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THE SIMULATION OF WELDING OPERATIONS IN ROBOTIZED PRODUCTION SYSTEMS

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Rezumat. *În această lucrare am realizat un studiu privind posibilitățile de programare off-line pentru un robot industrial utilizat în operații de sudură cu arc electric. Studiul a fost realizat în vederea optimizării traiectoriilor de poziționare a cleștelui de sudură în anumite puncte pe o caroserie auto. Pentru simulări s-a utilizat DELMIA V5.*

Abstract. *In this paper it was made a study concerning the possibilities of off-line programming for an industrial robot used in arc welding operations. We tried to optimize the trajectory of an articulated arm robots for positing the welding device in the specific point on the body car parts using DELMIA V5*.

Keywords: Industrial Robots, offline programming, welding points, DELMIA

1. Introduction

The social and technical needs of the industrial robots are liberating human beings from so-called 3K work (Kitui=hard, Kitanai=dirty, and Kiken=dangerous work) as workers in the age with a low birth rate and many elderly people, improving the work efficiency, reducing costs, providing highly reliable work (free from human errors), and cooperation with human workers in cell production.

The utilization of robots in the industries is due to a few factors, among them; firstly, robots are used to increase the productivity levels of production. Quality levels are also known to have increased with the use of industrial robots. This is because the characteristic of a robot is such that once has been taught to perform a certain task it will be able to perform that task at a consistent rate repeatedly.

Robotic applications are also gaining popularity because of its flexibility in the terms of usage as robots can be reprogrammed should there be any changes in the job scope or if the robot has to perform other tasks. In other words, robots can perform a variety of job functions with ease.

Today in the industry is a hard competition to getting out new better and cheaper products. The manufactures have to deal with the increasing demands of the customers. They have to improve continuously the conception methods of the products, to modernize the organization structure in order to create a fluent link, without limits, between studies, conception, preparation, manufacturing, commercialization and working life of the products.

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To become more competitive into a world with diversity of products, witch continuous change, the companies must to modernize, and increase the flexibility of their production systems. The most efficiently tool for a fast adaptation of the production at the strategically and operational options of the company is computer integrated conception.

2. Industrial development using CAD-CAM-CAE software

The main goals to the product development are to obtain a short time of design process and a low price and best performances of the final product. According to these goals, the product can be design using some modules of advanced CAD-CAM-CAE software and the internet on-line 3D catalogs for some parts (more or less standard).

The advantage obtained by using some modules from different CAD-CAM-CAE software is to use the most performant parts of these software (specific to the some engineering fields) at a low price (it isn't necessary all the software, only some specific modules). The internet 3D on-line catalogs offer the advantage to find very easy useful information about mechanical elements (prices, technical characteristics, 3D models, etc,)

Depending each software characteristics there are a lot of pluses and minuses regarding the performances into a specific engineering field. Some of these software's have better performances for some engineering fields as aeronautics, automotives, mechanical etc. Today it not exist single CAD-CAM-CAE software which can cover the entire industrial field to high performances and it isn't possible something like this (that represents a disadvantage). Another major disadvantage of that software's is very high prices for a full version. Usual the prices are starting from several thousands of Eur.

There are 3 advantages for the most CAD-CAM-CAE software's:

1. the software's are structured in modules, even in the same area (for example: in CATIA in mechanical design are: part design; sheet metal design, mold design, wireframe and surfaces design etc)
2. it can be bought only some specific package regarding computer aided design, computer aided manufacturing or computer aided engineering.
3. all these software allow to save date in some commune file format (for example: dxf for 2D drawings, step for 3D solids; iges for 3D surfaces etc). This types of files can be opened by almost all CAD-CAM-CAE software in some specific condition.

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products, to modernize the organization structure in order to create a fluent link, without limits, between studies, design, preparation, manufacturing, commercialization and working life of the products. To become more competitive into a world with diversity of products, with continuous change, the companies must to modernize, and increase the flexibility of their production systems.

The companies find out that the investment amortization using interactive computer integrated conception of a product (to create visual data base for CAD-CAM-CAE and industrial geometry design), is the most efficiently tool for analysis end evaluation.

Creation and simulation on the computer of a products or process allow to make substantially economy regarding the costs of the tests and conception errors and also at the costs for the manufacturing changes asked by beneficiary.

3. Aspects of the industrial robots performances

The working performance of an industrial robot (IR) is largely dependent on effector positioning accuracy, so it is particularly important to set up methods and means of determining this.

Accuracy and repeatability is referred to as the ability of each robot to place its end tip on any targeted point within its work envelope and can be defined in the resolution of space. The accuracy and repeatability performance of a robot can be defined as half the value of the space resolution, which represents the movement of the tools fitted to the robot's arms.

Accuracy and repeatability can also be defined as the ability of a robot to move precisely in a three dimensional plane. The velocity of movement and the payload greatly influences the accuracy and repeatability of a robot.

The trajectory accuracy depends of the robot operation speed, the payload and the dynamical behavior. Dynamic performance relates to how fast a robot is able to accelerate, decelerate when it is moving on the trajectory and stopping at any given point.

4. Welding process using Industrial robots

IR welding means using mechanical and programmable tools (robots), which completely automates a welding process by completing both the welding and the manipulation operations.

Processes like welding in protective gas, although are often automated; they are not necessarily equivalent with robotized welding for a human operator prepares the materials to be welded.

IR welding is most often used for spot welding in high productivity applications, like the auto industry.

The spot welding robot is the most important component of a spot welding installation.

Welding robots are available in different sizes, categorized by the lifting capacity and the action radius. Robots are also classified by their number of axis.

Spot welding with the help of IR is fast, efficient and precise. Spot welding is an economic solution.

Spot welding IR advantages:

- Quality welding
- Repetability
- Cost reduction
- Increased movement flexibility

5. Off line programming of an industrial robot

Simulation is the imitation of a real process, an object or a state. The act of simulating, generally, presumes something that represents certain key characteristics or behaviors of a physical or abstract system

A robot simulator is used for creating applications for a robot, without physically depending on the real machine, saving money and time.

In some cases these applications can be transferred on real robots, without modifications

DELMIA (Digital Enterprise Lean Manufacturing Interactive Application) is a program that helps producers in any industry to define, plan, create, monitor and control all production processes.

With Delmia, one can simulate from assembly processes, to welding with industrial robots and production cells to a complete definition of a plant and its equipments.

The programming of robots in Delmia was done in section of the program called process in which the robots, the car body part and other objects were put in the position that they would be in the actual plant and then the actual programming could begin.

The welding points were established by technological considerations.

The robot has the role of positioning the welding pliers in the interest points without interacting with the elements of the system, to hold the pliers in place for the welding to be performed and disconnect them without pulling the car body.

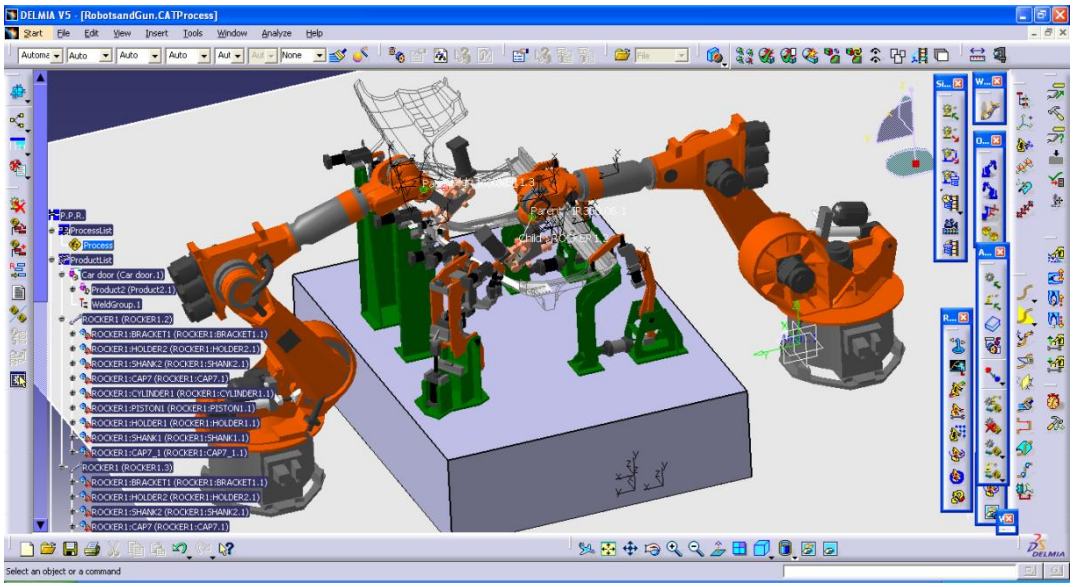

Fig. 1. Industrial robot simulation in Delmia V5.

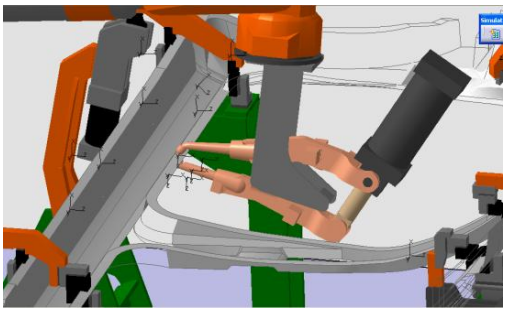

Fig. 2. Pliers in position for welding.

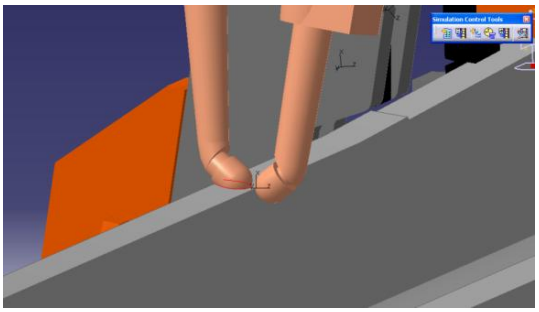

Fig. 3. Clash detection.

In Delmia, there is a tool called clash detection witch highlights the places where unwanted interaction is happening, making it easy to remove these errors.

For a correct positioning in the four welding points, the optimum trajectory was set through nine intermediary points.

The robot used is a KUKA IR360 , with six liberty degrees.

This robot is optimum for this process because it fits the workplace and it has all the technical requirements for the operations. The 3D model of the robot was inserted using the database existent in Delmia V5 and programmed using the teach command.

The models from this database have all the characteristics of real robots (dimensions, command system) given by their manufacturers and the tasks made in the program can be applied to the real robots.

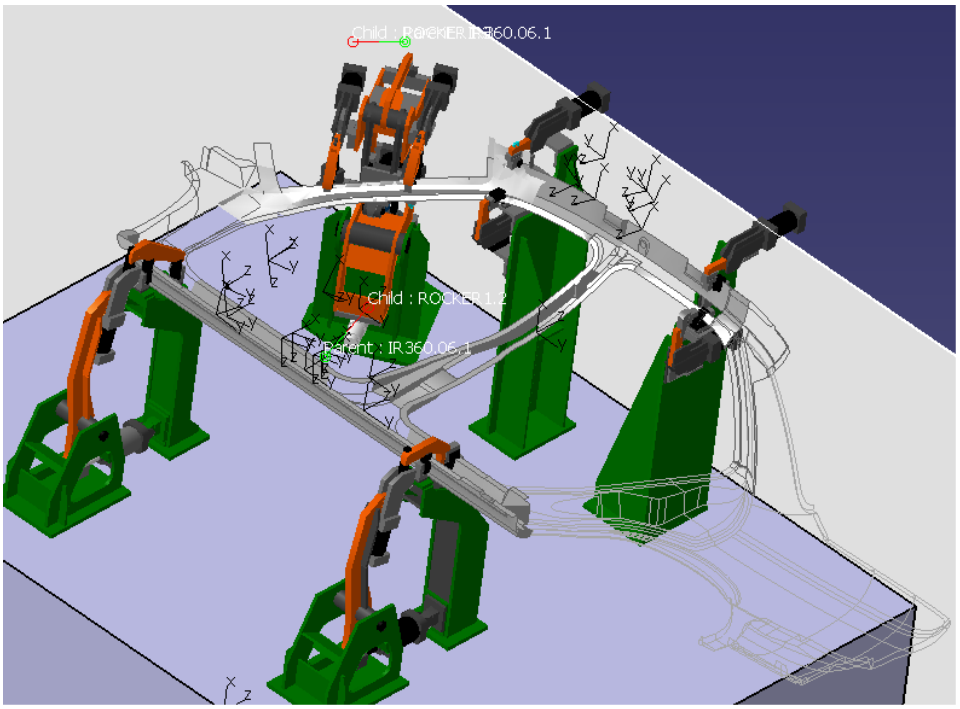

Fig. 4. Car body part with welding and trajectory points.

Fig. 5. KUKA IR 360 industrial robot.

KUKA IR360 specifications: Payload: 240/280/360 kg; Supplementary payload: 50 kg; Maximum reach: 3326/3076/2826mm; Number of axes: 6; Repeatability: < 0,08 mm; Weight: 2385/2370/2350 kg; Mounting position: Floor, ceiling.

Controller: KR C2.

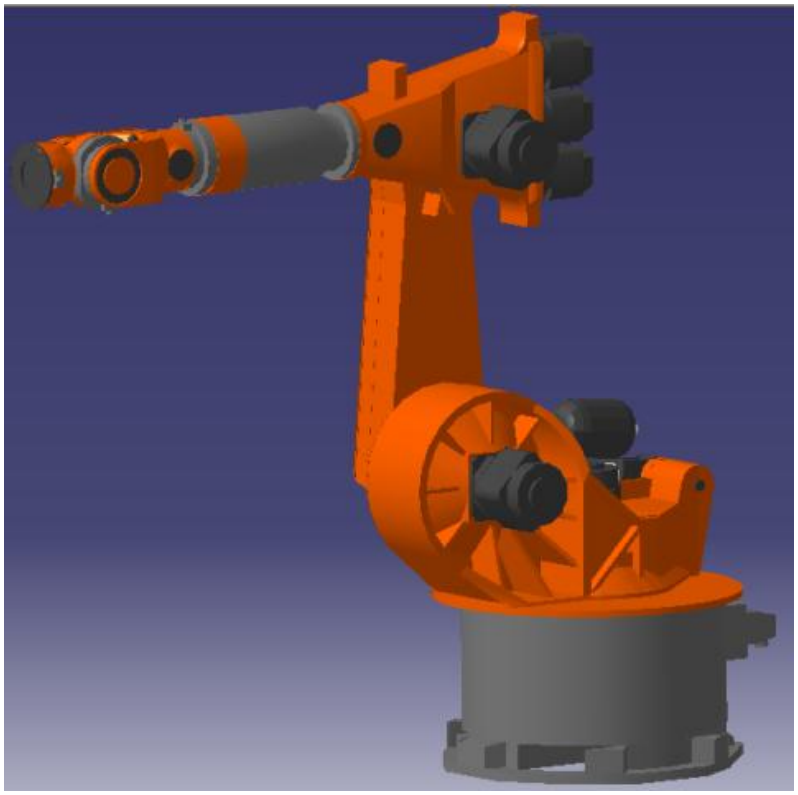

Fig. 6. 3D model in DELMIA V5.

Conclusions

IR welding is a efficient method, therefore it is extensively used in the auto industry

Simulation and application of IR activity with Delmia V5 is a very efficient of programming robots, because it saves a lot of time and it only needs a personal computer for using the program.

For achieve correct results of the programming using off-line methods the entire working environment of the robot must be highly accuracy created in Delmia. Usually the 3D environment is created an after is calibrated with the real one

Abbreviations

IR – Industrial Robot

R E F E R E N C E S

[1] Dassault Systems website: www.3ds.com.

[2] Kuka Robotics website: www.kuka-robotics.com.

[3] J. Norberto Pires *Industrial Robots Programming: Building Applications for the Factories of the Future*, ISBN 0-387-23325-3, Ed. Springer.