



PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Domenico Perna

XXIX Cycle

Training and Research Activities Report – Third Year

I Information

I.1 Name Surname

Domenico Perna , Electrical Engineer – University of Naples “ Federico II ”

I.2 PhD Cycle and University

XXIX Cycle – ITEE University of Naples “ Federico II ”

I.3 Fellowship type

Scholarship supported by Hitachi Rail Italy (ex Ansaldo Breda S.p.A.).

I.4 Tutors

Andrea Del Pizzo from D.I.E.T.I. - University of Naples “ Federico II”

Luigi Fratelli from Hitachi Rail Italy – a Hitachi Group

Roberta Schiavo from Hitachi Rail Italy – a Hitachi Group

II Study and Training activities

II.1 Courses

- No expected courses for the third year

II.2 Seminar

- “Challenging real-time measurement systems for immersive life-size augmented environment”
Dr. Giovanni Caturano
- "Microcontrollori di misura" - Alan Smith and Giovanni Di Sirio
- "Speech Technologies at Trinity College - Dublin" - Dr. Loredana Cerrato
- " DDoS detection in cloud and campus networks "- Jill Jermyn
- "Reti di Telecomuncazioni in Campania: Esperienza ed opportunità" - Francesco Castagna, Christian Pepe, Giuseppe Zonda
- " Embedded software validation" - Teoresi Group
- " Il monitoraggio della Qualità del Servizio oltre gli indicatori Standard: l'esperienza sulla rete mobile di Telecom Italia" - Alma Fazzolini
- " Oracle Italia : soluzioni Oracle per la gestione dei Big Data, Data base No SQL e Analytics"
- " Reactive Power Control in AC Networks from the State of Art to the Chopper Controlled Impedance Concept" - Philippe Ladoux
- " The Development of a Fast Pick - and - Place Robot with an Innovative Cylindrical Drive" - Jorge Angeles
- " Medical Robot Research at IPR - KIT Karlsruhe" - Heinz Worn
- " Nanostructured materials based biosensors: engineering next generation of biomedical devices"
- Luca De Stefano

II.3 External Course

- No expected external courses for the third year

III Research Activity

III .1 Title

“Control Strategies in Light Railway Systems to Improve energy efficiency and reliability ”

III .2 Study

The railway transportation is a multidisciplinary area of interest with many different and complex perspectives. The future of rail transport will be characterized by competition with other carriers in terms of costs and environmental compatibility. Therefore the introduction of new solutions able to improve efficiency, costs, reliability and security of the various subsystems of the railway vehicles is mandatory in order to meet the continuously evolving market challenges.

With reference to Light Railway Transportation Systems, different possibilities can be exploited to carry out at different levels improvements in railway field in terms of energy efficiency and reliability. First of all, exploiting from energetic point of view and in terms of speed sensorless vector control vehicles equipped either with Induction Motor (I.M.) or Permanent Magnet Synchronous Motor Drive (P.M.S.M.) and then taking into account energy management of energy storage systems in stationary configuration.

At following, the list of references :

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- [13] Acampa M. S. D.; Del Pizzo, A.; Rizzo, R., “A control algorithm of AC-Brushless drives for railways traction application”, *IEEE-ACEMP2007, Aegean Conf. on Electric Machines, Power Electronics and Electromotion*, Bodrum (Turkey), pp.33÷38, Sept. 2007.
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III.3 Research description

Activity 1:

Two different traction architectures of a light railway vehicles with IM or PM brushless motor drives are investigated by means of two kind of speed-sensorless field-oriented vector control. The dynamic and energy performance of propulsion units with IM and PMSM drives are evaluated and compared in correspondence of various operating conditions of railway traction vehicle over the entire speed domain. Moreover, taking into account typical profiles of urban routes, some well-

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known typical problems of speed-sensorless control have been addressed such as in correspondence of uphill starts of railway vehicles or in the so-called re-powering mode, just after an interval in which the motor is switched off for "coasting", to carry out improvements in terms of reliability and energy efficiency for the whole railway system.

PUBLISHED CONFERENCE PAPERS :

“ Energetical comparative analysis of I.M. and P.M. brushless drives in Light Railway Transportation Systems ” - *23th International Symposium on Power Electronics, Electrical Drives, Automation and Motion 22-24 June 2016*

"An Assisted Speed-Sensorless Control of Induction Motor Drives for Railways Applications" - 4th International Conference on Electrical Systems for Aircraft, Railway, Ship propulsion and Road Vehicles & International Transportation Electrification Conference, 2 - 4 November 2016, Toulouse, France

Activity 2:

The stationary configuration of Supercapacitors Energy Storage Ssystem (SESS) consists in the installation of one or several SESS placed along railway tracks. In this way is possible to store a part of braking energy that cannot be directly supplied to other non-receptive vehicles and feed it back into the overhead contact lines for subsequent accelerations in the same electrical supply section. On the other hand, is conceivable believe that the possibility of reduce the voltage drop long the power supply line allows the optimization of supply voltage profile with the benefit in the mid-long term of being able to reduce the costs due to new investment for infrastructure (i.e., avoiding the introduction of new Electrical SubStations (ESs) and / or reducing the section of the cables). It is important to say that the suitability of stationary SESS for the whole electrified transportation system is strictly connected to their size, position and operating conditions.

From the point of view of the control, the main difficulties are related to the choice of the time periods for storing and providing energy according to the network status which depends mainly on the traffic evolution.

Hence, the focus of this study is the introduction and validation of a control strategy, able to fulfill the benefits above discussed by means of experimental results obtained by using a prototype of a light rail system.

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IV Credits Summary

	Credits year 1								Credits year 2								Credits year 3								Total	Check
	Estimated	1	2	3	4	5	6	Summary	Estimated	1	2	3	4	5	6	Summary	Estimated	1	2	3	4	5	6	Summary		
	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth		bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth		bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth			
Modules	21	0	3	9	6	6	0	24	15	0	7	0	0	0	0	7	0	0	0	0	0	0	0	0	31	30-70
Seminars	5	0	0	0	0	0	0,4	0,4	5	0,2	0,2	0	0,6	2,8	0	3,8	5,8	1,2	2,3	0	0	0	1	4,5	8,7	10-30
Research	34	10	7	1	4	4	9,6	36	40	9,8	2,8	10	9,4	7,2	10	49	54	8,8	7,7	10	10	10	9	56	140	80-140
	60	10	10	10	10	10	10	60	60	10	10	10	10	10	10	60	60	10	10	10	10	10	10	60	180	180

Training and Research Activities Report – First Year

PhD in Information Technology and Electrical Engineering – XXIX Cycle

Domenico Perna

Year	Lecture/Activity	Type	Certification
1	Europrogettazione	Ad hoc module	x
1	Misure per l'Ingegneria dei Materiali	MS Module	x
1	Elettronica Industriale di Potenza	MS Module	x
1	22 hours for eleven laboratory sessions – Electrical Machines and Power Converters – Lecturer : Ivan Spina	External Course	NO
1	15th Edition of European PhD School PEEMEC - Gaeta 26 - 30 Maggio 2014	External Course	x
1	State of the art in Power Converters for High Voltage DC Transmission Systems	Seminar	x
2	Corso di Inglese FIRST CAMBRIDGE	Ad hoc module	x
2	32 hours for sixteen laboratory sessions – Electrical Machines and Power Converters – Lecturer : Ivan Spina	External Course	NO
2	16th Edition of European PhD School PEEMEC - Gaeta 25 - 29 Maggio 2015	Ad hoc module	x
2	"Mathematical Modelling of Atomic force Microscopes" - Dr. Martin Homer	Seminar	x
2	"Regularization of two-fold bifurcations in planar piecewise-smooth systems" - Prof. John Hogan	Seminar	x
2	Semantic Technology Made in Italy" - Dr. Vincenzo Masucci	Seminar	x
2	On the complexity of Temporal Equilibrium Logic - Dr. Laura Bozzelli	Seminar	x
2	Beyond the data: how to achieve actionable insights with machine learning - Dr. Matteo Santoro	Seminar	x
2	On motion planning, motion representation and its orbital stabilization for mechanical system - Prof. Anton Shiriaev	Seminar	x
2	Model based and pattern based GUI testing - Parte 1 - Prof. Ana Paiva	Seminar	x
2	Model based and pattern based GUI testing - Parte 2 - Prof. Ana Paiva	Seminar	x
2	The evolution of Railway signaling systems - Ing. Giovanni Bergellini , Ing. Giovanni Trezza	Seminar	x
3	"Challenging real-time measurement systems for immersive life-size augmented environment" - Dr. Giovanni Caturano	Seminar	x
3	"Microcontrollori di misura" - Alan Smith and Giovanni Di Sirio	Seminar	x
3	"Speech Technologies at Trinity College - Dublin" - Dr. Loredana Cerrato	Seminar	x
3	" DDoS detection in cloud and campus networks " - Jill Jermyn	Seminar	x
3	"Reti di Telecomunzioni in Campania: Esperienza ed opportunità" - Francesco Castagna, Christian Pepe, Giuseppe Zonda	Seminar	x
3	" Embedded software validation" - Teoresi Group	Seminar	x
3	" Il monitoraggio della Qualità del Servizio oltre gli indicatori Standard: l'esperienza sulla rete mobile di Telecom Italia" - Alma Fazzolini	Seminar	x
3	" Oracle Italia : soluzioni Oracle per la gestione dei Big Data, Data base No SQL e Analytics"	Seminar	x
3	" Reactive Power Control in AC Networks from the State of Art to the Chopper Controlled Impedance Concept" - Philippe Ladoux	Seminar	x
3	" The Development of a Fast Pick - and - Place Robot with an Innovative Cylindrical Drive" - Jorge Angeles	Seminar	x
3	" Medical Robot Research at IPR - KIT Karlsruhe" - Heinz Worn	Seminar	x
3	" Nanostructured materials based biosensors: engineering next generation of biomedical devices" - Luca De Stefano	Seminar	x

