Self-organized robots driven by attracting states in the sensorimotor loop

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Which kind of complex behavior may arise from self organizing principles? We investigate this question in particular for wheeled robots for which every actuator is controlled by only one or two neurons. The robot is self-organized on two levels, with the locomotive states of the individual wheels corresponding to self organized limit cycles and to fixpoints of the sensorimotor loop. There is also no explicit control of the overall behavior, which arises exclusively from the mechanical coupling of the individual wheels.

Our robot interacts autonomously with the environment exclusively by monitoring the state of its actuators, that is via propriosensation. External sensors are absent. In a structured environment the robot shows complex emergent behavior that includes pushing movable blocks around, reversing direction when hitting a wall and turning to climb a slope. Both limit-cycle and chaotic sensorimotor attractors are found.

Sphere Robot We developed a three-rod sphere robot with a three-neuron controller that we simulated within the LPZRobots environment (publication).

- The sphere robot in a structured environment (click for movie).
- The six limit-cycle attractors found for the sphere robot (click for movie).
- The chaotic attractors corresponding to explorative behavior (click for movie).

Wheeled Robot We developed an embodied controller for wheeled robots that simulates the transmission rod of classical steam engines.

- The forward attractor is destroyed when hitting a wall (click for movie).
- Chaotic mode of the Lego Mindstorms robot (click for movie).
- A train with ten independent wheels showing complex behavior (click for movie).