Bartneck, C. (2006). Reflection on Robotic Intelligence. Proceedings of the CHI2006 Workshop on HCI and the Face, Montreal.

Reflection on Robotic Intelligence

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ABSTRACT
This paper reflects on the development or robots, both their physical shape as well as their intelligence. The later strongly depends on the progress made in the artificial intelligence (AI) community which does not yet provide the models and tools necessary to create intelligent robots. It is time for robot developers to take this matter into their own hands and build embodied intelligence.

Keywords
Robot, Artificial Intelligence, Interaction.

INTRODUCTION
Robots are entering our society. So far, they have been mainly used in production, such as welding robots in the car industry, and remote or dangerous environments, such as planetary explorations to Mars. These days, robots for normal consumers are entering the market. The United Nations (UN), in a recent robotics survey, identified personal service robots as having the highest expected growth rate (UnitedNations, 2005).These robots are envisaged to help the elderly (Hirsch et al., 2000), support humans in the house (Breemen, Yan, & Meerbeek, 2005; NEC, 2001), improve communication between distant partners (Gemperle, DiSalvo, Forlizzi, & Yonkers, 2003) and provide research vehicles for the study of human-robot communication (Breazeal, 2003; Okada, 2001).

In the last few years, several robots have even been introduced commercially and have received widespread media attention. Popular robots (see Figure 1) include Aibo (Sony, 1999), Nuvo (ZMP, 2005) and Robosapien (WowWee, 2005). Robosapien has been sold around 1.5 million times by January 2005 (Intini, 2005) while Sony stopped selling Aibo in February 2006.

Furthermore, robots have been tested in schools, museums and hospitals. Kanda et al. tested a child-size interactive humanoid robot (Robovie) at an elementary schools for several weeks. The robot interacted with the children by using speech and gestures in a free play situation. In one of their studies, the robot motivated the children to learn English by talking in English to them (Kanda, Hirano, Eaton, & Ishigur, 2004). Wada et al. (2004) conducted a study in which a pet seal robot assisted elderly in their therapy and Burgrad et al. (1998) used a robot as a museum guide. A surveys of relevant robots is available (Bartneck & Okada, 2001; Fong, Nourbakhsh, & Dautenhahn, 2003).

While industrial robots have a clearly defined task, service robots and in particular entertainment robots lack a clear goal. The fuzzy statement that they are suppose to entertain is rather weak, since their novelty wears off quickly and people become less and less motivated to recharge the batteries of their pet robot. Recently, Sony stopped the production of Aibo and the other entertainment robots are in the same danger.

Figure 1: Popular robots – Robosapien, Nuvo and Aibo

To maximize the entertainment value of these robots, they are frequently given an animal or humanoid shape. This anthropomorphization makes it easier for the users to create a social bound with them. The users are supposed to start caring for their pet robots by interacting and communicating with it. The face place an important role in social bonding and communication, but a large number of pet robots does not have an expressive face. Notable exceptions are Kismet (Breazeal, 2003) and iCat (Breemen, Yan, & Meerbeek, 2005). More realistic robots, such as Repliee Q2 from Hiroshi Ishiguro struggle with the Uncanny Valley effect and fail to gain sympathy from the user. However, eventually we will be able to build robots whose appearance will be indistinguishable from humans. Implementing human like movements is likely to be more difficult, but the progress made in, for example walking (Honda, 2002), gives us confidence that there is hope for an artificial face that is able to express all the nuances humans are capable or.

But if we would have such a robot, what is it going to do? How is it going to behave? Even the advanced android of Ishiguro (2006) has only been able to make people believe it to be a human for a maximum of two seconds. After that it was clearly identified as a robot. While we are steaming ahead with the appearance of our robots, we are far behind with their behavior. And only the robots behavior will in

the end make them successful. The users will not be satisfied with just looking at a robot, they want to interact with it. They will want our robots to do something for them. And the more human-like we build our robots, the higher the user's expectations concerning the robot's abilities will be.

The reasons why are so behind with robotic behavior can be traced back to the field of artificial intelligence (AI). The robots' behaviors are based on methods and knowledge that were developed by AI. Many promises that AI has made in the past have not been fulfilled and AI has been criticized extensively (Dreyfus & Dreyfus, 1992; Dreyfus, Dreyfus, & Athanasiou, 1986; Weizenbaum, 1976). One of the main problems that AI is struggling with is the difficulty to formalize human behavior, such as in expert systems. Computers require this formalization to generate intelligent and human-like behavior. And as long as the field of AI has not made considerable progress on these issues, robot intelligence will remain on a very limited level. So far we have been using many bluffs and Wizard-Of-Oz methods to fake intelligent robotic behavior, but this will only be possible in the confined research environment. Also evading strategies have been utilized. The robot would show more or less random behavior while interacting with the user and the user itself interprets intelligence into the system. Such a strategy will not lead to a solution to the problem and its success is limited to short interactions. Given sufficient time the users will give up their hypothesized patterns of the robots intelligent behavior and be bored with its limited random vocabulary of behaviors.

CONCLUSIONS

The field of robotics is steaming ahead in building human-like and pet-like robots and the progress made so far gives us confidence that eventually we will have robots that look and move like living beings. While this endeavor is likely to give us insight into human physiology and the technology developed in the process might become useful for other application areas, we are falling short in the development of robotic behavior. The true challenge does not lie in the realistic appearance of our robots, but in their intelligent behavior. Unfortunately, the field of robotic depends on the progress made in the field of artificial intelligence, which has failed to fulfill many of its promises. Even after 30 years of development, not a single artificial intelligence has passed the Turing test. Maybe it is time that robotic researchers take the initiative to push AI forward. The main advantage that robots have over pure virtual agents is their embodiment. This embodiment might be the key to further developed of AI (Pfeifer & Bongard, 2006). Lets not waste any more effort on implementing methods from AI from which we know that they will not lead to intelligent robot behavior. We need to solve the core problem of robotic intelligence before we can truly developed human-like robots.

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