PhD within the framework of the European project (ETN) “MOIRA”:

Improving virtual sensing by multi-complexity models

Context

This PhD position is part of the “MOIRA” (MOnItoRing of large scale complex technologicAl systems) project, funded by the European Commission through the H2020 “Marie Skłodowska-Curie Innovative Training Networks” program (grant number 955681).

Modern technological systems increase in scale and are becoming more and more complex and sophisticated. Parallel, the revolution in electronics, digital technology and communications have drastically modified and expanded the physical diversity, scope, processing capabilities and complexity of the monitoring equipment and infrastructure used. Millions of networked sensors are being embedded in the physical world sensing, creating and communicating data. The amount of data available for capturing has been exploding and the era of Big Data is already here, as the Internet of Things (IoT) is becoming a reality. The main question which arises is how, following which steps and with which tools the data can be transformed to information and knowledge.

The objectives of MOIRA are

i) the development of novel signal processing tools for the monitoring of industrial processes based on machine learning methods applied on heterogeneous time series,
ii) the application of data mining technologies for the estimation of Key Performance Indicators which determine the operational profit,
iii) the conception, development and validation of methodologies for automated monitoring of cyber physical system fleets,
iv) the multi sensor machine condition monitoring under variable operating conditions.

The proposed MOIRA project brings together early stage researchers (ESRs) and experienced specialists from key players in academia and industry across Europe covering different scientific disciplines and industrial stakeholders from a broad range of backgrounds to optimally tackle the challenges ahead. The MOIRA Fellows will be trained in innovative PhD topics as well as receiving specific theoretical and practical education in the fields of mechanical engineering and computer science, focusing towards the online early accurate identification of abnormal incidents with minimum false alarms and missed detections.

Program of the PhD

Within the context of the MOIRA project, the PhD student will work on fleet monitoring, using a "generic model" and solving an inverse identification problem. In the case of an heterogeneous fleet of machines, the generic model has to face different levels of complexity or various phenomenological contents to describe correct dynamic behaviours of units. If one looks for sharing information between these units of the fleet, it is necessary to have common signals which may be virtual and not necessary physical. The choice and the use of different models that map the physical quantities of interest to the measured signals will be investigated in order to improve the general performances of a “**virtual sensor**”, which is achieved through inverse modelling. The richness of the sensor equipment of a unit (machine, vehicle etc.) will be used in order to correlate the virtual signal estimations from different inverse model architectures. Methodologies will be proposed for the identification of the particular

operating conditions of each unit, updating simultaneously their estimation by sharing reconstructed signals of the fleet units.
Considering the operating conditions and architectures of each unit in the fleet, it is necessary to consider behavioural models with different levels of complexity but which share identical signals to increase the efficiency of detection of abnormal situations. This can be considered as a "**virtual machine**" with its generic model identified on the basis of existing signals.
This work will be based on recent identification techniques and will benefit from an a priori knowledge of excitation components (bearings, gears, electrical machines, etc.). The general framework of **angular approaches** will also be used to describe the transfer path from known excitation components to physical signals (used for model identification and fault detection) and to virtual signals (used for fleet comparison between units and fault detection) in these machine architectures. In particular, **non-stationary operating conditions** will be investigated to extend opportunities of better identification performances and opportunities for detection of abnormal situations.
The methodologies will be applied to fleets of vehicles and wind turbines and/or of some specific components of such machines like drive trains or power transmission units.

Recruitment on the project is 36 months.

Candidates must have completed an M2 level with excellent academic results in vibrations and acoustics / **applied mathematics** / **mechanical engineering**; they must meet the eligibility conditions of ETN projects:

- no residence in France longer than 12 months in the past 3 years immediately before the date of recruitment
- not been involved in research for more than 4 years (full time equivalent) starting to count the date this person graduates his/her first MSc degree.

Supervision
Professors Adeline Bourdon and Didier Rémond (LaMCoS), University of Lyon, will supervise the PhD.
The PhD will take place in France (Lyon), with 3 months with IKERLAN (SPAIN), 3 months with SIEMENS (Belgium), including a substantial salary and living allowance (supported by the EC grant allowed to the project).
PhD candidates will be employed by INSA, including a substantial salary and living allowance (supported by the EC grant).

Application is open from March to December, 2020; send a message to
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