Control of Visual Attention and Posture in Quadrupeds with Recurrent Neural Networks — Simulation with Embodied Agents and Implementation in the AIBO robot

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1 Summary Description

We pretend to model the visual attention behavior of an embodied agent emergent from the dynamics and self-organization mechanisms of a recurrent neural network. We also intend to use a similar approach to the implementation of a neural controller for posture discovery in a quadruped. Both models should be implemented in simulation and installed in the AIBO robot. Integration between the two controller is also pursued.

1.1 Stage I — Control of Visual Attention

In stage I, we want to model mechanism of visual attention. The visual systems (representing head and/or eyes) is modeled with two degrees-of-freedom one for *pan* and the other for *tilt*. The instant value of the two dof is determined by the aggregated activation of (sub-set of) units in a Recurrent Neural Network. Due to the chaotic dynamics of RNN, the perceptual system is expected to manifest a continuous *exploratory* behavior. Sources of visual stimulus provide additional input to the neural units. In the presence of strong stimulus, the chaos of the system is reduced while it remain aligned with the stimulus. This work as an attention mechanism. In the implementation of the AIBO robot, the model can be modified to control three dof as they are available in the head-camera sub-system of this robot.

1.2 Stage II — Control of Body Posture

In stage II, we want to implement neural control mechanisms for vertical posture discovery in quadrupeds. We assume that body layout is made of two pairs of members. Each member is modeled with some number of dof (minimum one). The instant values of the control dof is determined by the aggregate activation of a sub-set of units of a RNN. Due to the chaos of the RNR, the system is expected to maintain a tendency to explore a variety body posture, with varied physical stability at the macro-level (dependent on body form and distribution of weight). We postulate pressure sensors in points of contact of the members with the ground and in joints, that get more active the more vertical the members are. This pressure sensor provide additional input to the neural units (in complement to input from other units). It is predicted that the RNN tends to prefer neural state regions where external perturbation is higher, and by implication that make the agent to stand more upright. It also expected that learning (plasticity) mechanism amplify this tendency.

1.3 Resources

Articles on *cognitive modeling* available from:

- `http://www.dcc.fc.up.pt/~jsimao/`

Use the link below (or other) as reference for control and programming in the AIBO robot:

- Wikipedia: `http://en.wikipedia.org/wiki/AIBO`
- AIBO official site — `http://support.sony-europe.com/aibo/`

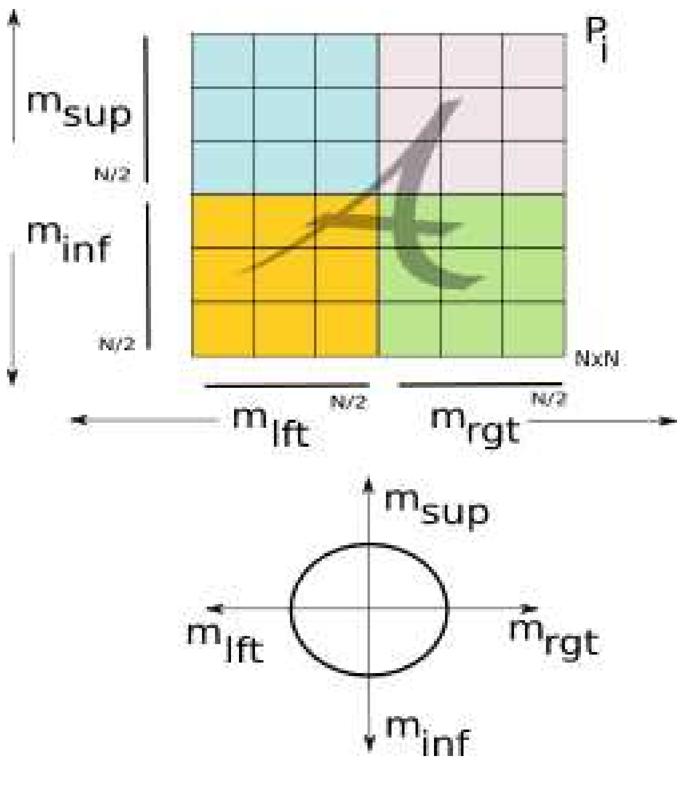

Figure 1: Motor control from neural activity.