ABSTRACT

The habilitation thesis presents a part of the professional and scientific achievements obtained after the defense of the doctoral thesis, from 2011 until now. The title of the doctoral thesis was "Contributions to the Study of the Stability of Sensorless Vector – Controlled Systems with Induction Motor" and was coordinated by Prof. Dr. Eng. Pană Teodor Crișan. The thesis was defended at the Technical University of Cluj-Napoca, on December 3, 2010.

The habilitation thesis is structured as follows: motivation; professional and scientific achievements; the professional, scientific and academic development plan, and finally, the bibliographic references used are presented.

In the motivation of the request to obtain the habilitation in the field of Systems Engineering, are presented the didactic and research activity, the results obtained so far, the national and international cooperation, as well as the expressed desire to continue the research at a higher level, once the habilitation certificate is obtained.

In the second paragraph of the habilitation thesis, the main professional and scientific achievements are presented. They are highlighted in accordance with the main research directions, addressed in the period 2011 – 2024. The main research directions are:

- modelling, simulation and analysis of induction machines. This research direction aims at the most accurate modeling of the induction machine, as well as its analysis in various operating regimes. The simulation analysis is carried out within the Matlab – Simulink program, using S-Function type blocks. The mathematical models of the induction machine are written in the input – state – output space. This facilitates the design of full/reduced order state estimators for use in induction motor speed control systems.
- tandem estimation of the speed and the d-q components of the rotor flux phasor of the induction motor, in order to obtain sensorless vector control systems with very good dynamic performance. These researches aim to reduce costs, as well as increase the reliability of the electric drive system, by using a static frequency converter (CSF), which does not require information about the speed of the induction motor (sensorless control systems). The dynamic performances of the CSFs depend on the robustness of the state estimators, compared to the variations of the electrical parameters of the induction motor (in particular, the variation of the stator resistance and the rotor resistance). In this sense, to increase the dynamic performance of CSFs, two strategies are highlighted:

  - online estimation of electrical parameters, in tandem with estimation of speed and d-q components of rotor flux phasor, of induction motor. Thus, depending on the estimated values of the electrical parameters of the induction motor, the speed and rotor flux estimator is adapted. This strategy allows obtaining some robust state estimators against the variations of the electrical parameters of the induction motor.
  - the second strategy is based on the use of state estimators that have good robustness and are stable in the entire operating range of the CSF.
- the study of the stability of sensorless vector control systems of induction motors. This direction of research is a promising one, considering the growing number of state estimators, as well as types of structures of vector control systems, of induction motors. Within this research direction, the studies carried out in the doctoral thesis are continued for other types of estimators and structures of vector control systems of induction motors.
- comparative analysis of the estimators that are used in the sensorless vector control systems of induction motors. This direction of research is very promising and aims to obtain a ranking of the estimators, based on their dynamic performances, in various operating scenarios. The ranking allows researchers/designers a basis for choosing the most suitable estimators for sensorless vector control systems.
- the proposing new structures of vector control systems, with double orientation, of induction motors. This research direction is a recent one and is based on two vector control systems with dual orientation. The first vector control system uses information about the position and phasor modulus of the rotor flux as well as the phasor of the air gap. On the other hand, the second vector control system uses information about the position and phasor modulus of the stator flux as well as the phasor of the air-gap flux. The estimators used in double – field – oriented vector control systems are based on the mathematical model of the induction motor where iron losses are not neglected. This research direction aims at obtaining superior vector control systems in terms of dynamic performances, compared to classical vector control systems.
- online estimation of the electrical parameters of the induction motor. Currently, this research direction is being addressed by several researchers around the world. During operation, the electrical parameters of the induction machine are affected by temperature, saturation and frequency. The importance of this research direction derives from the fact that any inconsistency between the estimated electrical parameters and the real electrical

parameters of the induction machine is reflected in the dynamic performances of the vector control system. For this reason, in high-performance vector control systems, online estimation of the electrical parameters of the induction machine is preferred, and based on the estimated values, the adaptation of the estimators and the vector control system is carried out. Considering the importance of online estimation of the electrical parameters of the induction motor, we have proposed two online estimation methods so far:

- the first method is based on an extended Gopinath estimator (EGO),
- and the second method is based on the use of an extended Luenberger estimator (ELO).

In the third paragraph of the thesis, which refers to the plan for the evolution and development of the professional, scientific and academic career, the main research directions to be addressed after obtaining the habilitation certificate are highlighted.

At the end of the habilitation thesis, the bibliographic references used are presented. The list of bibliographic references contains 73 articles (of which, in 21 articles I am co-author, and in 24 I am first author), 7 books (of which, in 2 I am co-author, and in 2 I am first author), 1 invention patent, 1 research project, 1 IEEE standard, 2 PhD theses, 3 EU regulations, 2 annual reports and a webography position.