IMESCON
A Marie Curie Initial Training Network (ITN) of the European Union

Two open PhD positions at K.U.Leuven/Belgium in the IMESCON Initial Training Network

IMESCON (Innovative Methods of Separated Flow Control in Aeronautics - www.imescon.eu) is an Initial Training Network (ITN) Nr. 264672, funded under the FP7 Marie Curie programme of the European Commission. Duration: May 1, 2011 - April 30, 2015.

OBJECTIVES OF IMESCON: The IMESCON network is a high quality training network to produce well qualified researchers in the area of active flow control and new helicopter technology. This training programme of best quality early stage and experienced researchers from industry and academia will combine expertise from fluid dynamics, composite material, Micro Electro Mechanical Systems (MEMS), control design, experimental techniques and numerical modelling of coupled multiple simultaneous physical phenomena. The research project will address key questions in the complex multi physics phenomena research related to active flow control with the application of the novel piezoelectric materials. In energy consuming applications like aircraft operation, active flow control is an effective method of substantial fuel consumption and thus CO2 emission reduction. Flow control methods influence the flow unsteadiness, thus impact the increased durability of the manufactured elements and noise reduction. Combination of the two cutting-edge technologies, the MEMS and the active flow control will provide an excellent training and career development path for researchers who wish to work on the analysis of the combined effects of multiple physical phenomena in environment-friendly modern technologies. IMESCON is Marie Curie ITN training programme involving 2 large European helicopter designers and manufacturers, 2 SMEs specialised in MEMS, 3 world class academic research groups and a prime engineering innovation partner. The strong involvement of the industry will shape the training needs of the researchers and increase their employability (project website is under construction).

MARIE CURIE ELIGIBILITY CRITERIA – in short:

- Early-Stage Researcher (ESR): holds an MSc degree in Engineering and has less than 4 years of research experience (1).
- Experienced Researcher (ER): holds an MSc degree in Engineering & preferably also holds a PhD degree. Has at least 4 years of research experience (or a PhD degree), but has no more than 5 years of research experience (1).

(1) The research experience includes the period since gaining a university degree giving the candidate access to doctoral studies (the degree must entitle the holder to embark on doctoral studies, without having to acquire any further qualifications) or already in possession of a doctoral degree, independently of the time taken to acquire it. Among others, following criteria apply for eligibility:

- the researcher shall not be a national of the State in which the hosting partner's research team is located
- at the time of appointment, the researcher may not have resided or carried out her/his main activity in the country of the hosting partner for more than 12 months in the 3 years immediately prior to her/his appointment
- women are especially encouraged to apply.

Partner K.U.Leuven is looking for two Early-stage Researchers (ESR's) on the following subjects:

1) Non-linear model based control technique

Multi-axial test rig shaking for dynamic analysis and structural integrity testing is an important component in the design process of complex engineering structures. Advanced test rig control approaches are needed in order to be able to accurately load the test structure with a predefined (single- or multi-axial) load profile. Some major (typically non-linear) cross-coupling between the various degrees of freedom may occur due to the internal dynamics of the test rig and its impedance coupling with the possibly non-linear dynamics of the loaded test structure. Therefore, a key challenge to be

addressed in the control approaches is the ability to decouple the various excitation degrees of freedom of the multi-axial test rig. To this end, Internal Model Control (IMC) strategies can be applied, which are based on a model of the control process. Their performance and robustness are largely dependent on the model inaccuracies and uncertainties. In this ESR trajectory, advanced virtual simulation techniques and model reduction schemes will be developed in view of the design of robust IMC controllers for multi-axial dynamic testing.
The hosting K.U.Leuven Noise and Vibration research group has a unique 6-dof hydraulic cube shaker table available, which will serve as key demonstrator case for the dynamic multi-axial testing of helicopter components, which will be provided by the industrial partners of the network project.

2) Iterative Learning control techniques for multi-variable systems
Iterative learning control (ILC) is an open-loop control strategy that improves the performance of a system executing the same task over and over again by learning from previous iterations/trials. ILC can be applied to improve a system's tracking and disturbance rejection performance for trial-invariant reference inputs, respectively, disturbances. ILC techniques are well suited for complex systems of which the dynamics are only partly know and/or change over time. Through continuous learning, ILC techniques learn the correct control signal and adapt it when the system dynamics change. Over the last years, K.U.Leuven has gained key expertise in ILC, which resulted in the development and experimental validation of several novel ILC techniques for motion, active noise and vibration control applications: model-based and model-free techniques, linear and nonlinear ILC approaches. Expertise in numerical optimization, especially convex optimization, is central in this research. These algorithms, however, have only been elaborated for SISO systems, while there is an urgent need for multivariable (MIMO) ILC methodologies. In this ESR trajectory, MIMO ILC techniques will be developed. The main challenges in this research are: (i) coping with increases in memory requirements and calculation time of the ILC algorithms when shifting from SISO to MIMO problems, especially if complex systems are considered, (ii) coping with changing system dynamics, and (iii) coping with complex models in ILC approaches that rely on model inversion and hence require model reduction techniques that are tuned towards the main ILC properties: stability, monotonic convergence, and robust performance. The developed ILC approaches will be validated in simulation and experimentally on the available Amplified Piezo Actuators (APA).

CANDIDATE PROFILE:
An ideal candidate has a degree in engineering (mechanical, control ....) and a strong background in control and dynamic system modelling, numerical optimization, programming (Matlab, C/C++), strong interest and experience for work on real-world experiments, and enthusiasm for the project. Proficiency in English is a requirement.

The research activities will mainly be carried out at the division PMA (Noise and Vibration Research Group) of the department of Mechanical Engineering, K.U.Leuven, Leuven, Belgium (www.mech.kuleuven.be) and combined with visits to other members of the network.

APPLY NOW! A start date in course of 2011 is to be agreed upon.

APPLICATION: To apply, send email to jan.swevers@mech.kuleuven.be
Subject of your email should be: “IMESCON PhD application”.
Include:

- a letter of interest (including motivation relevant to the research topic, names and emails of two references
- English language proficiency test results
- a Pdf of your detailed curriculum vitae (including study curriculum with rankings, relevant research experience and publications)
- a Pdf of your diploma and transcripts (including translation if possible)

Please mention clearly for which position you are applying.

The remuneration will be in line with the EC rules for Marie Curie grant holders and consists of a salary augmented by a net mobility allowance http://cordis.europa.eu/fp7.