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DLR – DAAD Fellowships

Fellowship No. 456

Research Area : Space/Security

Research Topic: **Swarm exploration of dispersal processes with cooperative mobile robots**

DLR Institute: Institute of Communications and Navigation, DLR Oberpfaffenhofen, Department of Communications Systems

Position: Doctoral Fellow

Openings: 1

Job Specification:

Detection and mapping of dispersal processes, such as pollutants or gaseous materials in the air is very challenging, yet important problem in a variety of applications such as monitoring and inspection of industrial sites and environmental protection. Typically, stationary sensor networks with in-situ gas sensing units are used for such tasks. However, this approach has several critical shortcomings.
We propose to use rovers and drones equipped with appropriate gas sensors to explore material concentrations. We follow two strategies: (i) use of in-situ gas sensors and (ii) use of remote gas sensing technologies, such as those based on Tunable Diode Laser Absorption Spectroscopy (TDLAS). While an in-situ gas sensor detects gas at the sensor's location, a TDLAS sensor measures a cumulative gas concentration along the sensor laser beam. The purpose of this fellowship is to combine both approaches in a single, intelligent gas exploration robotic system.

Specifically, the applicant is expected to develop and test a multi-agent system of flying and ground-based robots. Multiple robots are needed to cope with the high spatial dynamics of the gas: they naturally increase the number of measurements per time, can optimize measurement geometry by creating a flexible sensing aperture, and provide multiple computers for in-network, cooperative data processing. To support robotic operation and decision making the gas propagation is represented with a diffusion-convection Partial Differential Equation (PDE). The PDE models the spatio-temporal evolution of the gas concentrations. By casting the equation in a probabilistic setting, the

distributions of equation parameters – the locations of the gas sources and/or spatial gas concertation map – can be inferred numerically from TDLAS readings using methods similar to those used in computer tomography. The importance of the probabilistic approach to PDE representation is twofold. First, it will allow compensating for unavoidable model mismatches; second, it will serve as a basis of information seeking behaviour of the multi-agent system – an optimal selection of measurement positions and orientations that facilitates identification of the parameters of interest. The developed algorithms should exploit a decentralized architecture and generate optimal measurement position in real-time by using distributed computational and communicational resources on the robots.

The developed methods should be first developed and tested using numerical simulations, and then validated on robotic platforms under realistic constraints imposed by reduced robot dynamics, communication link capacities, robot positioning accuracy, environmental dynamics, limited flight time, etc. At DLR, ground based and airborne platforms are available for performing experiments. For a proof of concept, appropriate parts of the developed algorithms shall be tested using these hardware capabilities.

During the fellowship the presentation of (intermediate) results at international conferences is mandatory. Furthermore, the results of the investigations should be distributed through peer-reviewed ISI-listed international journals during the course of the fellowship. We expect the candidate to pursue and complete his/her PhD thesis in the framework of this fellowship. We help finding a professor at a university and supervise your work at DLR. We also offer a graduate program to improve scientific and social skills, and to learn about project management for the next step in your career.

Required Qualification:

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

Advantageous Skills: Experience with Python/MATLAB/C/C++/, passion for applied mathematics and engineering, machine learning, knowledge of embedded systems

English competence: See requirements on www.daad.de/dlr

Excellent command of English language (reading, speaking and writing)

Earliest Start Date: November 2020

Application Deadline: September 2020

Further Information: http://www.dlr.de
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