ANALYSIS OF METHODS AND SOLUTIONS REGARDING INTERCONNECTIVITY OF THE PRODUCTION SYSTEM ELEMENTS WITH INTEGRATED ROBOTS

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Rezumat. *Având în vedere nivelul ridicat al tehnologiei industriale care se așteaptă să fie pus în aplicare în toate sectoarele de producție și anume a 4-a Revoluție Industrială (Industria 4.0), acest articol conține o identificare a metodelor și soluțiilor pentru interconectivitatea dintre sistemul de producție și roboții industriali. Conexiunea dintre două echipamente industriale include software-ul și tipul de conexiune hardware. De aici putem dezvolta noi metode de analiză, clasificare și soluții pentru interconectivitatea acestora. Cercetările în acest domeniu pot duce la o normalizare conceptuală, dar și la analiza lor în timp, din care putem trage concluzii despre îmbunătățirea fluxului de producție.*

Abstract. *Considering the high level of industrial technology that is expected to be implemented in all production sectors, namely the 4th Industrial Revolution (Factory 4.0), this article contains an identification of methods and solutions for interconnectivity between the production system and industrial robots. The connection between two industrial equipments includes the software and the hardware type of connection. From here we can develop new methods of analysis, classification and solutions for their interconnectivity. Research in this field can lead to a conceptual normalization, but also to their analysis over time, from which we can draw conclusions about improving the production flow.*

Keywords: Production system, Industrial Robot, Industrial Engineering, Inter-connectivity

1. Introduction

Today's competitive market imposes many changes that become something usual and the speed of manufacturing processes is high, so manufacturing technology must be prepared to meet new requirements. As long as the demand for a product grows exponentially in a short time, manufacturing technology must respond as quickly as possible to this necessity. Behind the manufacturing processes there are a lot of production systems with all the auxiliary components, depending on the complexity of the production. Next we will refer to a flexible production system and take an example of hybrid machine tool that, through terminology, combines the cutting process with additive manufacturing. This machine offers flexibility

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during the automatic processing of a different number of parts [1]. For an even better response to the manufacturing time, along the flexible production system, various equipments are added to help with auxiliary drives, such as feeding and unloading. For this tasks, the most suitable equipment is the industrial robot.

The connection between the hybrid machine tool and the industrial robot can be made through several methods, depending on the flexibility we want to have and the available staff. Resources such as raw materials, utilities and human ressources are usually consumed for production The staff category also includes activities dealing with automation, design, etc. The choice of interconnectivity methods takes into account the requirement of product manufacturing, but also the possible changes over time, in other words the predictability of changes related to volumes, product changes, etc.

1.1. Hybrid machine tool

This type of hybrid machine tool offers a flexibility that until recently in specialized articles was mentioned only as a concept. In a very brief way, the hybrid machine tool offers the traditional subtractive machining, but in addition has the ability to depose material depending on the manufacturing process.

This deposition of material is called additive fabrication. Not long ago, a standard regulation on additive manufacturing was adopted, ISO/ASTM 52921:2013 [2].

The combination of additive manufacturing and the subtractive machining offers several advantages, namely the deposition of the material only in certain areas, where the part has a very high degree of use, after which the cutting process can obtain the desired size. This way, the cost of the material is reduced and the part is reused [3]. It's just an example, but the working methods are very different, and the engineers that use this type of hybrid manufacturing discover with each new project some advantages and disadvantages.

1.2. Industrial robot

The industrial robot is a programmable automatic unit with 3 or more axes of movement. The supply of industrial robots on the market is very large, precisely to meet diversified requirements. Next we will refer to the simplest case of industrial robot, namely the type of articulated arm with 6 axes of movement.

The industrial robot with 6 axes of movement is the most common on the market, it is available depending on the load capacity which can start from 3 kg and reach until 2300 kg.

Depending on the load capacity, there is also a range of action, thus combining the two parameters, the robot offers different speeds and accuracies depending on its field of action.

Usually, robot manufacturers allow the robot to operate only within the initial parameters for which it was designed, but there are also situations where the limits are exceeded, such as load capacity, after that threshold, its maximum operating values change, respectively the speed is getting lower, respectively the accuracy decreases.

2. Examples of applications for interconnectivity methods

As for the interconnectivity between several production equipments, it all starts with the user's desire for the control he wants to have and the system's flexibility. There are often simple solutions whereby the interconnectivity between two industrial equipments is achieved directly with the help of I/O (inputs/outputs) of the equipment.

Referring directly to the interconnectivity between the hybrid machine tool and the industrial robot, this can be done using the I/O beeing in place on the interface of the industrial robot and the machine tool (on different communication modules, profinet, profibus, ethernet, mod bus, serial etc.).

This type of connectivity offers the advantage of a low cost when communication distances are short. Programming can be done directly from the control unit of the robot and simultaneously from the machine tool. The principle of operation is based on the exchange of signals between the two equipments [4].

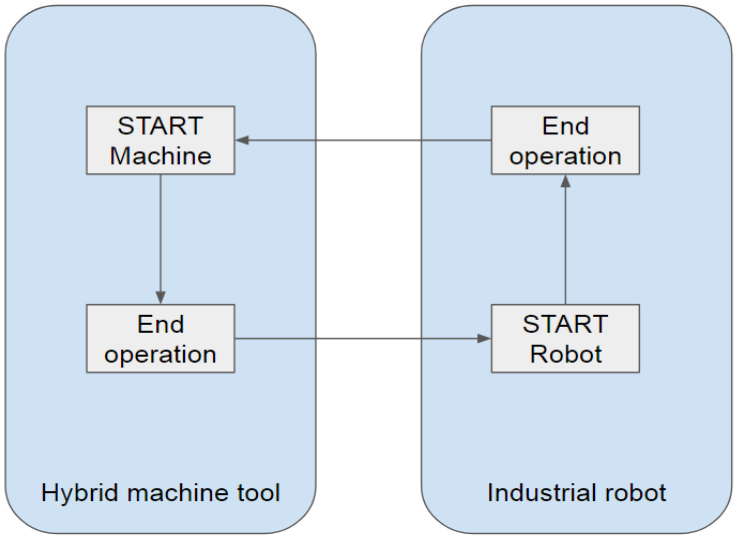

Fig. 1 Logical scheme, I/O signal exchange

The start-stop command will be made alternately, so that each piece of equipment sends the start signal to the other after the end of operations (Fig. 1). Electrical units, such as electrical panels, contain components that will ensure the safety of the system, involving the command and control of equipment.

The main disadvantage of this method is the limited number of inputs, so it is suitable for simple robotic cells. To install this option of interconnection, the costs may increase when the distances between different equipments are large.

Another option is to use a programmable logic unit for the interconnectivity between the hybrid machine tool and the industrial robot, presented on the Fig. 2. This programmable logic unit or PLC is a special computer without monitor, keyboard or mouse, which can be mounted in the electrical panel. It was specially designed to replace industrial mechanical switches (relays), with which the electrical and mechanical drives were controlled. A PLC contains the processor module (CPU), through which all automation is done, and I/O that can be found related to the processor module or separate. Finally, we find the advantage offered by positioning the I/O modules closer to the elements to be ordered, such as electric motors, sensors, etc. The signal type accepted by the PLC could be both digital and analog.

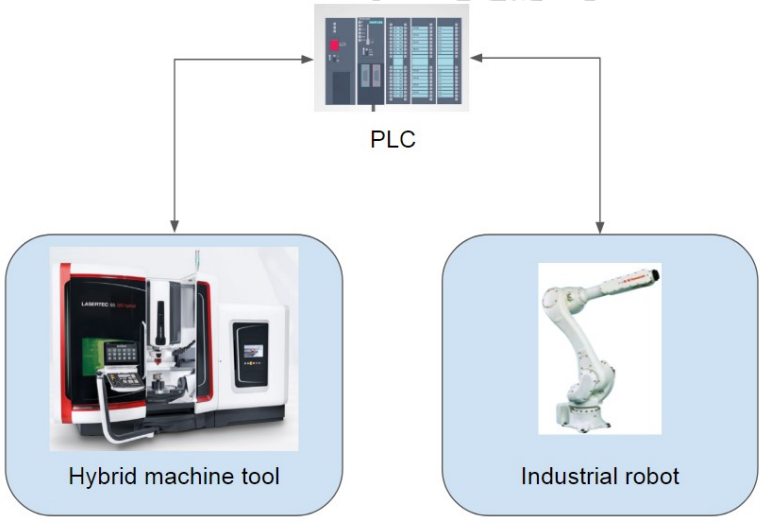

Fig. 2 Logical scheme, programmable logic unit

For the programming language there is a standard, IEC 61131-3:2013, which defines some programming codes with their advantages and disadvantages. PLC providers use programming interfaces that run on the laptop (for example, TIA Portal from Siemens), and the programs can then be uploaded to the PLC via an Ethernet connection or, most recently, via USB.

The programmable control unit has the advantage of being able to control a very large number of industrial equipment and even to generate, based on data collected from automation, graphs and productivity statistics (statistical process control or SPC), equipment shutdown, etc., which has high computing power and similar flexibility.

As a disadvantage for the implementation of this type of connectivity, the costs are high, and the installation staff must benefit from more in-depth studies for automation/programming.

3. Conclusions

In general, the choice of the method of interconnectivity between different equipments of a production system consists in its profitability, market supply and sustainability.

Digitization of the production process ensures remote monitoring and control, allowing the user to intervene whenever necessary. Some modification of decisions can be made by the programmable unit itself if the variables it encounters in the production process are loaded.

The next step will be the road to digitalisation that will solve more and more automation schemes, because, although we are on the upward slope towards automation, there is a shortage of qualified personnel to processes automation.

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