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PROGRAMMA SPECIALE PER LA PROMOZIONE DELLA COLLABORAZIONE INTERNAZIONALE TRA CNR, UNIVERSITA' O ALTRE ISTITUZIONI SCIENTIFICHE PUBBLICHE ITALIANE ED ISTITUTI DI RICERCA STRANIERI ATTRAVERSO LA MOBILITA' DI BREVE DURATA DI STUDIOSI E RICERCATORI ITALIANI E STRANIERI - ANNO 2010

RELAZIONE SCIENTIFICA SUI RISULTATI DELL'ATTIVITA' DI RICERCA svolta congiuntamente e dal prof. Maurizio Cirrincione del University of Technology of Belfort-Montbéliard (UTBM)), France", nel periodo dal 2 aprile al 17 aprile 2010 e dagli ingg. Marcello Pucci del CNR dal 11 giugno al 30 giugno e dall'ing Gianpaolo Vitale del CNR nel periodo dal 11 giugno al 9 luglio 2010.

A Maximum Power Point Technique (MPPT) technique for high performance wind generator with IG based on the Growing Neural Gas (GNG) network has been set up. The proposed approach exploits the speed control of the machine, instead of the torque control as in many applications in literature. To track the maximum generable power over a wide speed range by controlling the speed, the information of the wind speed is always necessary also to prevent the turbine from going into dangerous operating regions. Here a GNG network has been trained off-line to learn the inverse turbine model by using the information given by the direct model which outputs the torque versus wind speed and machine speed. The inverse model is implemented on-line to obtain the wind speed having as inputs estimated torque and measured machine speed. The machine reference speed is then computed utilizing the optimal tip speed ratio. For the experimental application, a back-to-back configuration with two voltage source converters has been considered, one on the machine side and the other on the grid side. Each converter has been controlled with a high performance vector control technique, respectively the FOC and the VOC. A test setup has been built for the experimental assessment of the methodology (Fig.1). Two DSPs have been used to control both the inverters, while the wind turbine has been emulated with a Permanent Magnet Synchronous Machine (PMSM) drive, controlled in torque, which instantaneously receives the torque reference signal by the DSP on which the wind turbine model runs (Fig.2-3). Experimental results show the correct behaviour of the proposed MPPT technique which permits the instantaneous estimation of the wind speed, also for small variations, and corresponding computation of the optimal reference speed of the machine for tracking the maximum extractable power (Fig.4). The proposed method can be applied to every turbine whose parameters are known or directly to experimental data if a wide range of wind speed is exploitable.
Finally, the comparison of the proposed GNG based MPPT with the classic Perturb & Observe (P&O) MPPT made on a real wind speed profile has shown a better behaviour of the GNG MPPT, which permits the generator to be exploited about 3 % more (Fig.5). The comparison of the proposed IG with a back-to-back inverter supply with a Doubly Fed Induction Generator (DFIG)

made on a real wind profile has shown that, even in windy conditions more favourable to the DFIG, the proposed IG is able to generate daily almost 13% as much as the DFIG energy.

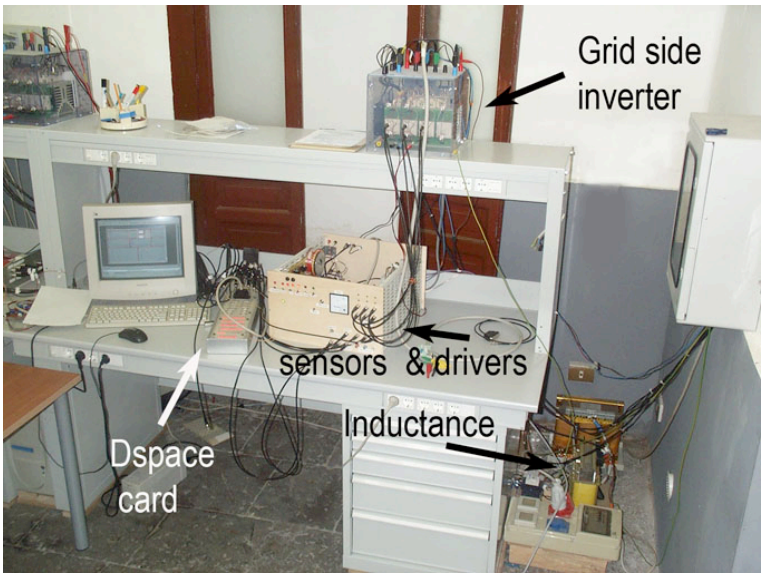

Figure 1. Photograph of the test setup (grid side inverter + inteconnecting inductance)

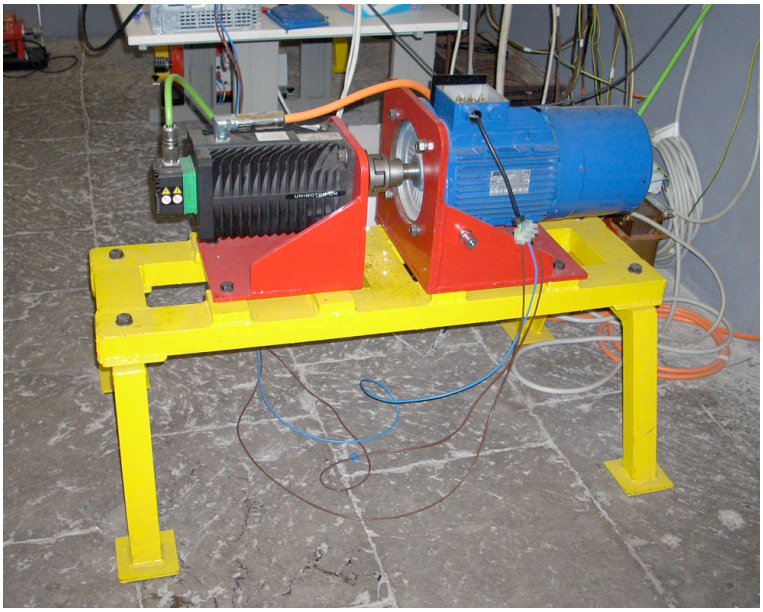

Figure 2. Photograph of the test setup (induction generator + turbine emulator)

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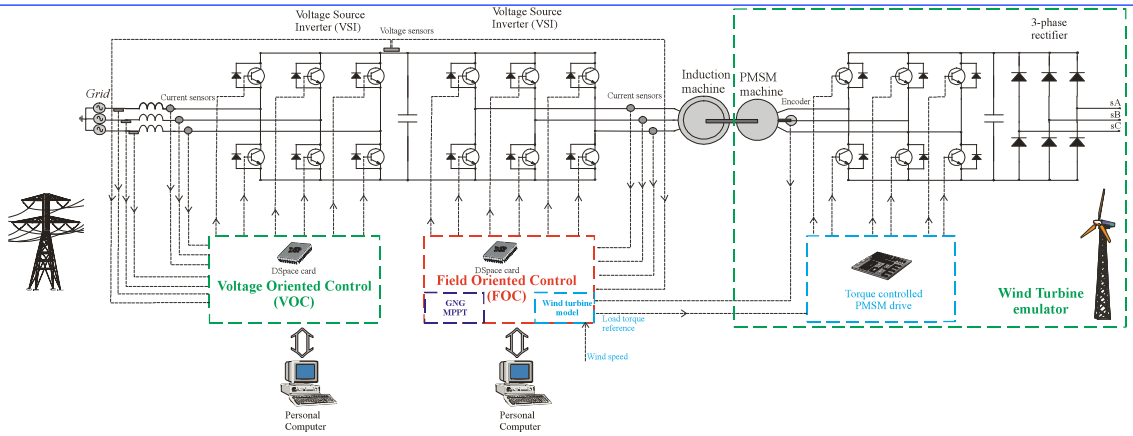

Figure 3. Electric scheme of the test setup

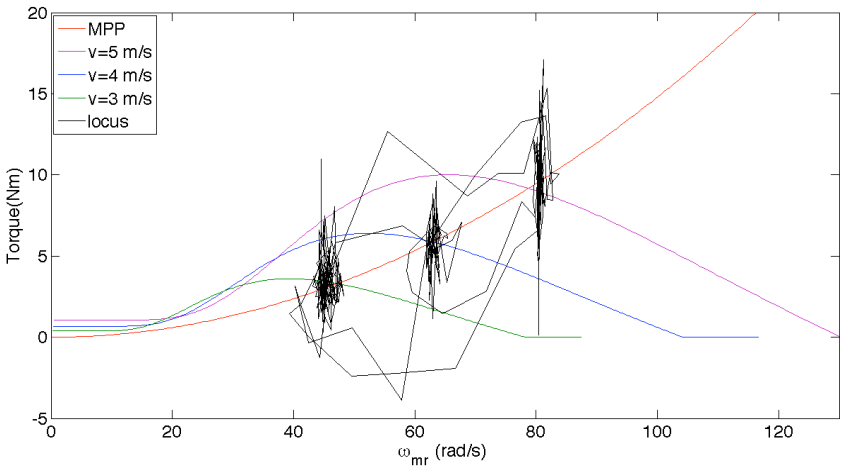

Figure 4: Torque vs. Speed locus

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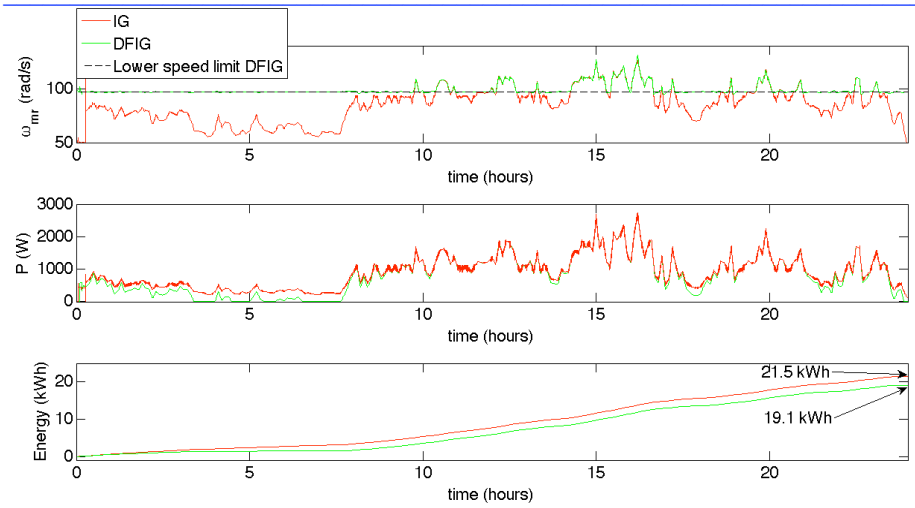

Figure 5: machine speed, active power and energy with the IG and DFIG configurations

Belfort (FRANCIA), 9 luglio 2010

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