Apprenticeship offer IFPEN

IFP Energies nouvelles (IFPEN) is a key entity in research and training in energy, transport, and environment. Innovation is at the heart of its activities, from scientific concepts in basic research to technological/industrial solutions in applied research. For more information: www.ifpenergiesnouvelles.fr

The apprenticeship takes place within the Control, Signal and System team. The department's areas of expertise includes optimal control, observation, estimation and prediction, graph optimization and data-based control. These skills are used to develop the energy systems studied at IFPEN.

Apprenticeship topic

Wind farm flow control design based on dynamic wake models.

Job description

Context

In the field of wind energy, operators today are concerned with optimizing the use of wind turbines in wind farms, so as to either maximize energy production, or produce energy at the right time and in the right quantity. In order to meet the needs of the power grid. This approach also aims to limit the mechanical fatigue of the wind farm's turbines, with a view to minimizing the overall cost of wind power. Interactions between a wind turbine's wake and downstream turbines can be reduced by controlling the yaw angle of the turbine rotor and the power output. This can allow to both minimize production losses and mechanical fatigue within the farm.

In this context, IFPEN is developing wind farm flow control algorithms. Wind farm flow control is still in an emerging phase, and is beginning to see the first full-scale experiments. Existing wind farm flow control solutions in the literature can be classified into two broad categories:

- Reinforcement learning, where the optimal solution is searched by trial and error on the system;
- Solutions based on optimization via a wind farm flow model.

For optimization-based solutions, there is a need for a reasonably simplified wind farm flow model to be integrated into the algorithm. Wind farm flow models fall into three categories:

- Models based on a precise simulation of the atmospheric boundary layer via the equations of fluid mechanics (high-fidelity);
- Simplified dynamic models, which describe only the main dynamics of the flow (medium-fidelity);
- Static models, which describe the average flow behavior for a set of inputs (low-fidelity).

Currently, most optimization-based solutions use static models, but researchers are also interested in the use of medium-fidelity models, which would allow the dynamics present in the flow to be taken into account and thus solve an optimal control problem. Although a few solutions have emerged, their relevance to industry the problems has not yet been demonstrated.

Missions

It is in this context of research and development that the apprenticeship takes place. The objectives are as follows:

- Identify medium-fidelity models suitable for use in an optimal control problem from the existing literature, and adapt them if necessary;
- Develop optimal control solutions based on medium-fidelity models, drawing from existing literature or designing innovative approaches;
- Evaluate the benefits of this type of solution compared with static model-based solutions, using data from wind farms and high-fidelity simulators.

These solutions will be evaluated in simulation and, if conclusive, may be tested in wind tunnels.

You will work closely with a team of engineers. You will be familiar with modelling techniques and advanced optimal control strategies. Working with our team offers a unique opportunity to conduct cutting-edge research applied to a major industrial challenge.

Techniques applied during the apprenticeship

- Control systems engineering
- Optimal control / optimisation
- Computer programming
- Dynamic modelling of wind turbine wakes

Requested profile and skills

- Apprentice engineer for the IFP School's Offshore Wind Project Development programme
- Interest for research and development in wind energy
- Specialization in applied mathematics, control systems or mechanical engineering
- Proficiency in Python and/or Matlab programming
- Curiosity, autonomy and good interpersonal skills

Contacts

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