

INDUSTRIAL ROBOTS AND THEIR APPLICATION IN SERVING CNC MACHINE TOOLS

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ABSTRACT

Application of the robots in industrial production processes, year after year is increased. The constant growth of the robot application is related for its functional justification. There are plenty reasons for it as operator's protection in bad working conditions and environments or operator's protection by hard works, time saving, higher quality, higher productivities, cost saving etc. Industrial robots are applied in all branches of the industries. Their use is still the largest in the manufacturing of motor vehicles industry but other industry branches record increase of industrial robot implementation. Information technology development has a big influence on changes in robotics that lead to the new functional solutions and the robot capabilities. In this paper is presented industrial robot application analysis in serving CNC machine tools. Analysis includes data about operational stock of industrial robots in European Union countries and comparative analysis with other industrial branches.

Keywords: manufacturing processes, industrial robots, CNC machines, metal product industry

1. INTRODUCTION

The efficacy of the technology implies improving of the technical solutions in domain of technological process automation and application of the intelligent systems in various industrial branches as metal product industry. Large numbers of industrial robot application in metal product industry are existed today. Their application are motivated by technical and economical reasons, some of them are [1,2,4,9,10]:

- increase the quality of finished products (machining, etc.),
- reduce the waste (in assembly processes),
- increase degree of uniformity of quality (in all processes related to repeatability of robot actions),
- increase degree of operating safety (in aggressive, flammable, explosive and other dangers areas, with high degree of robot protection),
- reduce the request for operators in routine and repeatable processes,
- reduce of manufacturing costs and maintaining in total,
- fulfilment of demands imposed by concurrence and increasingly quality standard demands.

Besides technical advantages, accomplished by robot application, it should be pointed to rationality of robot installation in concrete plants conditioned by production volume and operating characters which robot or robots has to perform. For example, production volume increase cause descent of robots cost, regard in metal product industry investments in robot are fast payoff [10].

2. APPLICATION OF INDUSTRIAL ROBOTS IN THE METAL PRODUCT INDUSTRY

Production in metal product industry implies machining process of metal to final product, or semi product. In metal product industry, industrial robots have application [4,6,8]:

- as a relevant part of a modern production lines which are planned with high degree of automation and flexible characteristic, where is difficult to separate and analyse robot and its efficiency out of flexible production lines.
- in integration of already installed production plants, where robots substantially increase efficacy of plant, ensuring its effectiveness. This reduces or postpones requests for new or higher investments, as showed in certain situations, that installation of robot is more cost-effectiveness then supplying new machines.

Application of robotic systems in metal product industry, whether it is total automation of systems or high automated production line, so called fix automation or possible flexible manufacturing cell, can be analysed through:

- material transport and machine serving support,
- processing,
- assembly and
- control quality of product.

In today's industrial plants of metal product industry still is dominated fix automation. One of the characteristic of today's global economic trends is the spread of the market regarding request for constant modification of existing products with new technology application, to ensure competitiveness in turbulent market conditions.

Table 1. Yearly supply and operational stock of industrial robots in period 2008/2009 and forecast for period to year 2012.

Continent	Yearly supply of industrial robots			Operational stock of industrial robots		
	2008	2009	2012	2008	2009	2012
USA	17.192	9.600	19.100	173.977	172.800	174.400
Asia/Austral.	60.294	35.900	54.000	514.914	509.000	523.000
Europe	35.066	22.600	34.200	343.700	346.100	957.300
Africa	461	300	500	1.784	1.800	1.700
Total:	113.345	68.400	103.800	1.035.674	1.031.000	1.054.000

Importance of robot has crucial meaning in this kind of conditions of flexible manufacturing of metal product industry [1,3,6]. Applications of robots in metal product industry are various. For some special areas of application are designed special robots. Robot selection for application area depends mostly of the operating process and robot's characteristic. Application of industrial robots is increasing therefore economical and technological advantages of applications. Robot in the future will have application in industry and in the other fields of human life. Yearly supply and operational stock of industrial robots in period 2008/2009 and forecast for period to year 2012.is presented in table 1[9].

3. EXAMPLES OF INDUSTRIAL ROBOT APPLICATIONS IN SERVING CNC MACHINE TOOLS

Operations that are used for support machines in metal product industry can be classified:

- moving workpieces from conveyors and positioning in machine for processing,
- removing workpieces after processing from machine and leaving to prepared area,
- change and lay out tools etc.

Cost effectiveness of the industrial robots in machine support is very important, where robots are synchronised in activities with machines means one robot for various activates as tool changing (Figure 2) or workpiece positioning (Figure 3) [14,15].

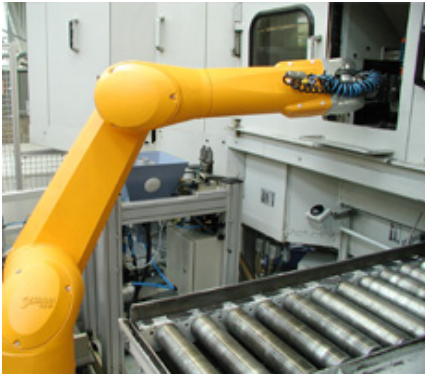


Figure 2. Tool changing on machine



Figure 3. Workpiece positioning

These kinds of the industrial robots are complex and expensive, so it has to be considering their profitability. Another possibility for solving economical problems would be to use same industrial robots in supporting more machines [11,14].

Handling different kind of work pieces would require flexibilities of end-effectors (flexibility with regard to variable shapes of work pieces). The solution would be application of the universal end-effectors or systems for rapid replacement. In modern plants machining is performed on machining cells. Machining cell is higher automated level of numerical controlled machine in terms of changing of tools, work pieces and accessories [11].

Typical machining cell is consisted by machine tool, transport system for material delivery and shipping and robot for support. High automation level of machining cell demands programming of industrial robots to support flexibility of systems.

By robot mechanics is demanded to meet functionality by electing end-effectors for variable shapes of workpieces. Control of robot has to be synchronised with control of machine tool, as with control of transport system. It has to be satisfied compatibility condition with environment which is solved by integrated control system. Control system has to satisfied high repeatability which is constant demand [3,13]. From standpoint of geometry it is necessary that robot has six degrees of freedom and possibility to change the end-effectors for gripping workpieces showed on Figure 4, which can significantly increase robot velocity in machining cell.

Figure 5 shows application of industrial robots for serving in machining cell [14].



Figure 4. Application of robots in gripping

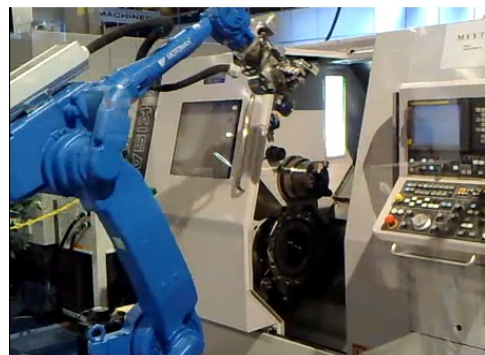


Figure 5. Machining cell support

Robots that serving machine tools in most cases are spherical or Cartesian type [11,17]. Spherical type of robots is placed near machine tool where supplies workpieces from frontal side therefore Cartesian type of robots serves machine tool from upside.

4. CONCLUSION

Implanting of robots in metal product industry, regardless of the method and complexity of implementation, consider the verification of feasibility application of intelligent systems. For this reason it should emphasize technical and technological advantages of industrial robot application in metal product industry, which represents cost-effectiveness reasons, namely:

- improving of the process increasing the quality of the product or semi product,
- reduce waste,
- productivity increasing (increasing the speed of production operations).

In each production, main aim is to reduce production costs and to improve quality of the products. Therefore, reducing of human labour is necessity because reasons as displacement human operators from hard physically and mentally jobs, operator's protection in bad working conditions and environments. Human labour is used for more quality and safest jobs like planning processes and manufacturing process supervising. For this reason it is necessary to consider prejudice connected with industrial robot implementations related to the product quality and labour force. When it comes precision and product quality, in operations with frequent repetitions, human operator can't be compared with industrial robots that always maintain same quality and operation process.

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