Evolutionary Robotics: Co-evolution of Controller and Morphology for Locomotion Functionality

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Evolutionary robotics is a method of auto-design for robot system. This approach imitates the mechanism of biological evolution from an engineering point of view and the main advantage is that the designer does not need to implement the desired behaviors of the robot system because unexpected behaviors can emerge from the interaction between controller, morphology and environment. Therefore, this approach has been applied to designing autonomous robot system. In our research, two evolutionary approaches are conducted to designing and investigating locomotors in both virtual world and real world: (a) controller and morphology of robots are co-evolved with genetic algorithm to achieve forward locomotion in three-dimensional simulation. With the results, “effective dimensions” are discussed in point of “locomotion functionality” (Fig.1); (b) some “morphological parameters” of a biped robot with minimum controller are evolved in three-dimensional simulation. As the results, the robot acquires pseudo-passive dynamic walking, which exploits it own dynamics. Moreover, the real robot “bendy” is built with the results and examined the characteristic of its walking. As the result, it has shown stable walking and indicated the possibility that morphology reduces computation resources of its controller (Fig.2).

Keywords: Evolutionary robotics, Genetic Algorithm, Morphology, Locomotion

References

1) Kojiro Matsushita, Max Lungarella, Chandana Paul, and Hiroshi Yokoi: "Locomoting with Less Computation but More Morphology", Proceedings of IEEE International Conference on Robotics and Automation (ICRA), pp.2020-2025, 2005

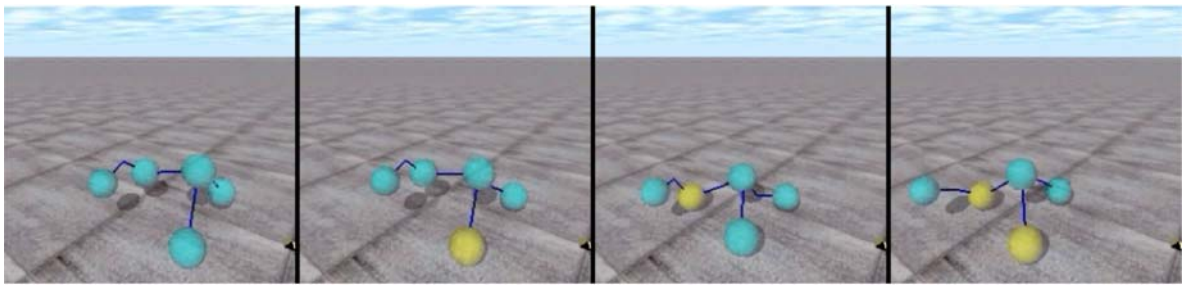

Fig. 1 Co-evolution of morphology and controller

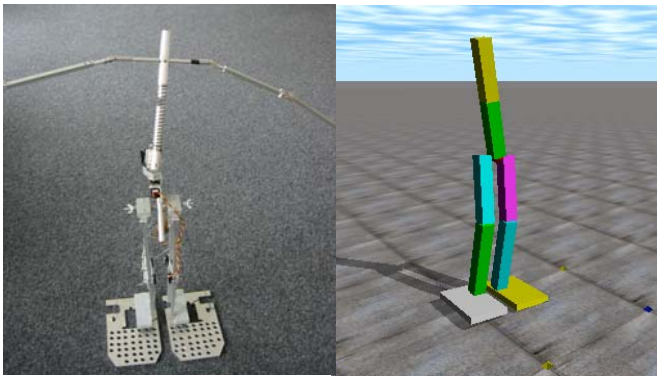

Fig. 2 Pseudo-Passive Dynamic Walker