PhD Project:

FLOCKINGbyEYE

Bio-inspired flocking based on realistic visual cues

Abstract:
The overall aim of this PhD project is to develop an innovative flocking model. The originality of this model will be to integrate biomimetic visual cues and to implement realistic control laws based on these visual cues. This model will allow us to better understand natural swarms and to propose bio-inspired control laws for robotic swarms.
Flocking is a common strategy among flying animals. Modeling flocking is a step towards a better understanding of this coordinated motion, but also an important step towards a transposition to artificial drones. However, current modeling approaches lack a realistic vision. Incorporating realistic vision in flocking models has been hindered so far by the lack of knowledge of bio-plausible visual cues taken by collective motion scientists (mostly with a background in Physics). Now, thanks to our new collaboration, we will be able to combine the expertise on collective motion models (Eloy's team) and the expertise on bio-inspired visual perception (Ruffier's team).

Duration: 36 months
Funding: thesis funded by AMU
Net salary: approx. €1,380/month (+ approx. €250/month with some teaching duties)

Required profile :
Internationally renowned Master's degree
Knowledge in Physical Modeling, Automation and Computer Science
Taste for experimentation,
Very good level of English (written and oral), TOEIC > 800.

Please send a CV and cover letter to :
Franck Ruffier, ISM (http://www.ism.univ-amu.fr/ruffier/anglais.html): franck.ruffier@univ-amu.fr
Christophe Eloy, Irphe (https://www.irphe.fr/~eloy/) : christophe.eloy@univ-amu.fr

Workplan:
1) To develop collective motion models based on realistic visual cues (18 months):
- Bibliography of collective motion models,
- Inclusion of realistic visual cues into "alignment-attraction-avoidance" models,
- Exploration of the "collective phases" exhibited by self-propelled particles when parameters are varied,
- Interaction with international collaborators,
- Presentations in workshops and international conferences.

2) To test such collective motion models using a swarm of available quadrotors (18 months):
- Reconstruction of realistic visual sensory information at each individual robot level on a computer on the ground, computed directly from the 3-D positions of each robots of the swarm delivered by the Vicon motion Capture system (available at the ISM flying arena),
- Implementation of the hardware-in-the-loop set-up on the ground for testing the flocking model,
- Test of the collective motion models by adjusting some of its hyper-parameters,
- Redaction of conference and journal papers as well as the PhD thesis.

We will use an interdisciplinary approach combining: (i) the development of mathematical models, (ii) the analysis of biological systems, and (iii) the assessment of realistic flocking models with Crazyflie flying robots.

References:
A. Filella, F. Nadal, C. Sire, E. Kanso, C. Eloy (2018) "Model of collective fish behavior with hydrodynamic interactions". Phys. Rev. Lett., 120, 198101. doi:10.1103/PhysRevLett.120.198101

F. Ruffier (2018). "Robotic-flapper maneuvers and fruitfly turns". Science, 361(6407), 1073-1074. doi: 10.1126/science.aau7350

J. R. Serres and F. Ruffier (2017). "Optic flow-based collision-free strategies: From insects to robots". Arthropod Structure & Development, doi:10.1016/j.asd. 2017.06.003.