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TOWARD ROBOTS AS SOCIALLY AWARE PARTNERS IN HUMAN-ROBOT INTERACTIVE TASKS

Rui Silva	Estela Bicho	Pedro Branco
Department of Industrial Electronics	Department of Industrial Electronics	Department of Information Systems
E-Mail: rsilva@dei.uminho.pt	E-Mail: estela.bicho@dei.uminho.pt	E-Mail: pbranco@dsi.uminho.pt

ABSTRACT

Robots are expected to directly interact with humans in everyday environments by helping people to do daily routines or as companions. This work aims at advancing towards more socially intelligent robots (i.e. autonomous robots capable of interacting actively with humans, rather than those used as mere tools) by integrating some basic social skills, that will increase the acceptance of the robot by its human partners.

The previous work that is done establishes the starting point to this work, namely, i) the development of the robotic platform (Silva, 2008); ii) development of a cognitive robot control architecture that implements a flexible mapping from action observation onto action execution (Bicho et al., 2008a; Bicho et al., 2008b; Erlhagen et al., 2006; Erlhagen & Bicho, 2006; Erlhagen et al., 2006; Erlhagen et al., 2007).

The robotic platform, ARoS, that will be used in this work, is equipped with a 7 DOFs arm, a three-fingered hand and a vision system mounted on a pan-tilt unit, was developed in the context of two projects: i) EU-IP-Project "JAST: Joint Action Science and Technology". Funded by the European Commission (ref. IST-2-003747-IP); ii) "Anthropomorphic robotic systems - control based on the processing principles of the human and other primates motor system and potential applications in service robotics and biomedical engineering". Financed by the Portuguese Foundation for Science and Technology (ref. CONC-REEQ/17/2001).

During the JAST Project, ARoS was endowed with some capabilities that were important not only to the ongoing projects, but also useful to the success of this work, namely: i) object position and orientation; ii) task state monitoring; iii) basic human actions monitoring.

The main contribution of the projects was the development of a cognitive architecture, based in Dynamical Neural Fields.

Today's robots are still far from being social, i.e. from being able to interact with humans in natural and human-like way (Breazeal, 2003; Fong et al., 2003). Needless to say that non-verbal communication is an essential component for every day social interaction. For example, we humans continuously monitor the actions and the facial expressions of our partners, interpret them effortlessly in terms of their intention and emotional/mental state and use these predictions to select adequate complementary behaviour (Blair, 2003; Frith & Wolpert, 2004). Thus, two important (high level) cognitive skills which would greatly increase the acceptance by human users are: i) understand human actions; ii) understand/interpret facial expressions. This allows for a fluent adjustment of complementary behaviours in human-robot interactive/collaborative tasks without the need to directly communicate action goals/intentions and emotional states.

Another important issue of human-robot interaction is the shape and structure of the robot because they help establishing social expectations. If a robot has a morphology that resembles a pet (e.g. Aibo dog from Sony, the robotic cat NeCoRo from Omron) people will just tend to treat it as a pet. On the other hand, when facing a robot of anthropomorphic shape, humans tend to interact with it in a way more similar as if they were interacting with another human (Duffy, 2003).

In the last couple of years Bicho and colleagues have developed a theoretical framework based on Dynamic Neural Fields (DNFs) which can be used as a design tool to endow autonomous robots with cognitive capabilities (Bicho et al., 2008a; Bicho et al., 2008b; Bicho et al., 2000; Duffy, 2003; Erlhagen et al., 2006a; Erlhagen & Bicho, 2006; Erlhagen et al., 2006b; Erlhagen et al., 2007).

Relevant for the current work, a DNF-architecture for human-robot collaboration that integrates action simulation, goal inference and action selection has been developed and implemented. The architecture has been validated in a joint construction task in which robot and human have to assembly a toy. However, the robot was unable to detect and interpret facial expressions of the human partner.

When pursuing the goal of a robot behaving as a socially aware partner this constitutes a limitation. Thus new challenges arise in this work: if the robot would be able to recognize and interpret facial expressions it could then act accordingly and even anticipatively correct its own actions.

In previous work (Branco et al., 2006; Branco et al., 2005; Eckes et al., 2007; Jaksic et al., 2006) have studied users' facial expressions in a human-computer interaction scenario. They monitored positive and negative (valence) facial expressions to infer about incidents using the interface (usability). Relevant for the current work, they developed FACEit, a system for automatically classifying the facial expression (Baron-Cohen, 1997; Ekman, 1972) using a web-camera monitoring the users' face.

From the integration of 'reading motor intentions' and 'reading facial expressions' into the robot's control architecture we expect a high technological impact since the fully working anthropomorphic robot endowed with this high level cognitive skills may serve as a harbinger for "a new generation of robots operating in everyday human environments and co-operating with humans" (cited from the EU-IST-Call-6:Advanced-Robotics).

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