Collaboration program

In the past the diagnosis of photovoltaic (PV) panels was mainly devoted to evaluate the performance degradation due to the manufacturing process and to guarantee the 25 years lifetime; these analysis was essentially based on off-line costly laboratory measurement. Recent studies shown that the degradation of PV panels is accelerated by various unpredictable and unavoidable phenomena, e.g, the extreme environmental and operating conditions, or by the type of electrical connections thus, in order to prevent the stop of the PV plants, the development of on-line diagnostic techniques is assuming great of interest for the customers and manufacturers of PV systems. The real-time monitoring of the electrical and environmental operating conditions, devoted to the energy productivity analysis, is a feature already offered to the PV customers. However these analyses are mainly used to quantify the return of the investment of the PV plants. The estimation of the global energy productivity is too coarse information for understanding the problems affecting the modules and for performing the right repairing.

The aim of the research collaboration concerns the development of new on-line diagnostic algorithms based on parameters identification methods devoted to monitor the status of the PV system and to predict failures before they lead to a significant reduction on the energy production.
The main result is the design and the implementation of digital techniques in embedded systems for real-time diagnosis. The methodologies will be suitable for performing the diagnosis of different components of the PV plant: the PV cells/modules/arrays as well as the electronic components of the power processing system and the energy storage elements.

The two groups started the cooperation some years ago in the frame of the Erasmus agreement and want to reinforce it by inviting Prof. Giovanni Petrone to Cergy-Pontoise during the academic year 2015-2016. Until now two PhD students, one of them in co-tutorship with the two universities, and two master-students worked for their thesis on this topic. Preliminary results have been obtained by implementing on a FPGA a Cross-Correlation-Method based on the use of a Pseudo-Random Binary Sequence as perturbation signal. The Kalman Filter and the Sliding-observer approaches are also under investigation. All these methods are well-known and largely used in many applications but not yet applied in PV systems for diagnostic purposes. Moreover they are based on simple mathematical models, thus easy to be implemented on embedded systems.
The collaboration between the two universities produced, until now, the following scientific papers:

1. P. Manganiello, M. Ricco, G. Petrone, E. Monmasson, and G. Spagnuolo, “Dual Kalman Filter Based Identification and Real-Time Optimization of PV Systems”, accepted for publication on IEEE Transactions on Industrial Electronics.
2. M. Ricco, P. Manganiello, E. Monmasson, G. Petrone and G. Spagnuolo, “FPGA-Based Implementation of Dual Kalman Filter for PV MPPT Applications” accepted for publication on IEEE Transactions on Industrial Informatics.
3. P. Manganiello, M. Ricco, G. Petrone, E. Monmasson, and G. Spagnuolo, “Optimization of perturbative pv mppt methods through on line system identification,” Industrial Electronics, IEEE Transactions on, vol. PP, no. 99, pp. 1–1, 2014. ISSN:0278-0046.
4. M. Ricco, P. Manganiello, G. Petrone, E. Monmasson, and G. Spagnuolo, “Fpga-based implementation of an adaptive p&o mppt controller for pv applications,” IEEE International Symposium on Industrial Electronics (ISIE-2014), pp. 1872–1877. ISBN: 978-1-4799-2398-4/14.
5. P. Manganiello, E. Monmasson, G. Petrone, M. Ricco, and G. Spagnuolo, “On-line optimization of the p&o mppt method by means of the system identification,” IECON 2013 - 39th Annual Conference of the IEEE Industrial Electronics Society, pp. 1784–1789, 2013. ISBN:978-1-4799-0223-1.