Evolutionary Robotics: Coupled Evolution of Controller and Morphology for Dynamically Stable Locomotion

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Evolutionary robotics is regarded as an auto-design method of robot system and is modeled with an engineering viewpoint of biological evolution. As a main advantage, this approach is excluding as much human bias on design as possible. In other words, designers do not have to implement desired behaviors by their own and, however, unplanned behaviors can be emerged by evolutionary computation. Thus, this approach is suitable to designing autonomous robot system.

In our research, we mainly focus on "inter-dependence between controller and morphology" and, therefore, applied coupled evolution of controller and morphology in order to design locomotive robots, which achieve dynamically stable locomotion such as running and jumping:

(i) For the investigation of relationship between controller, morphology, and dynamical stability, we conducted coupled evolution of controller and morphology on legged robots in three-dimensional simulation. As results, designed robots tended to acquire triped and quadruped locomotion even with five-and-six legged morphology as shown in fig.1 and those also tended to acquire high fitness. Moreover, those robots tended to acquire two kinds of gaits similar to trot gait and gallop gait in biological system.

(ii) An important issue in the filed of evolutionary robotics is to solve "reality gap" problem. This problem indicates that robots, which designed in virtual world, do not always work in same way in real world. In our research, we interdependently conduct evolutionary design, which eliminate human bias, and heuristic design, which utilize human skills (as shown in in fig.2) order to clarify necessity information on fitness function, reality constrains, and effective design components for dynamically stable locomotion.

Keywords: Evolutionary Robotics, Legged Locomotion, Dynamics, Morphology.

References

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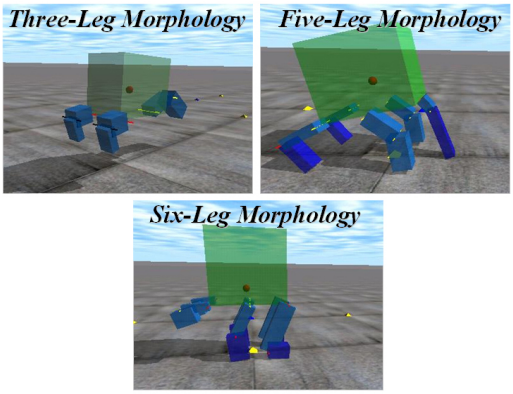

Fig. 1 Legged Robots

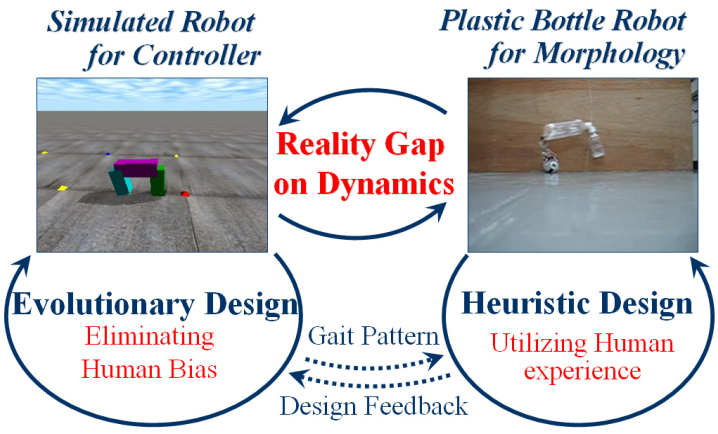

Fig. 2 Desgin System for Reality Gap