Post Doctoral Position 2009-2010

Conception and Design of
Attitude Determination Control for a picosatellite

Location : INSA de Lyon, Villeurbanne, Rhône (69), France
Laboratory : Laboratoire AMPERE – UMR CNRS 5005 – Équipes *Commande* et *Actionneurs & Systèmes* – http://www.ampere-lab.fr/
Contact : Richard Moreau – richard.moreau@insa-lyon.fr

Starting date : Between September 1, 2009 and December 1, 2009
Duration : 12 Months
Monthly salary : 1868 € (1539 € free of tax)

Context :
This post-doctoral position is part of a LST project (Lyon Science Transfert). A preliminary study has been achieved in the Ampère laboratory and it confirms the feasibility of an active attitude determination control for a picosatellite. This research project is based on this preliminary study which need to be completed. It concerns the design of an efficient attitude determination and control for an implementation on a picosatellite. A picosatellite is a 10x10x10 centimeters cube, its weight should be less than one kilogram and its power is limited to one watt. The « democratization » of space access leads the picosatellite concept to increasingly expend and to become popular to manufacturers. Indeed they are interested for the opportunity to carry on low-cost tests of their technological components. Nowadays, despite the poor performance of the existing picosatellites, several companies in the microelectronic fields constantly ask to embed their technological components on a picosatellite. To improve their current lifetime and their current performances, the picosatellites have to be equipped with an efficient active attitude determination and control. The picosatellites must be able to automatically orientate themselves according to their objectives (to display their photovoltaic cells toward the sun in order to reload their batteries, to orientate their instrument (video-camera, antenna, *etc.*) toward a station based on Earth or toward some other picosatellites). Currently, none picosatellite is controlled with an accurate system of attitude determination and control. The laboratory Ampère is involved to develop such system. Applications are numerous and concerns military and civilian aspects (to monitor ground activity, to relay information about ground traffic, to observe climate change, *etc.*) and some manufacturers would be highly interested in such a system.

Mission :
This project requires to develop an efficient attitude determination and control *i.e.* reliable, accurate and robust. The project is hence discomposed in four steps: it is necessary to establish a reliable model of the spatial environment, to choose the appropriate sensors and actuators and to identify their characteristics, to develop appropriate control laws and finally to proceed to the integration of the system in a picosatellite in order to realize a prototype.

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Activities :
The models will be developed using Matlab/Simulink and should be sufficiently accurate to enable the development of robust control laws. Concerning the sensors and the actuators, an exhaustive state of the art has to be carried on. Due to the picosatellite size, a simple scale from classic satellite is not the unique solution, it could be interesting to find inspiration from other technological fields (such as microrobotics, medical robotics, automotive, bioengineering, *etc.*). The adequate control laws has to take into account the selected sensors and actuators during their development. They will be then integrated in the control loop (*Hardware in the Loop*). Finally, all the development should be integrated in a prototype to prove the efficiency of the attitude determination and control system. Further validation will be possible once the prototype will be validated on the ground.

Competences :
The applicant must have a PhD in the aeronautics, mechatronics or control engineering fields. Expertise in the development of control laws and mechatronic systems will be highly appreciable. Excellent practices in Matlab/Simulink and with acquisition systems such as dSPACE, NI instruments and/or Genesis are also required. The project will gathered several researchers (assitant professor, research engineer, master students) but the applicant needs to be autonomous to achieve the study.

Application :
Application must include a brief vitae, a letter of candidature and a letter of recommendation. Application has to be sent by e-mail to richard.moreau@insa-lyon.fr.

References :
[1] Hassan K. Khalil, *Nonlinear System*, Third edition, Prentice Hall , 750 pages, ISBN 978-7121037047, 2001.
[2] Sigurd Skogestad et Ian Postlethwaite, *Multivariable Feedback Control, Analysis and Design*, Wiley-Intersciences, Second Edition, 608 pages, ISBN 978-0470011683, 2005.
[3] James R.Wertz, *Spacecraft Attitude Determination and Control*, Kluwer Academic Publishers, 858 pages, ISBN 978-9027712042, 2003
[4] Michel Courtois et al., *Techniques et Technologies des Véhicules spatiaux*, Volume 3, Cépaduès Editions, CNES, 750 pages, ISBN 2854284798, 1998
[5] Insu Chang, Sang-Young Park, Kyu-HongChoi, Decentralized coordinated attitude control for satellite formation flying via the state-dependent Riccati equation technique , International Journal of Non-Linear Mechanics, doi:10.1016/j.ijnonlinmec.2009.06.001, 2009