INTEGRATED MECHATRONIC CONTROL SYSTEMS IN MACHINING AND ASSEMBLY PROCESSES
PRESENT AND FUTURE

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Abstract – The control systems are an integral part of industrial production processes. These control systems are included in the production and is a link of specific production technology, regardless of different fields: mechanical, chemical, pharmaceutical, electrical, electronics, food, clothing, footwear, etc. These systems are complexed and realize the appearance, dimensional, shape and position control, status of areas, the assembly and other conditions as well as certain ancillary operations related to storage, handling, transportation, processing fixing devices, having supervised the entire process technology.

In Europe and the worldwide, the intelligent measurement develops apace, because it needs the involvement and the integration in integrative processes of measurement, testing and quality control of industrial production. The current trends in the field of industrial control process are heading to computerized devices (sensors, transducers, contact probes, actuators) etc. and are determined by the specific dynamics of mechatronics.

The development directions in the field of mechatronic control means and methods are:
- mechatronic equipments and intelligent measurement devices integrated into industrial processes (incorporating sensors and transducers);
- mechatronic equipments for testing and investigation;
- intelligent measurement devices for: dimensional inspection, pressures, temperatures, levels, flow, mass, forces and orologie industries;
- intelligent mechatronic equipments for environmental investigation laboratories: robotic systems; geophysical research equipment; seismology control and environmental monitoring;
- innovative mechatronic technologies for new materials, micro and micro-nano processing, unconventional processing technologies and mechatronic non contact control technologies.

Keywords – control systems, mechatronic equipments, intelligent measurement devices

1. Introduction

The mechatronic systems store, process and analyze the signals received and execute appropriate tasks. The general structure of mechatronic systems depends on the usefulness and the purpose of their products. The basic functions are represented by the:
- Kinematic subsystem;
- Drive subsystem;
- Command and programming subsystem;
- Sensory subsystem.

A basic element of all mechatronic systems is the engine - actuator – task ensemble, completed with sensors and control unit (hardware & software) which configure a mechatronic subsystem.

In Romania, there are concerns in drawing of complex equipments for technological lines and processing centers, developed by university institutions and research units.

2. Integrated mechatronic control systems in machining and assembly processes

The operating principle for mechatronic process and control systems shall consider:

a) the development of processing, measurement and control technology;

b) the development of positioning and settlement technology;

c) the development of the specific programs for processing, measuring / checking;

d) the positioning and fixing in work area;

e) the processing, measurement and control ongoing;

f) the detection, acquisition, transfer and processing of the informations derived from processing, measurement and control activities;

g) the graphical representation of measurement and control results;

h) the transfer of results in production line
management and quality management for measurement and control;
i) the collation of technical, technological, economic, physiological, environmental and social data.

The implementation of the modern mechatronic industrial processing systems ensures the efficiency of the production and the product quality.

These systems are complex and have sensors and transducers made in the amount of specialized software. The original and optimized solutions are based on high-tech mechatronic components and reliability offered by renowned manufacturers.

So, the integrated mechatronic control systems for machining and assembly is based on developing sensors and transducers.

Sensors and transducers

Much of the technical sensitive elements are falling into the category of sensitive transducer.

A transducer is a device that converts physical effects to electrical signals which can be processed by measuring instruments or computers.

A complex system control computer has the following structure:

![Complex computerized control system](image1)

**Figure 1: Complex computerized control system**

Main parts:
- probes / transducers;
- internal diameter measuring instruments;
- exterior diameter measuring instruments;
- electronic tools for checking bores;
- measuring instruments for holes in two points;
- display / selection / preselection unit;
- printer unit;
- processor unit (CIP);
- computer (laptop).

The processing, assembly and control can be achieved through a mechatronic system composed as shown below:

![Processing control assembly mechatronic system](image2)

**Figure 2: Processing control assembly mechatronic system**

**Example of mechatronic integrated control system in machining and assembly processes**

**Mechatronic control system for milling and assembly**

The integrated and automated processing and assembly system performed the following sequence of operations: supply / extraction from a storage, supply of workpieces in a CNC milling machine with an articulated robot, processing finished workpieces, removal and deposition finished workpieces on a conveyor, reception of workpiece on conveyor, using a robot assembly, final assembly with a cartesian robot.

![Mechatronic control system for milling and assembly](image3)

**Figure 3: Mechatronic control system for milling and assembly**

**SYSTEM COMPOSITION:**

1. Storage for parallelepiped and cylindrical workpieces. Characteristics: Size piece: diameter: cca. 40 mm, height: less than 100 mm, parallelepiped dimensions: cca. 150 x115x15 mm, possible to store 10 pieces;
2. Transportor with horizontal band. Characteristics: Dimensions: length 1500 mm, 150 mm (reference height): 800 mm (adjustable: + / - 100mm, drive with 0.18 kW induction motor - inverter for adjustment of speed;
4. Robot controller;
5. Procesing Robot. Characteristics: Number of degrees of freedom: 4; manipulated task maximum: 3 kg;
6. Gripper with two fingers. Characteristics: Race / finger: 15 mm, clamping force: 85 N, weight: 0.25 kg maximum load: 0.44 kg.
7. CNC milling machine with 4 axis, based on an axis robots. Characteristics: software for programming;
8. Automatic storage finished assemblies (based on a Cartesian robot). Racing axes X / Y / Z: 1050/550/150 mm, maximum load: 3 kg maximum / axis: 1200 mm / s (X), 800mm / s (Y)
1000 mm / s (Z), robot controller, pneumatic gripper, 12 posts indexed storage with software.

9. State for dimensional inspection and verification of processing components based on a two axis robot. Characteristics: races: 300...600 mm, maximum load: 3 kg, repeatability + / - 0.02 mm; robot controller. Dimensional control is achieved with an optical sensor; Sistem vision with light integrated source. Characteristics: Resolution: 512x484 pixels, Controller, imaging function, memory card slot, software, voltage: 20.4 to 26.4 VDC

10. Software simulation in 3D offline.

3. Tendencies. Estimate forecasts. Strategic Directions

The trends of development of mechatronic intelligent systems, instrumentation and information technology and integrated measurement fall into the trend of development of research and development on the European level.

The current trends in the field of industrial process control are turning to the computerized tools (sensors, transducers, contact probes, actuators), etc., determined by the specific dynamics of mechatronics.

In the field of the mechatronic means and methods of control, the development directions are:

- Development of intelligent mechatronic equipments and integrated measurement in industrial processes (incorporating sensors and transducers);
- Development of mechatronic testing and investigation equipment;
- Promotion of intelligent measurement: dimensional inspection, pressure, temperature, level, flow, mass, forces; orologie industries;
- Realization of intelligent mechatronic devices for laboratory investigation and environmental protection: robotic systems, equipment of geophysical research, seismology, environmental control and monitoring;
- Development of innovative mechatronic technologies, new materials: micro and nano processing, unconventional processing technologies and mechatronics integrated technologies in non-contact dimensional inspection, etc.

The current trends in sensors / microsensors of all control instruments are:

- Miniaturization and microminiaturization;
- Computerization;
- Integration in computerization;
- Endowment with artificial intelligence;
- Development of intelligent sensory systems;
- Isolation of noise, vibration or other external disturbing factors;
- Developed by multifunctional poliintegration;
- Integrated connectivity of control and monitoring systems, etc.

The nationally trends and needs in mechatronics and micromechatronics applications are directed towards:

- Advanced Micro-and Microtechnologies
- High-tech Microtechnologies to check vibration
- Micro and nanotechnologies intelligent control:
  - Micro and nano non-contact inspection of topography surfaces - roughness and contour;
  - Micro and Nanotechnology non-contact control surface topography - 3D topography;
  - Micro and nanotechnology control of micro/nanodimensional industrial parts – length;
  - Micro and nanotechnology control of micro/nanodimensional industrial parts – profiles;
  - Micro and nanotechnology control of micro/micronanodimensional industrial parts - 3D;
  - Micro and nanotechnology micro nanodimensional control of industrial parts – interferometer;
  - Micro and nanotechnology micro nanodimensional control of industrial parts – heights;
  - Micro and nanotechnology micro nanodimensional control of industrial parts - linear and angular inspection;
- Micro and nanotechnology advanced calibration.

It therefore considers that, compared with the control systems in the countries with advanced technology, in Romania is developing the field, although many companies, especially small and medium enterprises, have acquired advanced processing systems to fit without control systems "high-tech ", in particular because of high prices. Also, present economic and financial crisis in the Romanian industry and research, are not favorable to a positive trend, in volume and complexity and also as a contribution to value growth in the near future.

Strategic directions - short term

Overall / specific objectives:
1. The increase of competitiveness / economic performance in industry;
2. The reduction of energy consumptions and the increase of energy efficiency;
3. The harmonization standards / regulations and technical-economic indicators information with EU laws;
4. The reduction of environmental impact of industrial activities
5. The promotion renewable resources and organic products;
6. The increase of degree of recycling / recovery of wastes;
7. The increase of competitiveness and enhancing the role of research
Short-term results:
- the romanian industry compatibility with EU industry taking into consideration Romania's new status as a full member state
- the industrial production growth
- the increased export of high added value
- the increasing the share of industry's contribution to achieving the GDP

The largest increases for the next period are the products of measurement technique and conventional processing equipment and systems, over 40% respectively.

Strategic Directions - medium term
Overall / specific objectives:
1. The annual economic growth based on the increasing of the participation of national capital investment rate and on the attracting foreign investment;
2. The ensure that stabilizing and stabilizing strengthened structures by addressing productive perspective - mechatronic products with high added value;
3. The promote of alignment and integration policies, consistent and compatible with EU mechanisms, the revitalization and refurbishment based on technology and mechatronics informations;
4. The business development;
5. Identifying and updating the strategy, mono-industrial areas and establish the program of action and bring complementary and competitive field;
6. The revitalization of fine mechanics and mechatronics field, with electronics and electrical industries, in order to develop economic potential and complementary competitive switching

4. Conclusions

The mechatronics integrating industry has a strategic role in the developing of industrial subdomains own components and other industrial domains and subdomains of other components of the manufacturing industries.

The development of the mechatronic control systems integrated in machining and assembly processes have the following objectives derived and general decisions:
- Effective and competitive supporting of the Research-Development-Innovation activities, with finality and technology transfer;
- Boosting and development of internal demand;
- Stimulation of internal industrial production for export;
- Creation and development of new economic entities and industrial and scientific clusters;

- Stimulate investment processes for existing firms in its industry;
- Creating conditions for effective operation of integrative industry operators and other related industries;
- Supporting economic integrative industry and related industries and / or complementary technological capabilities to resize and modernization of the equipment and monitoring technologies;
- Accelerate the harmonization of legislation, specific for the integrating industry, components and manufacturing industries, in accordance with European priorities

The transition from the current range of products to this new range will not represent a great risk if there will be efforts to adecvay promote. Unfortunately, only a few nelerelevant companies can estimate the budgetary allocations for the new generation of products. So, it can not be made quantitative assessments regarding the budget in the future (2010-2013), when these products will enter in series production.

5. References

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