Modeling of Control Mechanisms in Flight Stability and Locomotion (with Recurrent Neural Networks and Embodied Agents)

J. Simão
DCC/FCUP
{jsimao@dcc.fc.up.pt}

January 22, 2008

1 Summary Description

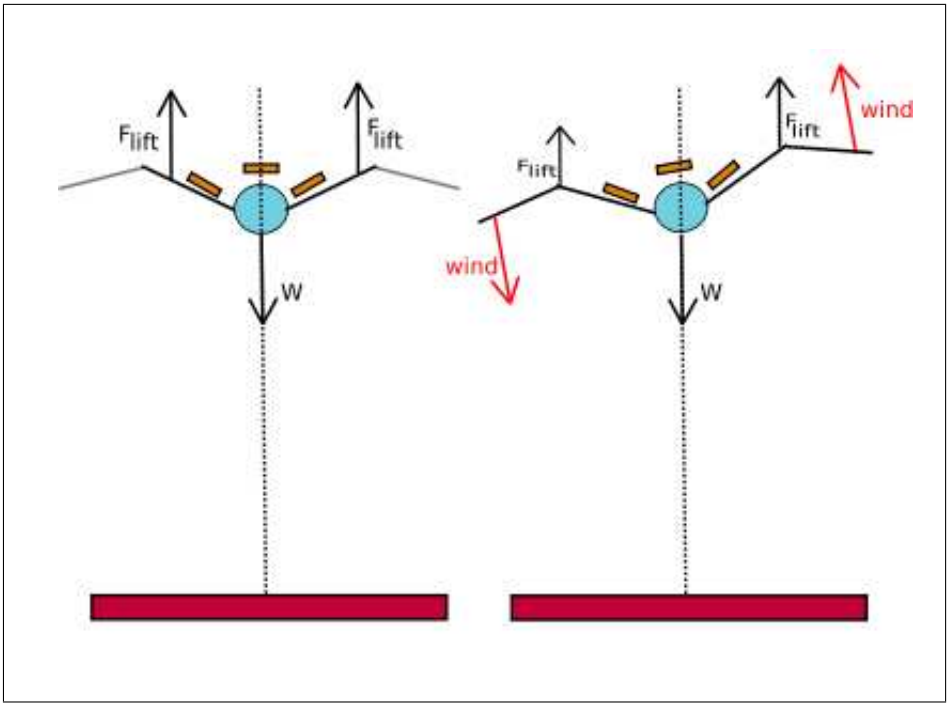
We want to model the oscillatory and (semi-)periodic movement of flying animals (such as birds or insects), emergent from the dynamics of a Recurrent Neural Network. This is done using a symmetrical-body agent with two or four links, representing the left and right wing of the animal.

1.1 Stage I

In Stage I, the considered an agent flying without external perturbation other than gravity. The agent is modeled with only on degree-of-freedom. To simplify, we assume the macroscopic movement of the center-of-mass is limited to one dimension — the vertical axis. The action of gravity on the agent's body (its weight) tends to impel the agent to the ground. Using a simplified model of the physics of flight, we make the self-generated propelling force from wing movement (trust and lift) proportional to angular displacement. Rate and amplitude of wing-flapping caused by muscular contraction is made dependent on neural activity. With the proposed model, neural dynamics tends to vary in quality from nearly periodic to aperiodic (chaotic). Sensors for proprioception, for signalling wing stretch, are used to increase rate and frequency of flapping. This is intended to increase the proportion of time the agent stays on the air, and also to increase height.

1.2 Stage II

In stage II, the agent movement is subject to an additional external force or macroscopic perturbation (e.g. from the wind). We model this by having the agent to rotate around itself due to the externally produced torque. This is modeled to reduce flapping efficiency. Sensors for inclination to provide feedback to the agent about instant inclination. This is intended to be used to correct agent inclination, and help to kept a straight (horizontal) trajectory.



2 Resources

Articles in *cognitive modeling* available from:

- `http://www.dcc.fc.up.pt/~jsimao/`

Links for additional information about flight aerodynamics in birds:

- Wikipedia: `http://en.wikipedia.org/wiki/Bird_flight`
- Video YouTube with pigeon getting of the ground: `http://www.youtube.com/watch?v=nzp5L-U00p8`