DIAGNOSTIC DAQ SYSTEM DEVELOPED FOR PROGNOSIS OF OPERATIONAL STATES

DIJAGNOSTIČKI DAQ SUSTAV RAZVIJEN ZA POTREBE PRAĆENJA PROIZVODNOG PROCESA

FABIAN, Stanislav & KRENICKY, Tibor

Abstract: *One of the most important motivating factors for development of non-destructive diagnostic methods is rationalization of production, leading to the increasing of efficiency of its planning, logistics, control, service etc. The original technical system realized on the Department of manufacturing systems operation of the Technical University in Kosice with seat in Presov is described in this article. The system is constructed on the modular platform Compact DAQ from the National Instruments with emphasis laid on a universality allowing wide variety of possibilities for acquiring and processing of the physical quantities and loop-check control of the examined system.*

Key words: *diagnostic system, automatic measurement, data acquisition*

Sažetak: *Jedan od najvažnijih motivirajućih faktora za razvoj nedestruktivnih dijagnostičkih metoda je racionalizacija proizvodnje što dovodi do povećane učinkovitosti u njenom planiranju,logistici,kontroli,uslugama itd. U ovom radu predstavljen je izvorni tehnički sustav osmišljen na Odijelu za upravljanje proizvodnim sustavom na Tehničkom fakultetu u Košicama sa sjedištem u Presovu.Sustav je konstruiran na modularnoj DAQ platformi National Instruments s naglaskom na univerzalnosti koja pruža brojne mogućnosti za prikupljanje i obradu fizičkih veličina i kontinuiranu provjeru sustava.*

Ključne riječi: *dijagnostički sustav,automatsko mjerenje,prikupljanje podataka*

Authors´ data: Stanislav **Fabian**, Assoc. Prof., Dipl. Eng., Technical University Kosice - Faculty of Manufacturing Technologies, Presov, fabian.stanislav@fvt.sk; Tibor **Krenicky**, Dr., PhD., Technical University Kosice - Faculty of Manufacturing Technologies, Presov, krenicky@fvt.sk

1. Introduction

The principles of diagnostics are used in wide area of data processing. Developed in the basic research, methods and tools are often quickly spread into manufacturing systems that are strongly dependent on the level of such a means, especially from the economic point of view. Continuous monitoring of the operational parameters of the manufacturing systems key parts and feedback involving on-line processing belong among components that are necessary to ensure quality, efficiency, continuousness and of no little importance safety of the production process (Castaneda & Zoltowski, 2006).
Thus, production flexibility is in this way directly dependent also on the capability of the technical systems to adapt to changed parameters of the controlled process. Standard solutions used in industry are characterized by restricted setup options and upgrade of the system while diagnostic procedures are usually secured against parameters change by an operator (Prosr & Strnad, 2005).
Diagnostic technical systems with continuous data flow are used for research purposes as well as for monitoring and operation control in manufacturing systems. Purpose of such a system is data acquisition, processing, evaluation and representation. Design of the assembly for measurement and evaluation of diagnostic signals in particular system is dependent on its intention. There exist wide palettes of the systems based on computer technology that are capable to perform from simple operations to complex tasks (Stoyanov, et al., 2006).
Selection of diagnostic parameters that are technically measurable and at the same time truly indicate the most probable critical states of the system as overheating, electrical circuits faults, pressure out of the limits, noise, vibrations etc. (Fedak & Fabian, 2007) is the key part in the measured system diagnosis (Sury, 1981). In addition to choice of the key parameters, dimensioning of diagnostic platform and modularity is of no less importance being closely connected with expectations of the system and technology expansion.
Main aim of the present article is to give survey focused on the design and capabilities of the original data acquisition and processing system developed at the Department of the Manufacturing Systems Operation, FMT TU Kosice.

2. Experimental setup

Technical system used for non-dismantling diagnostics of monitored systems have been designed and realized at the Department of Manufacturing Systems Operation, Faculty of Manufacturing Technologies with seat in Presov, Technical University of Kosice.
Generally, this-type diagnostic systems consist of the three main blocks: sensors, data acquisition and processing devices and finally, tools for analysis and presentation of results (see scheme - Fig. 1).
Key diagnostic signals were selected for monitored system and the way of their measurement was chosen as summarized below (Table 1).

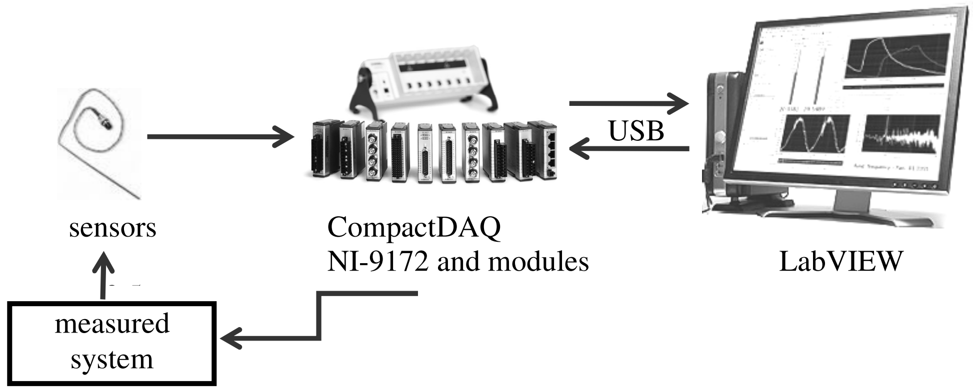


Figure 1. Schematic representation of the data flow for signals acquisition and processing on the basis of National Instruments CompactDAQ and LabVIEW software with outlined feedback for system operation control

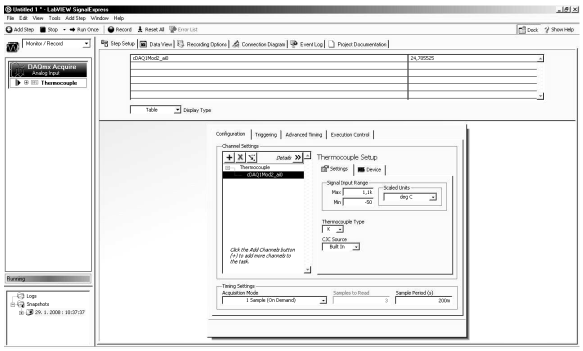
Parameter	sensor	HW
temperature 1	thermocouple type K	NI-9211
temperature 2	RTD Pt100	NI-9219
vibration	ICP accelerometer	NI-9233
acoustic signals	free-field type	NI-9233

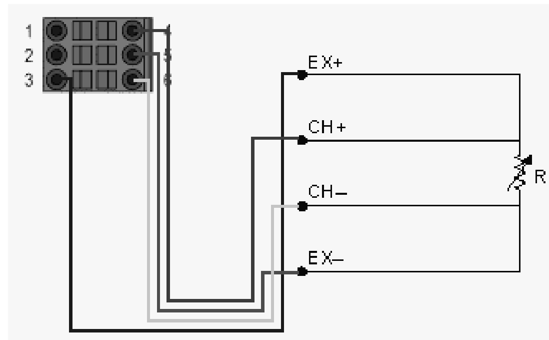
Table 1. Measured parameters and tools used for the data acquisition.

The presented system was built on the basis of the modular system National Instruments CompactDAQ. Chassis NI-9172 enables to hold up to 8 parallel connected I/O modules from variety models of the C-series. Particular modules are adjusted to perform specific functions for instance reading of analog or digital data, generating of analog or digital signals, relay switching, excitation of sensors, include data processing and so on. Sensors and controlled devices are connected to modules through standard connectors. Communication with computer is provided through USB 2.0 interface with speed up to 100 kS/s/channel and 400 kS/s/module with total maximal amount of 256 channels with speed 5 MS/s.
Functional modules in described system aimed at monitoring of operational parameters of manufacturing systems are: module NI-9211 used to monitor temperature of the key parts of the system by set of the thermocouples, NI-9219 used for temperature sensing by Pt100, NI-9233 for measurement of acoustic and vibration characteristics of the operational process providing after corresponding processing variety of information regarding in particular condition of moving parts of monitored devices. Programming and data storage are performed in the notebook, enabling the diagnostic system to be fully portable.
Hardware test and configuration was performed using MAX – Measurement and Automation Explorer. Simple tasks were configured using LabVIEW Signal Express, more complex operations were programmed using graphical representations of the functions in LabVIEW Full Development System extended with Sound and Vibration Toolkit containing palette of functions for processing and analyzing of signal. Tasks

configured in Signal Express can be used for suggestion of its proper involving in program code using export function. In return, configuration of the task in LabVIEW can be performed by calling Signal Express environment.

3. System control and data processing





Connection Diagram Report

Channel Name	Physical Channel	Device Type	Measurement Type
cDAQ1Mod4_ai0	cDAQ1Mod4/ai0	NI 9219	RTD

Figure 2. Configuration of the task in the LabVIEW Signal Express environment and indicated specification of the RTD sensor

Simple sequence of tasks is configured via LabVIEW Signal Express version 2.5.1 environment (Fig. 2) that enables configuration of operation by simple selecting of items from menus, without programming. The main advantage of this tool is configuration of all parameters, communication with hardware, processing and representation without textual or graphical programming including e.g. instructions for sensor connection.

Complex operations are configured in the object oriented programming environment LabVIEW, version 8.5 [7]. Programs often called virtual instruments are written in the Block diagram (Fig. 3) by the means of selecting and inserting of graphical representations of items from menus containing hundreds of functions, nominally FFT and octave filters; structures and other elements, all of them configurable. Execution of virtual instrument is governed by the way of the elements connecting into strings, grouping into groups inside blocks etc. User interface forming visual appearance of the whole instrument and its elements is configured via Front panel. LabVIEW can work even with signals streaming out of CompactDAQ, e.g. read or generate sounds through the sound card.

Virtual instrument from the Fig. 3 performs sensing of selected diagnostic signals, processing, evaluation and signalization of the operational states of the system under observation. Moreover, the program enables storage of the data, optical and acoustic signalization of selected states. Other functionalities are control from remote network computer, control of the electrical circuit switching through relay module NI-9481, synchronization with speed of rotation through optical gate signal counted by the module NI-9411 etc.

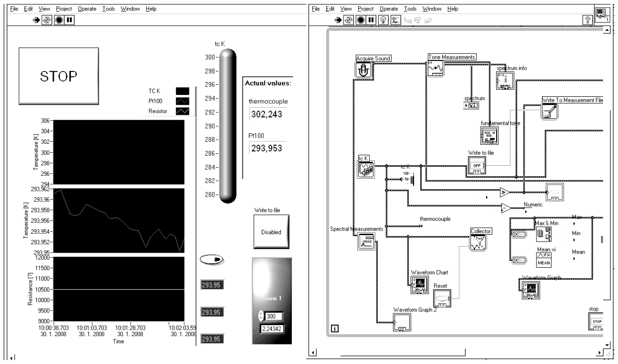


Figure 3. Parts of the Front panel (on the left) and Block diagram (on the right) of the virtual instrument

4. Conclusion

Presented technical diagnostic system for acquisition, evaluation and analysis of diagnostic signals in laboratory conditions was designed and tested with aim to develop compact portable tool which is at the same time opened unit with maximal flexibility for use on various monitoring and control tasks. So, modular complex based on hardware and software platforms CompactDAQ and LabVIEW from National Instruments was chosen. The system was completed by sensory set and program controlling its operation. Compared with closed solutions giving restricted or no possibility to change and upgrade appearance or behaviour of the tool, presented system can be changed practically in any way or extended for many types of sensors that provide electrical signal and I/O analog or digital modules communicating with sensors and devices. This way is effective also from economic point of view due to replacement of the need to buy some supplements as there is possibility to create their virtual substitute and provides possibilities to change, reconfigure and optimize procedure or the instrument.

5. References

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