



DLR – DAAD Fellowships

Fellowship No. 507

Research Area :	Space
Research Topic:	Design and Validation of Decentralized Navigation Algorithms for a Robotic Swarm
DLR Institute:	Institute of Communications and Navigation, DLR Oberpfaffenhofen
Position:	Doctoral Fellow
Openings:	1
Job Specification:	<p>A robotic swarm can rapidly explore a vast area, conduct simultaneous observations from different locations and avoid single point of failure, leading to a paradigm shift in future space exploration missions. The autonomous navigation capability of a swarm is an essential prerequisite for exploration, particularly in environments without navigation infrastructure such as Global Navigation Satellite Systems (GNSSs). Each robot in the swarm needs to localize itself, referred to as swarm localization, and chooses its own trajectory for exploration, referred to as swarm control. Both components, localization and control, enable swarm navigation.</p> <p>Within this fellowship, you are expected to design swarm navigation algorithms which are decentralized, scalable, robust, and with low complexity and high precision, ergo suitable for a large-scale swarm with dozens to hundreds of robots.</p> <p>For swarm localization each robot exploits all available information to estimate its state, which contains navigation relevant parameters such as position, velocity and attitude. The information to be fused includes (1) inter-robot measurements like range and direction of arrival (DoA), (2) kinetic measurements from inertial measurement units (IMUs) and command odometry, (3) environmental signatures like detected objects, maps, terrain profile and explored fields, and (4) observation and state inference shared by neighboring robots.</p> <p>Concerning swarm control, real-time decentralized algorithms need to be designed to steer the swarm into a preferable formation for both</p>

exploration and localization. First of all, the high-level mission objectives like environment sensing and safely returning the swarm to the mission base have to be fulfilled. Secondly, the swarm needs to account for improving localization performance, since the exploration effectiveness is subject to not only the sensor uncertainty, but also the uncertainty of sensing position and time. Last but not least, constraints like communication, power consumption, collision avoidance and terrain conditions have to be considered.

The research of this fellowship should be verified in both simulations and experiments with our swarm navigation system. Research results are expected to be published at top conferences and in top journals.

Required Qualification: M.Sc. in Electrical Engineering / Computer Science / Mathematics / Telecommunications with excellent grades; profound knowledge of digital signal processing, estimation theory and statistics.

Advantageous Skills: Experience with MATLAB / ROS / Python / C++, sensor fusion, navigation, Bayesian estimation, machine learning

English competence: See requirements on www.daad.de/dlr
Excellent (reading, speaking and writing)

Earliest Start Date: 1st July 2021

Application Deadline: Until position filled

Further Information: <http://www.dlr.de>
<http://www.daad.de/dlr>