STUDY ABOUT MACHINING WITH INDUSTRIAL ROBOTS HELP

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Abstract: *In the last period the industrial robots are used successfully in the process of different materials´ machining. The authors of this article conducted a study on the main parameters of robots that can bring clear benefits in comparison with CN machines, used in the same area of manufacturing. The study is carried out on the platform of performance technologies laboratories from University of Suceava, using equipment like an industrial robot Kuka 125 KRC2 and a MT-CNC Victor 55.*

Key words: *robot, processing, simulation.*

1. General consideration

In the last two decades industrial robots applications were increasingly more diverse. One followed a strongly increased production capacity available on the same area. Reducing production times, especially the dead time because of using robots led to significant production increases, some companies considering that the increase was from 20 to 30%. Organizing the production of robots in workshops, in two or three shifts (8 hours / shift), allowed the doubling or even tripling the production and this without imposing a significant increase of investment in basic machinery.

Using robots in various fields of industrial production processes has resulted in firms producing robots around the world to insist on diversifying production robots, both in terms of design, main parameters, but especially in applications that may be involved, both in the machine building industry as well as in many other industrial fields.

Processing parts by using robots is a relatively recent application proposed by the manufacturers of robots. Until not so

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long ago is was believed that performance of processing machines - tools with the CNC could not be reached, even comparable with other results of other machines of the same generation. [1]

2. Processing with robots

The milling application with robots became interesting when the rigidity and precision robots have become comparable with those of car - industry. Flexibility, due to specific degrees of freedom, has become an important advantage in favor of robots used in processing.

Applications of this type have been initiated recently in several companies in the world, producers of robots becoming a real competitor for machines with numerical order, especially the processing of less harsh materials (aluminum, plastics, wood). In figure 1 it is presented milling with special tools in various applications.

Our team's concerns in the robotics laboratory for processing with the

a *b*

Fig. 1 - *The processing of parts with Kuka robot help*.[3],[[7],[8].

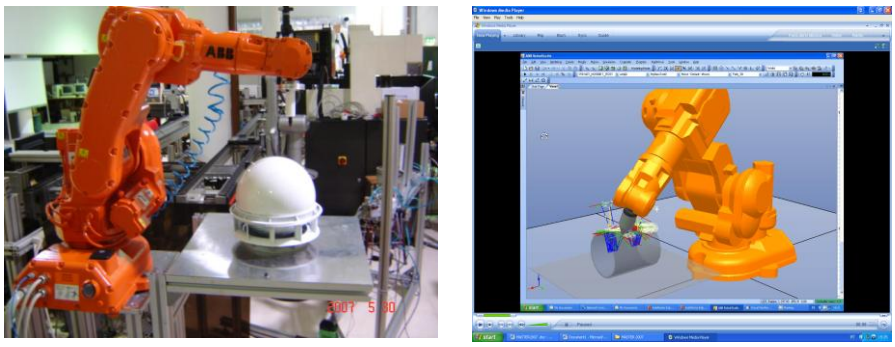
a *b* *c*

Fig. 2 – *Devices used for processing by robot. a- shop tools with multiple areas; b - shop tools linear, c - broach for milling, Kuka.* [7],[10].

robot are recent and began with an ABB robot.

In the Erasmus programs, one of our students prepared a final report in robotics laboratory at IST Lisbon, (2007). On this occasion, there have been some attempts of describing complex areas with tool attached to the tip of the robot body terminal. The piece was designed with the Solid Works CAD programs. The feature conferred by this software in the application is that the program offered by the manufacturer ABB, ROBOT STUDIO 5.07 can import different types of pieces made with these programs, virtual space quickly achieving specific application processing of the piece. In figure 3 one can see the robot used, describing a spherical area and simulation in virtual space applications.

Research to develop software robot used in processing have continued in Suceava, in the robotics laboratory.



a *b*

Fig. 3 – *ABB IRB 140 M 2000 robot* [5].
a - *description of a spherical surface with a tool caught at the robot*;
b - *Robot Studio 5.07 program.*

The equipment used is KUKA KR 125, a robot designed by the KUKA Roboter GmbH company. Among the technical data of the robot one can include the task which can reach up to 125 kg, arm length of 2650 mm, repeatability of + / -0.2 mm.

The robot is composed of KUKA robot KR125, a controller KR C2 and an interface KUKA Control Panel [5].

Fig. 4 - *Kuka KR 125 robot system.*

A first challenge was to achieve a spiral on a cylindrical piece. To achieve the processing of a spiral on a cylinder piece a scheme program was designed and executed allowing the attachment of a device (milling head) on the robot flange for processing parts of different materials, as in figure 5. Absence of a device that allows the change of milling regime limited the scope of applications.

To design parts one used software CAD, Solid Edge v.19, using functions such as: protrusion, chamfer, cutout, and obtained the piece from figure 8-b.

The produced piece has been saved and exported as a *dxf* file which can be imported into the specific programming *"off-line"* flexible robots cells, Kuka SimPro to achieve milling program for the desired operation.

Kuka SimPro is a special software that allows the programming and development of *"off-line"* applications with Kuka robots, offering the possibility of overlapping

productive times with the time to train new manufacturing tasks, a better examination of the possibility of optimization solutions and the possibility of optimizing robot's functioning programs without the pressure of time [6].

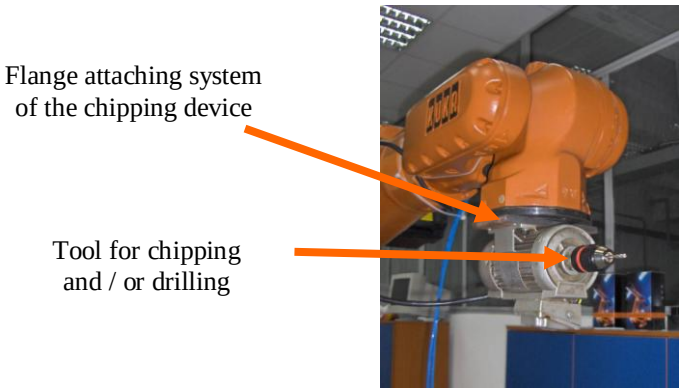


Fig. 5 – *Kuka KR 125 robot. Tool's attaching system*

Table 1

	MT- CNC Victor 55	Kuka KR125 robot	MU advantage	Robot advantage
Rated power input	25 KVA/400V	7,3 KVA/400V		√
Acquisition price	Approximately 80.000 euro	Approximately 75.000 euro	√	
Controlled axes	3	6		√
Occupied ground space	7,20 m^2	2,57 m^2 + 0,48 m^2 = 3,05 m^2		√
Volume of work	0,11 m^3	39 m^3		√
Soft	Fanuc	Kuka	√	√
The speed of changing tools	2,5 s	It isn't delivered to the laboratory It is estimated as more than CNC	√	
Tool travel reputability	0,012….0,02	± 0,2 mm	√	
Maintenance	More companies in Romania can provide maintenance.	The number of companies that provide maintenance is very small	√	

A flexible virtual cell was created (of the Robotics laboratory) where the specific parameters and the robot's position on the table were taken into consideration but also the position of the table on which the material for processing is found, i.e. an external system of coordinates to which the robot will be scheduled, figure 6.

By defining a tool one understands changing the position of TCP (tool center point). This point (figure 7, point A) is in the center of the flange which is caught on the 6^{th} axis of the robot, but in this case TCP should be changed and brought to the top of the terminal body, which in this application is given top of milling tool.

If the robot is programmed with the milling piece caught up in the device

without defining the tools coordinates, can be a fatal mistake, because the robot will slide half a tool down and thus can do damage the tool, machine parts and robot

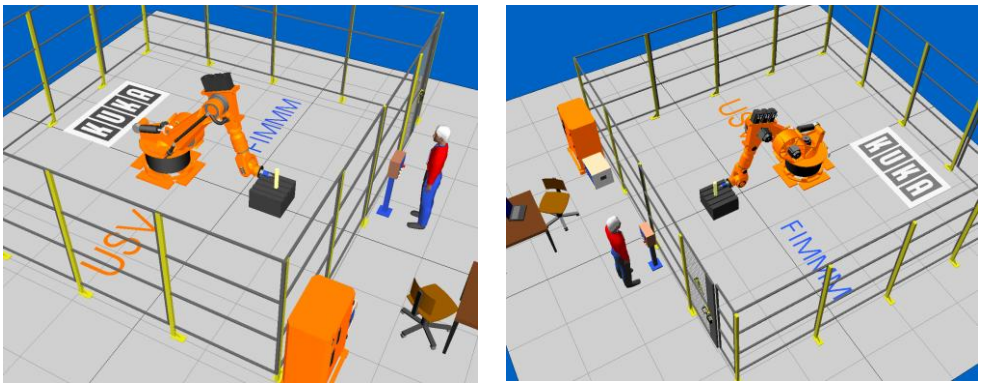


Fig. 6 – *Virtual milling application with Kuka Kr125 robot help develop with specialized software Kuka SimPro*

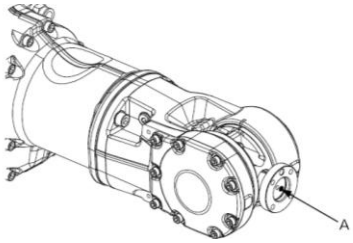


Fig. 7 - *TCP position before defining the position of tool.*

because the tool will hit the processing part. For a correct definition of the tool its weight should also be calculated because its accuracy depends on the weight of the robot handled. The robot will automatically calculate the point where the TCP is after mounting the new tool and registering its weight. Then, after making the virtual flexible cell, the 3D part was imported in imported 3D in *dxf* format taking into account the guidance system and fixing the caching device.

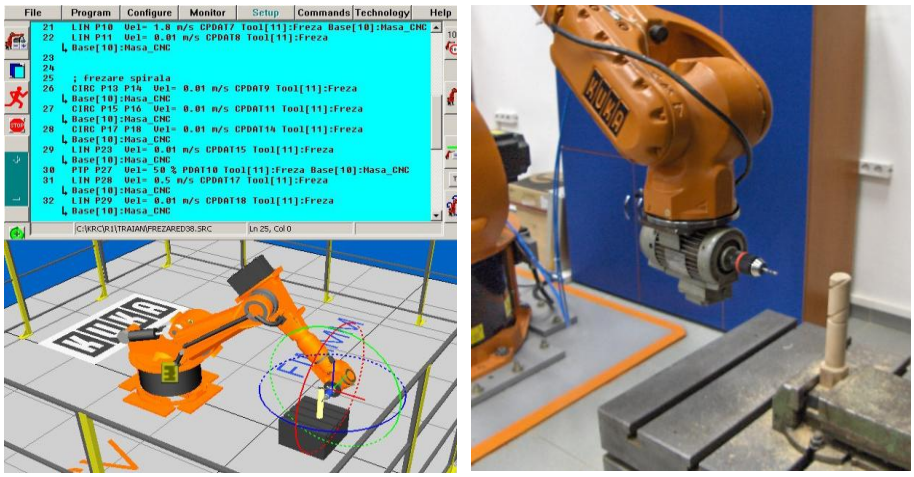
The milling processing using the Kuka Kr125 robot created with software KukaSimPro looks like in figure 8.

The elements presented lead to the idea of processing parts using the robot is accessible. Some companies already use the manufacturing process. A brief analysis of specific parameters MUCN Victor55 and Kuka125 robot, both belonging to the robotics laboratory, allows the emphasis of the benefits and disadvantages of each device, table 1. The main advantages of the machine are strictness, precision, repeatability and speed in changing tools. The main advantages of the robot are a greater number of controlled axes, the volume of work and flexibility. Another important advantage would be that the robot can adapt its equipment to other works in the undertaking, some very different than those for which it was originally purchased.

Conclusions.

1. The application that was developed by the robotics laboratory team means the opening of a research by the machine building industry. Through this application one tried to demonstrate, along with other researchers, that robots may, in some cases, replace the machines processing tools (even those equipped with CNC), rated as very expensive and with limited possibilities of flexibility (the mobility of robots in the detriment of MU rigidity).

2. Obviously, the uses of robots in processing applications are limited to low hardness materials.



a *b*

Fig. 8 – *Helicoidally channel milling program on cylindrical piece with KUKA KR125 robot help;*
a – *virtual simulated application* b – *milling application with robot* .

The development of devices with high-speed processing (HSM) attachable to robots, equipped with special tools, would considerably widen the area of applications and processing of high hardness materials can be possible. Our research is not aimed at removing MU manufacturing of CNC. But notices that, under certain circumstances, the robots can be means of processing that can bring some benefits.

3. We expect that successful applications would attract the interest of industrialists in the region and thus university-industry collaboration to be interesting for both partners.

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