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CYBER-MECHATRONIC SYSTEM FOR TELEMAINTENANCE PREDICTION AND SERVICE PREVENTION

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ABSTRACT: The smart system for prediction and prevention focuses on total efficiency of existing maintenance program, assessing all aspects, from the hardware and software which are monitoring the operational status of equipment, till the maintenance and production personnel skills. They operate safely until a certain level of wear, or when a fault occurs. These systems enable early detection, location and identification of parts failure or worn parts, and the calculation of the period of safely functioning of the machine. It is possible to plan the shutdown, preparing of the intervention, ordering spare parts and minimizing the duration of stationary repair, causing lower maintenance costs compared with the corrective maintenance and the planned maintenance systems. The smart system for prediction and prevention uses sensors, analysis systems and real time data collected which anticipate the equipment failure and respond fast to the unexpected situation. The main advantage of this technology is the small time of production shutdown to perform maintenance, the existence of a clear evidence of elements that must be changed periodically and the synchronization of them to be realized in a certain time interval and the improvement of the efficiency equipment by providing optimum working conditions.
Keywords: prediction, prevention, cyber-mechatronics, maintenance

1. INTRODUCTION

The continuous development of the industry has led to the creation of mechatronic systems and with them it was developed auxiliary specialized support and repair services which are called maintenance.

Mechatronic equipment are expensive investment that pay off over time and which require frequent maintenance. Maintenance costs are a large amount of the total operating costs of industrial systems, so it is essential to monitor the performance of a mechatronic system in real time. Using industrial mechatronic systems in optimal conditions and with high performances is closely connected with preventing defects due to wrong maneuvers, due to operator distraction or system's overload by excessive and premature wear of components etc.

Developing monitoring and diagnosis techniques and their implementation in industrial systems ensure safe and performing operation of them with positive effects regarding reliability and productivity. System monitoring begins by measuring the energy consumption so that it is possible to detect the moment when the state begins to deteriorate and this information is used to make a decision for scheduling maintenance operations.

The purpose of intelligent prevention and predictive systems is to remove unnecessary maintenance, avoiding the damages and increasing the efficacy of monitored mechatronic equipment. Defects are defined by the presence of anomalies in the operation of mechatronic systems, which will determine the type of the defect, the area of production, the timing, the cause and the behaviour in time.

Prevention and predictive intelligent systems are defined by the ability to analyze parameters and information from sensors and transducers, which are converted into data that are processed according to specific algorithms to determine the period of time in which the defect appears and to determine solutions to fix the causes that lead to it.

Predictive function establishes a relation cause - effect with algorithms between observed symptoms and the forthcoming defect, and the type of defect, of the area of production, of the timing of cause and of the behaviour in time.

The prevention function is represented by the decisions taken on prediction basis to fix timely the defect by spare parts ordering in time, preparing the intervention and the concerned area, scheduled stop of the equipment and avoid the appearance of indeterminate damage , scraps or low quality parts.

Operational efficiency is a major point application of the IoT and also it is an extremely important goal of companies.

2. PREDICTIVE AND PREVENTIVE MAINTENANCE

The widespread introduction of automated systems and flexible manufacturing techniques are major factors to increase productivity. Predictive and preventive maintenance of equipment is an application of major interest using sensors, analysis systems and real-time collected data to predict the equipments failure and to quickly respond to critical situations. Pressure on reducing production costs affects increasingly maintenance budget.

Maintenance can be considered a set of technical and organizational activities aiming at maintaining in operation, and repair of industrial systems. Maintenance is classified by how it is done in:

- corrective maintenance which allows a temporary full realization of the equipment function, intervening when a problem occurs;
- reactive maintenance which is performed when a malfunction occurs;
- preventive maintenance which consists in achieving a technical and organizational activity of evaluating the equipment regularly;
- predictive maintenance which consists in carrying out assessments and determining the causes that lead to equipment failure.

Another classification by type of maintenance is:

- software maintenance, which is represented by software upgrades;
- electrical maintenance, which is represented by system hardware changes to counteract equipment aging, lack of spare parts due to completion of mass production (end of life components)
- mechanics maintenance, which is represented by actions to counteract malfunctions in mechanisms functionality due to wear and which results in errors and anomalies in the system.

Maintenance classification by type of activity is highlighted on the diagram of the general architecture for integrated mechatronic systems for dimensional control in production.

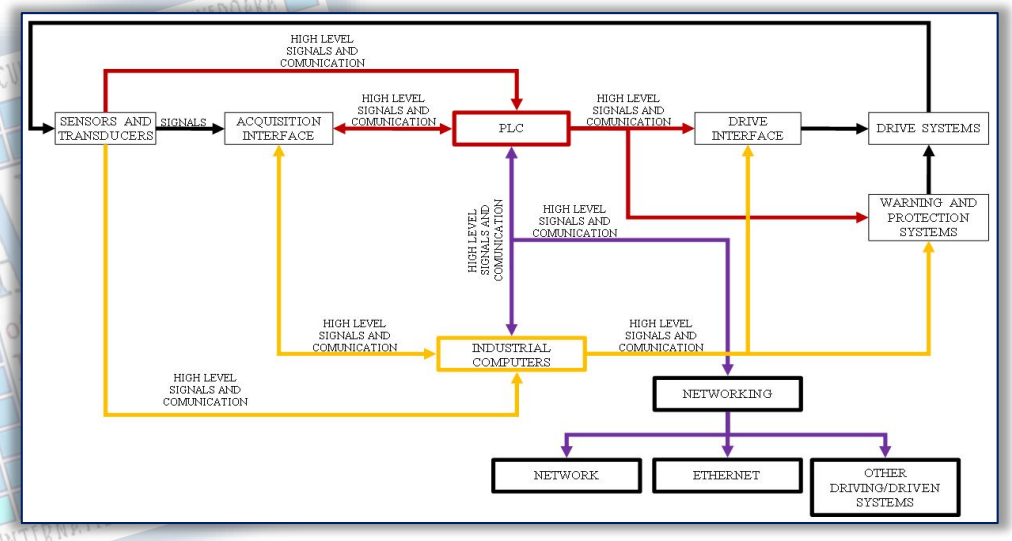

Figure 1. Diagram of the general architecture for integrated mechatronic systems for dimensional control in production

Precision and dimensional control systems maintenance is very important due to functions for which these systems have been designed, verification and control of parts after certain operations performed by other specialized equipment.

Preventive and predictive maintenance service aims to prevent errors, defects of integrated specialized equipment in the manufacture process of products, to optimize costs and to increase equipment availability.

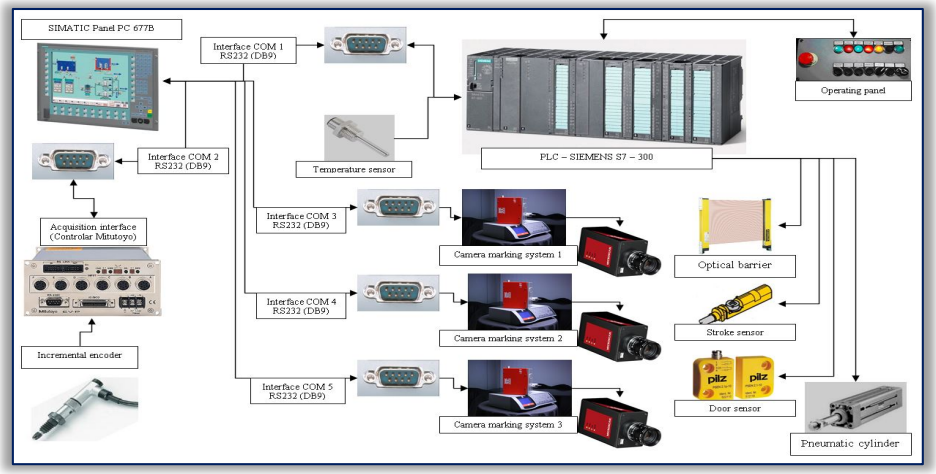

Figure 2. Architecture of a dimensional control system

In Figure 2 is shown the architecture of a dimensional control system composed of mechanical and electronic equipment, that are automated and which need a maintenance service. Each of the components of Figure 2 have certain specified operating conditions and any deviation from these can lead to defects that, if not corrected in time, lead to lower quality of parts or damage of the equipment; this leads to production stopping, to costs with defect remedy and delay in carrying out orders or loss of product orders.

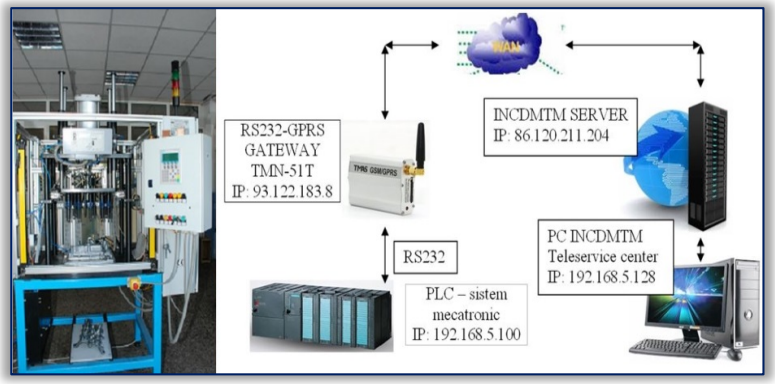

Figure 3. Diagram of the architecture for a predictive and preventive mechatronic system

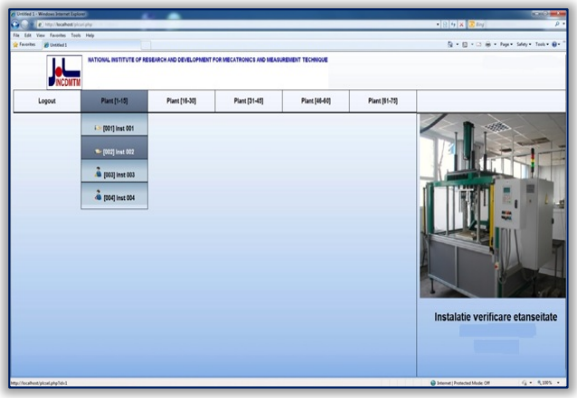

Figure 4. Software for prediction and prevention system

3. CONCLUSION

Maintenance and IoT (Internet of Things) is another important issue in synchronizing supply orders for spare parts with the programmed period of maintenance, so that this would be quickly and in time, when production is at a lower level or when there is stock of products, so that supply orders will not be affected by the production downtime.

The main steps in implementing such systems are:

» Placing sensors to analyze the wear parts to determine when it is necessary to replace them.

» Analyzing signals received from sensors

» Monitoring working conditions imposed for mechatronic systems in order to work properly.

Maintenance costs can be halved and production time decreased and improving maintenance and trouble-shooting service

The growing level of automation in industrial processes - continuous or not - includes particular telemaintenance problems. It is of paramount importance to insure the best possible productivity of equipment. Many tools and methods have been developed to optimize maintenance, to insure a better availability of technical means and to decrease costs. It consists of maintaining installations at a distance. [1]

Condition Monitoring; therefore, becomes an important part of service and successful maintenance providing that all machines are entered and logged accordingly in the original condition. New parameters can be determined later for evaluation of the machine capability or derivatives made for optimization of the production process with the functions provided on the platform. [2]

It has the potential to make industries significantly more agile—as well as driving value well beyond operational efficiencies. Its interoperable platforms and intelligent systems will enhance the flexibility of manufacturing processes. And by enabling real-time data analysis, it could create opportunities for innovative customer service solutions that span the entire product lifecycle. [3]

Operational efficiency is one of the key attractions of the IoT, and early adopters are focused on these benefits. By introducing automation and more flexible production techniques, for instance, manufacturers could boost their productivity by as much as 30 percent. Predictive maintenance of assets is one such area of focus, saving up to 12 percent over scheduled repairs, reducing overall maintenance costs up to 30 percent and eliminating breakdowns up to 70 percent. If producers share planning, forecasting, equipment health, field service and work schedules, they can dramatically increase production. The rising tide of data can float all boats.

Note

This paper is based on the paper presented at The 1st International Conference "Experimental Mechanics in Engineering" - EMECH 2016, organized by Romanian Academy of Technical Sciences, Transilvania University of Brasov and Romanian Society of Theoretical and Applied Mechanics, in Brasov, ROMANIA, between 8 - 9 June 2016, referred here as [5]

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