Automatic Design of Parallel Behavioral Arbitrators for Khepera IV Robots

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With the increased deployment of mobile robotics in a multitude of real-life scenarios, robots must face more and more complex situations. However, every robotic platform needs to be carefully programmed to fulfill its task, which, today, is often still done manually. Such programming operation usually represents an intense time investment and requests high expertise to eventually achieve the targeted performances in the real deployment, even more so if the application involves a multi-robot system. There are multiple approaches for the automatic generation of controllers (or specific components), whereas the nature of the control components ranges from Probabilistic Finite State Machines (PFSM) to Artificial Neural Networks (ANNs).

This project aimed at exploring the area in between PFSMs and ANNs by leveraging the Mixed-Discrete Particle Swarm Optimization (MDPSO) algorithm to automatically generate parallel behavior arbitrators for Khepera IV robots. After literature research on the state-of-the-art, a grammar was defined to describe both involved behaviors as well as their weights in a format compatible with the MDPSO algorithm. Using Webots, a high-fidelity robotics simulator, an arbitrator for a flocking scenario without obstacles was then designed using MDPSO and compared against a manually designed solution.

The main result of this project is an implementation of a grammar for parallel behavioral arbitrator, allowing the simultaneous use of sequential and additive controllers. The grammar combines behaviors and conditions to form an arbitrator as illustrated in Figure 1.

The results (as shown in Figure 2) need more evaluations in order to draw any statistically significant conclusions but remain promising for the development of such hybrid controllers.

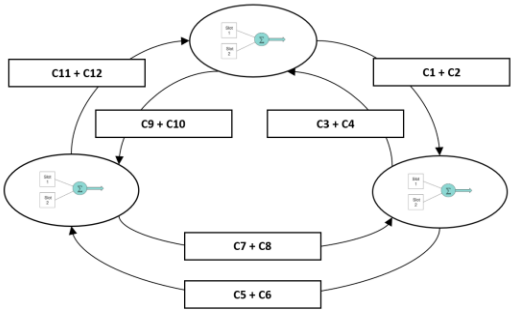

Figure 1: *A representation of an arbitrator that can be described using the grammar proposed in this work. C1 to C12 correspond to conditions, Slots are placeholder for basic behaviors.*

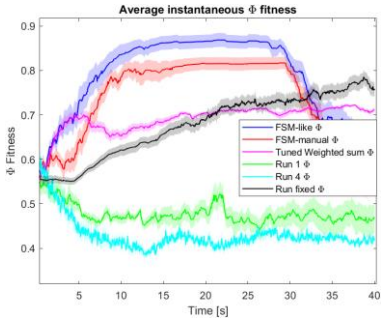

Figure 2: *Instantaneous fitness (Φ) for different arbitrators: two manually designed FSMs (FSM-manual, FSM-like), a manually designed weighted-sum using machine-learning for tuning the weights (Tuned weighted sum), 2 optimized arbitrators using machine-learning and the proposed grammar (Run 1 and 4), as well as a hybrid arbitrator using the proposed grammar with pre-determined behaviors (Run fixed).*

Disclaimer: this summary has been written by the project's supervisor due to unavailability of the student.