Job Title: Internal Research Fellow (PostDoc) in AOCS and Pointing Systems

Req ID **2205** - Posted **20/09/2017**

EUROPEAN SPACE AGENCY

Research Fellow opportunity in the Directorate of Technology, Engineering and Quality.

ESA is an equal opportunity employer, committed to achieving diversity within the workforce and creating an inclusive working environment. Applications from women are encouraged.

Post
Internal Research Fellow (PostDoc) in AOCS and Pointing Systems
This post is classified F2 on the Coordinated Organisations' salary scale.

Location
ESTEC, Noordwijk, The Netherlands

Description
Within the Systems Department, the GNC, AOCS and Pointing Division is responsible for:

- Engineering and research and development of Attitude and Orbit Control Systems (AOCS) for satellites including Failure Detection Isolation & Recovery (FDIR);
- Engineering and research and development of Guidance, Navigation and Control (GNC) systems for space vehicles including interplanetary cruise, aero assistance, precision landing, ascent, rendezvous and docking, re-entry, formation flying and drag-free systems;
- Technology development for AOCS and GNC sensors;
- End-to-end engineering and research and development on high pointing accuracy systems;
- Research and development of advanced control, estimation & optimisation techniques and tools;
- Development of control engineering standards in the frame of ECSS and ESA Standardisation Boards.

Within the Division, the "AOCS and Pointing Systems Section" is specifically in charge of:

- **Designing and implementing Attitude and Orbit Control Systems (AOCS) for satellites and high-accuracy Pointing Systems;**
- Proposing and managing Mission Enabling Technology R/D activities in the following areas:
  - Generic AOCS architecture & Building Blocks
  - Competitive Earth Observation, Telecom, Science AOCS & associated FDIR
  - **High accuracy pointing Systems**
- Technology development for AOCS sensors and electromagnetic actuators;
- **Research and development of advanced control techniques and tools;**
- **Defining, maintaining and operating the necessary computing and laboratory facilities in support of the above activities.**

The section objectives more particularly related to the proposed Research Fellowship activities are highlighted in **bold** in the above list.

Interested candidates are highly encouraged to visit the ESA website: www.esa.int

Field(s) of activities/research
Experimental validation of advanced active micro-vibration mitigation strategies.
Attaining high pointing stability performance is a critical objective for many current and future space missions. As line-of-sight stability requirements get tighter, mechanical vibrations become one of the key performance limiting factors. Commonly termed microvibrations, these low-amplitude disturbances span a wide frequency range from few Hz up to 1 kHz and are produced by a variety of mechanical and electrical spacecraft systems. Microvibrations can propagate, through

the structure of the spacecraft, towards the various optical or communication systems severely degrading their performance.
It is critical for mission success to design adequate vibration isolation systems that can minimize their impact.
Pure passive isolators, such as the ones based on elastomeric materials, are the current baseline for microvibration mitigation to dampen high-frequency perturbations. Yet, passive isolation methods are limited in the lower part of the microvibration range and can be insufficient in terms of isolation performance.
In order to overcome the frequency limitations of a purely passive approach and achieve broadband vibration isolation, the proposed research will focus on the design of a complementary active control strategy that primarly targets the lower range of the frequency perturbations such as the ones introduced by reaction wheels. In order to precisely tune these control strategies and guarantee both compliance with the mission pointing stability requirements and also safeguard against potential uncertainties or faults, accurate dynamic models of the end-to-end system must be obtained.
Mathematical models that reflect both the driving physical phenomena as well as uncertainties present in the system will be established and validated along the project. These models will supplement nonlinear simulations and capture the complex dynamic interactions between the microvibration sources, the isolation system, the spacecraft structural dynamics and the optical payload system.
With this knowledge, a second objective of the study is to demonstrate the capabilities of a common unified framework in which system design, robust controller synthesis, parametric sensitivity and worst-case analysis can be rigorously performed using a common set of well-established mathematical tools.
These analytical tools provide strong stability and end-to-end performance guarantees in the face of uncertainty without relying on time-consuming Monte Carlo simulations.
In a natural way, adaptive control solutions with guaranteed stability and performance margins will be obtained by design.
Finally, the project will lead to the development of an advanced experimental testbed that will serve as a validation platform for future microvibration control and high pointing stability research activities.

Research Programme Specifics

The Research Fellowship programme of work would be the following:

- YEAR 1. Detailed problem Formulation, Requirements Capture, Model Identification and Setup of the Simulation and Experimental Platforms, Preliminary Controller Synthesis
  (a) Development of the simulation environment (SimMechanics) capturing the relevant dynamics of the experimental platform
  (b) From the physical high fidelity E2E model perform the derivation of adequate analysis and synthesis models that capture model uncertainties using a linear fractional representation
  (c) Model identification, validation and uncertainty quantification based on experimental results shall be performed via an experimental system identification campaign
  (d) Definition of performance and robustness objectives based on the physical limitations of the system.
  (e) Setup of the IQC robust analysis framework to validate and verify a given control law.
  (f) Baseline controller synthesis, experimental validation and comparative analysis of a series of classical vibration control algorithms.
- YEAR 2. Advanced Controller Synthesis and Fault Tolerant Design
  (a) development of modern robust control design methodology in order to synthesize a family of adaptive high-performance controllers for different levels of uncertainty
  (b) experimental demonstration and validation of the robust control laws for the plant subjected to different parametric variations.
  (c) Addition of Fault tolerant capabilities to the system. Implementation of FDI and reconfiguration mechanisms.

Technical competencies

Ability to conduct research autonomously
Breadth of exposure coming from past and/or current research/activities
Research/publication record
Knowledge relevant to the field of research
Interest in space and space research
Ability to gather and share relevant information

Behavioural competencies

Innovation & Creativity
Continuous Learning
Self Motivation
Communication
Problem Solving
Relationship Management
Cross-Cultural Sensitivity

Education

Applicants must have recently completed, or be close to completion of a PhD in a related technical or scientific discipline, preferably Control Engineering. Preference will be given to applications submitted by candidates within five years of receiving their PhD.

Additional requirements

Applicants should have good analytical skills and be able to work in a multi-cultural environment in an autonomous manner.
Applicants should have a methodical approach to their work and the ability to clearly document their work and results.
The working languages of the Agency are English and French. A good knowledge of one of these is required. Knowledge of another Member State language would be an asset.

Other information

For behavioural competencies expected from ESA staff in general, please refer to the ESA Competency Framework.

The Agency may require applicants to undergo selection tests.

The closing date for applications is 18 October 2017.

In addition to your CV and your motivation letter, please add your proposal of no more than 5 pages outlining your proposed research. Candidates must also arrange for three letters of reference to be sent by e-mail, before the deadline, to temp.htr@esa.int. The letters must be sent by the referees themselves. The candidate's name must be mentioned in the subject of the email.

If you require support with your application due to a disability, please email contact.human.resources@esa.int.

Please note that applications are only considered from nationals of one of the following States: Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, the United Kingdom and Canada and Slovenia as well as Bulgaria, Cyprus, Latvia, Lithuania, Slovakia as European Cooperating States (ECS).
Priority will first be given to candidates from under-represented Member States.
In accordance with the European Space Agency's security procedures and as part of the selection process, successful candidates will be required to undergo basic screening before appointment