Abstract

The doctoral dissertation entitled "**Mathematical Modelling Methods for Diagnosing Faults in Permanent Magnet Synchronous Motors**" covers the issue of diagnosing faults in Permanent Magnet Synchronous Motors (PMSM). The work concentrated on the application of mathematical modelling methods in the diagnostics of the PMSM faults. These types of motors are increasingly used in industry due to their high efficiency and reliability. However, when faults develop, effective diagnostics are necessary to prevent deterioration of the motor's technical condition, which can lead to stopping of the process line. The research presented in the dissertation aimed to analyse the behaviour of a PMSM operating in a closed control structure by observing the symptoms of defects when they occur during machine operation under different conditions. Furthermore, the thesis aimed to develop relevant signal features derived from the mathematical model of motor faults that could be used for the detection of motor damage, using neural network-based techniques.

The doctoral dissertation analysed the current state of knowledge in the diagnostic field of permanent magnet synchronous motors, which identified the gap in the mentioned research area. The research was divided into several stages including analysis of the various mathematical models that allow the simulation of selected PMSM faults, the identification of symptoms and ideas to extract them and the further use of them in neural network-based diagnostics. During the first stage, electrical fault models were developed, i.e. inter-turn short circuits, demagnetisation, and a mechanical model of the rolling bearing. This research aimed to map the *Lenze MCS14H15* motor and its components during the occurrence of the mentioned faults. The selected models were then linked to the control system, conducting simulation and experimental studies to investigate the influence of current regulator settings on system performance. An analysis of the various signals present in the control structure was performed, based on which fault symptoms were extracted. The collected data was used to train two neural networks: multilayer perceptron and Kohonen self-organising map. The neural systems developed for the evaluation of PMSM condition evaluation were tested and verified for their performance under different operating conditions. As a result, they have shown high performance in diagnosing and monitoring the condition of the machine.

The entire research results presented in the dissertation represent a crucial step in the development of permanent magnet motor diagnostics based solely on mathematical models. The research extends the current state of the art on the behaviour of PMSMs during various faults, which enables the effective use of mathematical models to identify these faults. The results presented in the thesis provide a foundation for further work.

Mateusz

Krzysztofiak