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ROBOT MANIPULATOR MODEL CREATION USING THE RESOURCES OF ROBOT OPERATING SYSTEM FOR EDUCATIONAL PURPOSES

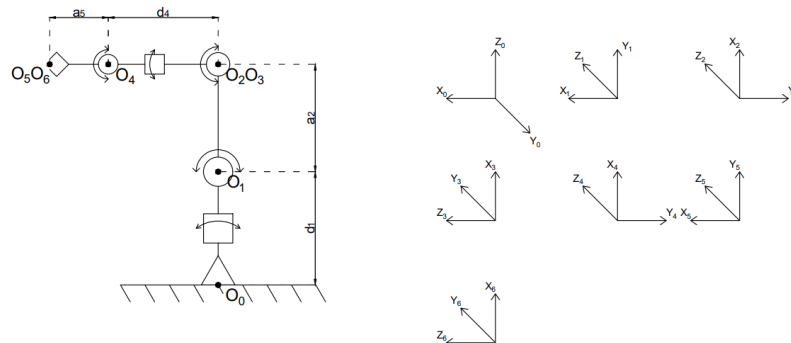
Introduction. Comprehending the complex nature of robots and their usage requires extensive knowledge across multiple fields [1]. Which makes tools that can ease human-robot interactions great for education and research purposes. Robot Operation System (ROS) is one of the such instruments.

Objective. To evaluate change of moment of inertia in dynamics for a robot manipulator model using ROS.

The object of research – the modelling of a robot manipulator system.

The subject of research – the usage of ROS methods to obtain a robot manipulator model.

Research results. The Custom Robotic Kit (CuRoK) robot manipulator was chosen to achieve the research goal. The kinematic diagram of the system is shown in Fig 1 and DH parameters are shown in Table 1.



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Figure 1 Kinematic diagram of the CuRoK

Table 1

DH parameters of the robot manipulator

	rad $\theta_i,$	rad $\alpha_{i-1},$	mm $a_{i-1},$	mm $d_i,$
	θ_1	$\pi/2$	0	232
$\pi/2$	$\theta_2 +$	0	220	0
	θ_3	$\pi/2$	0	0
	θ_4	$-\pi/2$	0	225
$\pi/2$	$\theta_5 -$	0	130	0
	$\pi/2$	$\pi/2$	0	0

To build the ROS model, the following parameters were calculated: maximum velocity, maximum torque, and mass. The STL files were linked to the kinematics in URDF

[2] format, which allowed us to visualize the model in detail and impose accurate collision constraints for further interactions with the robot. The result is shown in Fig. 2(a).

To simplify future calculations of the moment of inertia of the robot manipulator links, their shape was approximated to simple geometric shapes in the URDF model. Visualization of the approximation results is shown in Fig. 2(b).

ROS keeps track of the state of the joints and can calculate dynamic moment of inertia of each individual link.

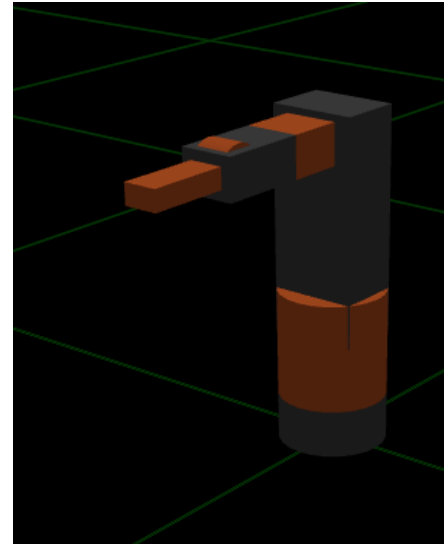
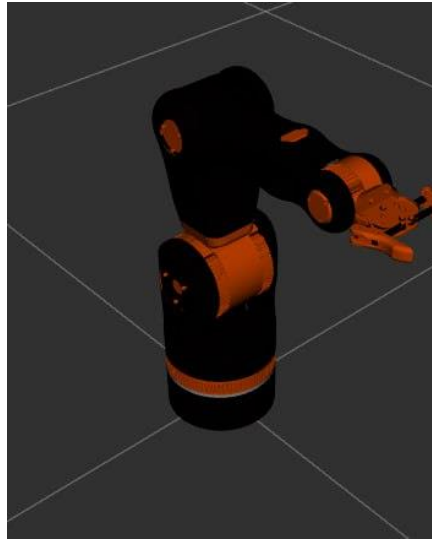


Figure 1 Visualization of the URDF format

a) visualization of the model by means of ROS-rviz[2], b) visualization of the moment of inertia approximation

The resulting model can be further used and studied using ROS tools or imported into Matlab or Simulink workspace. An example of the latter with connected torque sensors and a load is shown in Fig. 3.

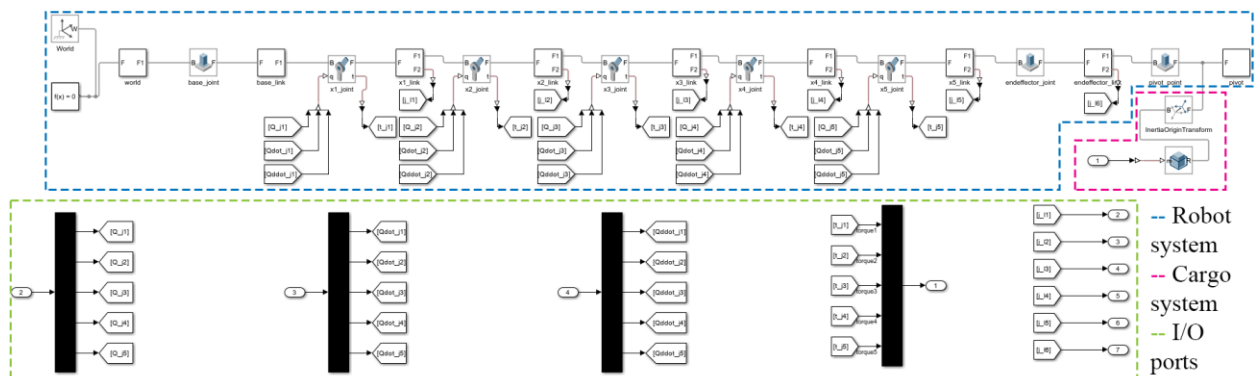


Figure 3 Imported ROS model into Simulink software

Conclusions. ROS methods provide accurate calculations of the moments of inertia and are powerful tools those allow you to freely implement your own robotic system, which can be subject to visualization rules, constraints, and moment of inertia distribution. Further study and testing of the resulting model can be carried out in a researcher-friendly software. In this way, ROS not only has a wide range of capabilities, but also shows flexibility in the possibilities for further work.

Reference:

1. Mark W. Spong, Seth Hutchinson, M. Vidyasagar. Robot Modeling and Control 2nd edition. 2020 ISBN-10 1119523990
2. ROS Wiki [Online resource] URDF. URL: <https://wiki.ros.org/urdf>
3. ROS Wiki [Online resource] RVIZ. URL: <https://wiki.ros.org/rviz>