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DIAGRAM OF AUTOMATED GRIPPERS CHANGING IN THE INTELLIGENT MANUFACTURING CELL

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Abstract

This paper deals with the complex design of sensor equipment which will be used by automated gripper changing systems in a manufacturing and assembly cell that is located at the Institute of Manufacturing Systems and Applied Mechanics. This complex sensor equipment design derives from knowledge about intelligent manufacturing systems. Sequential diagrams are used as a tool for the design of the sensor equipment. In this paper we describe the design of a sequential diagram for automated changing of grippers at the manufacturing and assembly cell.

Key words

manufacturing systems, complex design, sequential diagram, grippers, assembly cell, knowledge

Introduction

Industrial manufacturing is still moving forward. Today we do not talk only about using IT or classical automated instruments. When we are talking about flexible manufacturing systems it is effective to also talk about possible uses of a new generation manufacturing systems. These new-generation manufacturing systems are also called intelligent manufacturing systems (IMS). All IMS subsystems include components of so-called machine intelligence (or sensor equipment). Use of given systems in combination with machine intelligence will lead to the complete removal of the laboratory from the manufacturing system. Monitoring systems use sensors that are located at some proper place in the system, such as a particular tool, machine, or manipulating device. Sensors are identifying parameters which are then used as input data in the control system. Following from this data, some technological process, manipulation, or other helping process is administered.

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Analysis of flexible manufacturing cells

A flexible manufacturing cell can be found at the Department of Technological Devices and Systems (see Figure 1). This flexible manufacturing cell is created by some bearing subsystems such as:

- Industrial robot with Cartesian kinematics,
- Shelf storage system.

Fig. 1. *Flexible manufacturing cell and workplace of the cell*

There are five manufacturing phases integrated in the flexible manufacturing cell:

- storage (semi product storage and storage of final product just before shipping),
- transport and manipulation (transport and manipulation of semi products and products),
- manufacture (manufacturing of a single semi product through the final product),
- assembly (assembly of a single final product into the one final product assembly),
- shipping.

Following previous conclusions and knowledge which come from studies of intelligent systems, specially designed sensor units were added in the flexible manufacturing cell for each device. That means that every device will have its own sensor units which will be used for processing of primary information. Such information ensures communication between single devices and the control system. Before specification of single sensor units, it was necessary to specify the requirements, which will be given to the intelligent manufacturing and assembly cell that will be designed.

The main requirements used for intelligent manufacturing and assembly cell design were the following:

The designed intelligent cell has to be able to react to various situations which occur during the manufacturing process, such as:

- the changing shape of manufactured or assembled parts,
- changes of the part dimensions,
- usage or lack of usage of single subsystems by the manufactured parts,
- changes in the part types,
- change of the technological parameters,
- assurance of collision situations in the cell,
- low manufacturing costs.

Just as in the case of the flexible manufacturing cell, design of the intelligent manufacturing cell is borne of two basic subsystems and also contains five manufacturing phases.

Writing methodology for communication between single devices of IMC

Before design of sensor equipment for single system subsystems, it was necessary to establish writing methodologies for single stays and movements connected with parts. These stays of parts have to be created during running production processes in the intelligent manufacturing cell. Proper writing methodologies were created in order to define the communication methods between single devices during running production processes. Sensor equipment, therefore, can be designed according to the written methodology for communication between single devices. In the beginning, the two kinds of writing methodology were using evolution diagrams and algorithms, and writing that used rules of sequential diagrams.

Sequential diagram

This new writing methodology is most commonly used for the UML programming language. These diagrams are used to demonstrate the description of objects stays. Sequential diagrams are used for showing how single objects are communicating with each other simultaneously. The method of sequential diagrams was chosen as the appropriate means of demonstrating communication between single devices operating in an intelligent manufacturing cell. Only synchronous messages can be found in the designed intelligent manufacturing cell. This means there will not be any other operation created without backward signal in the control unit.

Sensorial equipment design of automated grippers changing

Writing methodology using sequential diagram is a useful way to analyze communication between single devices, which are placed in the working space of the cell.

The sensor of the type **SIEN – M8NB-PO-K-L** is applied to identify the particular storage grippers. Colour- sensing sensors were designed to identify single gripper types for fitting to their shapes. This application uses two such sensors with type **SOEC-RT**. Sensor placement is shown in Figure 3.

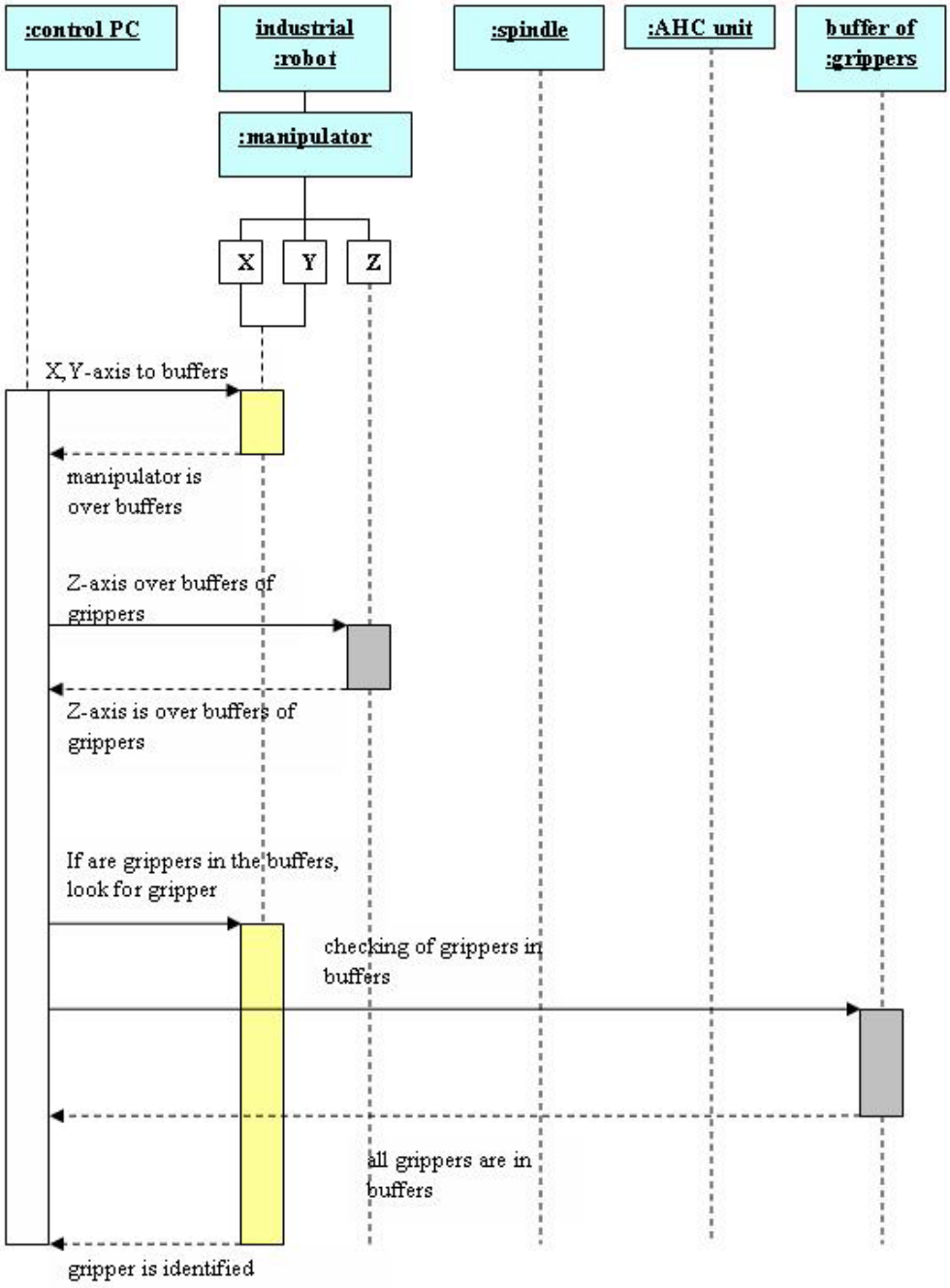

Fig. 2. *Sequential diagram beginning - diagram of automated grippers changing*

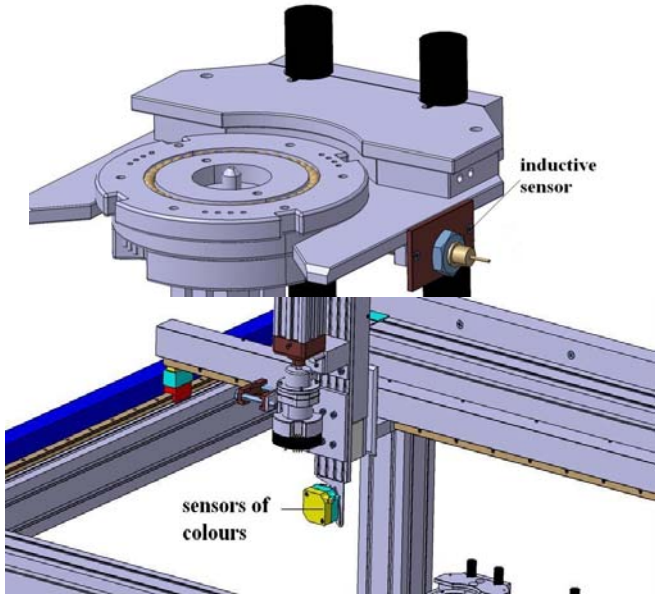

Fig. 3. *Placement of sensors at the manipulator body*

In the moment of manipulation the signal is coming to the control unit. This signal is indicating where there are free positions within the shelf.

Conclusion

During the design process of the intelligent manufacturing cell and automated tool changing system, a sequential diagram methodology was used. This methodology was chosen to describe communication of all devices during the manufacturing and assembly process. Sensor equipment was selected following information regarding communication and signal transmission. The purpose of using the sequential diagram methodology was to upgrade the flexible manufacturing cell towards the intelligent manufacturing cell with the help of sensor equipment. It will then be used for laboratory purposes.

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References:

[1] KOŠŤAL, P., MUDRIKOVÁ, A. Material flow in flexible manufacturing and assembly. In *Computing and Solutions in Manufacturing - Engineering*, 2008, September 25-27, Brasov, Romania. In *Academic Journal of Manufacturing Engineering*. Supplement, Issue 1, 2008, p. 185-19. ISSN 1583-7904

[2] MUDRIKOVÁ, A. HRUŠKOVÁ, E. HORVÁTH, Š. Model of flexible manufacturing - assembly cell. In *RaDMI 2008* : *8th International Conference from 14-17. September 2008*. Užice, 2008, A-27.

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