APPLICATION BUSINESS INTELLIGENCE TOOLS IN MULTICRITERIAL DIAGNOSTIC PROCESS

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Abstract:

Business Intelligence is set of techniques and tools for acquisition and transformation of raw data into meaningful and useful informations. Multicriterial diagnostic is approach to obtain real status of machining proces just in time and produce a big group of raw data. We want to prepare application business intelligence tools in multicriterial diagnostic process to obtain results of diagnostic process and find "hiddenly" influence the result

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1. Introduction

Currently we are seeing a significant rise in the modernization of processes and procedures across the whole spectrum of manufacturing companies in the engineering industry. This is a natural consequence of efforts to increase the efficiency of production processes primarily due to a reduction in production cost, reduction in energy consumption with emphasis on reducing environmental impacts caused by production itself, but also other dependent aspects, and also the efforts of manufacturing companies to ensure optimization of the indirect costs associated with human resources, that are an integral part of costs. Another very important reason for modernizing production processes are continually increasing demands of customers for increasing the quality of production with demand for delivering in the required time and the required quantity. Engineering production companies are due to diversification of customers largely focused on the automotive industry and thus is also the associated requirement of their customer base to conform to standards as defined by ISO/TS 16949, which entails very high expectations for the quality of production. Because of this multi-criteria diagnostics is very beneficial, based on analysis of the results obtained from manufacturers exact information about weaknesses in the processes of production and proposed solutions to existing or predictable problems can be made. An indirect consequence of globalization trends, is evident from all sectors of industry and economy, it is manifested by combining the small and medium manufacturing enterprises to large structures that are decentralized in geographical nature, but have shared leadership and shared the same level of process control. This creates multinational corporations influencing several countries and their production is influencing the economy at international level. In such enterprises original manufacturers are transformed from autonomous production structures with complex production to highly specialized manufacturing units.

The reason for the creation of specialized units is to ensure the maximum possible level of production quality and optimization of logistic processes within the group. However, this causes a new complication in the production process, the formation of hierarchical dependence of the manufacturing process where successive stages of production within the company are dependent on the production of the previous stages in the life cycle of production. For this reason, the occurrence of random and sudden interruptions of production or unplanned production decline is undesirable phenomenon with potentially serious repercussions for the entire production group. Prediction of the problems determined by the analysis of information obtained in production by obtaining measurable data is very beneficial method of eliminating the aforementioned problems of manufacturing. Production processes are complex in nature with a large number of interacting actors. Results of mono-criteria diagnostics are useful only in analyzing an isolated property of the production process, or in the case in mono-criteria diagnostics of more complex property (e.g. vibrations) the result have broader scope, but are susceptible to errors due to misinterpretation of the results analyzed or the emergence of errors in cases where the process is affected by new actor that did not appeared previously and then "hiddenly" influence the result.

Our aim is to as much as possible get a realistic and comprehensive view of the manufacturing process and obtain measurement results that their analysis produce results with high diagnostic value with accurate description of the state of the manufacturing process. Data obtained through multi-criteria diagnosis have a very large content value. Depending on the way in which we look at the data, in way of their further processing and, depending on the interpretation of the results obtained by the analysis of the collected data we can not only predict failures and need of scheduled maintenance, and also predict other phenomenon related to the production and manufacturing process. With correct data analysis and correct interpretation of data we can create very precise results for optimization of energy requirements and environmental impacts of manufacturing processes, also we can optimize usage of human resources, and material flow, and other important factors. Because of wide application opportunities of the proposed multi-criteria diagnostics, and analysis of the results obtained by it we can apply the research results in a wide variety of manufacturing companies at the international level.

Aim of our research is to ensure the development of analytical tools that process the data obtained through multi-criteria diagnostics to obtain the required answers to specific questions defined by mechanical engineering companies in the topic of increasing efficiency and optimizing production processes. The resulting data set has a very large scope and the maximization of the content value, is however dependent on a thorough knowledge of its structure and in particular in accordance with the dependencies observed in gathered data. Production process is a continuous sequence of tasks and the various actions in the production process are not an isolated factors affecting the final product, but are an integral set of mutually interacting factors that have both a direct impact on final product manufacturing, and also often lead to mutual interaction between each parameter by means of a visible but also hidden dependencies that need to be understood before of the processing and interpretation of data obtained thru multi-criteria diagnostics.

2. Multicriterial diagnostic

With multi-criteria diagnostics of the production process we are collecting in a relatively short time an extensive set of data. We need very powerful analytical methods and tools to obtain applicable results in real time. Therefore, we will focus our research on the implementation of advanced analytical methods for processing the large data set on comodity computing devices. We plan to achieve the desired performance when storing and subsequently processing data collected from the production process by implementing the tools on top of database systems and subsequently ensure progressive implementation of data processing methods presently known under the term Data Mining. These methods and approaches are significantly contained in the tools some times known under the name of Business Intelligence, the application of the general principles under which they carry out their tasks we already know, we will be able to deploy and modify them in order to achieve our goals with high efficiency.

The essence of muticriterial diagnostics is simultaneous usage of multiple methods of diagnostics in order to gain effects such as simplification of measurement, reducing time and costs necessary to perform measurements or to increase accuracy of measured data. Therefore, one of our aims is selection of suitable diagnostic methods in order to gain synergic effect as result of combination of conventional methods of technical diagnostics utilized for certain group of production machines, and monitoring of technological and non-technological parameters related to production processes. Each method of technical diagnostics and monitoring of production process is characteristic not only by measured parameters but also physical phenomenon used for its measurement and also by characteristic and volume of measured data and signals that have to be stored for evaluation. The purpose of integration of muticriterial diagnostics is optimization of diagnostics of production processes and setting of diagnostic processes in production in way that allows maximal positive effect on stability of production processes thru maintenance planning.

Keeping availability of diagnostic tools in mind, we expect usage of multiple available methods such as measurement of vibration in various places of production device, in multiple axes during its operation and taking sources of mechanical wave motion and it's spreading into consideration. Vibrodiagnostics as part of multicriterial diagnostics offers significant amount of information about state of monitored object such as changes of state, its character and localization. Same time, vibrodiagnostics allows certain amount of automatizability, what simplifies its implementation to long-term and short-term monitoring and also into multicriterial diagnostics. Particularly interesting results can be gained by measurement and analysis characteristic vibrations of spindle of machine tools. In terms of methods of signal processing and volume of data gained during measurement, vibrodiagnostics is similar to noise analysis, which differ mainly by used sensors, where microphones are used instead of vibration sensors. The recorded sound is processed through the various filters in order to extract usable signal is which can be scanned for distinctive patterns afterwards. Such patterns allows to determine corresponding events. Vibrodiagnostics provides wide range of information about condition of machinery, but it is unable to reflect the condition completely. Vibrodiagnostics is specific by significant amount of measured data what can complicate the processing.

Another methods with high potencial in multicriterial diagnostics, we determined, the thermography and measurement of temperature of constriction nodes of monitored objects. The increased thermal emissions and related increase of temperature of the component is usually directly related to increased friction, load or electrical resistivity as result of mechanical or electrical failure of monitored device. The first analysis allows to identify the nodes where change of temperature can occur as result of various events and localize positions where temperature sensors can be placed in order to perform long-term monitoring and diagnostics. Measurement of temperature of individual nodes can be relatively easy to implement into common production devices with no effect to its original purpose and functionality. The measured data can be easily analyzed directly in real time or in the context of activities carried out by monitored devices with further increase of the reliability and sensitivity to changes that may occur at various different levels and type of loads on monitored device.

The engineering industry uses dimensional geometric accuracy as one of the most important parts of quality of production. Accuracy of products, not only machined parts, is directly linked to precision of production device and therefore precision of positioning and its analysis should not be neglected in field of multicriterial diagnostics, even though it can be hardly implemented directly into autonomous systems. The alternative to fully automated system for monitoring is the implementation of measurement of positioning precision at regular intervals or at occurrence of event of change of monitored parameter or parameters. This requires specification of certain limits for monitored parameters that requires to repeat measurement of positioning precision. The implementation of precision measurement of production devices anticipates usage of laser interferometer and device for analysis of precision of positioning during circular interpolation. Described measurements gives information about complex technical state of observed production device as technical system and it's subsystems that are involved in positioning.

Precision of machinery is closely related to wear. The wear usually is not uniform along all effective workspace of machine tool and therefore it is possible to say that precision is function of position. The wear is directly linked to usage rate, so maximal wear is usually localized at most exposed places and vice-versa, the less used parts of workspace should keep maximal precision longer. The mentioned facts indicates that the monitoring of the working space of production device can be used as base for prediction of future wear of movement mechanisms based on usage rate of different parts of workspace. Besides of position there are other factors that have considerable impact to wear rate of machine such as forces produced during normal operation of device and therefore it is important to monitor other parameters such as spindle speed and federate in individual axes. Next parameter suitable for long-term monitoring which can easily reveal some aspects of machine state is amount of electric energy consumed to perform specific. If amount of electricity necessary to perform specific action rises it is usually caused indicates that energy is consumed to overcome previously absent resistance or obstacle. Data received by described monitoring will be included into basis of analyzed data. Important part of following analysis will be revealing of correlations between parameters obtained by multicriterial analysis and optimization of data harvesting processes accordingly.

Base methodology to deal with the second objective is the implementation of method to preserve data obtained in the process of multi-criteria diagnostics, implementation of relevant tools and consequently processing and evaluating the obtained data thru analytical tools. The results will be presented to final customer through suitable informative views.

Given the scope and nature of the data obtained during the implementation of multi-criteria diagnostics while respecting the need for rapid storage and processing measured data we propose to use database application approach. If deployed into the production environment on the corresponding sufficient hardware, it give us high-performance set of tools that will allow us to perform all the required tasks associated with storage of the measured (raw) data without restrictions due to different structuring of stored data and it will allow us to back up all the required data, and pre-processing of data on the data server, without sacrificing performance on computers that will implement the analytical processes, enabling us to flexibly create and modify the rights to stored data, and allow us to be very responsive when providing a response to a query processed by set of data analysis tools. An important part of the database system to allow processing of high volume data is a tool

for data optimization and data processing tools to maintain data integrity.

The complexity of multi-criteria diagnostics is proportionally depending on the number of data collected in the production process. They are the parameters describing the status of individual elements that are part of every process of production (machinery, tools, workpiece, etc.), but also elements indirectly affecting the production process (alignment of machines, cutting tool abrasion, state of coolants, etc.), and elements that externally influence the process of manufacture (ambient temperature, ambient humidity, the state of power network, etc.). As the number of monitored elements is growing, proportionally increases the number of endpoints and this causes proportional increase in data acquisition.

The data obtained during the multi-criteria diagnostics in the manufacturing process are usually very large in volume. Likewise, we can say that, when monitored data is properly defined data obtained during the multi-criteria diagnostics give us very large amount of usable informational. Our role is to provide an understanding of the data obtained in contexts of the monitored production process, detect cross-correlation between the parameters of the production process and enable to the user of our system to optimality access the presented information, by correctly defining the set of interpretation rules. To achieve these objectives, we need to have powerful analytical tools that allow us to process all necessary steps with the available data obtained by the multi-criteria diagnostics.

3. Application of Business Intelligence

For this reason, we propose to use in obtaining the necessary information tools designed to analyze large volumes of data, this tools are sometimes known as Business Intelligence tools. They can be defined as tools that arose from a set of concepts and methodologies for improving decision-making process based on the use of metrics and use of systems-based metrics. Business Intelligence (BI) is an important factor affecting the quality of business informatics processes in the competitiveness of enterprises. The basic principles of BI include data transformation from databases and production systems to the analytical data. BI solutions are based on multidimensionality in stored and manipulated data.

Fig. 1 *Tools of Business Intelligence in Enterprise*

The focus of our research in the transformation of data collected from multi-criteria diagnostics to information presented to the end user will be primarily done by using tools for paralles processing on multidimensional data of BI tools. From OLAP tools we will focus on defining data structures that are also known as OLAP cube, that allow us to carry out necessary analysis on the data gathered my multi-criteria diagnostics, for effective business planning.

Planned analytical process will be carried out through data mining. Data mining will be realized thru statistical methods and artificial intelligence, that will allow us to find correlations and other hidden or unknown dependencies between data acquired by multi-criteria diagnostics. Subsequently, the results of analysis will be processed thru predictor models or segmentation models and then presented in the form of the results to the end user.

On the basis of the described methodology to deal with defined roles and selection of tools that we plan to apply in our research we are confident to say that they are designed competently and with emphasis on the ability to meet the declared objectives in full.

We hope that our approach is right to obtain our intended aims.

4. References

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