Research program:
"Development of algorithms of strong control for the regulation of electric motors to independent (open windings) phases for a new generation of electric motors "clean"

Annex C

Center of Search of Athenaeum for the Management of the Innovation and the Technological

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Description
The research in industrial electronics has focused in recent years on the possibility of obtaining from brushless DC electric motors more power for the same size and weight, trying to optimize the circulation of current in order to minimize heat loss. Many of the solutions go in the direction of developing new generation of inverters capable of driving independently the three motor phases. This leads to the realization of three-phase motors stages "open", that is, not connected neither in a star nor a delta. The power obtained can be higher even by 70% compared to traditional systems, thanks to a more effective circulation of current and maintaining the structure of the windings. This will make it possible to develop electric motors "cleaner" because they are able to generate more power for the same size and weight. These solutions are having a significant impact on the use of aircraft (More Electric Airplane) and are only recently finding a job even in industrial (machine tools, electric machines etc ...).
The current drive is independent in the three phases with the purpose (obvious) to generate the maximum possible torque, leads to control solutions of considerable complexity and algorithmic implementation (in general PWM to 48 stages and systems of feedback control in cascade subject to -potentially- large model uncertainties). Is it therefore useful to use robust control methods for maintaining high performance, for example in compensating weakening and can tolerate the temporary loss of timing.
In this project we want to investigate methods to represent the domain of stability of the controlled system in the parameter space of the controller. Since the controllers of the electric motors are in cascade but with simple structure (P / PI), you can graph the domain of stability and the constraints, as restrictions on the actions of control or special performance requirements
We also wants to investigate the possibility of using randomized methods for calibration of the controllers. The randomized methods used to convey the control constraints using typical indicators of control engineering (phase and gain margins, saturations of the control, settling time, damping and pulsation of the dominant poles, etc ...) with the possibility of introduce constraints of mathematical type, such as for example the typical constraints H_∞ $\|T(j\square)\|_\infty<\square$.
The project activities are as follows
a) analysis of the state of the art, on methods used in independent phases control (and the performance obtainable), on randomized methods for control;
b) development of algorithms for control of the PWM minimizing losses and maximization of the torque
c) development of algorithms for controlling the current for the compensation of disturbances limiting the overall maximum torque deliverable
d) experimental tests
e) dissemination

Objective

The main results expected from this research are:

- New tools and methods for the quantification of energy saving systems and its correlation with the design parameters and control; in this way it is possible to completely dominate the trade-off power / efficiency;
- Innovative algorithms for control of the PWM which are reasonably robust to interference; normally such algorithms are implemented with approximation and are particularly sensitive to large variations in load disturbances;
- Self-calibration algorithms of electronic control systems based on randomized design methods; the idea is to make the calibration of the controller easy for the operator. In fact one of the characteristics of randomized algorithms is that they allow you to describe the specific control in traditional engineering terms.
- Build a prototype of inverter and a series of algorithms to be compared on a real application case. Current applications have poor experimental trials and performance is not always ideal.