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INFORMATION SYSTEM FOR AUTOMATIC DIAGNOSIS OF THE RAILWAY CONTACT LINE

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Abstract: In this paper we have defined and described the basic concepts of a management information system applied in the electric railway transportation system. This information system can be made today by using the databases and dedicated programming environments, called database management systems. This paper proposes an innovative method of maintenance management based on the use of an information system. The IT system allows the retrieval and storage of information about the actual contact line status in a database and the analysis of these values, which leads to efficiency of the maintenance of the contact line in the electric railway transport. The information system can analyze the database on a daily basis and provide two kinds of information: points where it must be immediately intervened because of exceeding some parameters, determined from the last dataset and the predictable evolution in time of the measured parameters, with the approximate determination of the moment when it must be intervened.

Keywords: maintenance management, electric railway transportation, information system, retrieval & storage

1. INTRODUCTION

The technical status of the railway contact line (CL) is the main factor that influences the number and seriousness of incidents of capturing the electric energy by the pantograph of the steam engine [1]. In present diagnoses of LC it is based on cyclic checks preprogrammed without considering its real state. This solution does not detect all existing flows on railway contact line.

The problem of mathematical modelling of the pantograph-catenary assembly is very complex and it has been approached by many authors [8-16]. In [17,18] an intelligent system is proposed to determine the real status of CL and to execute the maintenance work based on the system. In this way, trolley-pantograph existing at the company, used for maintenance works and repairs, may be equipped with an automatic system for measuring of technical parameters of CL. These measurements can be done every day, by moving the trolley-pantograph to different jobs and formed a database continuously filled with new of measured data every movement of trolley-pantograph. This data can be analyzed and used for taking some decisions: urgent interventions in the places where there are flows, based on the last measurements and predictions for evolution in the future of status of CL. In [17,18] is proposed the measuring of dynamic parameters by analysis of the contact force of the pantograph-catenary system determined the optical way, too. Advantages: safety growth in functioning of the CL, reduction of the needed costs for maintenance works of the C.T eliminating traffic disturbance and included costs. In this way, trolley-pantograph will be equipped with all the set transmitters needed for measuring main geometrical parameters of LC. (Zigzag, height, inadequate clips, missing or loose pendulums). With its daily movement at various tasks, measurements will be automatically done, which can be later used for analysis. These will be stored and transferred from the trolley to a computer existing at the maintenance department.

In this paper it is proposed a new method for management of maintenance jobs. This paper proposes an informatics system of management that uses relational databases [19-21], capable to provide information about:

- the points where one must urgently intervene due to exceeding some parameters, determined based on the last data set;
- the predicted evolution in time of the measured parameters, with the likely determination of the moment when one must intervene.

The proposed method in this paper for maintenance of the CL, starts from another principle: the real status of it. So, existing trolley-pantograph are equipped with a measuring system that allows detecting some flows and the control of suspension to small time periods. Thus, with each passing of the trolley on its activity sector, measurements are being done, which, centered and processed, represent the database for a proper and efficient maintenance that allows continuous identification of critical places and the intervention of teams only where there are problems. The proposed method uses a relational databases [21] (any database-management system can be used, for example Sql Server, Oracle, MySql) for storing measurements made at CL. Using a specific interface, the measurements are analyzed, warning about flows of CL. from train transport. The

information system allows an analysis by comparing the obtained values of parameters with standard values. This leads to a more efficient maintenance of railway contact line from train transport.

2. IMPLEMENTING THE INFORMATION SYSTEM OF THE AUTOMATIC DIAGNOSIS OF THE RAILWAY LINE

Storing the geometrical sizes

In [2-5] it is shown that the geometrical sizes of the CL which influence the quality of the energy intake and the safe functioning and which have to be measured to assure its normal functioning regime are: the zigzag and the height of the contact wire. Beside these, there must be realized:

— measuring of the contact force (to identify lack or pendulum looseness-with direct influence upon the dynamic behavior of the catenary suspension);
— localization of the flaws by identifying the supporting pillars of the catenary suspension;
— geographical localization of each measurement set;
— the speed of the trolley;
— the temperature of the environment in which the measurements are made.

To measure the presented sizes only optical or ultrasonic methods can be used, keeping in mind that the CL has a tension of 27,5kV. Identifying the lack or the pendulum looseness (and other faulty gripping) can be made by processing the curve contact force (also optically measured) and by the determination the specific signatures [6,7]. In conclusion, the following geometrical sizes must be measured the zigzag of the contact wire and the height of the contact wire as opposed to the rail head.

Also, there must be established:

– identifying the pendulum lack (breakage), their incorrect tension or other flaws of gripping of the CL;
– geographical localization of each measurement set;
– the speed of the trolley;
– the temperature of the environment in which the measurements are made.

To obtain these parameters which will be stored in the database an acquisition system will be needed, that will be presented in the following paragraph.

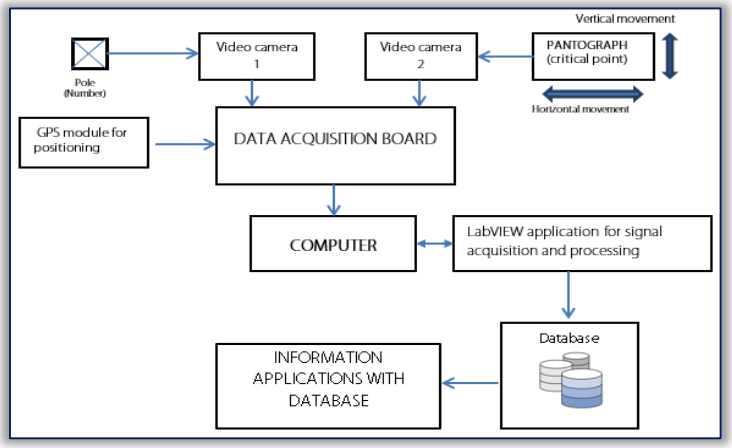

Figure1. System for measuring the specific geometrical sizes of the contact line

Structure of the information system of the automatic diagnosis of railway line

To implement this information system a series of stages are proposed:

– Stage 1: establishing the location points of the transducers and the computer equipment regarding the harsh work conditions;
– Stage 2: designing and realizing the measurement, acquisition and data synchronizing system in order for the information system to process them later;
– Stage 3: designing the information applications of measured data analysis and emphasizing the critical situations;

In this article the 3rd stage of the implementation of the information system will be emphasized. In figure 1 it is presented a diagram of the information system of the contact line diagnosis. A screenshot of the application can be seen in the following figure 2.

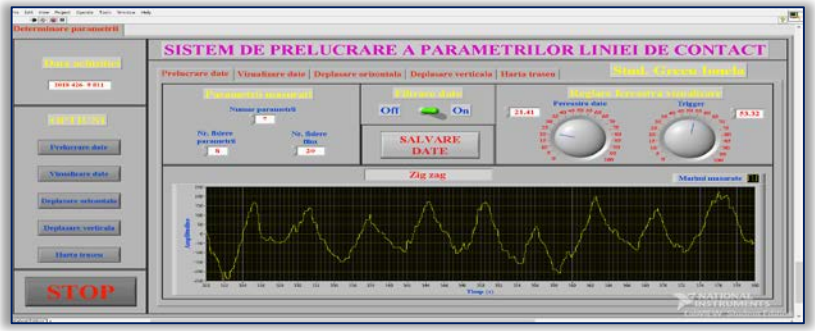

Figure 2. The measuring and data acquisition subsystem

Designing the information system represents going through the following sub steps:

– preliminary analysis of the data given by the acquisition subsystem;
– time and space correlation of the data given by the acquisition subsystem;
– forming the relational database;

- establishing the limit values and the warning methods, on degrees of danger, of the faulty situations;
- using the time and space evolution of the geometrical and dynamic parameters of the LC, establishing a set of rules that allow the prediction of their evolution in time;
- designing the user interface that will allow the visualization in graphic mode of the measured data, questionings, reports, etc.;
- implementing the information applications of a calculus system.

All the three stages correspond to the two information subsystems that will compose the information system of the automatic diagnosis of the railway line:

- The measuring and data acquisition information subsystem.
- The storing and data analysis information subsystem.

3. THE MEASURING AND DATA ACQUISITION SUBSYSTEM

The measuring system is composed of a portable computer, an acquisition board, a laser distance sensor to measure the vertical movement, a USB video camera for horizontal movement measurements, a GPS module for the processing of the geographical coordinates and a temperature-humidity sensor. The logical scheme of the system is presented in figure 3.

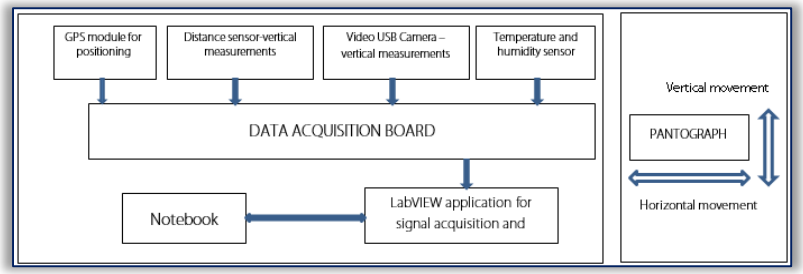

Figure 3. Logical scheme of the measuring and data acquisition system

4. STORING AND DATA ANALYSIS INFORMATION SUBSYSTEM

The information system needs the storage of the main geometric parameters of the CL. For a better prediction of the possible faults more measures are necessary. Therefore, a very big volume of data will appear. Such data volume requires relationship databases, which allow free redundancy storage and no flaws at the update and adding operations. Another advantage, these data basis can be easily questioned and in this way various information can be taken to be analyzed in order to find possible faults.

The acquisition programs, developed in Labview, have as output text files: either one or more files, the values from them being movable. The information system will need a relationship database like this. The database will allow the storage of the measurements and afterwards the analysis of the data. In this article the following relationship database structure is proposed. The relationship database will be formed out from at least two tables, which we will name them Measurements and Regional. A screenshot of the database can be seen in the following figure 4.

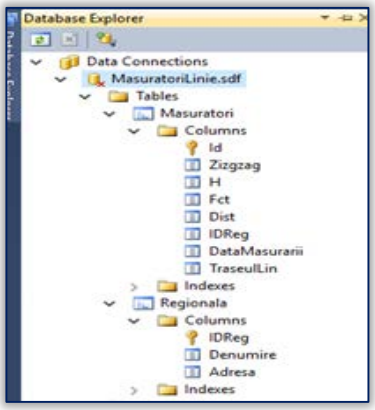

Figure 4. Screenshot of the database

- Measurements table: stores the measurements obtained on the contact line with the help of the trolley.
- Regional table: stores data about the regionals (geographical area)

The storing and data analysis subsystem is made of a relational database, stored on a local database server, an interface to access the analysis modules, the analysis modules and graphical displays. The logical scheme of the storing and data analysis subsystem is presented in figure 5. For maximum flexibility, the application will need a graphical interface implemented in a usual language like Java or C# that will allow the connection to the relational database and afterwards the extraction and the analysis of these data, display of various graphics.

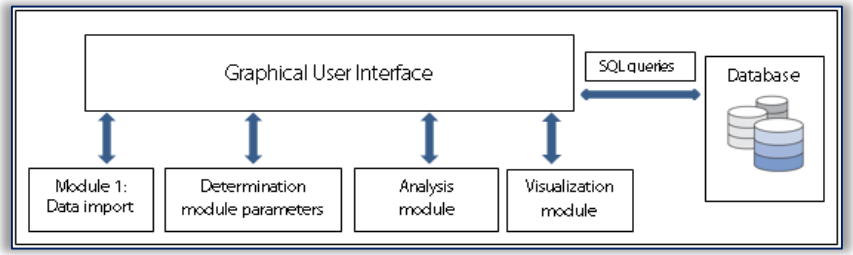

Figure 5. Logical scheme of the storing and data analysis subsystem

5. CONCLUSIONS

For optimizing the diagnosis process of railway the frequency of the inspections must be very high, which brings large datasets (a big quantity of data) which must be analyzed. It is necessary to use advanced methods for analyzing these problems in order to paint a clear picture in real time and automatic mode of possible flows

which can appear. In the paper it was showed the fact that by processing and storing of information about the status of the railway contact in a database, followed by an analysis of comparing the obtained values of parameters with standard values leads to efficiency maintenance of railway contact line from train transport.

In this article an information system of the automatic diagnosis of the railway line is proposed being composed from two information subsystems: the measuring and data acquisition subsystem and the storing and data analysis subsystem.

The proposed method uses a relationships database for storing measurements made at L.C. Using specific interface, the measurements are analyzed warning about flows of L.C. from train transport. The information system allows an analyses by comparing the obtained values of parameters with standard values leads at efficiency maintenance of railway contact line from train transport.

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