DOI: https://doi.org/10.30837/csitic52021232804

Intelligent Tools for Service Robotic System

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Abstract. *There is provided an analysis of flexible integrated systems of development for industrial application. Report shows an increasing importance of intelligent components for service robotic units, making supplement operations in production workspaces. There are considered the basic requirements for intelligent decision-making support systems, which can be introduced to production systems to solve the service tasks of different levels.*

Keywords: *intelligent control; decision-making support; intelligent problem solver; robotics; manipulations*

I. Introduction

Computer-integrated manufacturing (CIM) is used to integrate the different components of automated manufacturing. CIM uses the graphical interfaces with multimedia tools for manufacturing processes monitoring and control [1].

The next stage of modern manufacturing systems development is in introduction of intellectual systems of manufacturing control. For best understanding of "intellectual manufacturing systems", they can be compared to FIS. Currently, the automatized manufacturing system is manufacturing system with different levels of automation for manufacturing and non-manufacturing processes, different levels of integration for subsystems:

– technological (technological equipment collection);

– transport and manipulation (with implementations by industrial and manipulation robots, robocars);

– supervision (connected to devices without tools of process supervision);

– checkout (checkout function for all devices and systems) [2].

The application of intellectual manufacturing systems is conditioned be effectiveness of all their subsystems.

The intelligent manufacturing system is a system with inbuilt capability for adaptation to accident workspace changes, for instance for production list, market requirements, technology changes, social needs. However, intellect of such systems is often understood as software control but not as implementation of modern artificial intelligence technologies. Intelligent manufacturing systems include the systems simi-lar to the same of FMS: technological, transport, manipulation. Subsystems are equipped by tools that supply the certain intellectual level. IMS must be considered as highest FIS level.

II. Specifications of Intelligent Manufacturing Systems

IMS has the next functional possibilities [3]: intelligent design; intelligent supplement of technological operations; intelligent control; intelligent scheduling; intelligent support of processes.

The purposes of IMS introduction are:

– manufacturing costs decrease;

– production time decrease;

– easy integration of new processes, subsystems and technologies, their update, operational interaction supplement;

– decrease of production defects, of industrial pollutions;

– quick re-configuration, adaptation to predictable and unpredictable events.

In automation, the assembly operations have the most complexity. The determination of sequences to catch, to orient and position the parts of assembling system in conveyer is quite simple for human but is complex enough for manufacturing systems. The absence of general tools to deal with unordered workspace in FMS is compensated by use of delivery systems, palettes or specialized conveyers [4, 5].

The requirements to IMS development include the open architecture with modular structure that allows using the different methods of knowledge representation and its integration to manufacturing systems, to processes of decision-making and of knowledge acquisition.

IMS have to integrate methods and technologies of knowledge processing and of decision-making:

– artificial neural nets, which are AI-tool, able to simulate complex function, human brain learning procedures;

– fuzzy logic – the set of technologies and methods to formulize the natural language, the linguistic and numerical data processing;

– genetic algorithms and evolutional simulation methods, that include the learning algorithms, based on theoretical achievements of evolution theory, enriched by AI-methods.

The combination of mentioned symbolic knowledge presentation methods with expert system gives possibility to form complex software to solve decision-making problems at every stage of manufacturing functioning.

The structural organization of IMS is based on basic rule of OOP, which matches the processes of information and programming. Also, it assumes that the development process is based on conceptual object description and includes the method of development and introduction for computer-integrated manufacturing CISMOSA (Open System Architecture for CIM), developed by a number of EU projects.

The intellectual control system (as a part of IMS) can be considered as distributed control system in a next way:

$$IMS = \langle M, R(M), F(M), F(IMS)\rangle,$$

where $M=\langle Mi\rangle$ - the set of formal of logical-linguistic models, presenting the certain intellectual functions;

$R(M)$ — the function of needed model choice (or of model set) for the certain situation;

$F(M)=\{F(M)i\}$ — functions set for models modification;

$F(IMS)$ — the function of ICS and of its basic components ($M, R(M), F(M)$) modification.

Therefore, the modern tendency in manufacturing systems development is in the application of technical tools with bio- and human-similar properties (intelligence, experience, recognition and can be introduced by application of IMS. IMS can be created as opened structures, which unite the existing information systems with subsystems, using artificial intelligence to form the integrated environment to solve the IMS problems. Simultaneously, improvement of adaptive and intellectual tools of technological and supplementary equipment makes necessary to advance mathematics, organization, algorithms and software for decision-making systems of robotized systems.

III. Production Support Robotics Tools with Intelligent Control

For case of FIMS adaptivity is a possibility to keep manufacturing system workability for case of functioning condition changes, caused by external (other FIMS, transport system, energy supplement, ventilation system etc.) and internal (work of processing units, NPC-units, transport system, personal activity etc.) sources.

For such conditions FIMS must adapt to the current conditions and change the schedule (plan) for whole system functioning or from some parts, providing the adaptation of functioning strategy.

The technological process of mechanical processing and assembling must be provided in one or several workshops with processing centers, NPC-machines, industrial and transport robots, storages and the transport system, connecting the techno-logical equipment and the automated storehouse.

The lacks of production process organization for the mentioned mechanical and assembling workshops are:

– fixed mode of transport system and insufficient level of automation with limited application of industrial robots;
– manual loading for NPC-machines;
– absence of automatized tools to avoid the emergency or non-standard production situations.

To overcome the mentioned lacks there are proposed:

– to introduce the mobile assembling-transport robot to the equipment of flex-ible integrated systems and workshops (Fig. 1);
– to develop the mathematical and algorithmic supplement, the software for the mentioned robot.

The mobile assembling-transport robot must correspond to the following requirements:

– free movement in range of workshops out of technological equipment units workspace;
– robot supplies the devivery of billets and other materials to the workspace of processing centers and NPC-machines;
– robot supplies the delivery of needed instruments or equipment on regular or irregular calls;
– robot supplies execution of selected assembling operations;
– robot supplies the monitoring for technological and other equipment of workshop;
– robot checks the functionality of technological equipment.

To supply its functionality the assembling-transport robot must correspond to the following construction demands:

– presence of mobile platform chassis;
– presence of manipulator (or of several manipulators);
– presence of cargo block to transport billets, details, instruments and equipment;
– presence of communication system;
– presence of control system with computer on-board;
– presence of sensor system for chassis and manipulator.

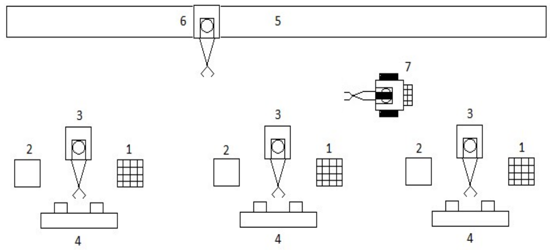

Figure 1 – The structure of flexible automated sector (1, 2 – input and output storages, 3 – industrial robot, 4 – NPC-machine, 5 – transport system, 6 – transport robot, 7 – intellectual assembling-transport robot)

The assembling-transport robot must be selected on base of existing models of transport robots and manipulators.
The particular element of control system for mobile assembling-transport robot is decision-making support system (DMSS). As to dynamics of robot’s workspace DMSS must supply the problem-solving for transition tasks of assembling-transport robot to particular workspaces, to schedule the loading-uploading operation for technological equipment, instruments and supplement, to plan some assembling operations. The dynamic nature of assembling-transport robot workspace, determined by particular production system, defined the demands of functioning strategies adaptivity, which must supply the increase stability and productivity of flexible manufacturing systems.

The further use of strategic planning methods should be based on logical models, considering the dynamic nature of intellectual robotic manipulation systems [5].

IV. Conclusion

The current problem with modern flexible integrated production systems still remains in supplement of production functions under the effect of various external factors, including those associated with changes in the conditions of execution of technological operations, adaptation to new elements of production technology and industrial units, interaction with other technological equipment [6]. Solution of these problems can be improved by wider introduction of decision support systems, implemented for mobile and manipulation robots and also for automated control systems of higher levels.

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