Model Driven Robot Simulation: RoboCell

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Abstract

Robotics courses are offered in the College of Engineering at University of Louisiana at Lafayette. Subjects such as robot applications, end of arm tooling, safety, and analysis of robot specifications are covered in these courses. These robotics fields have benefited considerably in the last three decades from the advancement of computer science, as advanced software tools were developed to study the working of robots. As robots have begun to proliferate in industry, so have the demands on the level of sophistication of their performance. Careful attention to safety planning has been required because; these industrial tools present many of the same hazards as conventional machine tools. Thus, engineers working in the areas of robotics must have a well-structured understanding of robotic systems. Model driven simulation is a valuable tool for helping in this aspect. RoboCell simulation software is one such model driven simulation program. Simulation is a powerful tool, but robotics research should be conducted on robots. In this paper we provide a brief approach to learning technical aspects of industrial robots through use of an educational robot and RoboCell simulation software. The educational hardware and software together emulate manufacturing environments. These aid engineers to rapidly test and refine new behaviors before running them on the actual robotic system.

Introduction

The robotics field has benefited considerably in the last three decades from the advancement of computer science, as advanced software tools were developed to study the working of robot. Impelled by concerns about productivity, worker shortage, and hostile environments, such diverse organizations as universities, government agencies, and private companies increasingly have been focusing on the research, development and application of robotics[1,2]. With the development of more sophisticated automation concepts, such as computer-integrated manufacturing (CIM), users learned that industrial operations are best automated through the integration of robots with machines into what is often referred to as a “work cell”. In these configurations, the robots, along with machines that they serve, are treated as a “unified system”.

In the last few years, introduction of simple-to-use simulation software has proven to be a valuable tool for the design, programming, and optimization of robot work cells. RoboCell simulation software is one such simulation software[3]. This robot simulation software can be used on all Windows platforms. This paper discusses a brief approach to learning the technical aspects of industrial robots through use of educational robot and RoboCell simulation software. These aid students in understanding the actual functioning of an industrial robot. The next section deals with the relevance of robot simulation in technical education and the motivating factors leading to integration of educational robot and simulation software. Then, we discuss the RoboCell simulation software, highlighting simulation procedure. We conclude the paper by presenting the key advantages of simulation in general, and RoboCell in particular.

Robotic Simulation In Technical Education

Engineers working in the area of robotics must have a well-structured understanding of what exactly a robot is[1,2,4]. Model driven simulation is a valuable tool for helping engineers in this aspect. Most courses in robotics use the educational robots and simulation software. This is a multi-segmented curriculum-driven program designed to provide students with a broad base of competencies in modern manufacturing technology. Its educational hardware and software are based on actual industrial components and together emulate manufacturing environments. This incorporates hands-on lab experience with simulation, creative design projects, problem solving and more. Students undergoing this program will learn the technical skills needed for competent use of industrial equipment and manufacturing technology.

Need For Simulation

Each industrial organization has different areas of interest that may or may not lead to simulation being the correct economic decision. Some industries need simulation to program robotic cells off-line while the line is still running.

During the off-line programming process, you can test for common trouble spots such as reach problems, collisions, joint limits, and cycle time. Once you are satisfied with the mechanics of your simulation, you instruct the simulation software to run the program. Other industries require simulation to test various scenarios, which may arise when setting up a production line. With simulation packages, these scenarios may be simply tested by moving the object in question on a computer screen and retrying the simulation. The two key motivation factors identified for simulation are:

Safety Issues

Today, we seem to be at the threshold of implementing robots with many of the characteristics long treated in a speculative fashion by science fiction writers and futurists. The initial arena has been manufacturing situations rather than simple tasks like material handling, spot welding, and spray-painting. Careful attention to safety planning has been required because these industrial tools present many of the same hazards as the conventional machine tools[1,2]. The robot programs can be tested and debugged on the simulated model before being executed on the actual robot itself. The wisdom of this lies in the fact that possible damage to the robot or to objects in the robot environment can be averted in the event of any mishap arising from undetected bugs in the programs. The verification of robot trajectories and the possibilities of early object collision detection within simulation systems provide a higher security and prevent serious damages.

Economic

The practice of off-line Robot Programming and Simulation also makes great economic sense when applied to automating factories. A fundamental advantage in industrial applications is the usage of simulation systems for off-line program development; due to this, it is not necessary to interrupt the work of the real world robots that are usually integrated in a complex production line[5,6]. This saves money, because the factory production needs not to be hindered.

The Off-Line Graphical Robot Simulator- RoboCell

RoboCell is a robotic control software package, which has been designed by Eshed Robotics[3] for use with the SCORBOT-ER 4pc. Its menu-driven structure and off-line capabilities facilitate robotic programming and operation. RoboCell supports the simulation of entire workcells. This means that not only robot motion, but also the interaction of the robot with the environment (e.g. gripper and other paraphernalia) is realistically simulated. All electrical connections between real work cell components can be mapped to I/O-connections of the simulated components for a comprehensive simulation. The RoboCell simulation software along with the educational robot forms a model driven simulation system with 3D visualization. The software program handles simulation and visualizing of the models.

The robot is the most generic machine known and that is why the most generic object in RoboCell system is a generic robot model. The generic robot consists of three main components that are illustrated in the figure below: a manipulator, a controller, and a program (task) interpreter. Any object that can be described using one or more of these components can be simulated in RoboCell.

The other system paraphernalias like conveyors; tables, parts feeders, etc. are realistically simulated without any further programming. Even commonly used sensors like optical sensors, are entirely simulated within RoboCell. It also provides a 3-D Graphical Display and User Interface to allow users to observe and interact effectively with the RoboCell simulation. Meanwhile, the whole program can be saved, stopped, repeated and reset easily. Figure 1 shows a typical setup of an educational robot.

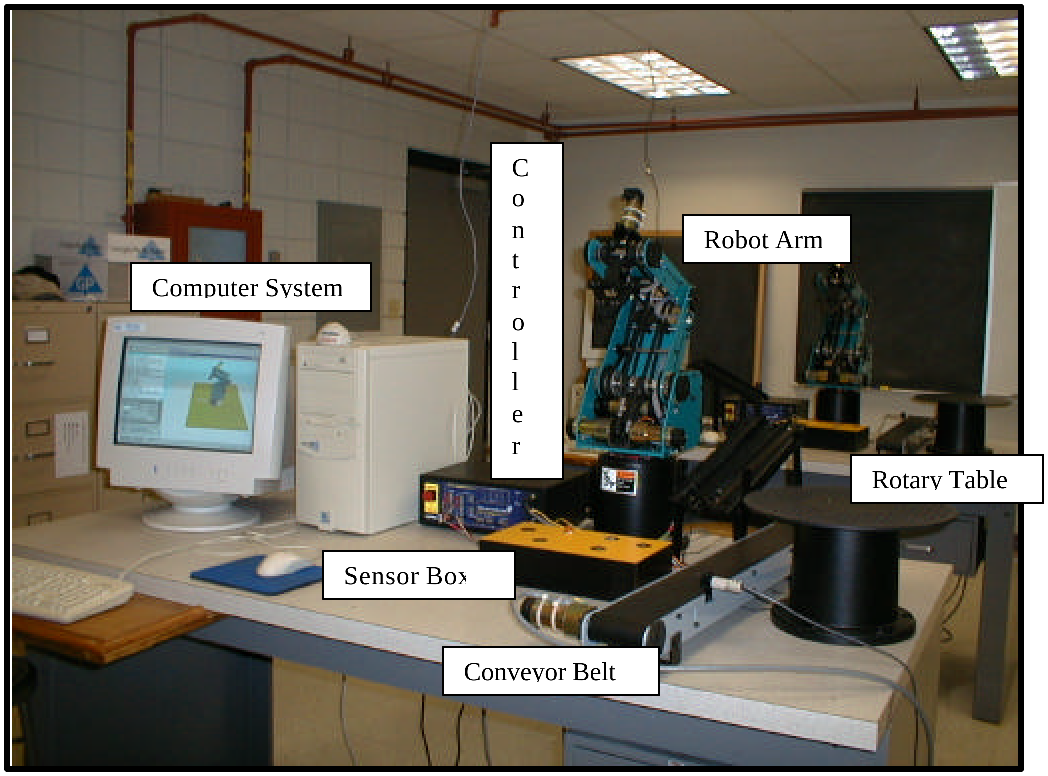

Figure 1: A typical educational robot system setup.

This system has the following capabilities:

Graphical Display Capability: The system will be able to show the result of the execution of command sequences graphically. Each instruction will be transformed into actions visible on the graphic display.

Command Sequence Editing Capability: The system presents a user-friendly interface for the input, editing and deletion of certain commands.

Different Run Modes: For example, the user can choose to run the program continuously; single cycle, or one can command the graphical robot simulator to present one frame at a time.

Collision Detect Capability: The system is able to warn the user whenever a collision is detected using the collision detection mechanism of the simulator.

Simulation Using RoboCell

Cell Simulation

In designing and maintaining an integrated manufacturing system the need for tools to project, plan and operate the system arises[6]. The simulation tool RoboCell supports this need. During projection and planning a virtual manufacturing system is developed in RoboCell. Then the program experiments and analyses can be performed without the need for costly equipment.

Experiments made in RoboCell can assist in decisions regarding whether investments should be carried out or not. In production operation the virtual production system can be calibrated and used for maintenance, supervision, data collecting and controlling. Cell simulation integrates the SCORBASE robotic software with a graphic display module, which allows you to teach robot positions and execute robot programs in a virtual robotic cell. The four main screens displayed when RoboCell software is opened are graphic display, teach positions, edit program window, and manual movement.

Figure 2 shows the default simulation and the run screen layout.

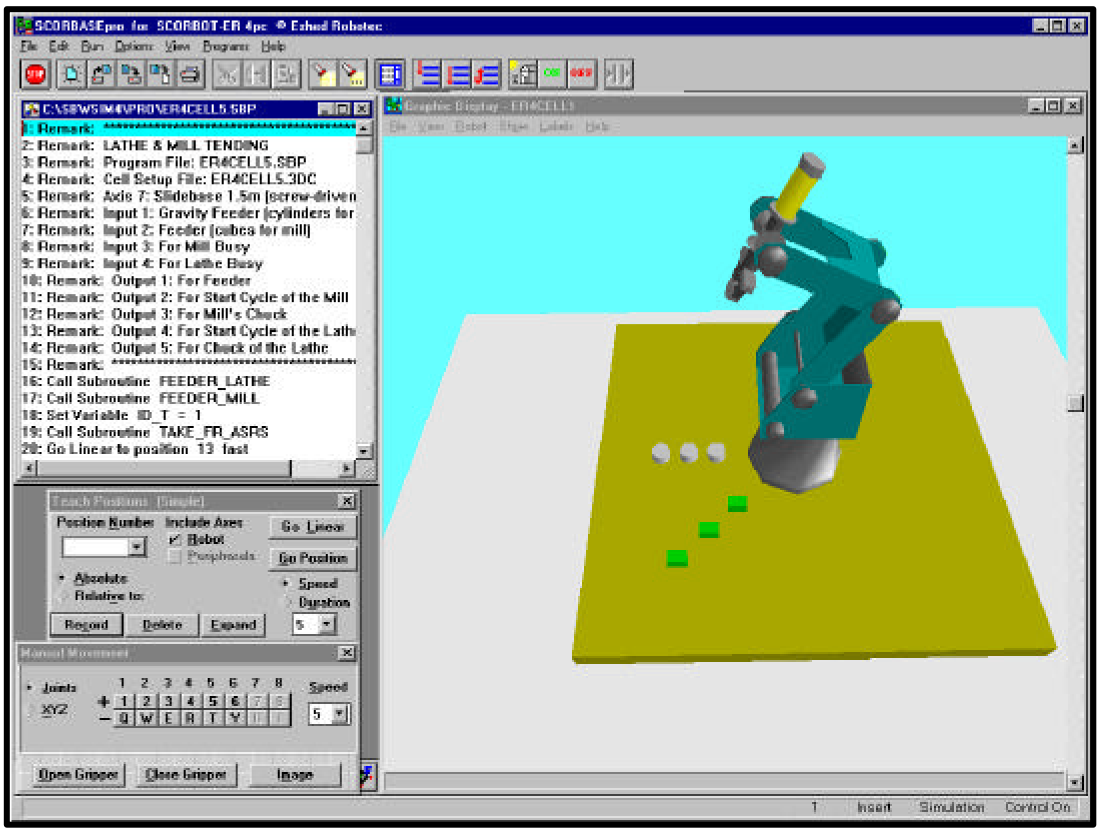

Figure 2: The Graphical User Interface of RoboCell.

Simulation Procedure

The simulation procedure is carried out in three easy steps as shown below:

Recording positions:

The various positions where the robot will move is recorded using teach position function available with the simulation software.

Programming:

The program you will create contains many similar segments. RoboCell uses an interpretive language. The commands are in built in the software. Users have to just copy these commands in the edit screen window. Depending on the applications, users can set the parameters through these commands. Below is a snapshot of a sample simulation program.

Open Gripper
Go to Position 1 fast
Go to Position 2 speed 5
Close Gripper
……..
Remark: START A

Note: For complete details about the programming, refer to RoboCell- Cell Simulation manual by Eshed Robotec[3].

Once the simulation creates the robot program, it can be downloaded to the robot.

Running the program:

Once the complete program is written, you can run the program using the RUN option of the RoboCell menu. As mentioned before, there are three RUN modes. User can use any of these.

Conclusion

The simulation of robots and robot work cells is one of the main aspects in robotics research. Whatever the application in robotics, it is essential to ensure that the investment, training, and operation in any factory automation project is both thoroughly researched and accurately implemented. Careful attention to safety planning has been required because; these industrial tools present many of the same hazards as the conventional machine tools. Off-line Graphical Robot Programming and Simulation has made the development of robot programs as well as the simulation of robot models possible. Introduction of simple simulation tools like RoboCell has enabled students to develop their technical understanding about the working of a robot under various applications. Simulation tools provide an efficient interactive graphical environment in which students can experiment and learn the way industrial robots are programmed for a particular application. The hands on activities enable students to develop and reinforce both technical, occupational skills and the general skills, which are required by all people, in any job or educational environment. Tasks enhance problem solving and decision making skills. Acquiring these skills will prepare students to successfully meet the social, economic and technological challenges of the 21st century.

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