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DIAMETER IDENTYFICATION OF AXLE SETS OF TRAIN BEING IN MOTION

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ABSTRACT

The paper presents research on measurement stand model for identification diameters of axle sets of railway vehicles being in motion. Special measuring modules have been designed. Signals form few kind of sensors are acquired. We are using contact and non contact sensors. Main goal of research is selection of best sensor and signal processing method. The paper presents the range of application of the method in the point of view of possibility of obtaining sensitivity of measurement, what means possibility of identification of minimum difference between theoretical and real diameter.
Keywords: monitoring, diagnostics, measurement, wheel sets, axle sets, railway, circular errors

1. INTRODUCTION

Natural wear of wheel's tracks in use is one of most important phenomena of rail transportation. The progress of wheel track wear is slow. Wheels wear process is more or less intensive, depending on many factors, i.e. rail curves, breaking conditions, start-up conditions of trucks (e.g. wheel skid), truck velocity and loading. Wear type can vary in a wide range of patterns, e.g. flat places of high local hardness may occur during breaking skid. It can be stated that the natural wheel wear invokes various shape errors of a wheel, called circular errors. In the example of rail tracks, circular errors can cause additional dynamic forces to occur at contact area between rails and wheels. It causes the increase in both noise and vibrations, what leads to uncomfortable transportation. Over past several years, the role of circular errors is still more significant as the speed of trains increases. There are so-called fast-moving trains, driven at speed up to 300 km/h. In such cases excessive circular errors can be very dangerous from point of view of transportation security regulations.

Circular errors and differences in axle set wheels are criteria to qualify the axle set to regeneration process. Regeneration process of worn wheels of a truck performs on special machine tools. The axle sets very often need to be disassembled before machining begins. The disassembly process is not only very expensive but also time-consuming as the worn wheels are excluded from use for a long time period. Thus, the decision about axle set regeneration is very important. If it’s taken prematurely, it can be unprofitable, from the other side if it’s undertaken too late, it can be simply dangerous. The best criterion for the problem of decision-making is to identify the actual state of a wheel track.

Research on the new method of identification of railway vehicle wheel diameter is made in Department of Machine Technology. Main goal of the research is develop a method for identification worn out wheels diameter with is one of the criteria to qualify the axle set to regeneration process. Regeneration is made by machining. We are make assumption, that proposed method could be used in the industrial environment.

Doctor’s thesis about some measuring method of diameter using of inductive sensors was presented in Department of Machine Technology. Presented results of method prove suitability of inductive

sensors for measurement with required accuracy. Significant sensitivity on construction parameters of measuring stand makes difficult to apply one in the industrial environments.
Presented approach is continuation of work began by A.Kolka [2]. Compare of three method of identification of diameter is main goal of research. Proposed method using:

- inductive non-contact sensors
- encoders,
- laser triangular measuring units.

Results must come to conclusions:

- about accuracy each of method,
- economical aspect as criteria of industrial application for railway repairing plants.
- Final and practical conclusion must show how to select each of the method taking in to consideration required accuracy and economic of industry.

First stage of project, simulation results for measuring units with encoders for identification of axle sets diameter are presented in the previous paper. Second stage of project, design of experimental measuring stand and results of data acquisition are presented in the paper.

2. MEASURING STAND

We are using two different approach. First of one is mechanical measuring module equipped in two kind of sensors. Measuring unit is presented in the figure 1. Rotating lever equipped with roller (1) staying in the contact with the axle wheel passing measuring stand. In the axis of rotation (3) of lever are set encoder and cam cooperating witch non-contact inductive sensor. Shaft of encoder is connected with shaft of lever. Under sector cam, on the bottom of unit is set non-contact inductive sensor. When railway car passing the stand axle wheel pushing lever by roll and lever rotation force rotation of encoder shaft and simultaneously sector cam. Encoder measuring angle position of shaft and non-contact inductive sensor measures distance between sector cam surface and sensor surface. Registered signals are represents complete change of angle of lever during contact with the wheel registered on two ways.

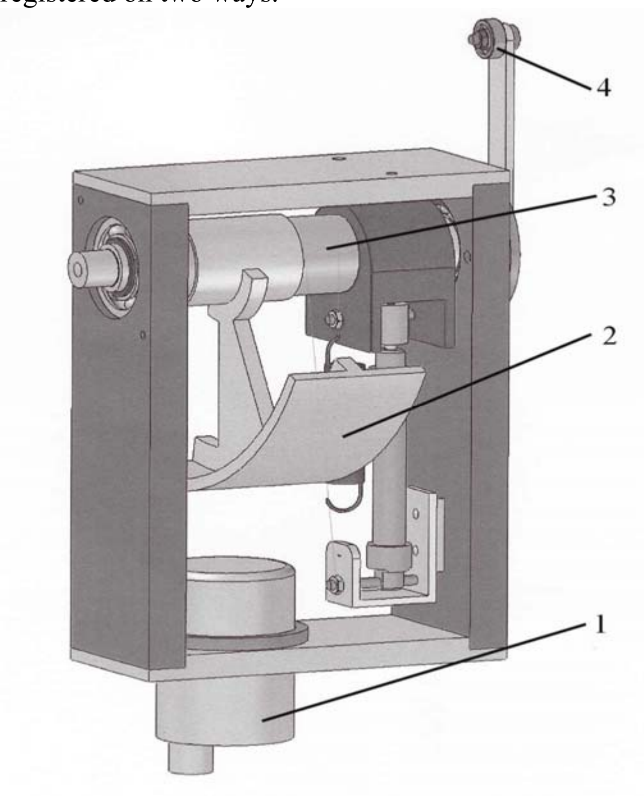

Figure 1. Model of diameter measuring unit: 1 –non-contact inductive sensor, 2 – cam, 3 – shaft, 4 – lever with roller

Figure 2. The Balluff distance sensor BOD 26K

Second approach uses laser Balluff distance sensor BOD 26K (fig.2). Main idea of use this kind of sensors where presented in Doctor's thesis about some measuring method of diameter using of inductive sensors [1]. In this case inductive contact sensors are replaced by laser units set in line. Differ than previous methods there are used inexpensive sensors with large sensing distance, and each of them working independent.

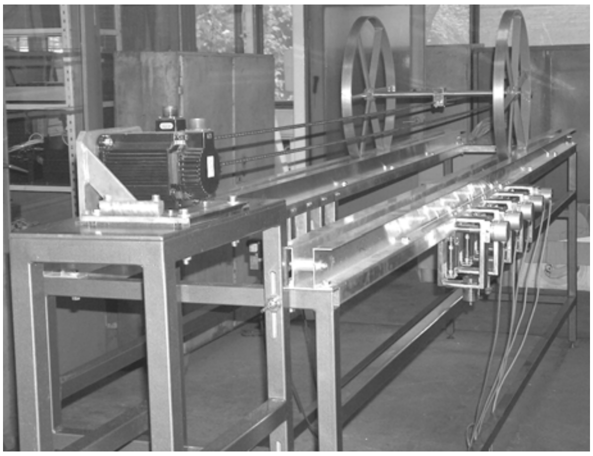

Figure 3. Rail of measure stand with assembled measuring units

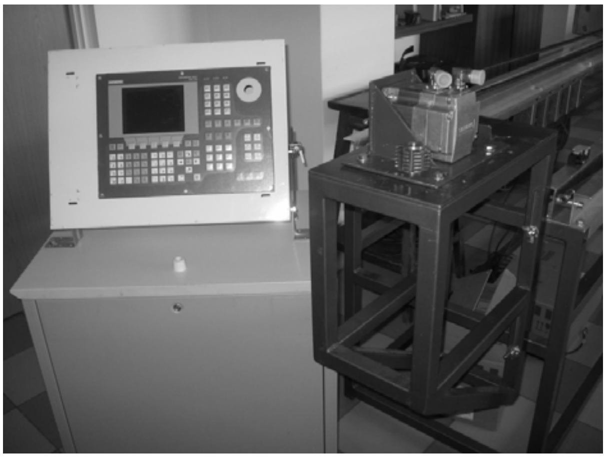

Figure 4. Computer Numerical Control and drive unit

Main concept of the method taking into consideration that standard signal changes form sensors are known. Identification of diameter of wheel is based on comparing obtained signals with standard signal with is stored in the memory of computer. This method of estimating axle set wheel diameter was a second goal of research. Standard signals where made on the way of computer simulation Theoretical plot where obtained for wheel diameter equal to real wheels. Due requirement of constant speed of axle set during data acquisition precise control of speed is required. For this task Computer Numerical Control and Servo drive are used (fig. 4). Additionally servo drive gives possibility for set wide range of speeds of axle set. Connection of recording computer and NC control enables possibility of synchronized operation.

3. DATA ACQUISTION AND PROCESSING

Computer program for simulation of measuring process and obtaining model data have been built and described [10,11]. Program for data acquisition and data processing have been prepared in LabVIEW environment. LabVIEW is very efficient tools for building graphical interface in short time, large number of served I/O devices and finally data processing units decided about selecting this tool. Example signal plots obtained during acquisition are presented below.

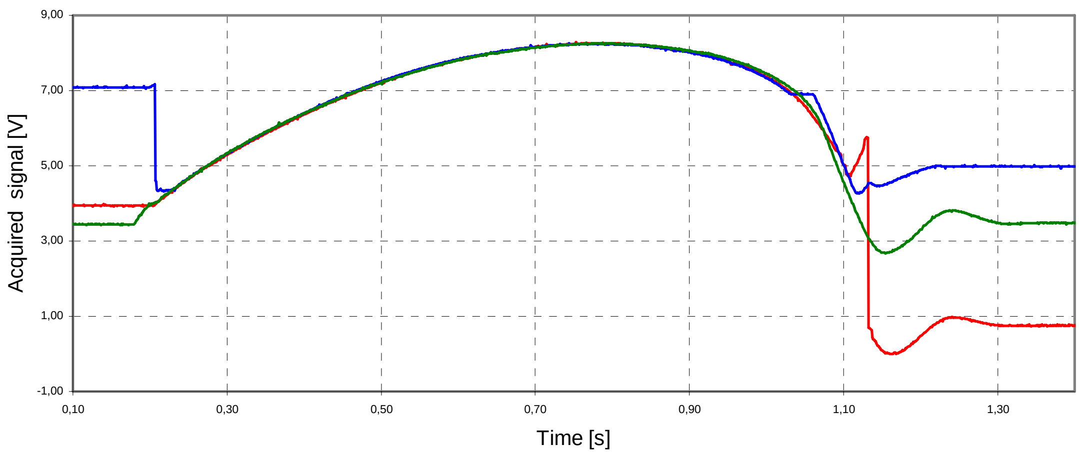

Figure 5. Example plot of acquired signals form rotary encoder

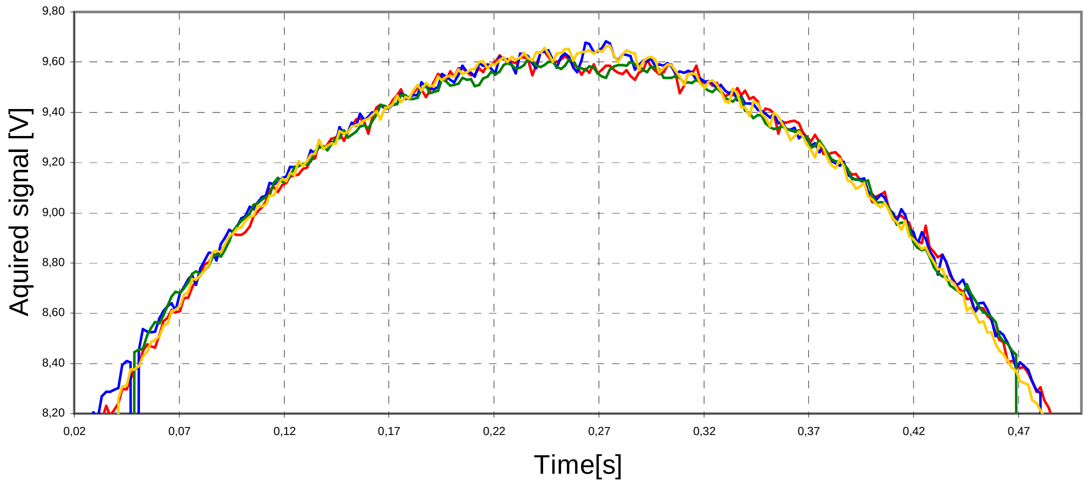

Figure 6. Example plot of acquired signals form rotary BALLUFF laser sensors

4. CONCLUSIONS

Presently experimental works are started. After finishing the one we can answer main questions like: It is possible to detect diameter difference by comparing theoretical and real signals from proposed measuring stand ? Is that method enough accurate ? Witch measurement units are better for application ?. With the answers will be possible to build final version of measurement stand.

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