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Code:
Project: TecnioSpring
Area: Energy Efficiency in Systems, Buildings and Communities Area
Area leader:
Group: Power Systems
Group leader: Dr. Jose Luis Domínguez García

Title: Expressions of Interest for Tecniospring Industry Fellowships in the Power Systems Group

Job Description

IREC, in Barcelona, Spain, is interested in receiving Expressions of Interest of potential candidates for the Tecniospring Industry 2021 call (ACCIO, Generalitat de Catalunya).

The **Power Systems** group at IREC encompasses a wide-spectrum of engineering disciplines (electrical, electronic, energy, communications, control, among other) required to comply with such evolving electrical system and sector. The aim of the group is to become an international reference in the R&D sector; with special emphasis in in the field of power Systems, grid Integration and Renewable energies.

The Power Systems Group research lines are focused on the resolution of challenges of the future power systems, allowing larger integration of renewable energy sources, energy storage, as well as power converters and electric vehicles. Power systems are evolving from passive networks to active systems with multiple power electronic converters and smart grid technologies, which are changing the way we understand the power systems as a whole from generation up to consumption; becoming a completely new energy paradigm.

The group is working in close relationship with industrial companies in both technological transfer projects and research oriented projects.

We're looking for potential candidates in the following areas:

Digital Twin development of distribution electrical grids with RES penetration

The objective of the project is to develop a Digital Twin of the network with advanced functionalities in order to improve its operation and management by taking advanced of increased digitalization of the grid and computational techniques.

This aims to create a virtual replica of the distribution grid with renewable energy sources aiming to monitor plan and act at different levels. The main objective of the Digital Twin will be to optimize O&M actions.

Power Electronics for advanced RES integration

This project is of great relevance due to the large renewable penetration, aiming to provide new solutions towards a zero inertia stable grids, ensuring it through the proper control of the novel

generation assets. The project will produce models of RES for control development, in addition to centralized and distributed controls for ensuring grid stability from RES, and holistic control designs of hybrid energy systems, i.e. RES+ESS. In addition, it will work on the development of required capabilities as Grid Forming to ensure the creation of islanded/isolated grids after disconnection.

This work will include modelling and control of different energy systems. Implementation of low order and structure to identify and control existing dynamics as well as RES+ESS control, communication and management. Additionally, experimental activities experimental set ups with IREC's lab facilities are expected.

The extensive use of Renewable power plants (including wind, solar and tidal energy) and the connection of additional devices based on PE, requires advanced controllers to ensure grid stability and security. The project will include:

- Modelling RES and ESS for control design purposes.
- Analysis of advanced control schemes for AS provision and coordination of different RES and ESS.
- To propose a controller for a grid-forming ESS which is capable of dealing with unbalance voltage conditions (in grid-connected mode) and unbalance currents (Island-connected mode).
- Analysis of control schemes limitations in a 100% RES generation scenarios and stability aspects on the network to ensure novel capabilities of power electronics.

Modular Versatile Power Converter

The objective of the project is the design and construction of a modular power converter prototype. The converter is composed of several low power modules (2-5 kW) which are interconnected to form a high power device providing a flexible system. The modules must be constructed in a way that they can be stacked in a rack. The design of the modules must allow AC or DC power input with minimum changes which should be automated as much as possible. The control system will include a high-level controller to synchronize the operation of all modules making them behave as a single power converter.

The researcher will perform the design of the modular power converter and develop a simulation model to validate its functionalities in the first phase of the project. The researcher will be also in charge of selecting and dimensioning the components based on the simulation results. In the second phase the researcher will implement a first module prototype and will verify its performance using Power-Hardware-In-the-Loop (PHIL) technology for rapid prototyping the control system, this phase will be finished when the correct performance is achieved. In the third phase 2 additional modules replicating the first one will be constructed and the control system will be implemented in a control board, the goal of this activities is to validate the modularity of the design interconnecting the modules to ensure the correct behavior as a whole unit, additionally the control board will be validated in PHIL before its integration into the power converter. In the fourth and final phase the researcher will integrate all components into a single modular unit and test it experimentally in the micro-grid facilities available at IREC. several scenarios will be presented and the performance of the development will be evaluated using a set of Key Performance Indicators (KPI) of industrial interest.

Advanced Flexible Battery Management System

The objective of the project is to develop a BMS with advanced features including modularity, flexibility, provision of second life applications and improved models of the non-linear battery behaviour for enhanced state estimation. The developed system will be experimentally evaluated with real batteries to verify its functionalities.

In the first phase of the project the researcher will develop a conceptual design of the BMS aligning the advanced features in a single design before starting the hardware design. In parallel a set of experiments will be detailed with the objective of obtaining the data necessary to model different types of batteries using artificial intelligence and machine learning strategies.

In the second phase the experiments for battery modelling will be executed and the need for additional sensors evaluated which will be included in the data acquisition system to enhance knowledge on the battery state. The additional sensors will be included in the conceptual design in this phase.

In the third phase the PCB hardware design will be performed including the prototype fabrication, the initial prototype will be evaluated with a Hardware-In-the-Loop (HIL) rapid prototyping system and a voltage source to ensure its correct behaviour. The control system will be implemented using dummy models obtained from the experiments performed.

In the final phase the BMS will be used with a test-bench including the real batteries modelled, a power converter, a variable load and the set of sensors required to validate the functionalities in real conditions. The scenarios required are electric vehicle and grid applications regarding second life use of the batteries. The system will be fully operational when it can perform its tasks with different battery types and under several conditions of use.

Qualifications and experience required:

Essential:

- PhD in Industrial Electronics, Automatic Control, Electronics, Electrical engineering or similar.
- Experience with power electronics and electrical networks modelling.
- Experience with simulation software.

Preferred:

- Knowledge on distribution grid operation and management as well as ADMS
- Experience in applications with renewable energy, energy storage systems, electric mobility and grid integration are expected.
- Experience with Control design and Applied Mathematics.
- Experience with modelling and communications
- Control and operation of power converters.
- Experience with robust control and system identification methods.

Personal Skills:

- Team Worker

- Flexibility
- Results-oriented
- Analytical and synthesis capabilities

Benefits

The annual budget includes funding for salary plus research expenses. The salary will be in accordance with the Tecniospring Industry call.

Fellows will be based at the IREC headquarters in Barcelona.

Elegibility criteria:

According to the Tecniospring Industry 2021 call, the fellows must:

- Hold a PhD plus 2 years of additional postdoctoral full time research experience (or at least 6 years of full time research experience).
- Mobility rule:
    - TS Incoming: Not have resided or carried out their main activity (work, studies, etc.) in Spain for more than 12 months in the last three years.
    - TS Outgoing: Not have resided or carried out their main activity (work, studies, etc.) in Spain for more than 12 months in the last three years.

Application:

Researchers willing to apply should check that they meet the eligibility requirements and send the expression of interest, including:

- Their CV
- A motivation letter
- A summary of their research proposal

Expressions of interest should be sent by email directly to the KTT Office (ktt@irec.cat) indicating "Call for Expressions of Interest for Tecniospring Industry Fellowships in the Power Systems" in the subject.

Nr of positions available: 3

Research Fields

- ✓ Advanced Control
- ✓ Power Electronics
- ✓ Modelling and Power Systems

Researcher Profiles

Recognised Researcher (R2)

Established Researcher (R3)

Application Deadline: 15/05/2021