DESCRIPTION FOR THE GENERAL PUBLIC

Application of deep learning methods in detection, classification, and compensation of the measuring sensors faults in permanent magnet synchronous motor drive system

Electric motors are one of the most important elements of modern industry, the most popular of which becomes Permanent Magnet Synchronous Motor (PMSM). This is due to its numerous advantages, such as a high power-to-weight ratio, high energy efficiency, and high robustness to overloads. Motors of this type can be used in control systems that demand the highest accuracy. However, to ensure such high-quality operation, PMSMs require the use of appropriate vector control structures with feedback - **measuring sensors**. In systems with a PMSM drive, a speed sensor, at least two current sensors, and a voltage sensor are commonly used. Incorrect measurement may not only threaten further machine failure but may also pose a direct threat to humans. PMSMs are popular in industries including **electromobility, spacecraft, and aircraft**. So-called Fault Tolerant Control (FTC) systems are used there. The task of such systems is to detect damage as quickly as possible, locate it, and then compensate. Measurement sensors are elements exposed to many types of damage. The most dangerous of them is the complete or periodic loss of the measuring signal. The operation of the drive system may also be disturbed by the appearance of noise or variable gain of the measured value. In addition, the operation of many diagnostic systems relates to failures of the electric motor itself or other components of the control system rely on measuring sensors. In the literature, however, the detection of damage to measuring sensors is poorly described, in particular for a drive system with a PMSM. The solutions presented in the literature are often based solely on simulation results. Besides this, the results are presented in a small speed or motor load range. The solutions available in the literature are not practical in nature and there is a lack of universality.

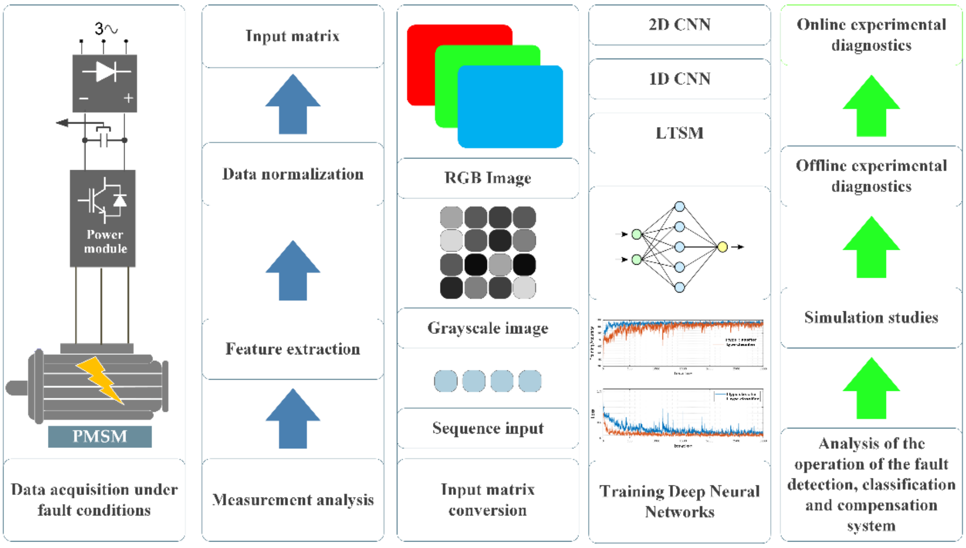

Fig. 1. A diagram showing the general assumptions for conducting the project.

The project involves developing new detection, classification, and compensation algorithms based on deep learning methods for PMSM drives during sensors faults. The project assumes failure detection of current and speed sensors. The initial phase of the project will concern the analysis of the impact of damage to the measuring sensors on the control structure, which will allow the selection of damage symptoms. In the next stage, the training process of deep neural networks will be carried out with the use of various data types inputs and various neural structures. The next stage involves the development of innovative speed and current estimation systems based on deep neural networks. The research will be conducted both in simulation and experimental studies. Experimental research will be carried out in a wide range of motor speeds and mechanical loads. It is planned to test two PMSMs of different nominal power in order to obtain the greatest versatility of the solution.

The proposed solution uses deep learning methods that have not been used so far in drive systems with PMSMs for sensors faults issues. In addition, the proposed FTC will be based on an exhaustive analysis of failure’s impact in a wide range of operating parameters. Damage detectors and classifiers prepared in this way should enable to obtain a sufficiently short detection time, which will allow for much more extensive experimental research than previously described works. The project involves the use of deep learning methods to eliminate the disadvantages of the solutions described so far in the literature. **In the project, it is also planned to analyze the use of deep neural networks in the estimation of state variables, to finally obtain an innovative and fully-automated FTCS based solely on deep neural networks.**