A distributed architecture for sensory-motor coordination

R. Tellez and C. Angulo

Technical University of Catalonia, Spain
r_tellez@ouroboros.org, cecilio.angulo@upc.edu

This research focuses on the characterization of a general control architecture for autonomous robots, created using evolutionary robotics techniques, capable of controlling a robot on several sensory-motor coordination tasks.

The design is based on distributed neural networks since they are easy to auto-organize using neuro-evolution, provide a smooth search space, are robust to noise, and are a biological plausible metaphor.

The architecture is also highly modular. Typically, modular controllers are more scalable and robust in front of failures, and some evidences from previous experiments realized show that they perform better than non-modular ones. Modularity is achieved by creating a distributed controller composed of several neural networks that cooperate to obtain a global behaviour in the robot.

The problem when creating a distributed controller is where to put the division that define what each network should control without introducing a big bias from the designer point of view. In order to minimise this effect, modules are defined at the level of sensors and actuators. Then, the number of modules required for each robot is the number of sensors and actuators of it. Every module is formed by an Intelligent Hardware Unit (IHU, see figure 1a), which is composed of a sensor or actuator and a processing element (in this case an artificial neural net). Each IHU is in charge of one sensor or one actuator. It process the data sensed by its sensor or is in charge to control its actuator, but it is also aware of what the other IHUs are doing, by using an internal communication network (figure 1b). This structure creates a network of neural nets. The whole group of neural nets is then evolved using a neuro-evolutionary algorithm, called Enforced SubPopulations (ESP), on the task that requires the sensory-motor coordination. The result is a group of different nets that are capable of controlling the whole robot in an exercise of coordination.

The architecture has been applied to an Aibo robot in both simulator and real robot. On a first experiment, Aibo was required to learn how to stand up from a lying position and it was achieved in both simulator and real robot. On a second experiment, Aibo was required to keep a standing up position without falling down and it was also achieved. Current experiments not finished yet, try to implement the architecture to generate a walking pattern on the robot (experiments been conducted at present and expected to be ready for the submission of full length papers).

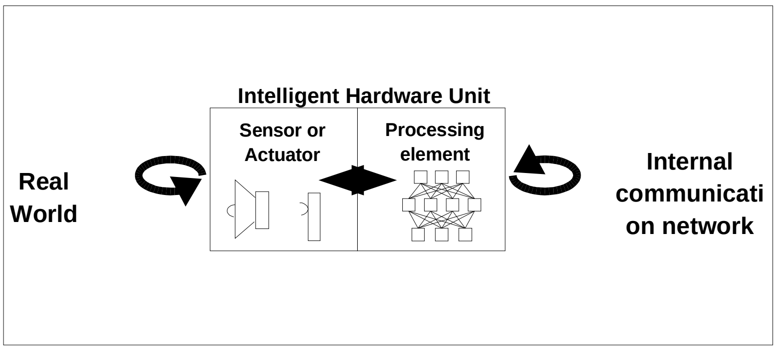

Figure 1a: Intelligent Hardware Unit schematics

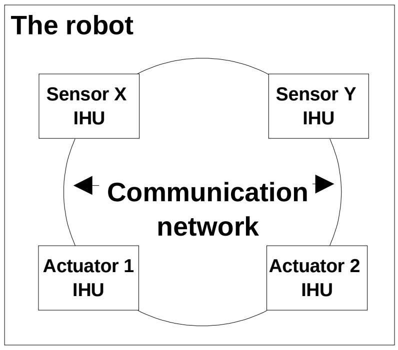

Figure 1b: Communication between 4 IHUs inside a robot