Control of hexapod walking in biological systems

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Abstract

To investigate walking we perform experimental studies on animals in parallel with software and hardware simulations of the control structures and the body to be controlled. In this paper, we will first describe the basic behavioural properties of hexapod walking, as the are known from stick insects. Insect walking behaviour is based on extreme decentralisation. This appears on two levels: legs can be regarded as independent units that are coupled only by low bandwidth connections that provide the temporal and spatial coordination between legs. The four most important coordination rules will be described. The second control level concerns the joint angles. Inspired by biological results we assume that during stance, joint movement is controlled mainly by local positive feedback. This principle could simplify the control problems dramatically. These ideas are summarized in the form of a simple neural network called Walknet which exemplifies these properties and also shows some interesting emergent properties. The latter arise mainly from the use of the physical properties to simplify explicit calculations. The model is simple, too, because it uses only static neuronal units. As this model is only realised as a software simulation based on kinematics, experiments with real robots are necessary to test these hypotheses. Therefore, the system is currently tested using an adapted version of the robot TARRY II. First results will be presented. Finally, behavioural results will be described that show that even "simple insects" apply internal states of variable strength that might be described as "low-level motivation" like motivation for swing or for stance.