INTELLIGENT PRODUCTION SYSTEMS AND CLAMPING SYSTEMS FOR INTELLIGENT PRODUCTION SYSTEMS

Abstract: Within solving the project "Intelligent Assembling Cell" in the Institute of Production Systems and Applied Mechanics this paper goes into concepts like production system, intelligent production system, clamping system. Further it addresses characteristics, division and requirements of clamping systems used in intelligent production systems.

One of the project aims "Intelligent Assembly Cell" is to replace the existing pneumatic clamp placed on the work board in the workplace of the Cartesian robot by a clamping device suitable for working in intelligent production systems.

Key words: production system, flexible production system, intelligent production system, clamping system

1. INTRODUCTION

Before mentioning clamping device for intelligent production systems it is necessary to clarify the terms: production system, flexible production system and intelligent production system. The mentioned terms are not clearly defined in any standard and this is a reason of their different interpretation in literature.

The paper also addresses the concept of clamping system what is actually one of subsystems of the production system. The clamping system itself consists of main and auxiliary structural elements, driving mechanism, control system including monitoring elements. Clamping systems determined for intelligent production systems have to satisfy special requirements.

2. TERM OF PRODUCTION SYSTEM

2.1 Production System

The term of production system is not clearly defined, in available literature there appear even several definitions of the term – production system.

For example the production system can be understood as units beginning from an individual machine and group of machines up to the whole plant including construction and assembly.

Another interpretation of the term: The production system can be defined as a group of production machines consisting of several subsystems the role of which is to execute a specified production process aimed at processing a semi-product into a required finished product.

Production system can be divided into two main subsystems:
- subsystem providing for the production process itself,
- subsystem providing for preparation and control of the production process.

Based on production process it is possible to divide the production system core into individual subsystems:
- control and information,
- technological,
- handling and transport,
- measurement and checking,
- storage.

2.2 Flexible Production System

Analogous to the term of production system also the term of flexible production system is not clearly defined and that’s why there are various interpretations in literature.

The flexible production system is represented by minimum three or more machines and is characterized by a lower degree of flexibility that means a closer assortment of components made in bigger lots (small-lot and lot production).

It also is stated that a groupment of several flexible production cells or flexible production cells and modules formed mostly by CNC machines and connected via one common transport and control system can be named a flexible production system.

Flexible production systems can be divided into three basic types:
- flexible production cells,
- flexible production systems,
- flexible production lines.

All above mentioned types of flexible production system are in principle of the same composition and consist of individual subsystems:
- control and information,
- technological,
- handling and transport,
2.3 Intelligent Production System

Artificial intelligence is explained as an attribute of technical systems (it can be talked about machine intelligence). Artificial intelligence is an attribute of the system artificially created by a human, characterized by an ability to distinguish things, phenomena and situations, analyze relations between them and create so an internal world model where these systems exist.

Characterization of artificial intelligence enables to determine explicitly and appoint partial theoretical tasks falling withing artificial intelligence. Artificial, the so called machine intelligence includes tasks like recognition and processing of visual information or language, automatic planning, solving of tasks by consideration, adaptation and learning, expert systems, communication with computer in natural language.

Intelligent system is a system with intelligence that enables it to know and understand reasons of changes, utilize these information for learning and adapt to changed conditions.

Intelligent systems with machine intelligence include systems able:
- to learn from data and acquire knowledge from data,
- store acquired knowledge, and
- make use of acquired knowledge.

Intelligent production system can be regarded as the highest development level of flexible production systems which must be equipped with means and methods giving a certain intelligence degree to these subsystems.

Or it is stated that the intelligent production system can be defined as a system able to respond to various situations occurring in production that means change in shape of the component being made, change in dimensions, sudden transfer to another type of product etc. The specific reaction can be reached by means and elements of machine intelligence that should be contained in individual subsystems of the intelligent production system.

Ability to process the primary information entering the system by means of sensors or intelligent sensory elements is an attribute of production monitoring systems.

Monitoring is an integral part of today’s production systems, the so called systems of new generation, intelligent production systems.

3. CLAMPING SYSTEMS FOR INTELLIGENT PRODUCTION SYSTEMS

Clamping system is one of production system subsystems. Having explained terms of production system, flexible production system and intelligent production system it can be said that clamping system for intelligent production systems must serve as a classical clamp and in addition it must be equipped by a control system including monitoring elements and drives.

Clamping system consists of:
- main elements (clamp body, moving parts, grip etc.),
- auxiliary structural elements (screws, pins, stops etc.),
- driving mechanism (e.g. pneumatic),
- control system including monitoring elements (various sensors).

Generally, clamps have to satisfy following functions:
- position the workpiece,
- fix the workpiece taking regard to action of forces and moments during production process.

Intelligent clamps must provide for following functions:
- check presence of grip in case of replaceable grip,
- check grip position to be able to insert the workpiece,
- position the workpiece,
- check presence of workpiece,
- fix the workpiece with regard to action of forces and moments during production process,
- check clamping of workpiece, value of clamping strength,
- self-diagnose driving system and in case of need to report the condition of the clamping system to the superior control system.

4. FLEXIBLE PRODUCTION CELL

In the Institute of Production Systems and Applied Mechanics – Department of Technological Equipment and Systems there is a flexible production cell (Fig. 1.) which consists of 2 main subsystems:
- 3-axial portal SMC robot,
- shelf stacking machine.

![Fig. 1 Present status of flexible production cell in UVSM](image-url)
4.1 3-axial portal SMC robot

The kinematic chain of the 3-axial portal SMC robot consists of translational kinematical couples with a motion possibility in axes X,Y,Z. This arrangement of kinematical couples enables maximum utilization of working place and positioning is relatively precise. Bad access to individual components is a disadvantage of this system.

The robot’s working place is shaped like a block with dimensions 1000x1000x300mm. The supporting frame and four legs are made of dural profiles. The supporting frame includes a grooved height-adjustable working board. Grooves in the working board serve for fixing the stand of tools for automatic tool replacement, tool magazine, rotary unit, pneumatic clamp, etc. The robot’s load capacity is 10 kgs.

3-axial portal SMC robot consists of (fig. 2):
- robot driving mechanism,
- robot control,
- stand of tools for automatic tool replacement,
- tool magazine,
- rotary unit,
- pneumatic clamp,
- finger magazine,
- AHC unit (AHC – system for automatic finger replacement).

4.2 Shelf stacking machine

The shelf stacking machine is placed on the right robot side. Its frame is made of dural profiles. The pallets made of thick plexiglass are placed on legs in the shelf stacking machine. Capacity of the shelf stacking machine is 13 pallets of 250x250mm with maximum weight of 3 kgs. Components exchange between the shelf stacking machine and the robot is provided by a rotary unit – a swivelling table. Removal of pallets from the stacking machine to the swivelling table is done by means of a travelling linear pneumatic manipulator.

Shelf stacking machine consists of (fig. 3):
- shelf,
- mobile linear pneumatic manipulator.

Pneumatic clamp

Pneumatic clamp (fig. 4.) is placed on the work board in the workplace of the Cartesian robot and serves for clamping of components. Grip drive of the clamp is ensured by means of linear double-acting rolls. Grip movement is synchronized through the geared transmission. At present this clamp is not equipped with means and elements of machine intelligence; well it doesn’t meet the basic requirement of clamps determined for intelligent production systems.

5.  CONCLUSION

One of the project goals „Intelligent Assembly Cell“ is to replace the existing pneumatic clamp by a clamping device suitable for working in intelligent production systems. This objective will be achieved by sensory equipment of the mentioned clamp as well as other parts of the flexible production cell. Control of both the flexible production cell and clamp will be able to receive process information and properly respond to stimulations from all system sensors.

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6. REFERENCES


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