Demonstration proposal to appear in IEEE Consumer Communications and Networking Conference (CCNC2006), January 8-10th, 2006, Las Vegas, NV

The Huggable: A Therapeutic Robotic Companion for Relational, Affective Touch

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Abstract

Numerous studies have shown the positive benefits of companion animal therapy. Unfortunately, companion animals are not always available. The Huggable is a new type of robotic companion being designed specifically for such cases. It features a full body "sensitive skin" for relational affective touch, silent, muscle-like, voice coil actuators, an embedded PC with data collection and networking capabilities. In this paper we briefly describe the Huggable and propose a live demonstration of the robot.

1. Introduction

Many countries of the world are facing a crisis as the elderly population becomes a larger percentage of the total population. In the United States, the largest population increase was among 50-54 year olds in the 2000 US Census. In Japan, the ratio of senior citizens to working adults will be 1.5:1 by 2050[1]. The current trend is that hospitals and nursing homes will become larger with a lower number of empty beds. This combination leads to a stressful environment where often, in the case of nursing homes, the residents become over-medicated and suffer from loneliness or lack of care [2].

One solution to this problem of loneliness, helplessness, and boredom, is the use of companion animals in an animal assisted therapy (AAT). Much research has been done in studying the benefits of this therapy such as mood elevation and social facilitation [3]. Unfortunately, this form of therapy is not always available due to the fear of allergies, dog bites, or disease. In addition, when this therapy is offered it is a scheduled activity that happens only for a few hours once or twice a week with a qualified animal therapist present at all times.

Recently, the field of robotics has begun to address this need. Robotic companions such as Sony's AIBO, and the Paro [4], have been brought into nursing home facilities and have shown promising results. However one area in which these robotic systems lack is *full body* relational touch capable of detecting the affective content of the interaction.

The "magic" in how an animal helps to provide comfort is through the fact that it is able to understand that it is being petted, scratched, or touched in another affectionate way and actually look back at you as it shows its response. In this way the animal relates to the person through touch. In this paper we propose the demonstration of a brand new robotics platform, the Huggable, designed for such a type of interaction.

Figure 1. The Huggable

2. The Huggable

Figure 1 shows a photo of the Huggable. Unlike other robotic companions based upon real animals, the Huggable is based upon a fantasy animal – the Teddy Bear. This choice was deliberate as the Teddy Bear is a symbol of warmth and comfort familiar to many different age groups and cultures. Also, the use of a fantasy animal alleviates both the expectation of how the Huggable should behave as well as the fear that this technology will replace animal assisted therapy. The goal of this project is to provide another form of

therapy which can exist not as a replacement to traditional therapy methods, but in tandem with them.

The Huggable features a set of novel core technologies that distinguish it from other robotic platforms. First, it is being designed with a full body "sensitive skin" featuring over 1000 sensors on the surface of the robot underneath a layer of soft silicone synthetic skin. Lessons learned from the study of the neuroscience and the biology about how the human and animal somatosensory system influenced the design of this "skin." Thus the "sensitive skin" of the Huggable features the four modalities of human and animal somatic perception – touch, pain, temperature, and kinesthetic information. Quantum tunneling composite (QTC) sensors are used to detect force, thermistors are used to detect temperature, and electric field sensing is used to detect the proximity of a human hand to the surface of the robot. By combining these sensors together into receptive fields we can detect the affective content of touch. Early preliminary results have shown the ability to detect petting, rubbing, tapping, scratching, and other types of interactions that a person usually has with an animal [5].

Another novel technology in the Huggable is the use of voice coil actuators [6] for a 3-DOF neck. Unlike the geared DC motors used in the majority of current commercial robotic applications that are noisy, have backlash, and can result in broken gears the voice coil actuators are silent, back drivable, compliant, and smooth. These properties allow for the actuators to not distract from the interaction. Additional degrees of freedom include a 2-DOF eyebrow mechanism and 1-DOF ear mechanism for expression of internal state as well as a 2-DOF shoulder mechanism for relational touch output.

In addition to having "sensitive skin," the Huggable is equipped with small video cameras in the eyes of the Teddy Bear, microphones hidden inside the ears, and an inertial measurement unit in the body which allows for the Huggable to know how it is being held. This information is then processed using an internal 1.8 GHz Pentium M embedded PC with 1GB of DDR RAM and 8GB of Compact Flash memory for local data storage. The embedded PC allows for sensor processing, data storage, and behaviors to be selected.

The Huggable also has the ability to transmit both data as well as video and audio from the embedded PC to a remote PC at a nurse's station. Thus the Huggable functions as an important team member with the patient/resident as well as the hospital/nursing home staff.

3. Demonstration Proposal

CCNC 2006 will be the first public exhibition of the Huggable. We have already developed the core technologies of the "sensitive skin" and voice coil actuators, and have prototyped much of the mechanical understructure. For the demo at CCNC 2006, we will show the Huggable functioning in two modes. In the first, the Huggable will be interacting with people, responding to the affective content of their touch with appropriate reactions. Graphical visualizers will be displayed on the remote PC showing how the sensory systems are processing the data. In the second mode, the Huggable will function in the data gathering mode and display visual information from the eye cameras and audio information from the microphones to the remote computer. As the Huggable is still very much a work in progress it will be tethered to a power supply for these demos.

We will require a space of approximately 10'x10' with two 6-8' long tables to set up computers and handout information about the project. We will also need a network drop and at least two 120V power outlets.

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