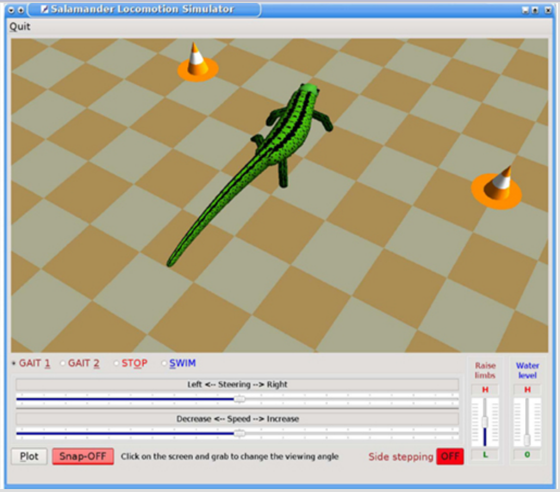
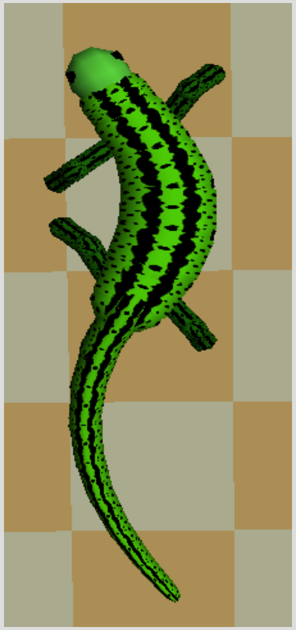
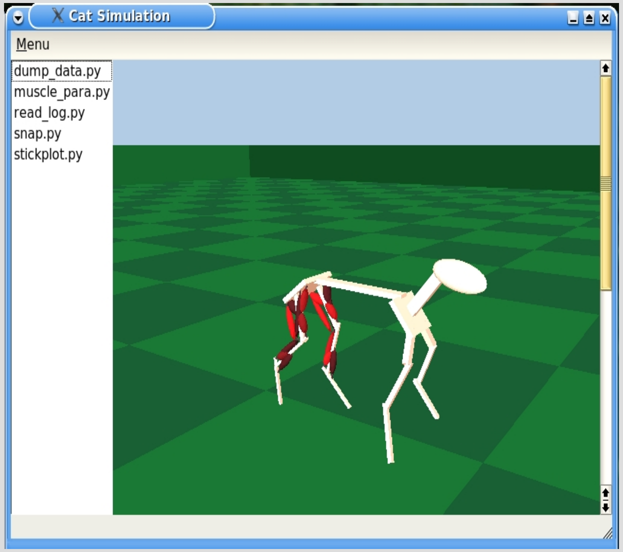
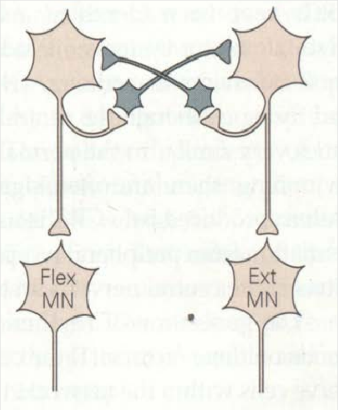
Neuromechanical Simulations in the Study of Cat and Salamander Locomotion









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Aims & objectives

- To understand the neural control mechanism behind vertebrate locomotion *(Cat, Salamander)*
- To investigate the sensory feedback related to locomotion
- To investigate learning and adaptation to the environmental changes (perturbations)- ***control algorithms*** for robotic devices

- Common theoretical framework for neuroscientists and robot/computer engineers

Tools/People involved

- **Scripting:** Python Language (python 2.5.5)
  (www.python.org)
- **Mechanics:** Open Dynamics Engine (ODE 0.5)
  PyODE – python wrapper
  (www.ode.org)
- **Neural:** Nest (2.0 beta)
  PyNest
- **Graphics:** OpenGL, PyOpenGL – python wrapper
  pygame, Qt library

- *Supervisor: Associate Prof. Örjan Ekeberg, CB, KTH*
- *Prof. Keir Pearson, Dept. of Physiology, University of Alberta, Canada*
- *Prof. Jean-Marie Cabelguen*, Pathophysiology of Neural Plasticity, Neurocentre Magandie, France
- *Prof. Auke Ijspeert*, EPFL, Lausanne, Switzerland

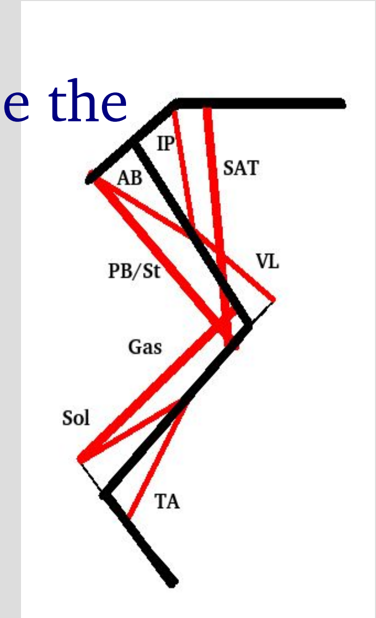
System identification of muscle-joint interactions of the cat hind limb during locomotion (Harischandra et al. 2008)

- To Identify the open loop linear systems between muscle activations and the joint angles of the cat hind limb during walking ***(linearization around different leg positions in the step-cycle)***

- To identify the ***changes of the systems*** at different phases (swing and stance)

- To find out the ***control requirements*** in order to stabilize the walking pattern

- ***Inherent stability*** during stepping
- Pole positions indicate that the MS system for the locomotion operates under ***critically damped condition***



A 3D musculo-mechanical model of the salamander for the study of different gaits and modes of locomotion

(Harischandra et. al 2010)

- To introduce the ***simulator*** of a 3D-biophysically realistic salamander locomotor model *(Neurocentre Magendie, Université Bordeaux)*
- To compare the ***walking gait*** where a wave of activity in the axial muscles travels between the girdles, with the ***trotting gait*** in simulations using the musculo-mechanical model

- To compare different strategies for turning while stepping; either by bending the trunk or by using side-stepping in the front legs.
- Use of side-stepping alone or in combination with trunk bending, was more effective than the use of trunk bending alone.