Feedforward versus Feedback Control in Synthetic Palaeontology

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Abstract

Synthetic palaeontology is an approach that builds models of ancient organisms in order to test ideas about how they might have behaved when alive. It uses the morphological evidence available in the fossil record and also evidence from related modern animals to specify the anatomy and physiology of the organism and this is translated into a suitable machine mimic (either a physical construction or an in silico simulation) for analysis. One area where this approach has proved valuable is in reconstructing the locomotion of fossil vertebrates such as dinosaurs. This presentation explores whether a feedback control method (tegotae) can be used in this context and how it compares with the central pattern generator (CPG) feedforward approaches that have been used in the past. An intermediate complexity simulation of the dinosaur *Giraffatitan brancai* (a.k.a. *Brachiosaurus brancai*) is constructed using best estimate mass and muscle properties and both control approaches are used to generate walking gaits. The tegotae approach requires only 5 parameters to specify the gait and thus is able to produce walking with a much reduced computational effort. The feedforward approach uses a 73 parameter stacked boxcar CPG and thus parameter optimisation requires the use of high performance computing approaches. However the gait produced is more than double the energy efficiency compared to the tegotae approach. These results illustrate that tegotae style control has the potential to produce high quality gaits and for the first time brings synthetic palaeontology to the desktop computing environment. However the current tegotae implementation, whilst usable for feasibility studies, is probably insufficiently well optimised for energetic estimates in its current form. This is an area of active research and the computational benefits mean that it is likely to overtake feedforward approaches in some areas of fossil gait research.