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To cite this article: K Lysek *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **591** 012055

IOP Conf. Series: Materials Science and Engineering **591** (2019) 012055 doi:10.1088/1757-899X/591/1/012055

The use of the NX mechatronic module to simulate of a simple machine work

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Abstract. Mechatronic is combination of three main disciplines like mechanic, electronic and theory of control. CAD/CAM systems is part of them. The aim of this article is to describe how to use CAD system (NX Siemens) with mechatronic module to designee simulation process. That module allows to resolve problems from mechanical, electrical and automation discipline. As an example author creates simple machine using this module. That aim was established in that form has been obtained. The created simulation is working and allowing to resolve mechanical robot's problems. The simulation was based on kinematics parameters of robot. The article is the introduction to further work on the use of the Mechatronics module to perform the most real simulation of the Fanuc ARC Mate 100iB industrial robot.

1. CAD/CAE/CAM

CAD (Computer Aided Designed) program is software which can be used to model some objects. Examples of popular CAD modeling programs are NX, Solid Edge and Inventors. These types of programs have to have geometric parameters. Example of a CAD model is shown in figure 1 [1-5].

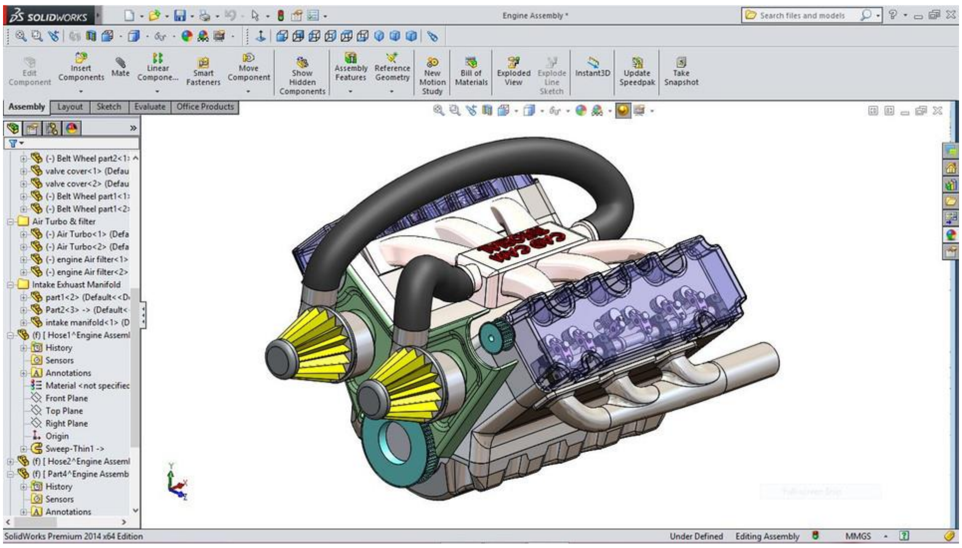

Figure 1. The example of CAD model [5].

CAE (Computer Aided Engineering) program is software that can be used to solve an engineering problem. The most popular programs of this type use the FEM (finite element method) for that. These types of programs have to have material parameters to solve the problem. In the case of the most popular method, accuracy depends on the density and quality of the grid (including the type of finite elements used). There are programs created specifically for computational purposes like Ansys, Abaqus or Patran/Nastran, but programs such as NX also in most cases can solve the problem with acceptable results. Example of a CEA model is shown in figure 2 [6].

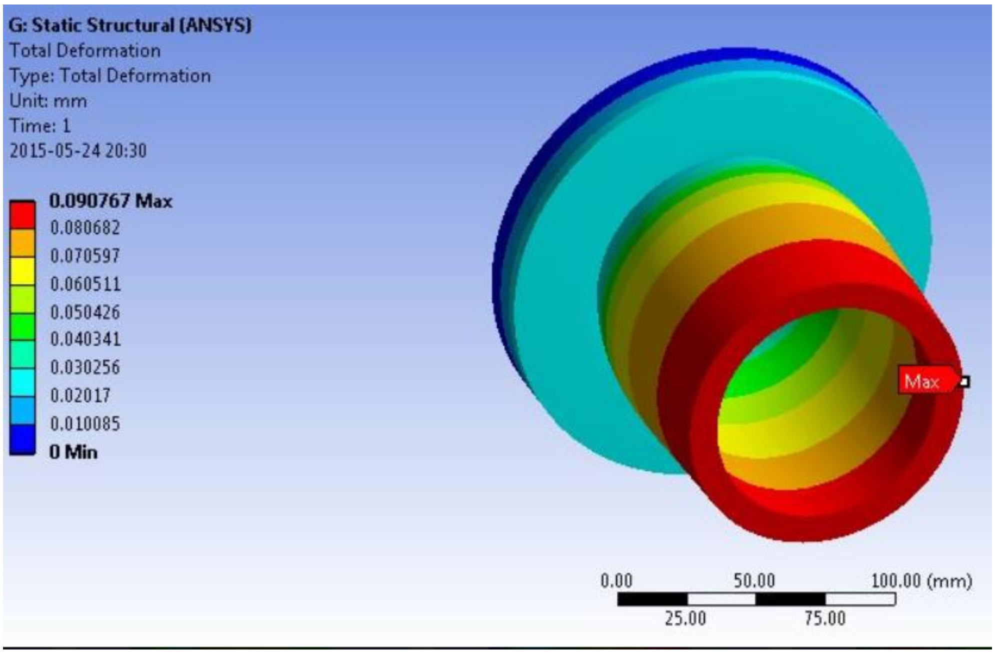

Figure 2. The example of CAE to deformation.

CAM (Computer Aided Manufacturing) program is software that can be used to simulate the real work of the machine in its working environment. These types of programs have to have kinematics parameters of machine. Example of a CAM model is shown in figure 3 [1-4, 6].

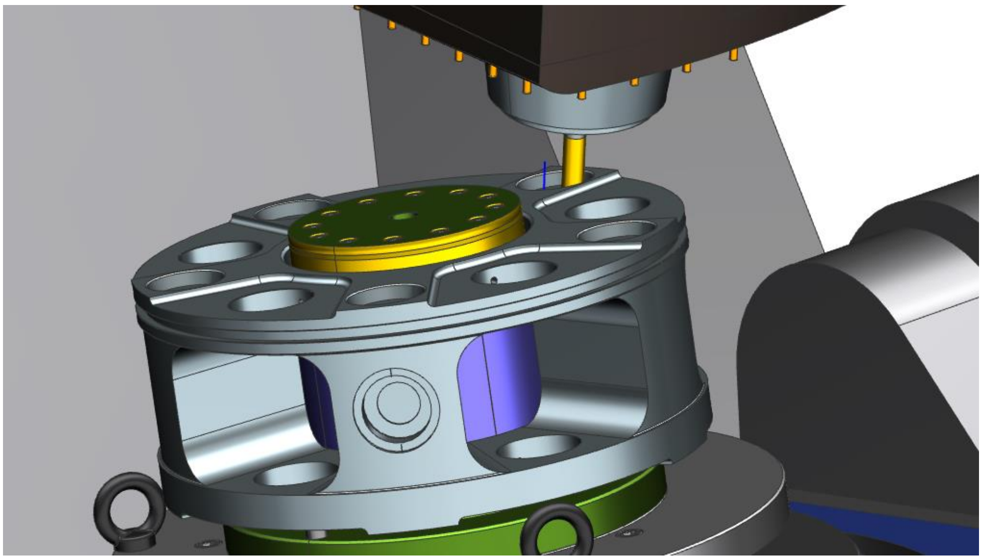

Figure 3. The example of CAM operation [6].

2. Fanuc ARC Mate 100iB

The device used for simulation is the model of the industrial robot FANUC ARC MATE 100iB. It is a six-axis robot with a modular design driven. In which modules are driven by a servo drive. It weighs 135 kilos, and its load capacity allows transporting elements weighing 6 kg with an accuracy of 0.08 mm. This robot type is mainly used for MIG, MAG, TIG welding and cutting. The robot is shown in the figure 4.

Figure 4. Real robot FANUC ARC MATE 100iB in the University.

3. NX's Mechatronics module

In order to use the mechatronics module for a simple simulation, it was necessary first to read the Mechanical and Electrical tabs. The first of the tabs contains object properties such as a body:

- Rigid body – defines a rigid body for physics body for simulation. Each element that does not have additional functions is defined as rigid;
- Object source – creates an object source which copies physics objects during simulation;
- Object sink – creates an object sink which deletes copies of physics objects during simulation;
- Object transformer – creates an object transformer which transforms one rigid body to another during simulation;

The joint was also used from the described bookmark. Examples of these are:

- Hidge joint – connects objects along an axis of rotation;
- Sliding joint – connects objects along a fixed linear axis;
- Cylindrical joint – connects objects along a rotatable linear axis;
- Screw joint – connects objects along a rotatable linear axis with movement and rotate at fixed ratio like a screw;
- Planar joint – connects objects with slide and rotate relative to each other (while remaining in planar contact);
- Fixed joint – connect object with global coordinate system (the object has zero degrees of freedom);
- Ball joint – connect object at as shared point.

IOP Conf. Series: Materials Science and Engineering **591** (2019) 012055 doi:10.1088/1757-899X/591/1/012055

The basics elements used in the Electric tab are Actuators. Examples of this group are:

- Position control – moves object along the axis to the given positions;
- Speed control – moves object along the axis with set speed;
- Force torque control – set a force or torque to an axis joint.

4. Simulation in the NX's Mechatronics module

The Siemens NX program is a multi-tasking tool helpful in solving many engineering tasks. One of the simplest applications of the program is using the Mechatronics module to create a simulations of work with 3D model.

The simulation was created using the industrial robot model Fanuc ARC Mate 100iB and appropriate connections between the moving axes. All objects used in the simulation included in the robot's composition were declared as Rigit Body with designated mass and mass moments of inertia, the exaple is showin figure 5.

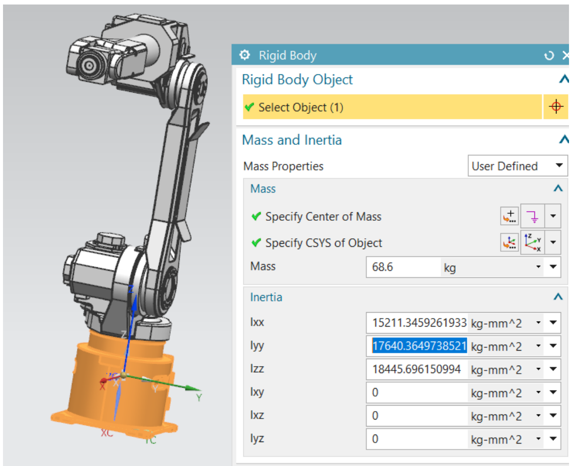

Figure 5. Robot basis as Rigid body.

The individual elements have been connected with appropriate nodes to the base, which made it possible to make the movement correctly (relative to the given base). The example of jointing of elements is shown in the figure 6.

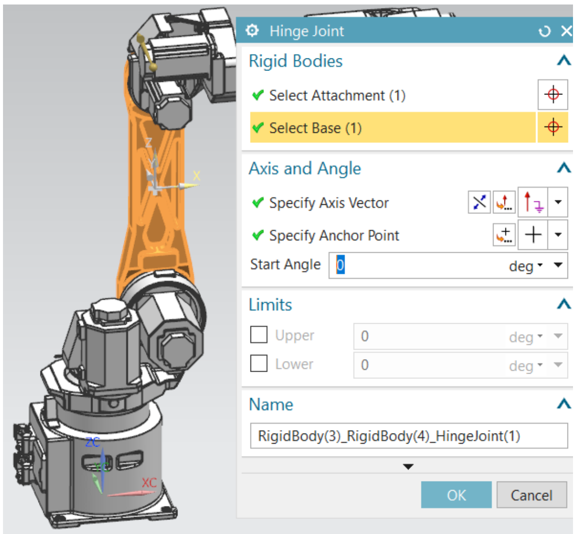

Figure 6. The example of jointing of elements.

The base has been rigidly joined using a fixed joint, while the other elements have been combined using a joint hidge. The robot model with all joints is shown in the figure 7.

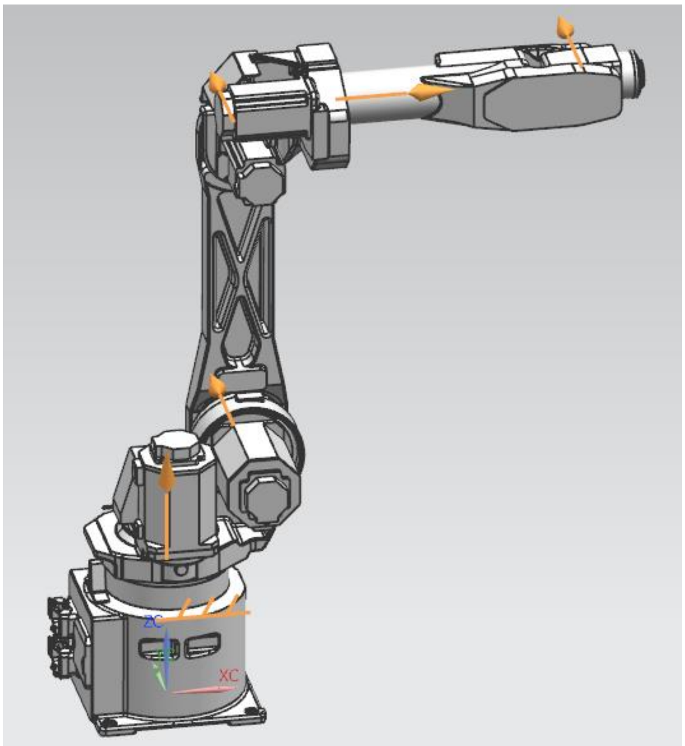

Figure 7. Robot model with all of joints.

In order to allow the robot to move, it was necessary to add a actuator. The simulation uses position control. The controls had to be assigned to specified joints. The connection types and element properties is shown in the figure 8.

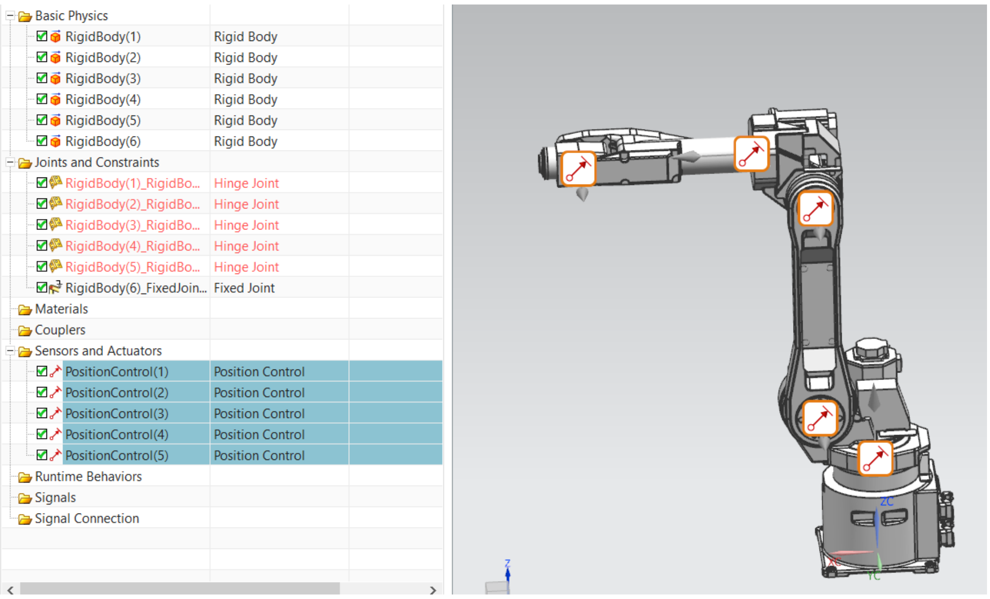

Figure 8. The connection types and the element properties.

IOP Conf. Series: Materials Science and Engineering **591** (2019) 012055 doi:10.1088/1757-899X/591/1/012055

The result of the work is presented in the cycle shown in figure 9. As can be seen, the robot performs its tasks sequentially while maintaining the coupling between the drives 2 and 3.

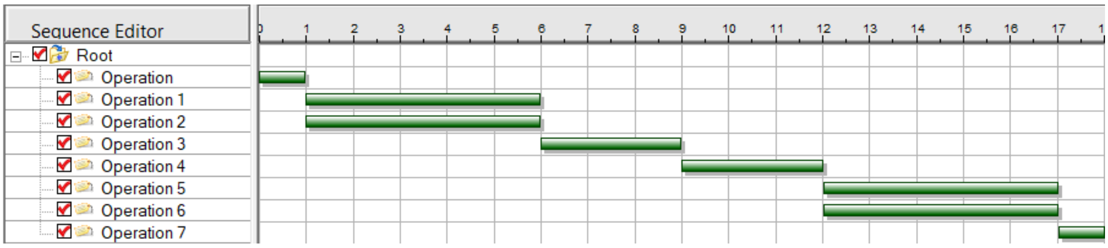

Figure 9. The cycle of the robot works.

The model of the robot during the movement is on figure 10. The movement is executed sequentially by assigning appropriate conditions with assigned runtimes parameters.

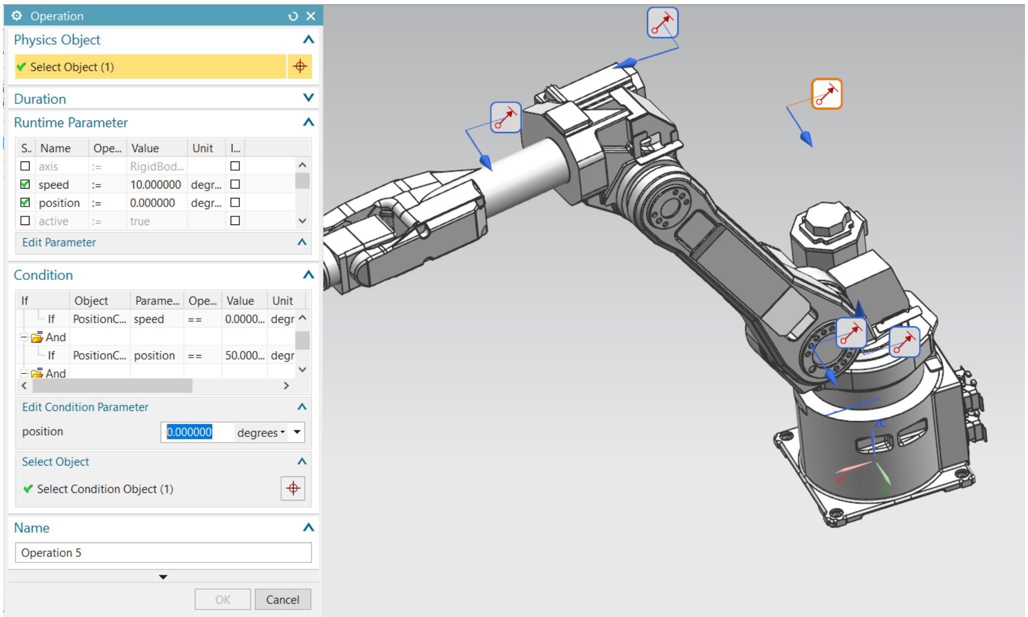

Figure 10. Assigning the appropriate movement sequences and definition of movement condition.

5. Conclusions

The use of the mechatronics module made it possible to use the robot to carry out the simulation using a pre-set sequence of movements. Moreover, the mechatronics module gives many other options using the options from the Automation department, which is one of the plans for further actions within the modeling of mechatronic systems in the NX program. It is also possible to use communication between the simulation and the actual controller using the network protocol, which has been studied in the literature [7, 8].

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