International Journal of Computing, Programming and Database Management

E-ISSN: 2707-6644
P-ISSN: 2707-6636
IJCPDM 2023; 4(1): 08-12
Received: 04-10-2022
Accepted: 11-11-2022

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Modelıng of flexıble productıon automatıon scheme

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DOI: https://doi.org/10.33545/27076636.2023.v4.i1a.75

Abstract
The application of the Flexible Production Area (FPA) allows to increase labor productivity, improve its quality, and promptly respond to the changing needs of the customer. The main purpose of its application is to free a person from heavy and monotonous physical labor, as well as from working in conditions that are harmful to the body. Flexibility in FPA refers to or is characterized by the ability to move quickly from one type of product to another at regular intervals and at low cost.
Creation of FPA of advanced technology high-performance equipment,mechanization and automation of transport, warehousing and loading operations, automatic control of product quality, use of computer equipment and software. The application of FPA in various industries has shown that it is not only a system that is fully supported by material and information, but also a system that ensures the production of the required amount of product over a period of time.
In the article is discussed modeling of flexible production automation scheme.

Keywords: Flexible, technology, robot, elements, active elements, production system, transport systems, processing, system, operation

Introduction

As it is known, the stages of the evolutionary process of automation of production systems develop from fairly simple to very complex systems in terms of the degree of uncertainty and diversity of elements: automatic lines, flexible technological modules, flexible production systems, computerized productions, etc.

The elements that make up automatic lines are usually homogeneous and operate under deterministic conditions.

Flexible technological modules are relatively complex systems and consist of various elements - program-controlled machines, robots, positioning mechatronic devices, etc. consists of.

The next stage in the evolution of production systems is flexible production systems. In addition to the elements of the previous stages, the structure of the FPA includes warehousing and transport equipment, management and planning systems, local computer networks, etc. includes. The operation of the FPA is mainly stochastic and fuzzy, as the FPA does not have complete and accurate information about the environment and the processes taking place within the system.

FPAand subsequent production systems belong to the category of complex systems, and there is a need to apply new, modern approaches to their design, which can be done using theories based on information and communication technologies, effective modeling devices and SOFT Computing technologies.

The most widely used modeling devices for the study of the modeling and initial design of FPA are finite automata, parallel-acting asynchronous processes, Frame, logic and production models, semantic and Petri networks. Compared to other modeling devices, the Petri network (PN) is a more universal device and has found a wide range of applications. This is due to the fact that the studied process is modeled by the structural elements of the PC and the feasibility of creating a FPA is assessed by analyzing the main properties of the PC outside the system. Modeling and researching the performance of these devices under uncertainty requires the use of new approaches.

FPAs belong to the category of complex structural systems. Therefore, their complex modeling and research by computer experiments at the stage of system design are accompanied by certain difficulties, but in most cases it is not possible. Therefore, in the initial design phase, the GIS is described as a set of finite number of FPA that perform logically completed functions and are studied with different purpose modeling devices. Because the main equipment of the FPA is mechatron devices, and in most cases they operate in three-dimensional space in common working zones, they have specific features. Thus, the failure to take into account the fuzz in the behavior of the elements of the FPA in their behavior, routes of movement, positioning, as well as the positioning of objects operating on mechatronic devices, ultimately leads to waste production, accidents and so on. creates grounds for unpleasant situations.

The advantage of simulation modeling in a computer is that it is built on the principle of module, this principle is universal and it is possible to describe other subsystems with the help of one module. The main disadvantage of the modular principle is the difficulty of its interaction with other modules. Imitation modeling is the most widely used method for designing complex systems. However, when it is applied in practice, there are certain difficulties, which are mainly the following: the development of an imitation model requires large economic resources, and the application of the developed model is possible only by the program; the creation of an imitation model based on traditional methods does not meet modern needs, etc.

Computer modeling of complex dynamic systems is a topical issue. Basic concepts of modeling: object, model, system, mathematical model, computer model, dynamic system, hybrid systems, as well as a model for clarifying the listed concepts. It provides a classification of two basic mathematical models - the classical dynamic system and its generalization hybrid systems, as well as the construction of a multi-component hierarchical structural model of complex dynamic systems.

FPA are composed of a large number of active elements, technical devices, transport systems and other ancillary devices. Thus, GISs belong to the category of complex managed systems. From this point of view, the design, testing and application of such systems require a special approach. As a rule, FPAs are created on the basis of a large number of mechatronic devices. Each macro device performs a single function, and can be in a number of situations while performing these functions.

One of the methods used to model FPA s operating in an uncertain environment is machine modeling. Such modeling is distinguished by its flexibility and versatility for arbitrary objects. The advantage of network models, especially PCs, is that with the application of this mathematical device, a model of parallel, hierarchical structural objects is built.

FPA is a complex of program-controlled technological equipment, modern computers and computing equipment, automated design tools, production and planning work. It is the management system of the FPA that combines and manages these resources into a single system.

The FPA consists of several FPAs, which are designed to perform different operations on the details, have a single production purpose, fully integrated with each other by an automated transport system. According to the type of operations performed, FPA is divided into processing, positioning and measurement-control classes. The processor may include one or more devices, one or more industrial robots. Measuring and control FPA includes equipment equipped with measuring devices and devices that provide measurement and control. The positioning FPA locates the control and measurement resources of the processed parts, semi-finished products, measuring devices.

The construction of a modern FPA model is the process of formalizing the data obtained in the process of its initial design. The aim of this new research method is to conduct computer-friendly simulations and computational experiments on given and received data. The solution to such problems is to build synchronous and asynchronous models of discrete systems. The basic data for modeling asynchronous systems are the events that take place in the system and their logical connections. In asynchronous processes, the cause-and-effect relationships of events in the system are given in the form of a set of "condition-events". It is difficult for the FPA to build this structure as a whole. The structuring of data depending on the subject area simplifies and accelerates the problem of modeling FPA.

As is well known, FPAs are composed of a large number of active elements, technical devices, transport systems and other ancillary devices. Therefore, FPA belongs to the category of complex managed systems. In this regard, the design, testing and implementation of such systems requires a special approach. As a rule, FPAs are created on the basis of a large number of mechatronic devices. In addition, the achievement of the ultimate goal in FPA is based on the coordination of interactions based on defined criteria [1, 2, 3].

The architecture of a FPA is a set of properties and characteristics that characterize it, ie these properties and characteristics indicate the possible functions of the FPA in the considered modes.

As we know, FPA is not only a complex system, but also consists of subsystems. The issue we are considering is that mechanical processing is part of a flexible production system.

As an object of research, let's look at the model of the module of operation of the processing center of a flexible production system of mechanical processing. The processing center consists of an individual access holder, an operating device, an individual output holder, and an industrial robot (İR) (Figure 1).

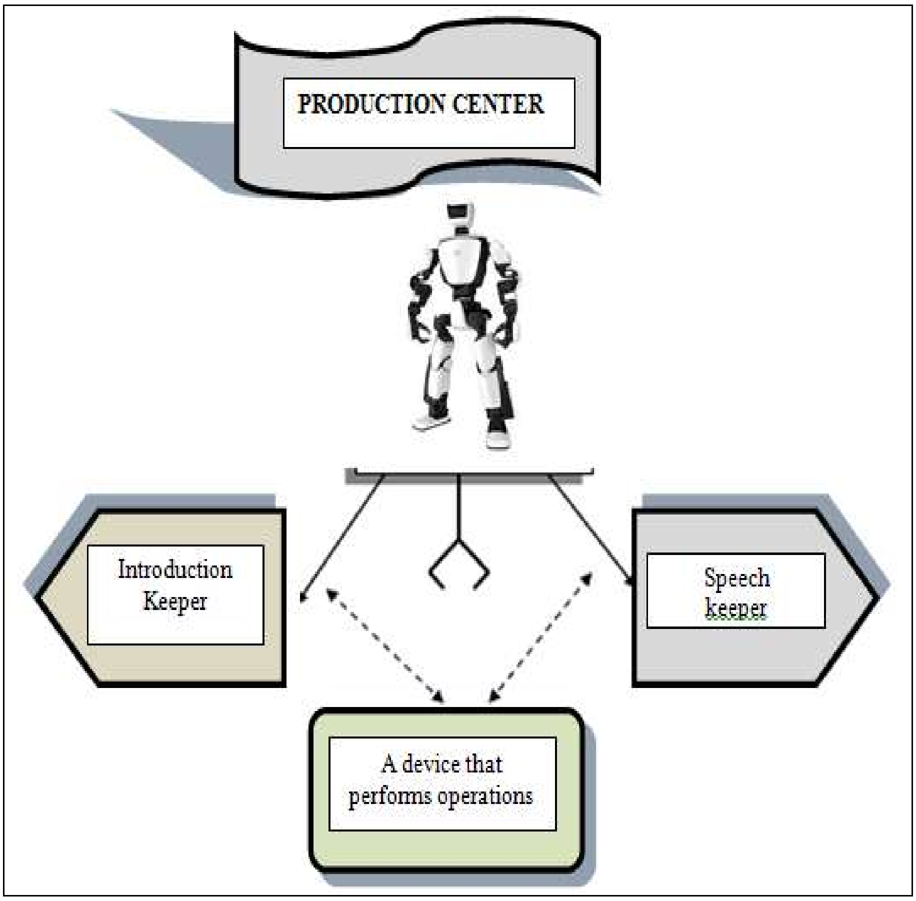

Fig 1: The activity of an industrial robot

The access holder accepts various types of details and stores them until they are processed. The output keeper receives the processed parts and transmits them to the next module. The industrial robot transfers different types of parts to the required positions, coordinates and synchronizes the operation of the module [4, 5].

The connection of the module with the previous and subsequent modules is carried out by means of the above-mentioned holders in accordance with it. Suppose that the module processes two types of details. The details are entered into the individual access holder and awaited processing. A part of the first type requires the first operation, and a part of the second type requires the second operation. If the device is configured to perform the first operation and the holder receives a type I component, it is placed by the İR at the input of the device to perform the operation on the type 1 and the device is removed after the operation. If at this time the device is set to perform the first operation and the holder receives a second type of detail, then the device is set to perform the second operation from the first operation. After that, the part is processed and the second operation is performed. If the device is configured to perform a second operation and the holder receives a second type of part, then the İR is placed at the entrance of the device to perform the operation on the second type of part, and after the operation removes the device and removes it from the device.

If the device is set to perform the second operation, the holder receives the first type of detail, then the device is set to perform the first operation from the second operation. Only then is the part processed and the first operation performed. Both types of processed parts enter the output storage via the İR and wait for transmission to the next module [6].

Figure 2 shows the architecture of the flexible production module (FGM) automation scheme. Let's look at the requirements for the management of FGM as a subsystem of the three-level management system of FPA. In order to determine the condition of the mechatron devices of the FGM, various sensors and performance mechanisms for changing their position are installed in their positions, such as [7, 8].

X_1- determining the status of the details to be included in the access holder;

X_2- determination of execution of details of the first type;

X_5- İnitial condition of the hand of the İR;

X_6- The final position of the hand of the İR;

X_7- Condition of the arresting device of the İR;

X_8- Final condition of the rotating device of the İR;

X_9- Upper position of İR lifting device;

X_{10}- low position of İR lifting device;

X_{11}- Determination of placement of the first type of İR part at the entrance of the device;

X_{12}- determination of the state of transition from the first operation to the second operation by adjusting the device;

X_{13}- determination of the status of the first operation;

X_{14}- setting of the device for the first operation;

X_{15}- Determination of taking the machined part of the first type of İR from the output of the device and placing it at the entrance of the output holder;

X_{16}- Determination of placement of İR type type detail at the entrance of the device;

X_{17}- determination of the status of the transition from the second operation to the first operation through the

adjustment of the device;
X_{18}- determination of the status of the second operation;
X_{19}- setting the device for the second operation;
X_{20}- Determination of the machined part of the second type of İR taken from the output of the device and placed at the entrance of the output holder;
X_{21}- determination of the condition of the processed parts in the output storage;
X_{22}- determination of the condition of the first type of machined part;
X_3- for transmission to the entrance of the device to determine the performance of the second type of parts;
X_{23}- determination of the condition of the second type of machined part;
By processing the information received from the indicated sensors placed in different positions of the FGM mechatronic devices, control signals are sent to the appropriate execution mechanisms (EM) and its operation is ensured [9].
X_4- İnitial condition of the rotating device of the İR;
The following EMs are located in the architecture of the turf:
IM_1- access custodian office;
IM_2- first type part processing control;
IM_3- control of processing of the second type of part;
IM_4, IM_5, IM_6, IM_7- İRs hand movement control (lifting, turning, holding);
IM_8- İR transmission control to the input of the device for processing of the first type of part;
IM_9, IM_{10}, IM_{11}- control of the device performing the operation for the first type of part (adjustment, processing and transmission of the part having the first type);
IM_{12}- Management of the İR of the processed type of detail from the output of the device to the input of the output holder;
IM_{13}- Control of transmission of İR to the input of the device for processing of the second type of part;
IM_{14}, IM_{15}, IM_{16}- control of the device performing the operation for the second type of part (adjustment, processing and transmission of the second type of part);
IM_{17}-İR control of the second type of machined part taken from the output of the device and placed in place at the input of the output holder;
IM_{18}- outboard storage management.

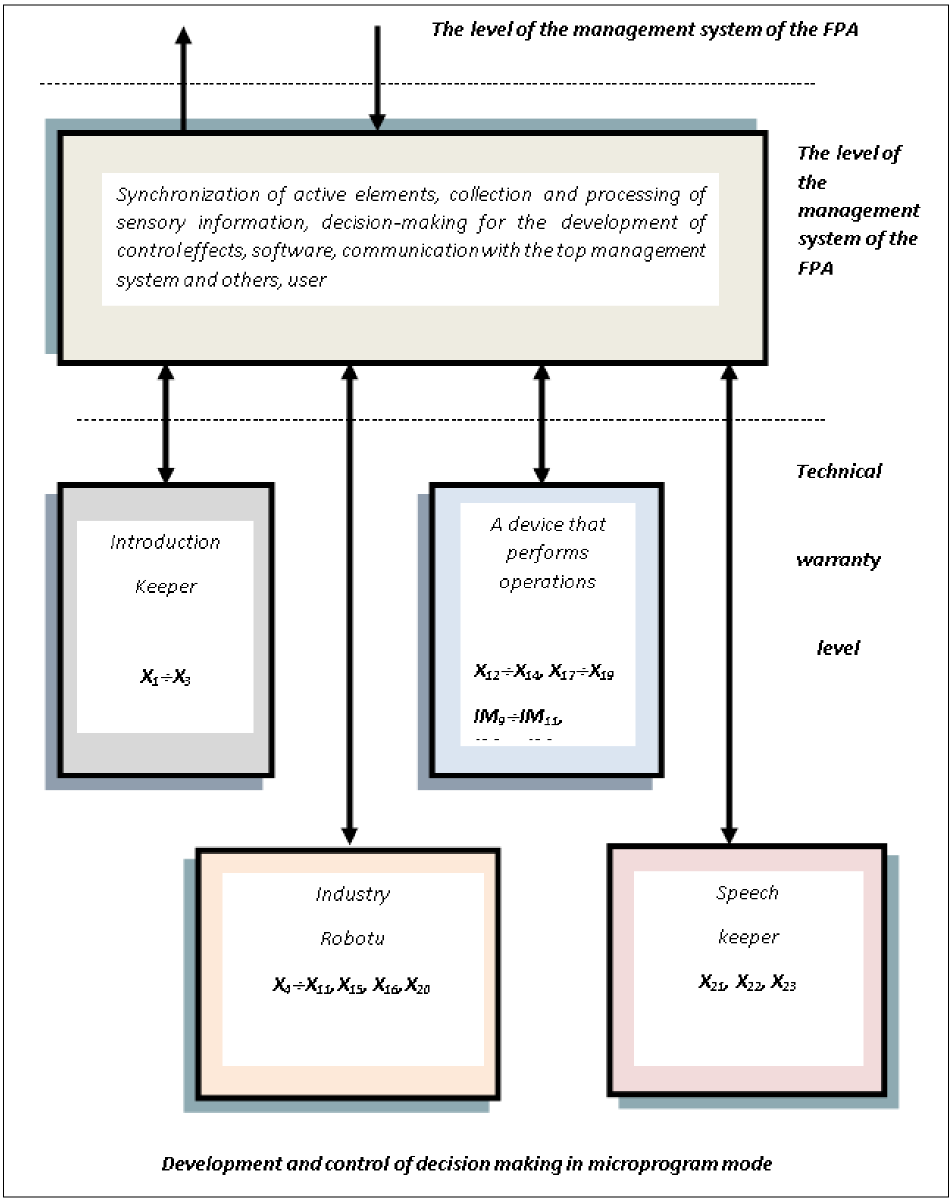

Fig 2: The architecture of the automation scheme of the flexible production module (FGM)

IM_{19}- processed first type part management;
IM_{20}- control of the second type of machined part.
The study and analysis of the proposed models using Petri networks (PN) for the management of FGMs with automated circuitry with developed architecture helps to create effective management algorithms [10].
PN is defined by the following five:

$$N=(P,T,I,O,M_0).$$

Here,

$P=\{p_1,p_2, ...,p_n\}-$ is a finite set of positions; $T=\{t_1,t_2 ,...,t_r\}-$ is the finite set of transitions; $I:PxT\rightarrow(0,1,...)$, $O:TxP\rightarrow(0,1,...)$- are the input and output functions of the network, respectively. $M_0 \ :P\rightarrow\{0,1,...,\}$ $-$ The start is branding.
Compared to other modeling devices, PN is considered a more universal device and has found a wide range of applications. This is due to the fact that the researched process or information is modeled with the structural elements of the PN, and the expediency of its creation is evaluated by analyzing the main properties of the PS outside the system.

Acknowledgment
I express my gratitude to my colleagues working in the Department of Information Technology and Programming, who are not co-authors of the article, but influenced the results presented in it, as well as to the management of the Sumgait State University, who assisted in conducting the described study.

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