detect moisture or water in the library. To round up the second brainstorm, the three best ideas from each group were presented for the others.

2.2.3. First refinement of ideas.

The next exercises consisted of fleshing out the best application ideas by discussing them. To make this easier, we provided pre-defined questions for the participants to reflect upon. Each idea was intended to be discussed for maximum 10 minutes. The questions were:

1. Describe the users of the application.
2. Describe the place/activity without robot support.
3. How can a robot support the place/ the activity?
4. What are the requirements for a robot useful in this application? Describe the robot, and why its form and function is suitable for this application.
5. Name of application.
6. Overview of what the application does.
7. How does it work (technically)?

The questions were intended to help the participants view their ideas critically, and refine them based on what they knew about the chosen place and activity and potential robot support.

Figure 3. Model of robot-plants on wheels that would distribute themselves to accommodate crowds of people.

2.2.4. Second refinement of ideas.

The next activity also involved refining concepts, but with a different method. We used a method called *Six Thinking Hats* [1] where participants take turns to provide different views of the application. Each view is represented by the color of a "hat". For example, a person wearing a white hat would focus on facts, a person wearing a black hat would focus on pointing out the weaknesses of the idea and a person wearing a yellow hat would share positive and optimistic views of the idea. By taking turns in wearing different hats, people questioned and contributed to the application ideas from several different perspectives.

2.3. Resulting Application Mockups and Scenarios

After brainstorming and refining application ideas, the participants selected their favorite application concept to build a rough physical model. This activity was intended to let the participants figure out an appropriate way to present the idea, preferably with a scenario, that would make the application more concrete for the other participants. The material used was a mix of clay, paper, fabrics, paper objects, threads and metal strings, magazines, and a variety of other objects.

The three final scenarios were as follows:

2.3.1. Self-organizing robot-plants.

One group presented a model of robot-plants on wheels. The plants could distribute themselves in different positions in a space to accommodate crowds of people in public spaces. They would act as dynamic architecture or self-coordinating interior objects (see Figure 3). This idea was initially based the combination of "rock-star", "emergence", "queuing" and "shy". The initial idea came out of thinking about how people were lining up to see a rock-concert. The finished model visualized how an airport could use self-arranging plants that would distribute themselves to guide people to efficient paths.

2.3.2. Robotic travel companion

The second scenario illustrated how a robot can act as an entertaining travel companion or provide useful information, when traveling by car. This idea originated from the following combination: "Real size robots Anthropomorphic (human, dog)", "Natural dialog conversing", "Driving", "Traveler". The application was intended for lonely travelers, for example truck drivers or tourists. It could interact with the user socially in several ways, and act as an extra memory source for the user. The robot could primarily be a listener, or present information from the outside world, informing rather than distracting the driving.

2.3.3. Amusement park guide robot.

A third model, presented a robot that would accompany people at an amusement park. This was based on "Drone", "Fear", "Amusement parc" and "Humourists". The robot would enhance the experience at the park and give suggestions on what to attend. It could enhance peoples' thrilling experiences of joy and fear, or even adapt the attraction to the visitors' preferences. The robot could follow the visitors' around and go on the rides with them. The model envisioned how the robot would use some kind of futuristic hovering capability to follow visitors around the park.

3. Discussion

Although the resulting scenarios that came out of the brainstorms are not ready to develop as products, the process itself proved successful in exploring and pushing the boundaries of the robot application domain. We believe that this activity touched upon many issues that are crucial for designing successful robot applications. For example, in some cases it became necessary to clarify the benefit of having a robot instead of some other form of computational support. A computer is normally used as a tool (e.g. creating text or searching information) and can often be viewed as an extension of human properties (e.g. extending our memory capacity, communication capability etc). An autonomous robot could instead be viewed as an individual or a companion.

A robot could be a supplement for, or an expert on, current human activities. Robots can perform activities we might like humans or animals to do, but with a different set of capabilities and preconditions. For example, the Paro seal-robot could be viewed as supplement for an animal, having "patience" far beyond any living creature. The self-organizing robot plants in the brainstorm could be viewed as self-coordinating interior objects. They could also be viewed as assistants in complex tasks that humans have previously conducted (for example a policeman arranging the traffic). Technological advancements outside of robotics can also help to raise ideas when exploring interesting everyday applications. A robot might for example have a specific sensing capability far beyond ours, and at the same time be much more limited. Such robot properties can be found in recent technology advancements, not only in robot research but also for information technology applications.

The first brainstorm sessions for generating categories and then combining them, was considered a fruitful approach among the participants. Some stressed that generating an even higher amount of combinations should be considered, to have even more material at the refinement stage. One participant suggested that building mock-ups could be used earlier in the process. Another suggestion was to start with a form and then brainstorm about technical functionality. The challenge is to go beyond stereotyped and limited views of robots, to use robotic properties as a complementing design material for new services and products.

This event was our first international experience of exploring possible robot applications, and to test new methods to generate ideas. We look forward to attend and organize similar activities about robot applications for everyday environments.

Acknowledgements

We thank all participants and student volunteers at the workshop *Designing robot applications for everyday use,* held in Göteborg in January 2005. We also thank our colleagues, Lalya Gaye and Maria Håkansson for improving the writing of this paper. This event was conducted within the EC-Agents project, a European research collaboration sponsored by the Future and Emerging Technologies program of the European Community (IST-1940).

References

[1] De Bono, E. (2000) *Six Thinking Hats®* Penguin Group, London

[2] Designing Robot Applications for Everyday Use. International Workshop held in Gothenburg, Sweden, 2005. Further information, participant presentations and personal statements are available at: www.viktoria.se/fal/events/robotworkshop

[3] Fong, T., Nourbakhsh, I. and Dautenhahn, K. (2003) *A survey of Socially Interactive Robots* in *Robotics and Autonomous Systems 42* (2003) 143-166

[4] IST Advisory group, Report on Ambient Intelligence (2003): From vision to reality, http://www.cordis.lu/ist/istag-reports.htm

[5] Karlsson. J. (2004) World Robotics 2004, United Nations Press/International Federation of Robotics, Geneva, CH, October 2004

[6] Lego Mindstorm. Further information available at: http://mindstorms.lego.com/eng/default.asp

[7] Mondada, F., Pettinaro, G. C., Guignard, A. Kwee, I. V. Floreano, D. Deneubourg, J.-L. Nolfi, S. Gambardella, L. M. and Dorigo. M. *SWARM-BOT: A new distributed robotic concept* in *Autonomous Robots,* 17(2–3):193–221, 2004.

[8] Shibata, T., Wada K., Saito T., Tanie, K. (2005) *Human Interactive Robot for Psychological Enrichment and Therapy* in *Proceedings of the Symposium on Robots Companions: Hard Problems and Open Challenges in Robot-Human Interaction,* 12-15 April, AISB'05 Social Intelligence and Interaction in Animals, Robots and Agents, Hatfield, UK

[9] Robosapien. Further information available at: http://www.robosapienonline.com/

[10] Roomba. Further information available at: www.irobot.com/consumer

[11] Sony Aibo. Further information available at: http://www.sony.net/Products/aibo/

[12] Weber, W.; Rabaey, J.M.; Aarts, E. (Eds.) (2005) *Ambient Intelligence,* Springer-Verlag, New York.