

# A Behaviour Network Concept for Controlling Walking Machines\*

J. Albiez, T. Luksch, K. Berns, R. Dillmann

Forschungszentrum Informatik Karlsruhe, Interactive Diagnosis- and Service Systems,  
Haid-und-Neu-Str. 10-14, 76131 Karlsruhe, Germany, albiez@fzi.de

The high complexity of the mechanical system and the difficult task of walking itself makes the task of designing the control for legged robots a difficult one. Even if the implementation of parts of the desired functionality, like posture control or basic swing/stance movement, can be solved by the usage of classical engineering approaches, the control of the overall system tends to be very inflexible. This paper introduces a new method to combine aspects of classical robot control and behaviour based control. Inspired by the activation patterns in the brain and the spinal cord of animals we propose a behaviour network architecture using the special signals activity, activation and target rating to influence and coordinate the behaviours.

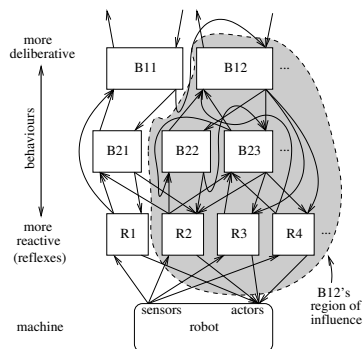


Figure 1: The concept of behaviour networking as proposed in this paper.

When considering the insights gained through PET and EEG scans and spinal cord activity plots of animals performing certain tasks, as well as the problems when dealing with real sensor information and highly complex robots, the following key aspects can be identified:

- A certain action of an animal always creates activity in the same area of the animal's brain or its spinal cord.

- Such an active area can result in the stimulation of further regions as well as inhibit activity in others.
- Even though the classical approach to robot control has difficulties handling the complexity of the whole system, these established methods should be applied to solve simpler sub-problems.
- As hierarchical systems have been approved in robotics as well as in nature it is advisable to use some kind of leveled system with an increasing degree of abstraction regarding sensor data and motor signals.

Taking these observations into consideration, we designed a control architecture consisting of a hierarchical network of behaviours. Each behaviour or reflex is developed using methods of classical control system design or artificial intelligence. Only the interaction of the behaviours and their placement in the network will result in the desired actions of the overall system.

In this paper the general concept of a single behaviour as well as their interaction within the network is described. This architecture is tested on the four-legged walking machine BISAM and experimental results are presented.

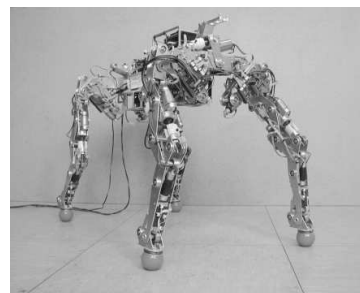


Figure 2: The quadrupedal walking machine BISAM. Due to the five active degrees of freedom in the body and the ability to rotate the shoulder and hip, BISAM implements key elements of mammal-like locomotion.

\*This research is funded by the Deutsche Forschungsgemeinschaft (DFG), grants DI-10-1, DI-10-2 and DI-10-3