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ON LEARNING AND GENERALIZING REPRESENTATIONS FOR PERSONAL SERVICE ROBOTS

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EXTENDED ABSTRACT

One important condition for a successful service robot is its ability to interact with a human user in a natural manner. Most importantly, the robot should able to observe actions, anticipating their goals or end-states and in consequence produce appropriate complementary actions.

The main goal of the PhD work is to validate in real-world experiments learning techniques that allow a robot to develop autonomously through observation and practice an understanding of the intentions of a human partner in collaborative tasks. The theoretical framework for the learning experiments is the dynamic neural field theory (DFT) to cognitive robotics that takes inspiration from Cognitive Neuroscience. The Minho group has developed over the last couple of years a DFT-based architecture for joint action [1, 2]. It consists of a set of coupled dynamic fields that represent task relevant information by dynamic activity patterns of local but connected neural populations. Thus far, task-relevant representations and the "synaptic couplings" between the various fields are set by hand. Nevertheless, this synaptic predefinition has severe drawbacks since it makes extremely difficult or even impossible to respond properly to mutable environments and ever changing robot-human tasks. Similarly to what happens in the brain it is possible to acquire new knowledge storing it as changes in the synaptic connections between existing representations [3]. Most importantly, the learning process also allows evolving the architecture by creating new population representations not pre-specified by the human designer [4].

Addressing this questions necessarily means "to develop system capabilities that respond intelligently to situations that have not been specified in the design" (citation from the FP7-call "Challenge 2: Cognitive Systems, Interaction, Robotics" of the European Commission, (ftp://ftp.cordis.europa.eu/pub/ist/docs/cognition/cognitionwsrep-final_en.pdf).

The focus of the work is on exploring different correlation-based and reinforcement learning techniques [3] for the development of a sophisticated intention reading capacity.

In previous work, the Minho group has shown that a learned goal-directed sequence of motor primitives may be use during observation to infer the goals of others [4,5]. However, this basic action understanding capacity is not sufficient for more complex tasks since the same action done in different contexts may reflect different intentions. The capacity to evolve and generalize context-dependent representations is thus crucial for a socially aware robot companion. Currently, attention is being devoted to this subject of formation of neural representations through the use of Hebbian [6] based learning techniques combined with dynamic neural fields. The use of Hebbian Learning techniques to allow the learning of associations was studied in previous work [7] under the scope of project LEMI "Learning to read the motor intention of others: towards socially intelligent robots", (POCI/V.5/A0119/2005, 08/2007-12/2008) financed by FCT. Now it is being extended to address the matters of knowledge representation, namely of the goal-directed action sequences that allow the inference of goals of others. It is intended that the conjugation of Hebbian learning techniques with Dynamic Neural Fields result in a dynamics that allows the formation of context-dependent representations of goal-directed sequence of motor primitives.

In the follow up, learning experiments will be conducted that are expected to have a great impact on the interdisciplinary projects studying the neuro-cognitive mechanisms of social interactions that the Minho group has with partners from Neurobiology (FCT project LEMI) and Cognitive Science (EU-project JAST: FP6-IST2 proj.nr. 003747).

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EMANUEL F. SOUSA was born in Guimarães, Portugal and went to the Universiy of Minho, Portugal where he studied Industrial Electronics and Computers and obtained a Master Degree in 2008. In 2009 he started the PhD program on Electronics and Computers Engineering in the area of automation and robotics at the University of Minho. His e-mail address is : `esousa@dei.uminho.pt`

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http://cordis.europa.eu/ictresults/index.cfm?section=news&tpl=article&BrowsingType=Features&ID=90631

http://staging.esn.eu/projects/ICT-Results/Success_stories.html;
http://dei-s1.dei.uminho.pt/pessoas/estela/.

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