



Fully funded PhD thesis:

Cohesion of a flotilla of drones through bio-inspired visual learning

Some ants can follow long learned routes using their low-resolution panoramic vision $(7^{\circ}-10^{\circ})$. Their routes can be different to and from the nest (see fig. 1A). A. Wystrach and his team (CRCA Toulouse) have developed, in simulation, a simple model based on insect neural circuits that explains the ant's route following and return to the nest in a remarkably robust way [Wystrach et al, 2020]. This principle, based on visual familiarity, has been successfully implemented on the AntCar mobile robot for route tracking with panorama sequences stored in a highly digitally compressed way [Gattaux et al, 2023, preprint].

In the ANR muteSWARM project, the aim is to extend this principle to implement visual familiarity for formation flight of quadrotor UAVs. The aim will be to show that this visual familiarity index alone (without the need for communication between UAVs or knowledge of inter-UAV distances) can confirm the cohesion of a UAV flotilla (see fig. 1B-C).

Initially, the PhD student will simulate a flotilla of drones in Gazebo, equipped with these particularly frugal learning algorithms to maintain its formation.

The next step will be to test the cohesion of this flotilla trained by bio-inspired vision on real drones. To include the multimodal aspect, a sound map component could also be learned.



Figure 1: I.a) Different routes ants take to and from the nest [Mangan & Webb, 2012]. II.b) An ant's visual exploration sequence to learn how to return to the nest. I.c) Panoramic view taken from the Antcar robot [Gattaux et al, 2023, preprint]. II.a) Flotilla of drones equipped with panoramic cameras. II.b-c) Flotilla of UAVs in Gazebo, and panoramic view taken from UAV A for low-resolution visual memorization.

Gabriel Gattaux, Roxane Vimbert, Antoine Wystrach, Julien R. Serres, Franck Ruffier. Antcar: Simple Route Following Task with Ants-Inspired Vision and Neural Model. 2023. (hal-04060451)

Mangan, M., & Webb, B. (2012). Spontaneous formation of multiple routes in individual desert ants (Cataglyphis velox). Behavioral Ecology, 23(5), 944-954.

Wystrach, A., Le Moel, F., Clement, L., & Schwarz, S. (2020). A lateralised design for the interaction of visual memories and heading representations in navigating ants. bioRxiv.

Salary: 3-year doctoral contract; In 2024, gross salary 2100€/month or 1687€net; in 2025, 2200€ or 1768€net; in 2026, 2300€ or 1848€net; Possibility of teaching appointments.

Profile: Robotics, Automation, Signal processing, ROS, Computer vision, Machine learning

Location: ISM Biorobotique (CNRS - Aix-Marseille Univ), Luminy Campus (Parc National des Calanques) in Marseille, with possible stays in Strasbourg and Grenoble (to be defined together) in partner laboratories of the ANR muteSWARM project.

Please send a CV and a short covering letter outlining your motivations to : Dr Franck Ruffier (CNRS Research Director at ISM Marseille): <u>franck.ruffier@univ-amu.fr</u> Dr Sylvain Durand (Assistant Professor INSA Strasbourg / ICube) : <u>sdurand@unistra.fr</u>