Abstract of the doctoral dissertation:

„Diagnostics of the electric barrier machine using machine learning”

Author of doctoral dissertation: mgr inż. Roman Pawełczyk
Dissertation supervisor: dr hab. inż. Damiana Grzechca, prof. Pol. Śl

The dissertation proposes a new type of diagnostics for the electric barrier machine. It consists of three new methods of performing diagnostics, i.e. BMAD, BMMT, BMFD and models of events occurring during the operation of the electric barrier machine. All the three methods use machine learning techniques.

An analysis of the available literature leads to the conclusion that the problem of diagnostics of railway systems, and in particular of a signalling system comprising electric barrier machines, has been studied from many angles. However, there is a gap in terms of diagnostic mechanisms dedicated to such problems, as the angular position of the boom, the total movement time or the classification of events occurring during the operation of the barrier machine. Three proposed methods provide solutions in this respect.

The non-invasive Barrier Machine Angle Detection (BMAD) method for detecting the position angle of the boom of the electric barrier machine is the first one. This method provides continuous output information in two formats based on the analysis of the supply current waveform. The first is the current value of the angular position and the second is the information about the detection of the selected angular position of the boom. The BMAD method does not interfere with the design of the barrier machine or the control interface.

A method for predicting the total boom movement time, i.e. BMMT (Barrier Machine Movement Time) is presented as the second one. The author proposes a concept that paves the way for optimising the warning time of level crossing systems. The method provides a prediction of the total boom movement time based on the power current waveform and selected environmental variables. An encoder signal indicating the current angular position of the boom in the initial phase of its movement is one of the inputs.

The Barrier Machine Failure Detection (BMFD) method for detecting events during the operation of an electric barrier machine is the third method. First, the models of selected events used in the development of the BMFD method are presented. In the second part, the BMFD method is proposed, providing event classification based on the supply current waveforms occurring during a given phase of electric barrier machine boom movement.

All the diagnostic methods, together with event models, were developed and tested using a dedicated test stand providing operating conditions representative of the target installation site.

The BMAD method was the subject of a dedicated implementation project, which was successfully completed - the solution developed was formally transferred to the product management team for implementation.