"PRO INVENT" RESEARCH CONFERENCE-24.03.2016

Efficient LIghtweight Electro-Magnetic PropUlsion System for Electric Vehicles (ELIMPUS)

1 October 2015 - 30 September 2017 / 549'930LEI

Research team:

Daniel FODOREAN (manager) <u>Claudia Violeta POP (PhD student)</u> Gyorgy Tamas (PhD student) Aron Attila POPP (PhD student) Dan Cristian POPA (postdoctoral researcher) Petre Dorel TEODOSESCU (postdoctoral researcher)



TEHNICA

ELIMPUS Project - Summary

- 1. Motivation of the ELIMPUS project
- 2. Objectives and activities
- 3. Milestones and challenges
- 4. Results and next steps





ELIMPUS Project - Motivation

- The electromagnetic propulsion concerns the main loss source of a propulsion system.

- The use of pure electromagnetic transmission (magnetic gear) offers the following advantages:

- ✓ high transmission ratio can be achieved;
- ✓ no lubrication needed;

✓ no local heat (contact on teeth) and mechanical losses (except on bearings);

battery 9% converter 19% electrical propulsion 72%

<u>Important</u>: - the main loss source in a MG is the iron loss, thus, a special attention should be paid on the used materials;

- our projects exploits the possibility of using variable transmission ratio.

- such solutions can be used in power generation too.





ELIMPUS Project - Motivation

- The elements of an electromagnetic propulsion system: the electric motor and magnetic gear (MG), with/without variable transmission ratio:
- The MG can be integrated within the motor (having intrinsic variable Transmission ratio):
- A second MG under study can have electromagnet configuration => produces variable transmission ratio – patent proposal under preparation.





ELIMPUS Project – Objectives/activities

1. Design and structural analysis of purely electromagnetic propulsion.

Activities: design, simulations and optimization of the electromagnetic propulsion kit, by using analytical methods based on electric-thermal-magnetic equivalent circuit.

2. Testing and validation of purely electromagnetic propulsion.

Activities: construction of the motor-gear propulsion system, with variable transmission, and their associated converters. Optimal control strategy for the energy management will be elaborated for the entire electromagnetic integrated system.





ELIMPUS Project – Milestones/challenges

	Months	1	2	3	4	5	6	7	8	9	10	11	12 1	3 1	14	5	16	17	18	19	20	21	22	23	24
	WP1. Electromagnetic propulsion architecture & requirements																								
	T1.1 Propulsion system architecture & requirements															\downarrow								\square	
	T1.2 Methodology implementation																							\square	
	WP2. Design of the pure electromagnetic propulsion system									\star						\downarrow								\square	
	T2.1 Design of the high speed electrical machines (HS-EM)															\bot								\square	
	T2.2 Design of the control unit (converter included) for the HS-EM																							\square	
	T2.3 Structural analysis of the HS-EM																								
	T2.4 Design of magnetic gear with variable transmission (MG-VT)																								
	T2.5 Design of the active control unit for the MG-VT																								
	T2.6 Structural analysis of the MG-VT																								
RTI	WP3. Modelling&Optimization of the electromagnetic propulsion					•											★								
	T3.1 Modeling, simulation & optimisation of HS-EM																								
	T3.2 Modeling, simulation & optimisation of control unit for HS-EM																								
	T3.3 Modeling, simulation & optimisation of MG-VT																								
	T3.4 Modeling, simulation & optimisation of control unit for MG-VT																								
	WP4. Prototypes construction & evaluation																					×			
	T3.1 Assistance for manufacturing/assembling of HS-EM & MG-VT																								
	T3.2 Construction of the control units for the HS-EM and MG-VT																								
	T3.3 Characterisation of HS-EM prototype with its power converter																								
	T3.4 Characterisation of the MG-VT with its active control unit																								
	T4.5 Integration of the complete propulsion system																								
I 0	WP5. System validation																								\star
EN	T5.1 Assessment of test results of the integrated propulsion system																								
D	T5.2 Revaluation of the design approach based on the measured results																								
S	WP6. Dissemination																								
SIC	T6.1 Publications, project website creation (continuos update)																								
I	T6.2 IPR & Technology watch																								
IEN	WP7. Management																								
GEN	T7.1 Administrative & Finacial Management																								
NAC	T7.2 Reports								lacksquare																lacksquare
MA	T7.3 Project Meetings	*													\mathbf{x}							*			
	Legend		W	P du	rat	ion		Tas	sk d	ura	tion		Deli	vera	able		*	Me	etin	ıg		\star	Mil	eston	e

ELIMPUS Project – Results/next steps

RESULTS:

- ✓ Design of numerical analysis of a PMSM with integrated MG.
- ✓ Preliminary work on analytical desgin approach of MG, based on equivalent reluctance network and vector potential.
- ✓ Evaluation of losses and efficiency on MG and electric motor with integrated MG.
- ✓ 1 article to be presented at SPEEDAM2016 (ISI Proc), Capri, Italy June 2016

FUTURE WORK (2016)

- ✓ Structural analysis, thermal behavior evaluation and optimization of studied MGs
- ✓ Participation at a training for thermal analysis of electrical machinez (Cedrat training in Padova, Italy May 2016)
- ✓ Second paper proposal at UPEC2016 (Coimbra, Portugal September 2016)
- ✓ Preparation of a ISI journal proposal by the end of 2016.





© DMCDI

ELIMPUS Project

© DMCDI

Thank you for your attention!

www.elimpus.utcluj.ro

Contacts: <u>claudia.pop@mae.utcluj.ro</u> daniel.fodorean@emd.utcluj.ro



