Dynamic fields and interactive systems

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The dynamical system approach is an interesting framework to analyse and design complex control architectures [7, 6]. Focusing on the dynamics allows to overstep some limitations of functional approaches and to enlight possible emergent properties. For instance, in previous works, using the perception ambiguity, we have shown that a simple visuo-motor homeostat can be used to trigger low level imitation capabilities [5, 4]. Moreover, dynamical neural fields allow to combine easily in a single system different control strategies (different motor commands obtained from different neural networks working at different frequencies can be easily merged in a single neural field allowing the control of several degrees of freedom). Yet, in these systems performances directly depend on the human capabilities to maintain the interaction. To allow turn taking or simply long term interactions the robot must not be only a reactive system but must be endowed with some "will" to interact. In recent works, we have shown a simple internal oscillator can be used to maintain low level interactions. To go one step further, we try to address the question of predicting what could be the stable states of a system interacting with its environment [2, 3]. As a toy problem, we have analysed how an expressive robot head could learn to associate the facial expression of a human or another robot with its own internal emotional state. We have shown in the case of a simple reactive architecture that a solution to obtain a stable state of interaction is that the human teacher mimics the robot facial expressions. This idea has been successfully tested with a real robot head. Moreover, we have shown that the robot head can learn through the interaction game to perform in an unsupervised manner a face / non face discrimination by using the capability to predict the rhythm of the interaction [1] as a learning modulation to decide whether some visual features can belong to a face or not. At last, we propose a definition of the shared perception as a dynamical system and question the possibility to develop mathematical tools allowing to predict and study how interacting systems can develop more and more complex skills through the interactions.

References

[1] P. Andry, P. Gaussier, S. Moga, J.P. Banquet, and J. Nadel. Learning and communication in imitation: An autonomous robot perspective. *IEEE transactions on Systems, Man and Cybernetics, Part A*, 31(5):431–444, 2001.

[2] P. Gaussier, J.C. Baccon, K. Prepin, J. Nadel, and L. Hafemeister. Formalization of recognition, affordances and learning in isolated or interacting animats. In *SAB04 (From Animal to Animat)*, 2004.

[3] P. Gaussier, K. Prepin, and J. Nadel. Toward a cognitive systems algebra: Application to facial expression learning and imitation. In *Embodied Artificial Intelligence, F. Iida, R. Pfeifer, L. Steels and Y. Kuniyoshi (Eds.) published by LNCS/LNAI series of Springer*, pages 243–258, 2004.

[4] J. Nadel, A. Revel, P. Andry, and P. Gaussier. Toward communication: first imitations in infants, low-functioning children with autism and robots. *Interaction Studies*, 5:45–75, 2004.

[5] J.P. Banquet P. Gaussier, S. Moga and M. Quoy. From perception-action loops to imitation processes: A bottom-up approach of learning by imitation. *Applied Artificial Intelligence:An international Journal*, 12(7-8):701–727, 1998.

[6] M. Quoy, S. Moga, and Ph. Gaussier. Dynamical neural networks for top-down robot control. *IEEE Transactions on Man, Systems and Cybernetics, Part A: Systems and humans*, 33(4):523–532, 2003.

[7] G. Schöner, M. Dose, and C. Engels. Dynamics of behavior: theory and applications for autonomous robot architectures. *Robotics and Autonomous System*, 16(2-4):213–245, December 1995.