Modeling Synchrony for Perception-Action systems coupling

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1. Introduction

One of the key feature of a communicative system is the ability to detect important signals in the interaction process, which can allow an agent to adapt and act properly. If we consider the case of natural gestural interaction among neo-natal and pre-verbal children (Nadel et al., 1999), most of theses signals are non explicit (i.e not directly associated to explicit symbols), and nevertheless, the establishment of turn-taking, role switching, gestural exchanges seem to be "easy" and reliable. At the opposite, most of our efforts in designing autonomous systems fails to avoid the use of explicit and arbitrary reinforcement signals in order to manage learning and communication processes. Additional effort is necessary to understand how communication ability develops and what are the key underlying mechanisms that can explain non-verbal communication among autonomous systems. In this poster, we propose that the ability to synchronize with someone's action is one of these key feature. The detection of synchrony should allow systems to characterize that "the other is doing the same thing at the same time". In conjunction with immediate imitation (allowing to "kick off" gestural games), synchrony is a good means to detect if the others can interact with me, in order to reach important stable states that may be involved in the recognition of the behaviors of other. As a characterizable landmark of the interaction, synchrony can in turn be exploited as a transition state for behavior selection or modulation. It should help autonomous systems to stay locked, alternate roles, select and enrich their motor repertory via interaction, in a word to communicate. This poster presents an energy-based Neural Network architecture allowing perception-action systems to synchronise their actions when perceiving the same sequence of actions.

2. Architecture

The idea of this architecture (Fig: 1) is to be able to benefit from the "energy" given by the other during the interaction to modify the system's self behaviour. In particular, detecting that the other is doing "the same as" the system should help synchronisation, especially if the other is producing "before" what the system is predicting. Thus, the energy brought by the other could be a mean to "accelerate" the prediction of the system so as to maintain the synchrony with the other. Conversely, if nothing is predicted by the system, it should be able to learn the elements of this new sequence. Given those considerations, the proposed architecture is build as follows : (i) Perception input and internal Prediction are able to separately trigger action: A sole prediction can trigger action (immediate imitation and learning), a sole prediction too (reproduction of a learned sequence), (ii) if both information (perception and prediction) corresponding to the same action are activated, the addition of energy induce an earlier overshoot of the corresponding motor threshold : the system accelerate. Inspired from

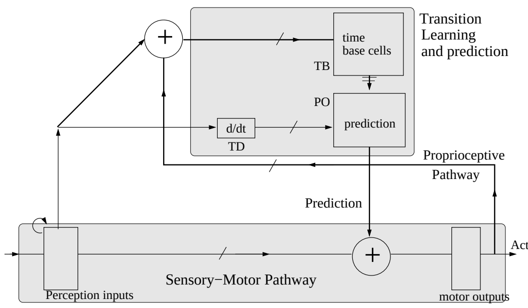

Figure 1: see text for details

an impulsion-based neurobiological model of the hippocampus (Banquet et al., 1998), this architecture, by using energy-based information, result in an emergent property of synchronisation between perception inputs and internal predictions.

References

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Nadel, J., Guerini, C., Peze, A., and Rivet, C. (1999). The evolving nature of imitation as a format for communication. In *Imitation in Infancy*, pages 209–234.