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DISSERTATION REVIEW

OF THE DOCTORAL THESIS

Doctoral thesis: **WAYSIDE DIAGNOSIS OF RUNNING GEAR RELATED FAULTS IN RAILWAY VEHICLES**

Student name: Onur KILINC, M.Sc.

Supervisor: Ing. Jakub Vágner, PhD.

Specialist supervisor: doc. Ing. Michal Lata, PhD.

Branch of study: 3706V005 Transport Means and Infrastructure

Programme of study: P3710 Technique and Technology in Transport and Communications

Schooling place: University of Pardubice
Jan Perner Transport Faculty
Department of Transport Means and Diagnostics

1. Up-to-dateness of the topic

The diagnosis of running gear faults like wheel defects, wheelset and traction motor bearings and gearbox faults using model based and wayside diagnosis techniques based on acoustic and vibration sensors is an up-to day topic. The analysis of the investigated parameters in the work is for sure not brand new, but up-to day and permanently important and from the point of view of practice, very interesting too. This issue is very closely connected with the safety of railway operation and vehicles cost effective maintenance as well. Railway vehicles condition monitoring systems completed with suitable trustworthy data evaluation methods represent a crucial unavoidable assumption for vehicles faults recognizing and adequate maintenance procedures execution.

2. Selected methods of writing

The selected method of writing is standardly used for the graduation work completing. The work consists of introduction and eight chapters. The sixth chapter is devoted to conclusions, contains references and in the final eight one, there are specified publications of the PhD student related to the theme of the dissertation. The work in its beginning is completed by a list of tables, figures abbreviations and symbols. The thesis consists of 89 numbered pages. The structure of the thesis is common; where in the beginning of the work there is analysed the current situation in the area of dissertation. I appreciate, that the aim of the dissertation is specified in a separate chapter.

The overview of the applied method is described in the chapter 3 and results and discussion are evaluated in the chapter 4. The further discussions (chapter 5) contents a summarisation of the Ph.D. student own contributions. The resulting chapter 6 contents the conclusion. The work is closed by chapter 7 with the specification of 97 items of references and chapter 8 with the list of Ph.D. student publications.

All the work structure is meaningful and proportions of the text formations are acceptable. The Ph.D. student applies correct terms specified for the processed field of study. The work is written on a very good graphical level.

3. Objectives and their meeting

The objectives of the work are written in the separate chapter No. 2: “Definition of dissertation objectives”. This study aims to designing an appropriate framework for fault diagnosis of running gear components like wheel, wheelset/traction motor bearings and gearboxes in railway vehicles, using cutting-edge feature extraction and classification techniques in diagnosis, application of contemporary digital filtering techniques in signal processing, validation of the methods both with measurement and simulated faulty data and maintain a real-time monitoring by accelerometer and acoustic sensors data.

In the subsequent text the whole procedure or the chain of steps are described in detail, the procedure could lead to the requested aim. More precisely, there are in advance specified all detailed activities that are needed to meet the specified work.

On the base of the thesis study I can express, that these objectives were fulfilled.

4. The dissertation thesis adding

The main objective of this thesis was to design an adaptive fault diagnosis framework that can diagnose running gear faults like wheel defects, wheelset bearing faults and gearbox faults. The multi-functional MATLAB software was created that reads data of measurement and segment signals referring to their train set ID, executes a filtration and feature extraction automatically for the given intervals, from wayside diagnosis measurements. The proposed novel one-period analysis for bearing fault detection and wheel defect detection was validated. In the simulated faulty modes section, faulty signal frequencies were calculated according to the model based approaches by a speed adaptive way both for normal and faulty samples for bearings and gearboxes. Kurtogram envelope was used to filter out the transients in the fifth scale which is based on speed adaptive determination of rotating machinery components and noise removal was applied by using wavelet denoising and detection accuracy of the faults improve significantly in wavelet energy methods. In all classification results, both dimensionless feature normalization and best feature selection were investigated in order to achieve better results which in some cases aid improving overall classification accuracy of several feature extraction techniques. It was observed that the novel proposed combined methodologies had requested classification accuracies; wheel defects, wheelset bearing, ORF, TM-eccentricity with the vibration sensor data and both wheelset bearing IRF and gear tooth faults by the acoustic sensor data. In the classification stage, the novel classifier combination was defined by the involvement of five different classifiers. The last successful investigation was subjected to classifying real faulty cases of traction motor bearings.

I can take into account as a new findings the systematic investigation in this experimental and statistics field (by means of computer simulation computation comparable results).

5. Significance for profession or scientific development

The work may be adequately significant for wayside fault diagnosis of running gear related faults of railway vehicles by using vibration and acoustic sensors and accompanying optical gates for wheelset position detection. The results may aid specialists who are focused on the condition monitoring systems or maintenance. Further adjustments and improvements may be done when more faulty data information is available and the framework may work in a better performance. Such material may be used for educational purposes in engineer or doctoral study.

6. The extend and quality of the published works related to the dissertation

In dependence on the processing of this work, during the doctoral study were processed and published 8 publications. Six of them were published at conferences (in the Czech Republic). The advantage of the conference articles is that probably all of them were presented in front of experts from the field of study. Two articles were published in scientific journals (Turkey and Czech Republic). Three articles from the conference "Vibroengineering" are registered in the SCOPUS database. So this one proves that the good quality of the published works has been achieved.

7. Questions

How long has the diagnostic system been utilized?

What was the reaction of the operator on the need of introduction of the maintenance process for the given vehicle?

Does the operator use also other diagnostic systems; if yes, how do their findings correlate with the proposed diagnostic system?

The Doctoral thesis and Doctoral thesis precis fulfilled all requirements there are connected with this type of document.

FINAL ASSESSMENT

I can state, that reviewed dissertation thesis of Onur KILINC, M.Sc. meets the requirements for creative scientific work for awarding the title

**„Philosophiae doctor"
(Ph.D.)**