Berichte aus der Robotik

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Abstract - Animals are amazing navigators. Even insects with tiny brains exhibit remarkable navigation capabilities. Yet there remain many unanswered questions about the underlying mechanisms. Biorobotics is an approach that tests biological hypotheses on mobile robots. The research in this thesis aims at closing the gap between animal and robot navigation, in a way that allows us to find out more about the behaviour of animals and to apply the inferred mechanisms and design principles to the construction of autonomous robots.

The inspiration for the robotic models in this thesis comes from two principle sources. One is the visual homing ability of insects, which has been studied intensely in bees, wasps, and specifically in the desert ant *Cataglyphis*. The other is the remarkable ability of rats to learn cognitive maps of their environment. The cognitive map hypothesis is supported by the discovery of place cells in the rat's brain.

This thesis focuses on the evolution and development of navigation behaviours over different time scales. At the time scale of individual development and learning, I present a visual homing strategy that can reproduce many aspects of insect homing behaviour, which is learned by a mobile robot during the course of several exploration tours. At a much longer time scale, I also present a study in which evolutionary strategies are applied to visual homing and to the evolution of optimal parameters for cognitive map learning.

Extending previous research which explicitly implemented navigation strategies on a mobile robot, I will show how such strategies can be *learned* by the robot. Learning of navigation behaviour is a first step towards developing robots that can behave intelligently by learning from experience through interaction with their environment and from others.