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

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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, which 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, Louro, Hipólito & Erlhagen 2008b; Bicho, Louro, Hipólito & Erlhagen 2008a).

The robotic platform ARoS, which will be used in this work, is equipped with a 7 DOFs arm, a three-fingered hand and a stereo vision system mounted on a pan-tilt unit. During the JAST Project, ARoS was endowed with some capabilities that were important not only to the on-going projects, but also useful to the success of this work, namely: i) calculate object position and orientation; ii) task state monitoring; iii) basic human actions monitoring. The main contribution of the previous project was the development of a cognitive architecture, based in Dynamical Neural Fields (DNFs).

In the last couple of years Bicho and colleagues have developed a theoretical framework based on DNFs which can be used as a design tool to endow autonomous robots with cognitive capabilities (Bicho, Louro, Hipólito & Erlhagen 2008a; Bicho, Louro, Hipólito & Erlhagen 2008b). 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.

An important step towards a more fluent Human-Robot interaction is the development of a system that enables the robot to direct its attention to a person and maintain it. To accomplish this, the vision system detects all the faces in its visual field and also the distance to the robot, which is an important feature, the closest the face is, the more important it gets.
The information from the vision system (face position and distance from the robot to the person), serve as an input to a 2D DNF that produces a decision of where the robot should look. At the beginning, the decision relies on how close the face is, but, when a decision to look at one face is taken, the attention is maintained, even if this face gets further away in comparison to others. The fact that this system is implemented using DNFs, assures it inherits some of the cognitive principles present in the brain, modelled by this theory, such as: memory, decision making, and prediction, among others.
This attention system endows the robot with the ability to track the person whom is interacting with, even if the person momentarily disappears, it is able to estimate the direction where it was going and predict where it could reappear. This system will provide the robot with a high-level behaviour that will facilitate the engagement with persons when interacting with them, providing persons with a necessary feedback of interaction with the robot.

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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RUI SILVA was born in Póvoa de Lanhoso, Portugal and went to University of Minho, where he studied Electronics Engineering and obtained his degree in 2005. He worked for a couple of years as a research assistant while at University of Minho where he concluded his MSc in robotics in 2008. He started his PhD in 2009 on the Electronics and Computers Engineering. His e-mail address is: rsilva@dei.uminho.pt

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PEDRO BRANCO is at the Department of Information Systems at UM. He graduated in Computer Science from University of Porto, Portugal, in 1997. In 2000, he joined Fraunhofer's U.S. operations as Researcher/3D Software Engineer in the development of virtual reality interaction techniques. Starting in 2003 he worked at IMEDIA in Providence, RI, studying user interface usability based on physiological monitoring. He received his PhD degree in Information Systems from University of Minho in 2006 with the topic: "Computer-based Facial Expression Analysis for Assessing User Experience". His research interests are on monitoring users' non-verbal language, intelligent user interfaces, anthropomorphic interfaces, tangible interactions, and the intersection of these technologies with interactive art. He is currently PI for a nationally funded research project on Human-Machine Interaction. He is director of the Master Course in Technology and Digital Art at UM, and is also establishing the engageLab (www.engagelab.org), a research space where he works closely with students from a wide range of backgrounds developing interactive systems that explore a synergy of technology and aesthetics, exploring future directions for our interaction with technology.