Modelling of industrial robot in LabView Robotics

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Abstract. Currently can find many models of industrial systems including robots. These models differ from each other not only by the accuracy representation parameters, but also the representation range. For example, CAD models describe the geometry of the robot and some even designate a mass parameters as mass, center of gravity, moment of inertia, etc. These models are used in the design of robotic lines and sockets. Also systems for off-line programming use these models and many of them can be exported to CAD. It is important to note that models for off-line programming describe not only the geometry but contain the information necessary to create a program for the robot. Exports from CAD to off-line programming system requires additional information. These models are used for static determination of reachability points, and testing collision. It's enough to generate a program for the robot, and even check the interaction of elements of the production line, or robotic cell. Mathematical models allow robots to study the properties of kinematic and dynamic of robot movement. In these models the geometry is not so important, so are used only selected parameters such as the length of the robot arm, the center of gravity, moment of inertia. These parameters are introduced into the equations of motion of the robot and motion parameters are determined.

1. Introduction
In this article we will show the combination of these two types of models [12, 13]. The model will be modelled both the geometry of the robot, and the robot kinematics and dynamics. Such models show better movement of the robot but they are more complex and therefore require more parameters. Construction of appropriate models and the selection of parameters is complex and difficult to obtain so this model will be further developed.

In some offline programs [8] it is possible to replace the default controller by a special one for the robot. In such cases, the robot behaves in a manner similar to the actual robot, but the functionality of such programs is limited to tracking robot trajectory and collision testing.

Such a controller cannot be modified or used in other development system, but its use reduces the time and better to check the possibility of a collision. The savings associated with buying the right controller is a better use of the robot and fewer problems on initial startup.

So there is a need to build a model that allows not only to visualize or simulate machine operation, but also to study the influence of the control system on machine operation.

The presented method is not intended for modelling only robots, it can be used for modelling any machine including control system even whole systems [5, 15].
2. Import CAD model to Labview
The first step is to import the CAD model into LabView Robotics (figure 1). It is very difficult at first to require exporting the model to the appropriate file format. Unfortunately, the number of file formats is limited and does not include all CAD formats. This is discussed in more detail in [1, 2].

![Figure 1. LabView window to import CAD element.](image1)

It is very important to introduce the constraints and check the mass and geometric and material [16, 17] parameters of each element of the robot (figures 2 and 3).

![Figure 2. Constraints of the robot.](image2)

![Figure 3. Mass and geometric parameters of the robot.](image3)
3. Labview Robotics project

Figure 4 shows the window with the tree project. There are 3 files in the main part of the tree:
1. *.txt - with names of parts of the robot,
2. *.vi - main program,
3. *.xml - project information.

Such a project is ready to run (figure 5) but the robot does not make any moves. Now it is necessary to build a controller.

The txt file (figure 6) contains information about the part names of the imported model. These names will allow you to refer to the relevant element.

LabView [3, 4] standard components can be used to build the control system, but the large Robotics library figure 7 contains many components dedicated to the construction of mobile robots and robotic arms.
4. Model of robot control system
It is very difficult to find detailed information about controlling each robot's arms. The use of a robot or kinematics or dynamics is described in the literature. Industrial robots use servo drives that are used in drive systems of other numerically controlled machines. That is why the servo drive, from the Labview Robotics library (figure 8), was used as the first test.

![Figure 8. Control system with servo.](image)

Such a control program makes it possible to control individual robot arms. Setting the angular positions of all the arms causes the robot to change position, but the dynamics of movement is different from the robot.

![Figure 9. Visualisation and control panel.](image)

The robot position results from Labview Robotics were compared to robot positions and similar results were obtained. This means that the virtual robot and the real robot for the same joint settings have the same positions and touch the same point, (figure 9).
In this solution the problem is the servo model used, the parameters of this element (its
construction and characteristics [6, 7] cannot be changed. This is particularly evident in figure 10.

![Figure 10. First joint angular position.](image)

Using a motor and encoder model to build your own servo drive is a good solution. Possible
construction of a model of any complicated control but the problem is the proper choice.
The PID controller is the first to be tested. The encoder value was used as the input signal, and the
output signal of the regulator was connected to the motor speed setting.

![Figure 11. Motor control system with PID controller.](image)

Figure 11 shows a program section with an encoder, a PID controller and a motor. Changing
the settings of the controller makes it possible to obtain different servo drive characteristics.

![Figure 12. System with P controller response.](image)
The settings of the P and PID (figure 12, 13) regulators are exemplary and have not been selected by any means, hence the adjustment time is long.

Better selection of parameters is a complex process because the robot is a complex system, will be presented in next articles.

5. Conclusion

Comprehensive analysis and simulation of electrochemical systems with control and mechatronic systems is available in more and more programs.

Unfortunately, CAD programs that have added mechatronics modules have poor controllability functionality, and for modelling programs for control systems it is very inconvenient to insert a 3D model. In Labview Robotics, it is very inconvenient to insert a CAD model, but the layout of the control system is easy.

It would be nice if the program had the ability to model 3D mechanics as in CAD programs and control systems like Labview.

Thanks to the possibility of connecting measurement control devices, network modules, etc. to a computer with Labview, it is possible to better analyse and simulate mechatronic systems.

6. References

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