DIPARTIMENTO DI INGEGNERIA
CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE -
PHD COURSE IN INDUSTRIAL AND INFORMATION ENGINEERING - 34TH CYCLE

Title of the researchactivity:	Innovative control and monitoringtechniquesforwindturbines
State of the Art:	Control and monitoring has become a major topic as regards wind energy technology, also because public subsides are declining and therefore it is crucial to optimize the efficiency of wind kinetic energy conversion and the reliability of the operating wind farms. Full-scale wind turbines nowadays are commonly equipped with Supervisory Control And Data Acquisition (SCADA) systems, recording information, with a sampling time of the order of some minutes, about environmental conditions, operation, mechanical, electrical, thermal behaviour of the wind turbine. Wind turbines can be equipped also with Condition Monitoring (CM) systems, recording vibrations (with a sampling frequency up to the kHz) at meaningful parts of the shaft transforming the slow rotation of the wind turbine in the fast rotation to be submitted to the grid. Despite the different sampling times of typical SCADA and CM systems, calling for different techniques for the successful analysis of the data, the criticality is the same: wind turbines operate under non-stationary conditions and this implies that complex methods are needed, about which there is a flourishing scientific literature [1, 2].
Short description and objectivesof the researchactivity:	The Department of Engineering has established consolidated cooperation with companies owning and managing wind farms and this has guaranteed vast availability of SCADA and vibration data for analysis and model validation. On these grounds, the research unit has therefore been recognized among the leading experts about the use of operational data for wind turbine fault prevention [3, 4], control and monitoring [5], comprehension and optimization of the performances in light of the features of the wind resource at the microscale level, especially in complex terrain [6].

	One of the most up to date topics is the study of wind turbine power curve upgrades [7]: they can be aerodynamic (for example, installation of vortex generators and passive flow control devices) or they can regard the control system (for example, soft cut-out strategies for extending the operation at high wind speed or pitch control optimization). This kind of upgrades on one hand improve the energy production and it is worthy to study how much through real test cases, on the other they hand might exacerbate stressing mechanical conditions and affect the residue lifetime of the wind turbine. The research project therefore deals in general with the use of SCADA and vibration data for the control and monitoring of wind turbines, in relation to the most up to date topics in the scientific literature. Particular attention shall be devoted to the study of wind turbine power upgrades. The possible objectives of the research are several: • Formulation of methods and test case studies for performance control and monitoring, in particular in relation to wind turbine retrofitting; • Formulation of methods and test case studies for fault diagnosis, through the use of SCADA data and-or vibration data. • Study of the dynamics of the wind turbine through the use of time-resolved high frequency data, at the aim of characterizing the control of complex conditions as for example wake interactions between nearby wind turbines.
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