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How to achieve the huggable behavior of the social robot Probo? A reflection on the actuators

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ABSTRACT

Most robots have a mechanical look or are covered with plastic or metallic shells. Their actuators are stiff which gives them not only an unnatural look, but also an unnatural touch. The goal of the huggable robot Probo is to serve as robotic research platform for human–robot interaction (HRI) studies with a special focus on children. Since not only cognitive interaction, but also physical interaction is targeted a new mechatronic design must be developed. To give Probo a huggable and safe behavior a new set of actuators is developed together with a triple layered protection cover which is presented in this paper. Probo's soft touch is introduced, on the one side by use of novel passive compliant actuators, Compliant Bowden Cable Driven Actuators (CBCDAs), and on the other side by combining custom made servo motors, Non Back Drivable Servos (NBDSs), with flexible components and materials such as springs, silicon and foam. The working principle of the novel CBCDA is extensively described, together with experiments in order to determine its level of compliance and its bandwidth.

1. Introduction

The overall trend in robotics is that robots will work more frequently with humans. For a good collaboration a good communication between the robot and human is necessary. To communicate in a proper manner the robots can be equipped with some human-like traits, for instance, facial expressions and gestures. According to Mehrabian [1], most of our communication goes over non-verbal means, like facial expression and gestures. When a robot has these capabilities as well, one can speak of social robots. The face is the most important element to express social cues and different projects focus on the face like eMuu [2], Feelix [3], iCat [4] and Kismet [5]. Robots that also include gestures by moving the whole upper body, including arms and hands, are Leonardo [6], Infanoid [7], Kaspar [8], Robovie-IV [9], WE-4RII [10] and Nexi [11]. ASIMO [12], QRIO [13], Kobian [14] and iCub [15] are complete humanoids that use their full body to interact with the humans and the environment. Paro [16], Robota [17], Keepon [17] and the Huggable [18] are social robots that especially focus on robot assisted therapy (RAT). These social robots place the human central during human–robot interaction instead of the robot itself. The research field that studies this is called human–robot interaction (HRI) and is a multidisciplinary field with contributions from human–computer interaction, artificial intelligence, robotics, natural language understanding, and social sciences. This new research area requires proper designed mechatronic systems.

Over the recent years different social robots have been built and some of them are commercialized. Aibo [19] and Pleo are intelligent companions that appeared on the market embodied as robot pets. Despite the potential this was not a great success yet. Only the cheap robotic toys like Furby and the WowWee robots were able to have commercial success. Nonetheless are these robotic toys contributing to the future market for social robots. Results from research will be gradually implemented in these toys to enhance the interactions with the user. Most of the social robots now are used for HRI studies.

Our huggable robot Probo's purpose is to serve as a multidisciplinary research platform for HRI focused on children. In most social robots is focussed on vision and audio, the study of tactile communication has often been neglected [10] with exceptions as Paro [16], Leonardo [6], the Huggable [20] and Robovie-iv [9]. Probo aims besides cognitive interaction also physical interaction. This desire leads to other design requirements that need to be fulfilled. For instance, safety aspects are one of the most important issues during physical HRI. To achieve these goals, a concept of a new child-friendly artificial creature, called Probo has been developed. Fig. 1 shows a section view of the real prototype of Probo. A close up of Probo's robotic head is presented in Fig. 2. The main difference with other social robots is the use of compliant actuators,

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