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ROBOT LEARNING OF SEQUENTIAL TASKS: A DFT APPROACH

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EXTENDED ABSTRACT

It is common knowledge that the majority of our daily routine tasks involves the performance of sequences of actions. For instance, the simple act of preparing a morning breakfast requires a multitude of simple sub-tasks, that must be performed in a specific order (e.g. putting the coffee inside the machine before turning it on). From a robotics point of view, integrating the ability of learning and performing sequential tasks will allow robots to better cope with the role of interaction partners able of an effective cooperation with people in everyday tasks. Humans are experts in coordinating their action and decisions with others in order to achieve shared goals. Integrating this same ability in robots is crucial for their acceptance by common users.

In previous work (Bicho, Erlhagen, Luis Louro, & Costa e Silva, 2011; Bicho, Luís Louro, & Erlhagen, 2010; Bicho, Luís Louro, Hipólito, & Erlhagen, 2009) a dynamic neural field approach to natural HRI was presented that builds on shared knowledge of an assembly plan as a means to predict the users ongoing object-directed actions and to timely select an adequate complementary behavior. However, the interactions with the humanoid robot ARoS were limited to the specific task since the assembly plan was hand-coded by the designer. Here we report our ongoing research on incremental learning of sequential action plans which ultimately will allow the robot to assist different users in a variety of cooperative tasks.

Concretely, we adopted an interactive learning by demonstration approach (Calinon & Billard, 2008; Nicolescu & Matarić, 2003; Pardowitz, Knoop, Dillmann, & Zollner, 2007) in which a human expert first demonstrates to a robot (ARoS) the sequence of assembly steps for a new toy object and subsequently gives immediate verbal feedback about the success of individual assembly operations when the robot tries to execute the memorized sequence itself. Learning via observation of the high-level task representation is possible because ARoS is able to recognize the end states of individual assembly steps which are associated with goal-directed action sequences (e.g., reach-grasp-attach a specific component) in its motor repertoire (Bicho et al., 2011). The verbal feedback from the teacher in practice greatly improves the learning since limitations in robot vision in a challenging environment may prevent ARoS from recognizing some assembly operations. Ultimately, a service robot should be able to adapt to different users that may show individual preferences in the sequential order of task execution. To this end, the interactive learning was performed with different teachers instructed to exploit possible variations. The learning takes place within an existing dynamic neural field architecture of joint action. Based on sub-symbolic dynamic representations consistent with fundamental principles of neural information processing (Erlhagen & Bicho, 2006) the architecture reflects the notion that neuro-cognitive mechanisms of human joint action may provide important guidelines for building socially aware humanoid robots (Chaminade & Cheng, 2009). After learning, the generalized sequential structure of the assembly plan is encoded by newly established synaptic connections between neural populations representing end states of individual assembly operations.

Results show that ARoS is able to learn from demonstrations provided by different users. After the learning, ARoS cooperates with the tutors to execute the sequence, and may still be corrected by them, when due to limitations in the vision system makes errors.

Ultimately, because ARoS can learn from different tutors, it will be able to adapt to their individual preferences

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