



Literature Review on Simulation and Trajectory Planning of Six-axis Robotic Arm

Shubham Tiwari, Prof. M. Shakebuddin

Department of Mechanical Engineering, Anjuman College of Engineering & Technology, Nagpur, Maharashtra, India

ABSTRACT

Robots have been a success in the manufacturing industry. It is a well-known fact that robotic arms have played an important role in improving the efficiency of production lines across various sectors. In this paper we have discussed the simulation, path planning and kinematic analysis of robotic arms using Robot Operating System and MoveIt in detail. We have also briefly introduced other options available for the purpose of simulation and path planning.

Keywords : MoveIt, Path planning, Robotics, ROS.

I. INTRODUCTION

Robot development requires a multi-disciplinary approach including mechanical engineering, electronics engineering, electrical engineering as well as computer science. A simulator provides a virtual environment to test the robot that is to be developed. Using simulation techniques we can check all the hardware and software related aspects of a robot without making a real robot. Simulation techniques are important in robotic development for quick verification of new prototype, algorithm or applications and performance.¹

Most of the robot manufacturers such as ABB, KUKA robotics have built their own simulation suits. There are other platforms such as Microsoft Robotic Developer Studio (MRDS) is a Windows-based environment for robot control and simulation. MRDS can handle a wide variety of robot hardware, include

support for packages to add other services to achieve complex behaviors.² MRDS is likely to be a powerful and widely used platform before it has not been updated or patched since 2012. Open Robotics Automation Virtual Environment (OpenRAVE)³ provides an environment for the development of motion planning algorithms in robotics applications, which focuses on offering interfaces and implementations of motion planning algorithms. ADAMS virtual prototype environment can also be used for motion planning purpose along with Solid Edge ST4 for modelling.⁴ ROS is an open-source, meta-operating system developed by Willow Garage, a California based company, formed in 2006.⁵ It is a middleware which implements various open source packages. It provides an environment to test every aspect of a robot ranging from kinematics to electronic sensors. A large community of active ROS developers makes it easier to tackle any problem. Since ROS is open source and has a large user base it

has a large variety of many successful robotic frame works.⁶

II. METHODS AND MATERIAL

The steps involved in simulation of a robotic arm can be broken down in following manner.

- 1) Modeling
 - a) Creating a 3D model in Solidworks.
 - b) Converting 3D model into Unified Robot DescriptionFormat (URDF)
- 2) Creating a MoveIt configuration package.
- 3) Path planning of arm in Rviz.
- 4) Simulating the same motion in virtual environment using Gazebo with ROS as a middle ware

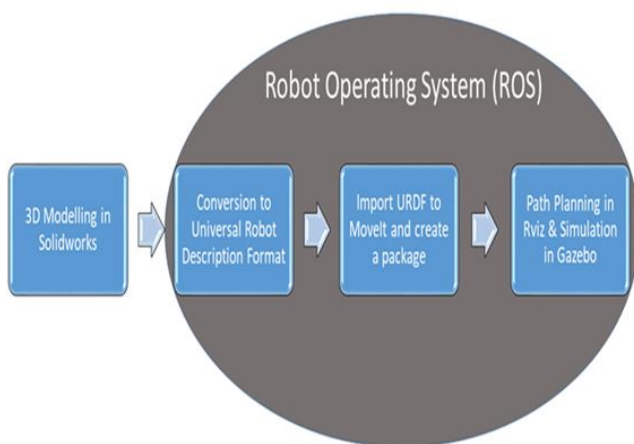


Figure 1: Flow chart for path planning and simulation of robotic arm

1. Modelling

This is the first step which involves creation of a 3D model of a robotic arm. There are many options to perform the same task such as using a 3D modelling software and then converting the design in meshes

using Blender software. The other option is of using Gazebo model editor to create a model. However Gazebo uses SDF (Simulation Description Format) for modelling. However SDF is currently not compatible with MoveIt hence it will not be a best option for path planning using MoveIt.

The best method is to breakdown this step into two sub-steps which are given below

a) Creating a 3D model in Solidworks.

There are many software available for 3D modelling. But Solidworks is the best suited for robot modelling as it is much easier to convert a Solidworks model into Unified Robot Description Format (URDF).

b) Converting 3D model into URDF

A 3D model can be converted into URDF either manually or directly by using SW2URDF plug-in.⁷ The direct method is much simpler but it requires a modeler to make some modification in final URDF script.

2. Creating a MoveIt Configuration Package

A MoveIt configuration Package⁹ is a set of configuration files which consists all the necessary information regarding the robotic arm. The inputs required for creating this package are given below.

- a) URDF of arm
- b) Self Collision Matrix
- c) Virtual Joint (to connect the robot with world)
- d) Planning Groups
 - i) Manipulator Group
 - ii) Kinematic Chain
 - iii) Joints and Links

3. Path Planning of Arm in RViz

The MoveIt package from second step is imported into the RViz. In various studies the simulation results were visualized using Rviz and were found

to be satisfactory¹⁰. Here we set an initial position and goal position and we can choose any motion planner provided by RViz to plan and execute the path between the two positions. RViz provides multiple option for motion planners which are mentioned below.

- a) Open Motion Planning Library (OMPL)
- b) Covariant Hamiltonian Optimization for Motion Planning (CHOMP)
- c) Stochastic Trajectory Optimization for Motion Planning (STOMP)

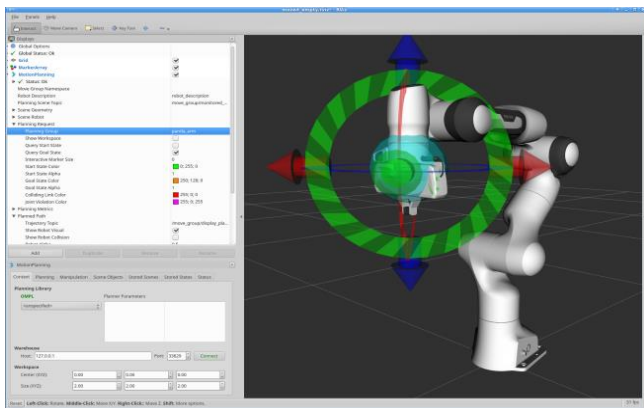


Figure 2: Example of path planning in RViz

One can compare the performance of these motion planners and select the most appropriate one. Or one can also use two motion planners in a pipeline for smoother performance.

4. Simulation in Gazebo

The RViz configuration can be stored and then we can create a program to execute the motion planned in RViz. However instead of testing the program on real robotic arm we can test our codes in simulation using Gazebo.¹⁰

This will help us in improving the efficiency of our program without actually making a real model. We

can run our program through ROS and visualize the results in Gazebo.

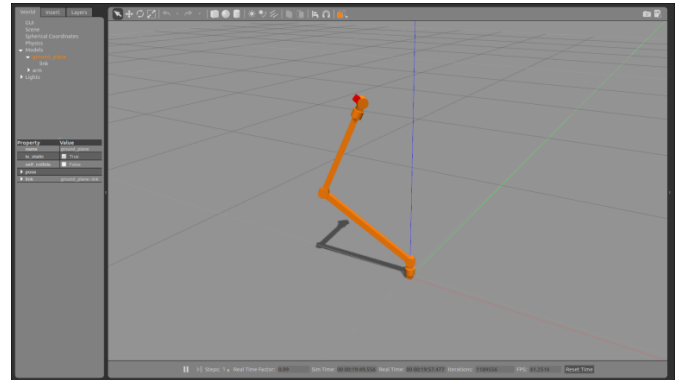


Figure 3: Example of Simulation in Gazebo

III. CONCLUSION

After conducting this literature review we reach to the conclusion that ROS being an open source platform has wide variety of frameworks for robot development. Most of the other platforms are focused on a particular brand and their scope is also limited to that particular brand. Hence ROS comes out to be the best option for developers and researchers working in the field of robotics.

We have also discussed a method for path planning using Rviz, Moveit, Gazebo and ROS. There is plenty of supporting material available on the web for free regarding the same procedure. One should also refer to those tutorials and documentations for better understanding.

IV. REFERENCES

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