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Offline programming of an ABB robot using imported CAD models in the RobotStudio software environment

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Abstract. Current trend in automation area is focused to the innovation in all fields of the technologies and technological devices. Probably industrial robots and manipulators belong to development too. Industrial robots and manipulators belong to progressive elements of automation. Modern concept uses the offline programming as a tools integration of the virtual CAD models into programming environment. Offline programming carries a lot of advantages for example possibility of the programming without real robot system, possibility of the collision state debugging. Implementation of CAD models in virtual environment of Robot studio achieves better workplace station of creating robotic system and also it generates rather trajectories of the robot path in this system.

Introduction

This contribution deals with possibilities use of the robotic simulation mainly oriented to the offline programming. It is used mostly to the automation of the production applications and process. A robotic workstation includes a robot system, containing one or more robotic tools or grippers used for the technological operation or manipulation with semi-products or final products. Industrial robotics and automation represent the best solution in the framework of the productivity and flexibility. Nevertheless, the programming of industrial robotic system for a specific application is still very difficult, time-consuming and expensive. Nowadays, in practical industrial applications, there are two main possibilities of robotic programming methods, which are online programming (including lead-through and walk-through) and offline programming (OLP) [1]. In general, robot programming methods are normally classified to:

- On-line programming methods, where a robot is used to generate the program,
- Off-line programming methods, used where there is no need to access of the robot in order to develop the control program. Well at least, no need until the final test of the program. It is basically consisting of writing a program using a text-based robot programming language like 'Siemens Process Simulate' or 'ABB RobotStudio (Fig. 1) shows the main methods used in the robot programming [5].

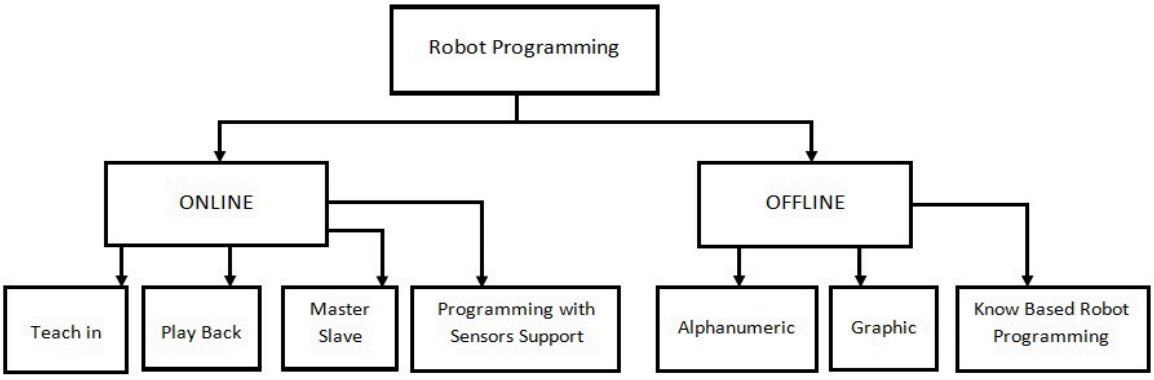

Fig. 1 Main methods of the robot programming

Conventional robot simulation and offline programming of the robotic tools are mainly oriented to the skilled programmers rather than a person without too much skilled background focused to this problematic. In this contribution, it is primary contained the setting up creation of the virtual workplaces for offline programming and simulation by using CAD models imported to the programming environment [2]. Very important in offline programming of the robot system to need to be considered the aspects of modeling a geometrical entity; generating robot targets and paths; adjusting robot targets; planning path configuration; positioning snap objects etc.
High repeatability and flexibility of the robot provide an achievement of high quality and economic coatings aspect. The most important advantage of the robot is its flexible movements; it can achieve a projection on some complex, free-form work pieces. When using the robot, we can expect better reliability and functional properties, and also costs can be reduced.

Creating of Offline programs by the OLP method

OLP methods, which utilize 3D CAD data (Fig. 2) of a work piece to generate and simulate robot programs, are widely used for automation system with large product volumes. Herein the complete robotic work place is modeled in 3D model in Robot Studio. The user can test the reachability, fine-tune properties of robot movements and handle process related information before generating a programs that can be downloaded to the robot controller [2].

OLP programming method has a many advantages against the online method. At first, the programming process does not require the real robot, minimizes the production robot down time. Robot programs can be developed before in the design / production cycle and programming can be carried out in parallel with production rather than in series with it. In second, programs generated offline are more flexible than jog-and-teach method. OLP changes can be incorporated quickly by only substituting the necessary part of the program and previously developed routines can be easily included in new programs. In third, simulation is usually incorporated into the OLP method. As a result, programs can be pre- checked, hereby confirming the robots' movements, minimizing the chance of error and therefore improving productivity and safety. There is also a greater possibility for optimization of the workspace layout and the planning of robot tasks [4].

The main advantage of OLP programming is the use of the possibility of predisposition visualization resources which facilitate subsequent implementation of robotized workstation. The creating of workstation in a virtual environment will allow us to better:

- perceive conceptual design as complex workplace,
- possibility of interactive correction of the position of the workstations,
- integration of CAD models into Robot Studio environment and recognition of particular edges and points which define the exact targets of robot,
- visualization of kinematic motion of the robot, as long as the simulation is based on the use of virtual controller, which is identical to the real character controller,
- simulation of material flow in the workplace,
- whole simulation of the workplace, ensuring the elimination of the collision and adverse influence during assembly or technological operation,
- creation of OLP and the whole workplace can reduce total costs of investment, as long as is possible it can determine the optimal solution in terms of material flow and the overall layout of particular workplaces.

OLP starts from 3D CAD model (Catia, Solid Works etc.) what is primary start of the creation workstation and workpieces. Very important part of modeling of individual workpieces, components and their supporting of peripherals and their proper modeling were used by 3D model software Catia.

In our case, it is necessary to save model as STL format and continue with second step, to convert 3D model as to IGS format by some CAD exchanger. Since Catia doesn´t know directly export this format. Consequently, it is possible to insert modeled parts into Robot Studio, but we must remember to tick all edges and points on the given model.

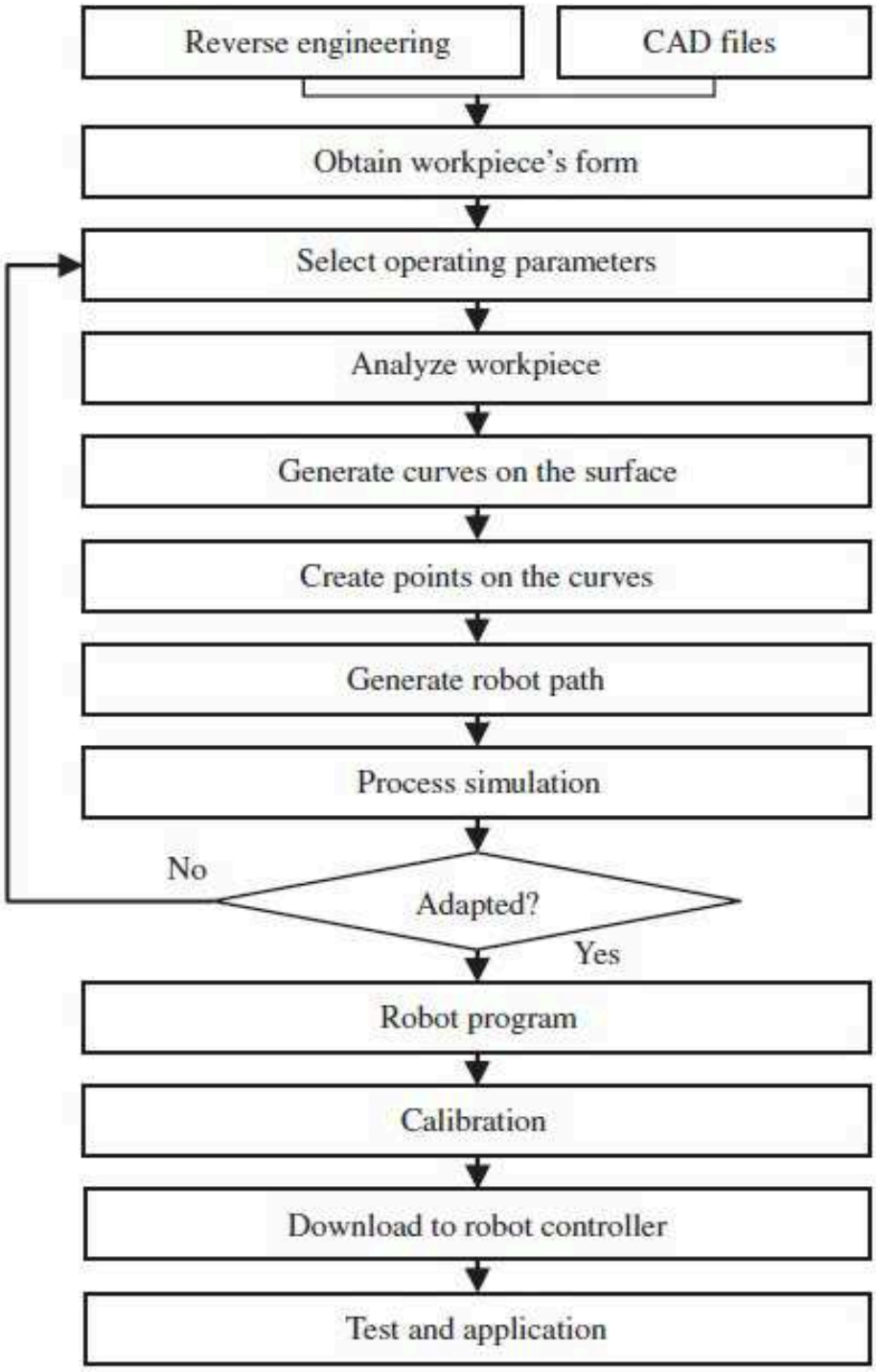

Fig. 2 The process of creating the robot trajectories using OLP method [3]

Interesting steps of the OLP

OLP is more complex than online programming as the programming method has to have 3D robot targets but also has to have trajectory of robot motion and it has to generate optimal sequence of the path process [6]. The key steps of OLP are shown at (Fig. 3).

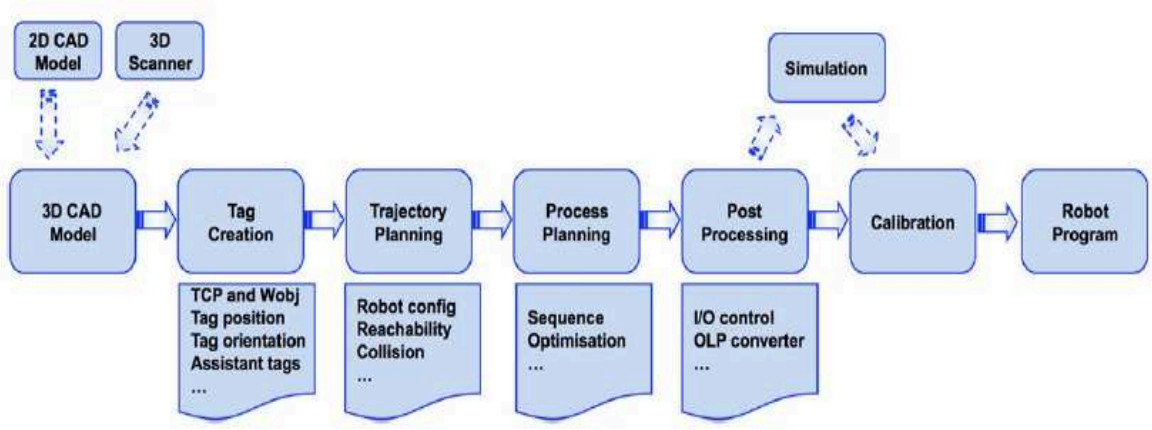

Fig. 3 Interesting key steps of Offline programming [6]

Offline programming of an ABB robot using imported CAD models in the RobotStudio

On the basis of previous analyzes, specific task was determined, which aimed to verify the applicability of the theoretical knowledge of creating the workstation by offline method [8]. At the beginning it was necessary to create a workpiece what have a rugged character, as is shown in (Fig. 4). Workpiece has projections which characters are straight and curved surfaces. It is therefore possible to deduce that when creating individual TARGET, respectively PATH will be generated the motion in a linear but also curve movement. The process of CAD models importing is created in CAD software CATIA as it has been mentioned above [7]. A new workstation (Fig. 5) was created in RobotStudio, where was the suitable type of the robot imported. In the next step, it was selected a work table from the library on which the aid of command "SET POSITION" gives workpiece into a suitable position. On the base of appropriate positions of the workpiece we can create individual targets. Very important issue is to take into account what position of the tool comes to the workpiece (coming to his perpendicular or at an angle). Target orientation should be alignment oriented to the axis of the tool. Correct orientation of the target can be verified by the command "JUMP TO TARGET". If a problem occurs when we applied this command, we must re-orientate target with respect to the tool. The correct orientation of the target allows us to generate a sequence of "PATH". Verification of the motion correctness is carried out using the command "MOVE ALONG PATH". Important is to check the targets before creating offline continuous simulation of the PATH (feasibility of individual "PATH") by the command "CHECK reachability". Setting of the simulation rests in choosing of the movements sequence and their gradual steps (Fig. 4).

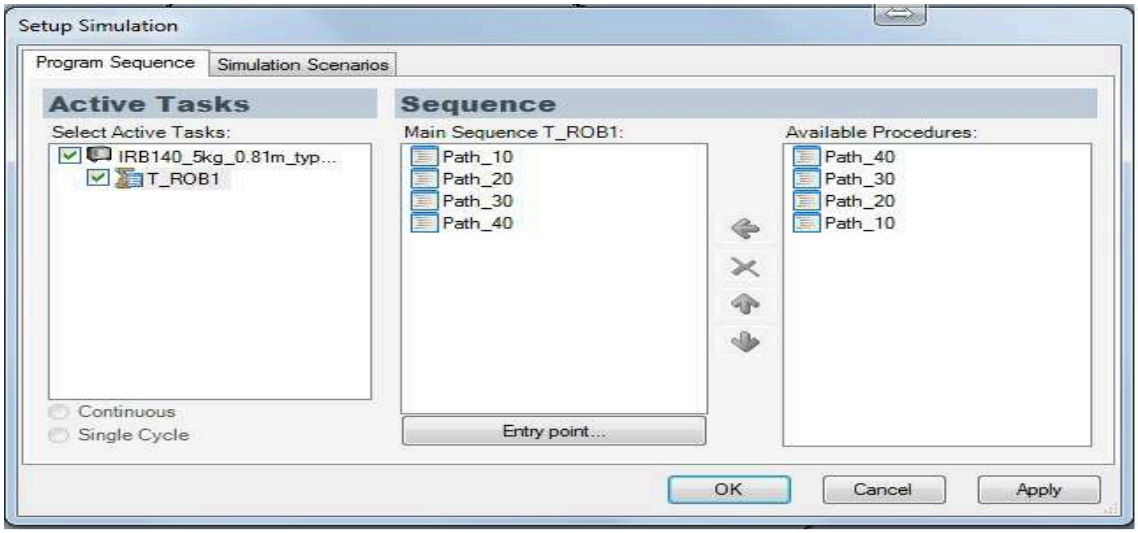

Fig. 4 Setting of the Simulation setup in OLP RobotStudio

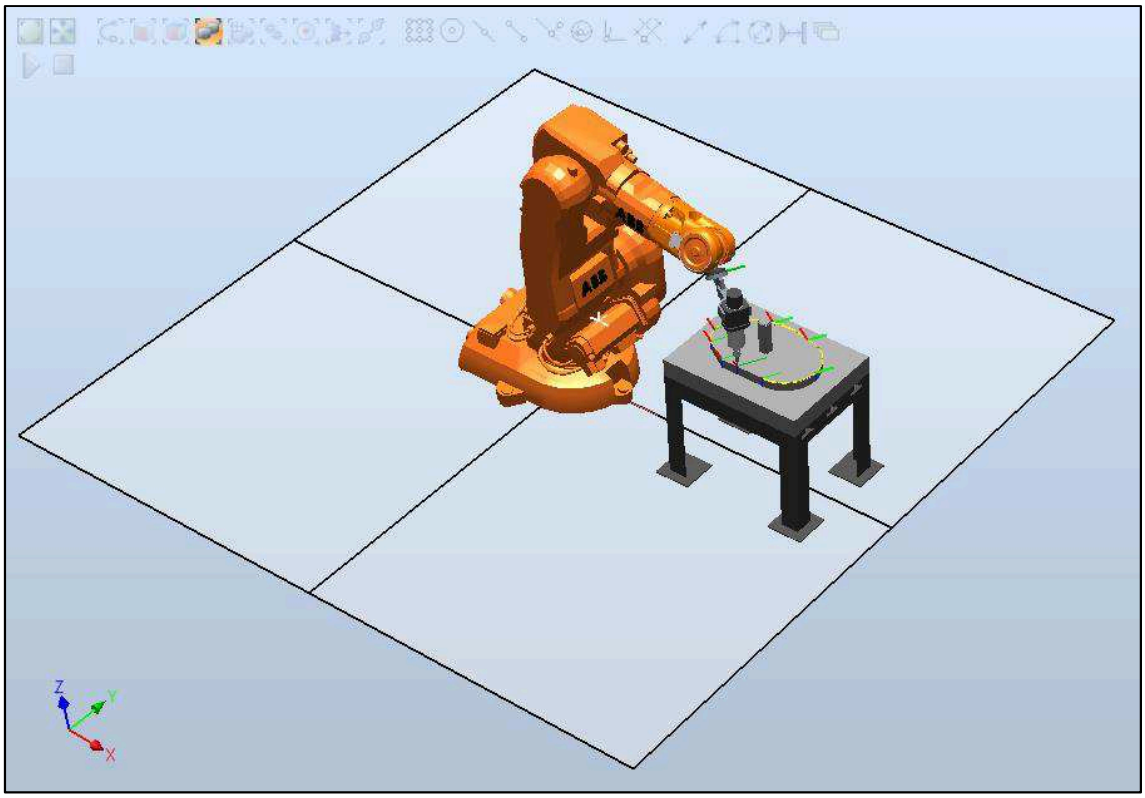

Fig. 5 CAD model imported to the created workstation Robotstudio

The simulation is continuous and the robot goes into all TARGET. Paths can be still adjusted by command "Zone", which tell us how accurate of robot has come to that target. Subsequently, the using of the commands “Offline” is getting to the generated program (Fig. 6), which can subsequently be used as a backup for the control of real robot trajectories, which have been generated using the offline programming.

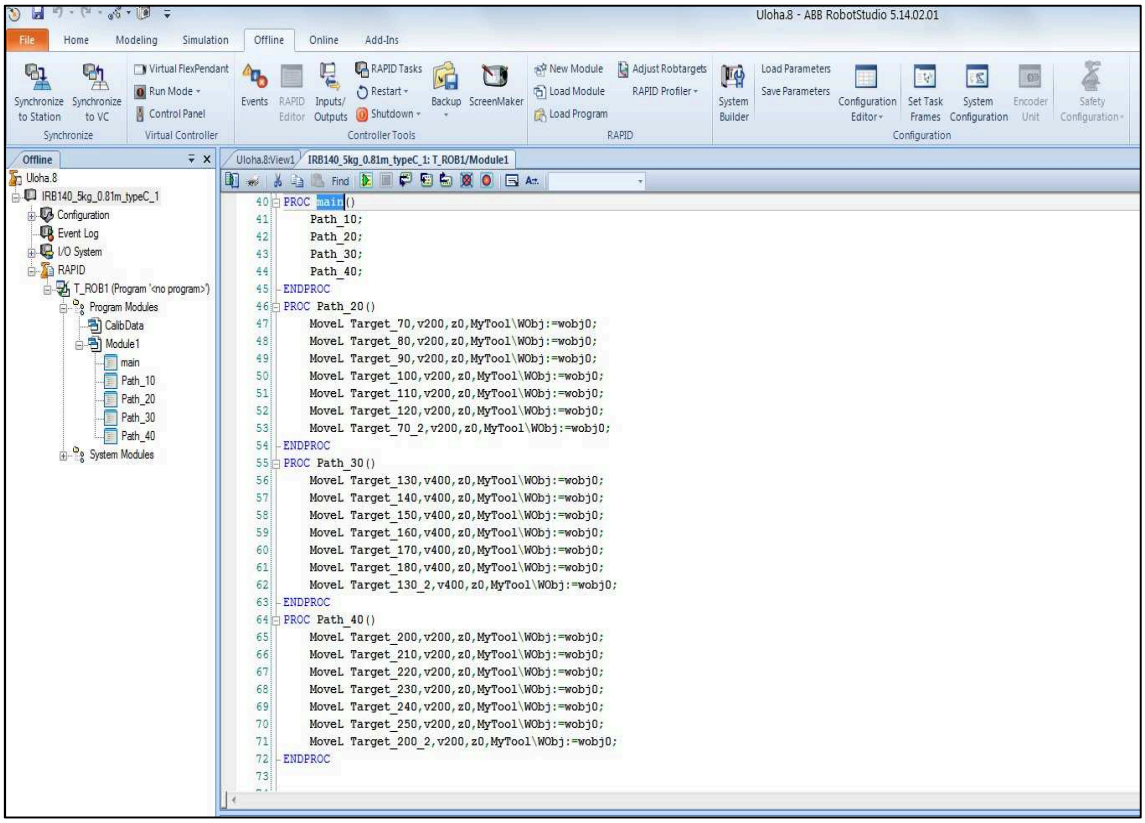

Fig. 6 Program generated from the individual trajectories of the robot

Summary

This contribution is focused on the import of CAD models for the creation of the robotic workstations by using the offline programming. A very important aspect of successful integration and functionality of the CAD model in work environment of RobotStudio is correctly modeled workpiece, in our case it is CATIA. It is necessary to observe principles of engineering drawing in 2D and also 3D solid model creation. Following the successful creation of the 3D model is necessary to follow the procedure to import (insert the CAD model in the correct format), to avoid problems of recognizing edges and surfaces used as CAD models. For this purpose, it serves a variety of supporting CAD programs that can convert between them a wide range of 3D models of various formats. Created programs for ABB robots in RobotStudio are complex series of related sequential steps, which cannot be accelerated. Creating "Targets" and consequently "Paths" are nevertheless the best way to be used in an offline programming method. If the correct procedure is achieved, the functional simulation of future work will be easier in the frame of whole robotic workstation area, CAD models and integrated peripherals, which cooperates with each other. Proper function program created by offline method programming will allow us prior to implementation in the real production better debugging, optimize the overall layout of the workplace, improve work efficiency, eliminate collision states etc. The program, which is ultimately created is more-less usable in the real environment using a minimum of interference.

Acknowledgments

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