PhD Proposal at ISM Biorobotics, Marseille, South of France

Bio-inspired visual strategy embedded on a quadrotor

Insects navigate swiftly through the most complex environments, often attaining a level of agility that greatly outperforms that of present-day aerial robots. Insects use optic flow (the retinal sleep on an agent retina of the contrasted objects in his environment) they perceive thanks to their compound eye to navigate autonomously in unknown environments.

Insects use therefore principles to perform outstanding tasks like three-dimensional autonomous navigation, ground avoidance, collision avoidance with obstacles, hovering, autonomous take-off and landing… It is these principles, still unknown, that we want to understand, model and validate by implementing them into a small rotorcraft equipped with a bio-inspired visual motion sensor.

The goal of this PhD Thesis is to implement an autopilot into a free flying quadrotor to endow it with the ability to visually control its altitude and its side thrust without colliding with the ground or any surfaces. The PhD student will develop the new strategy including the sensors suite based on CurvACE and mount it on the existing open source X4-MaG quadrotor. Then, the PhD student will perform practical experiments of obstacle avoidance, altitude control and automatic landing. Other PhD candidates, an electronics engineer, a micro-mechanics engineer and a CNRS researcher will assist the PhD student to carry out his research.

F. Expert and F. Ruffier (2015) *Bioinspiration & Biomimetics, IOP* Accepted & Open Access
Flying over uneven moving terrain based on optic-flow cues without any need for reference frames or accelerometers

J. R. Serres and F. Ruffier (2015) *Journal of Bionic Engineering (Elsevier)* Accepted
Biomimetic autopilot based on minimalistic motion vision for navigating along corridors comprising U-shaped and S-shaped turns

Optic Flow Regulation in Unsteady Environments: A Tethered MAV Achieves Terrain Following and Targeted Landing Over a Moving Platform

F. L. Roubieu, J. R. Serres, F. Colonnier, N. Franceschini, S. Viollet and F. Ruffier (2014) *Bioinspiration & Biomimetics IOP*
A biomimetic vision-based hovercraft accounts for bees' complex behaviour in various corridors

D. Floreano, R. Pericet-Camara, S. Viollet, F. Ruffier et al. (2013) *PNAS*
Miniature curved artificial compound eyes

Outdoor field performances of insect-based visual motion sensors

Optic flow regulation: the key to aircraft automatic guidance

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**Figure 1:** A) Open source X4-MaG quadrotor [www.gipsa-lab.fr/projet/RT-MaG/]  B) Flying arena at Marseille  C) Curvace sensor

No French language skill required

**Student profile**

- Automation, Electronics, Robotics, Computer sciences.
- Interest for RC aero-model and/or for bio-inspiration

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