GlowBots: Robots That Evolve Relationships

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ABSTRACT

GlowBots are small wheeled robots that develop complex relationships between each other and with their owner. They develop attractive patterns which are affected both by user interaction and communication between the robots. The project shows how robots can interact with humans in subtle and sustainable ways for entertainment and enjoyment.

Keywords

Embodied Agents, Human Robot Interaction, Multi Agent Systems, Design

1. INTRODUCTION

What is the potential role of robots in everyday life? Most people think of robots as futuristic mechanical slaves doing our bidding, or as zoomorphic creatures modeled on real pets. This perception is sustained both by popular culture and by corporate demonstrators such as Honda's humanoid (ASIMO) and Sony's robot dog (AIBO).

In our work, we are trying to break with the traditional view of robots and find a new basis for designing robot applications. For instance, in the workshop "Designing Robots for Everyday Life" we gathered an international community of human-robot interaction researchers to brainstorm completely new forms of robot applications [7]. The results of this process included robots shaped like indoor plants that would subtly guide people at an airport, and an amusement park guide that would enhance the overall experience by encouraging the visitors' feelings of fear and delight.

We have also been systematically developing new design methods to see how users' interests can be transferred into novel design – in particular for robots [9]. In one case, we transferred the special relationship that some people have with unusual pets, such as snakes, lizards and spiders, to robot designs – but without transferring the anthropomorphic properties of these pets (Figure 1). The results of this process were turned into design concepts for four types of robot applications. They all have very different properties but have in common subtle basic elements that generate interest and are a foundation for long-lasting relationships.

Figure 1: *When designing the GlowBots we took inspiration from the relationship people develop with unusual pets such as spiders*

With GlowBots we will demonstrate one practical result of this process. The GlowBots are small wheeled robots that communicate with the user and with each others through sensors and displays. Over time, they develop complex relationships between each other and with their owner, which in turn manifest themselves in attractive patterns on their display. The project shows how robots can interact with humans in much more subtle, but also more sustainable, ways than the robots we have come to know from science fiction and spectacular industry demonstrations.

2. BACKGROUND

What would be design requirements for a more subtle robot technology, one which could be found in the intersection between robotics and ubiquitous computing; - robots that quietly find their ways into our everyday life and eventually become an integral part of it?

People have an underlying assumption that robots are socially capable [3]; hence they are quite biased when it comes to their image of a robot. The word itself originates from Czech "robota", which means work or compulsive labor. The general definition of the word given in the Merriam-Webster dictionary also reflects this perception:

”An automatic apparatus or device that performs functions ordinarily ascribed to human being or operates with what appears to be almost human intelligence”.

As a consequence we instead prefer to use the term ”embodied agents” to describe a more general and open view of robots that moves the focus away from such traditionally biased anthropomorphic preconceptions [8]. Other researchers prefer the term ”robotic product” to denote mechanically based interactive applications [4].

Examples of robots intended for practical use include the *Roomba* vacuum cleaner [14], the *Artemis* guard robot [11] or the *Minerva* museum tour guide robot [13]. These are in line with the origin of the word robot, as they opt for performing specific jobs on the behalf of humans.

Another example, the *Robot Fish* [6], is designed to be a copy of a common fish in terms of looks, properties and behavior. This approach is quite common, and often anthropomorphic values are added to the designs as a mean to extend interaction. Examples of that can be seen in Aibo, RoboPanda and Furby [10] to name a few commercial examples.

In a sense our work is the opposite to the above approaches; we have no intention to make a new dog or cat, or replace work already performed by humans. Several researchers are also pursuing such alternative views of robots. For instance, *The Hug* [2] is an example of a robot that does not look like anything biological, but instead reminiscent of an artifact that can be found in an everyday setting, in this case a pillow. It does not have any sophisticated communication capabilities like speech, or complex behavior like walking. Instead it appeals to our most primitive need of affection. Our work is similar in that we also move our focus away from the ordinary expectations of robotics.

Another study with a similar objective looked at peoples’ relationships with everyday artifacts, such as computers, corkscrews and notebooks [5]. It pointed out that a notebook will increase in perceived value over time as it is filled with notes and sketches, while e.g. a computer’s value actually decreases as it becomes increasingly obsolete. We found such observations inspirational in regards to where we should position ourselves and think about future robot applications.

3. METHODS

In the field of human-computer interaction there are a number of methods for inferring design implications either directly from studies of users or by extrapolating from known human needs and interests. One such method is to use fictive representative characters called *personas* [1]. We started by looking for possible sources of established interaction and engagement where autonomy plays a significant role. We decided to study and interview users of unusual pets, e.g. spiders, lizards and snakes. We conducted a total of 10 interviews with six male and four female subjects. Three of the interviews were made face-to-face and the rest by phone due to logistic restrictions. Typical questions would then be:

- Why are you interested in this particular species?
- Describe what your pet does
- What do you do together with your pet?
- How can you tell the mood of your pet?

Transcribed answers from the interviews were then cut up and written down onto Post-its. The general idea in this case is to form distinct characters representing different intrinsic characteristics based on real data gathered from the interviews.

From the scrambled Post-its we then linked together different properties in various constellations. After iterating this process several times four distinct clusters started to emerge representing the rough outline for the personas.

The next step is to create personas, which are descriptive scenario of an imagined user. We produced a total of four personas [8]. From this point we will focus only on the persona that is relevant in the context of GlowBots.

In one of the clusters we could read several statements without any apparent contradiction e.g.:

- He does not pet his pets, nor is he interested in different personalities of the pets.
- He is interested in breeding his pets in order to create nice patterns.
- He enjoys reading about his pets and often meets up with people that have similar pets, to look at or even exchange pets.

The scenario is created by filling in general fictive ”glue data” that connects the different statements into a meaningful coherent description. We even named the persona, which is a powerful way of building a mental image around a common reference. This persona goes by the name Nadim. At this stage the scenario still referred to a relationship with pets; however, by simply changing the word ”pets” to ”agents”, we shifted or *transferred* the scenarios to our target domain [9]:

Nadim is 32-years old and works as a network engineer, living alone in a two-bedroom flat in a small town. He has always had a great interest in collecting and exploring various things, and as he got older he became fascinated in having agents as a hobby. Nadim finds it exciting to try to understand their behavior and sees them as a research area where there is always something more to learn. He enjoys watching them communicating to each other and changing their patterns. Every single agent has its own specific colour pattern, and when it is put close to another agent they both start to change their individual patterns. The surrounding light, sounds and movement etc, also affects their patterns. The changes are slow, and sometimes it takes several days until it Nadim can see how an agent is reacting. The challenge is to avoid results that are bland or unattractive. Nadim is quite good in developing agents with unique interesting patterns, and he puts pictures of the agents on his website. The number of agents Nadim owns varies, and he has never bothered to give them any names. He likes to read everything that crosses his path; Internet pages and magazines. He also frequently visits other sites to compare patterns and sometimes he writes in a forum for people with the same type of agents. They sometimes also meet to let their agents affect each other's patterns.

This scenario now expresses what a potential user of an autonomous agent would look like. The final step in this process includes matching technology with the scenarios to sketch out real designs:

The agents can evolve interesting patterns over time, but it is a lengthy process and might not always succeed. Agents will be equipped with a color display on their back and have one or more sensors for light, movement and sound. The sensing can be different for different agents. Each agent will have a unique color pattern, developed from meetings with other agents the environment it is in. By touching the agent in a particular way makes it possible to temporarily freeze a pattern. Achieving a nice pattern requires several agent-agent interactions and an attention to timing.

Based on this description we could now proceed with technical implementation.

4. TECHNICAL DESIGN

The GlowBot is based upon an open experimental robot platform, the e-Puck, developed by EPFL [12]. Despite its size, the platform contains an impressive number of components. There are eight IR proximity sensors, one camera, three microphones, a 3-axis accelerometer, a speaker, two stepper motors, a Bluetooth interface, a number of LEDs, a PIC micro controller, and a twelve step mode-selector.

In order to implement our scenario, we needed to increase the communication capability of the e-Pucks. We developed a small display consisting of 148 light emitting diodes (LEDs) that can be individually controlled. The display turret consists of two sandwiched PCB's; one controller board that takes higher level commands from the e-Puck through a serial port, and one matrix board holding the LEDs. Basic requirements for the development were to make it inexpensive, visually appealing and energy efficient. The LEDs are quite cheap in large quantities and they can be pulsed by short bursts of electricity to make them brighter and more energy efficient.

In our first proof-of-concept prototype the GlowBots play a distributed version of Conway's Game of Life, a well-known example of how to create evolving patterns of cellular automata. The next version will let users create patterns directly and observe how they disperse and evolve among a collection of robots.

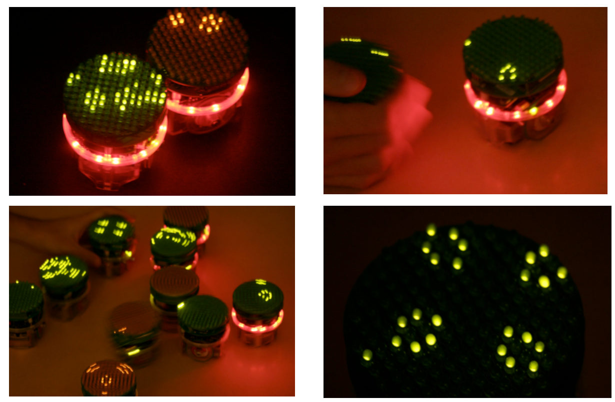

Figure 2: *GlowBots interact among themselves and with users to create interesting patterns.*

In a demonstration setting such as SIGGRAPH, people will be able to gather around the demonstration, and interact with the GlowBots (Figure 2). By gently picking up or putting the hands around the GlowBots they will react immediately and visibly by producing new patterns on the display. The user can affect the new pattern by actuating the various sensors, for instance producing noise into the microphones or subjecting the robot to light. When the user then puts the GlowBot back with the other robots, it starts to mingle with them, immediately sharing its new pattern. The other robots will be affected by it, and start to evolve their own patterns and share it among their neighbours in turn. The effect to the attendees will be like sowing a seed that spreads among the other robots as they move around. Thanks to the openness of the set-up several people can interact with the GlowBots simultaneously, and even more will be able to watch and enjoy the demo without directly interacting.

5. CONCLUSIONS

We have presented a novel prototype, GlowBots, that was the result of a design effort developed to open up new perspectives on the future role of everyday robots. We wanted to encourage a more long-term relationship with the robots, inspired by how people interact with artifacts and creatures in everyday settings. One aspect that crystallized in this process is the need of open ended play – an important factor to sustain interest over time. We believe this work shows that it is possible to develop new and novel products that last considerably longer and have a much more rewarding interaction than what is being offered today.

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