ADVANCED PARAMETER IDENTIFICATION OF ELECTRIC DRIVES IN CLOUD ENVIRONMENT FOR INDUSTRIAL AUTOMATION

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INTRODUCTION: In this article an innovative Supervised Model Reference Adaptive System (SuMRAS) for the rotor flux linkage identification in Superficial Permanent Magnet Synchronous Machines (SPMSM) is introduced.

Estimations are updated in an autonomous way when convergence is reached. The proposed SuMRAS can be applied also to operating motors without requiring manual analysis, hence it is suitable for large-scale implementation in cloud services. The effectiveness of the proposed approach is assessed in a real-world cloud environment through hardware-in-the-loop (HIL) validation experiments.

AIM:

Traditional techniques for parameter identification of electrical machines, such as extended Kalman Filter, recursive least square algorithm, artificial neural network, or sliding-mode observers, can provide accurate estimations, but they are designed to be applied to single motors during specific test sessions for performance or diagnostic evaluations. Moreover, they need manual evaluation to assert whether and when the algorithm is converging or not.

Therefore, this approach is not applicable for the parametric estimation of SPMSMs in large-scale industrial processes, as the machines should be taken away from operation to perform the tests. In addition, a large-scale service should work remotely, with non-programmed responses. Moreover, a highly scalable service should not require any manual actions.

The gap can be closed by reengineering these techniques using Internet-of-Things (IoT) and cloud strategies and considering a completely new paradigm, where parameter identification is performed on-line during the normal operating processes.

MATERIALS AND METHODS:

The rotor flux represents a critical parameter that severely affects the motor efficiency and electromagnetic torque. Reversible changes of this parameter can be observed during normal operations, but, over the entire motor life cycle, over-currents, overtemperatures and vibrations can cause irreversible demagnetizations. The MRAS makes use of adaptive laws designed in a proportional-integral (PI) form to satisfy the Popov hyperstability. However, this approach suffers of deteriorated performances during transients, load variations and low speed operations.

A novel MRAS model with steady-state identification is presented. The steady-state identification procedure is based on R-statistic algorithm which updates the estimation only when the steady state is reached. The proposed approach provides a convergence feedback, allows a simpler implementation and is suitable for cloud computing environments

RESULTS:

Hardware-in-the-loop (HIL) results show the effectiveness of this new approach; in fact, SuMRAS: has been effectively implemented as a cloud service, using Amazon Web Services (AWS) technologies;- autonomously performs updates of rotor flux linkage estimation only in convergence conditions, tracked by a specific feedback;- can remotely be applied to data received by operating motors, without any specific test or manual post-processing.

CONCLUSIONS:

The proposed estimation scheme has been effectively implemented as cloud service in an AWS cloud prototype. The data are provided by a HIL simulator and analyzed without any specific test or manual support. Future developments include large-scale testing with motors data provided by real production plants. Moreover, the SuMRAS performance can be further enhanced by considering more motor parameters on wider operating ranges. Finally, this work opens enormous opportunities for reengineering of other identification techniques as cloud services, using this new approach. This would further increment and enhance the on-line functionalities available for electric machines, such as diagnostics, maintenance and performance optimization.

KEYWORDS:

Cloud computing, model reference adaptive system (MRAS), parameter identification, permanent magnet synchronous motor (PMSM), steady state identification, R-statistic.

BIOGRAPHY:

Angela Anguilano was born on October 1992. She received the MSc degree in Automation Engineering from the Polytechnic University of Bari. She currently works as R&D Engineer and Data Analyst, mainly for Predictive Maintenance and Industry 4.0 projects.