Conveyor Simulation of ER Performer MK2 Robot

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***Abstract**--Robot simulation softwares are usually required by designers or engineers to model a robotic work-cell, simulate its operation, and program the robot before operating it in its real situation. One of the most powerful 3D CAD/CAM robot simulation softwares is CATIA, a product name developed by Dassault System. This software is well recognized by several of its positive features in which two of them are wireframe modelling and collision detection.*
The development and operation of ER (Eshed Robotic) Performer MK2 robot modelling and simulation in this research was carried out using wireframe modelling capability of the CATIA software. This software capable to create 3D objects in 3D space mode.

***Keywords**: CAD/CAM, robotic work-cell, collision detection, wireframe modelling.*

A. Introduction

An industrial robot, commonly defined as a re-programmable multi functional manipulator, is designed to move parts, tools, materials, or specific devices through variable programmed motions. A good program and a well designed work cell are required for the installation and ongoing operation of a robot so that the robot capable to reach parts, machines, conveyor in its work-cell without collisions [3]. Designers or engineers usually use robot simulation softwares to model a robotic work-cell, simulate its operation, and program the robot before operating it in its real situation. One of the most sophisticated and widely used robot simulation softwares is CATIA (Computer Aided Three-dimensional Interactive Applications). It is a powerful 3D CAD/CAM (Computer Aided Design/ Computer Aided Manufacturing) system which originally developed by Dassault System, a French Company, and marketed by IBM.

There are several typical features of the CATIA simulation software. Two of them are wireframe modelling and collision detection. Wireframe modelling is one of CATIA capabilities to create 3D objects using lines, points, curves, etc. Its model can be constructed both in 2D space mode as well as 3D. Moreover, it establishes the foundation for production of more advanced surface models such as certain types of solid models.

This research implements wireframe modelling capability of CATIA software to create a model of the Performer MK2 Robot work-cell based on its real system, and to test the robot model with respect to its arm manipulation and motion systems, also to create a robot task for moving an object from a certain location in robot's environment to a conveyor. The conveyor will transport the object to its defined location. The objective of this research is to investigate the wireftrame modelling capability of the CATIA software in constructing a robot model and simulate its operation.

B. Research Method

This research was carried out through an extensive literature study followed by developing a model of the Performer MK2

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Robot work-cell with its conveyor line, simulate its operation, discuss its results, and then drawing conclusion.
Wireframe modelling capability of the CATIA simulation software was exploited to create a model of the Performer MK2 Robot work-cell based on its real system and to test the robot model with respect to its arm manipulation and motion systems, also to produce a robot task for transfering an object from a certain location in robot's environment to a conveyor. The conveyor will bring the object to its determined location.

C. Result and Discussion

Robot Physical Configuration

The ER Performer MK2 Robot is a vertical articulated robot which have a jointed arm configuration [5]. The configuration is similar to the human arm. The arm consists of several straight members connected by joints which are analogous to the human shoulder, elbow and wrist. The robot arm is mounted to a base which can be rotated to provide the robot with the capability to work with in a work space. Figure 1 depicts photo of the real robot at IRIS laboratory.

Basic Robot Motion

Whatever the configuration, the purpose of the robot is to perform a useful task. To accomplish the task, an end-effector, or hand, is attached to the end of the robot's arm. It is this end-effector which adapts the general purpose robot to a particular task [4]. To do the task, the robot arm must be capable of moving the end-effector through a sequence of motions and positions.

Work Volume

The term "Work Volume" refers to the space within which the robot can operate. To be technically precise, the work volume is the spatial region within which the end of the robot's wrist can be manipulated [1]. The work volume is determined by the robot's physical configuration, size, and the limits of its arm and joint manipulations. The work volume of a jointed arm robot will be somewhat, irregular, the outer reaches generally resembling a partial sphere.

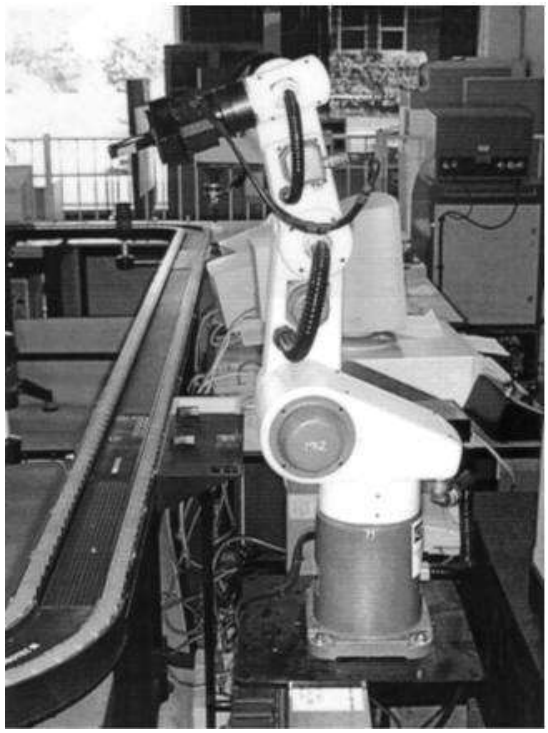

Figure 1. Photo of the real ER Performer MK2 Robot.

Modelling Steps

The steps involved in producing a wireframe model of a robot in its workcell and useful tasks for the robot [2] are as follows:

- Construct wireframe geometry of robot, cell and parts, using POINTS, LINES, and other geometry, and unfixed axes using AXIS;
- Place elements in their respective sets using SETS;
- Create a robot by defining joints, base and flange axes using ROBOT and CONTROLR;
- Move the robot using ROBUSE;

- Create tasks to perform useful operations using TASK;
- Run the tasks in WORKCELL;

Photo of the model constructed using CATIA ER Performer MK2 is displayed in Figure 2.

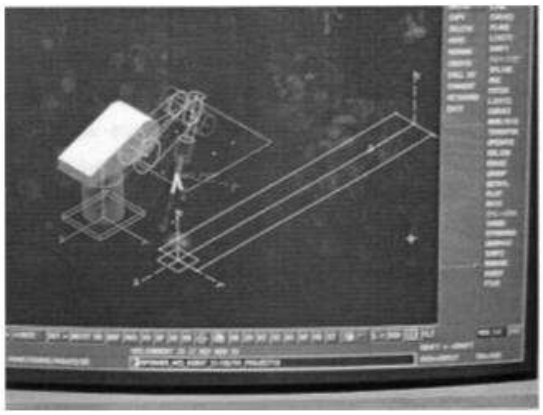

Figure 2. Photo of the Model Constructed using CATIA – ER Performer MK2.

The model was succesfully constructed and its arm motion were tested. A conveyor was also constructed and its motions were tested. Finally tasks were defined to pick the object from a "loading point" and place it on the conveyor. The conveyor transported the object to its pre-defined location. The designed system performed the above task successfully.

This research gave an opportunity to understand the CATIA system and its capabilities. Four tasks were defined. First the robot picks up the object and loads on to the conveyor and the robot arm goes to its home position. Secondly the conveyor transports the object to a pre-defined location. Thirdly the conveyor brings back the object to its original location which is simulation of a scenario where another robot is assumed to exist at the other end of the conveyor. Finally the robot picks the object from conveyor and places on to the work space. The robot arm goes to its home position.

D. Conclusion

A simulation of assembly operation in a manufacturing environment by implementing a model of the Performer MK2 robot work-cell with its conveyor line has successfully implemented. Wireframe modelling capability of the CATIA software shows a good performance in constructing a robot model and its operation.

Assembly operations are seen on an area with big potential for robot application. The term that some companies use for such a system is Adaptable Programmable Assembly System (APAS), and robot-type arm constitute an important component of these systems.

The APAS would be composed of both conventional material handling devices (conveyors, part-feeders, etc.) and robot arm, probably in an in-line arrangement. The robot arm would be used for some parts handling duties, but its main function would be assembly. The features of an industrial robot that make it suitable as a component of an APAS line are its programmability and its adaptability.

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