Curriculum vitae of Roberto Perini

He got the MSc degree and Ph.D. degree in Electrical Engineering in 1991 and 1997 from Politecnico di Milano, Milano. In 2000 he became Assistant Professor at Politecnico di Milano, where now he is Associated Professor.
UP to 2000, he worked as a free consultant in the design of industrial electric systems.
At Politecnico di Milano, he taught "Principle of electrical engineering", " Electrical machines", and now he has been teaching "Power Electronics" for several years.

Scientific activity

The scientific activity can be subdivided into subjects, briefly described in the following. Each activity led and leads to the publication of some papers in International Conferences and Journals.

Power electronics and Electrical drives

Microgrids

The analysis deals with isolated microgrids supplied by renewable energy sources through switch-mode converters. The power delivered by each inverter is regulated according to the droop-control law.
The research analyzes stability conditions and design requirements for the control parameters. The analysis focusses on a single inverter unit with AC (output) filters and interface transformer, as this may be regarded as the elementary component of a microgrid. Both the droop linear and derivative terms are taken into account. Besides, the virtual impedance is considered, necessary to decouple the real and reactive powers.

Wind energy conversion

The analysis deals with the two following machines:

1. An autonomous induction generator connected to a capacitor bank for the self – excitation and to an a.c. – d.c. conversion system, feeding a storage battery. Different solutions have been analyzed and compared, above all referring to the solutions to sustain the excitation. The analysis has been performed from an analytical, a simulation and an experimental view point.
2. A PM synchronous generator connected to a capacitor loaded diode bridge. In this study only the continuous conduction mode of the rectifier has been analysed.

Doubly fed induction machines and sensorless control

Doubly fed induction machines (DFIG) can work in a wide speed range around synchronism, controlled by a converter with a design power much less than the power delivered by the machine. The analysis of some sensorless control systems has been performed, above all based on the MRAS (Model Reference Adaptive systems): the regions where the operation becomes unstable have been highlighted and explained. Moreover, some new sensorless control schemes have been proposed: as an example, one of them is based on the natural fifth harmonic of the line voltage, without the need of stator current measurement.

Iron losses in the electrical machines fed by a static converter

An accurate model for the calculation of the additional losses in the iron core of electromagnetic devices fed by inverters is developed. The models of the iron losses in periodical steady state and the procedures to identify the parameters of the loss contributions are analysed.

Electromagnetic and thermal models of electrical machines

Operating models and design of synchronous generators

The voltage waveform of salient pole synchronous machine is an important functional characteristic, since a low harmonic distortion implies a good operation for the loads and the telecommunication devices.
The work deals with an analytical–numerical method for the computation of the no–load harmonic distortion; the method is based on the study of time-varying equivalent magnetic networks, from which the tooth flux, the flux linkage as a function of each stator – rotor position and the e.m.f. are derived. The method takes into account the teeth, the type of winding and the saturation in each part of the iron core.

Models and design of universal motors

The universal motor, for low power applications (around 1 kW) and at high speed (up to 35000-40000 rpm), is very wide-spread, above all for domestic appliances.

The work has followed these lines:
- construction of a steady – state equivalent circuit, which does not exist in literature;
- analysis of the iron core;
- analysis of the design criteria to reduce the machine losses;
- operation in a transient state fed by a triac;
- analysis of the commutation and construction of a minimum equivalent network;
- analysis of the phenomena involving brush wear.

Thermal models of induction machines

This study deals with submersible pumps, characterised by a high length/diameter ratio and by the water inside the machine.
The innovative method introduced in the thermal analysis consists in considering a thermal network where the definition of the thermal nodes is not linked to the discretized representation of the machine; the nodes interconnect circuital elements which "exactly" model particular given thermal subsystems of the motor. These thermal subsystems are derived analytically.

Innovative electrical machines

Models, design and tests of Permanent magnet, synchronous machines with tooth windings.

This research starts from an European patent by Prof.s Di Gerlando A. e Ubaldini M., dealing with tooth coil machines. The patent refers to the methodology of definition of the number of teeth and poles for every electromagnetic cycle, the construction of windings with two coils per tooth (two layers), the pitch between layers, the description of the possible machine configurations. This machine shows, as a generator, a sinusoidal voltage waveform with very low distortion, and as a motor a very low cogging torque. Its main advantage consists in the operation at very low speed keeping the dimension limited. The prominent analysis deals with the energy conversion with a direct drive connection to the prime mover and a lot of laboratory tests have been carried out on various prototypes.
The following aspects have been analyzed during the years:
- design criteria, as for radial and axial machines, taking into account various configurations such as Single Stator – Double Rotor, Double Stator – Single Rotor;
- thermal analysis;
- analysis of particular applications, like the modulated damping of seismic vibrations and the linear actuators;
- operation of a permanent magnet machine feeding a diode rectifier with a capacitive load, above all for wind energy applications;
- analysis of the effects of manufacturing imperfections on the operation of axial flux machines;
- analysis and minimization of DC current and torque ripple through a particular modulation of the converters connected to each module of the Modular PMSGs for Multi-MW Wind Energy Applications.

Electrical machines for special applications

Design of an induction heating power plant, so as to heat pipes for the following hot working.

This work starts from a contract with a firm. It deals with the design criteria and the operation analysis of an induction heating power plant used to heat pipes so as to bend them. Two different equivalent circuits have been studied and a criterion to choose the optimal frequency has been introduced.

Contracts

He took part to some contracts with external firms, both as the person in charge and as a collaborator.

Partner	Type	Title	Start date
Aturia Pompe Gessate (MI)	Research	Induction motor for submersible pumps, fed by an inverter	1995
Cena S.p.A. (Brescia)	Research	Analysis of the optimal frequency in induction heating power plants so as to bend pipes	1995
Brusatori S.p.A.	Research	Analysis of commutation in dc motors	1997
Ametek Italia S.p.A. Ripalta	Research	Design criteria and analysis of the commutation in	1997–

Cremasca (CR)		universal motors for domestic appliances	2002
ALGA S.p.A. (Milano)	Research	Electro-inductive devices to dampen of vibrations of buildings and bridges due to earthquakes	2000-2003
Metelli S.p.A. Cologne (BS)	Research	Study and design of an innovative motor with a double rotor for water pump in a car	2007
Epis Gianfranco	Research	Design and manufacturing of a PM synchronous machines with concentrated windings , for wind energy generation	2007
Cefriel (Milano)	Research	Characterization of a compressor used in refrigerators	2008
GCOMM S.r.l.	Research	Design of a PM motor for dental usage	2009
WNT s.r.l.	Research	Design manufacturing and testing of a PM synchronous machine with concentrated windings, for electric energy generation	2009
Italtech wind s.r.l. (Mazzano – BS)	Research	Design manufacturing and testing of a 200 kW PM synchronous machine with concentrated windings	2009 -
Eon	Consulting	Analysis of the fault occurred to group 6 in the thermal power plant of Tavazzano –Montanaso (LO)	2010
Magneti Marelli (Corbetta -MI)	Research	Design optimization of electric motors for KERS (Kinetic Energy Recovery Systems) applications	2010
BTicino S.p.A. (Varese)	Consulting	Preliminary design review of a 25 kV 320 A reactor	2010
BTicino S.p.A. (Varese)	Consulting	Design review of a three – phase three – winding transformer	2011, 2012 and 2013
Cofely	Teaching	Lessons on electrical generators and power systems in generating power plants	2013
Eon	Teaching	Lessons on electrical generators and power systems in generating power plants	2013
Terna	Research	Feasibility study of an anti-icing device for high voltage transmission lines	2016