Trajectory planning

Preface: ROS on Raspberry Pi 5 and Jetson-nano runs in Docker, so the performance of running MoveIt2 is average. It is recommended that users of Raspberry Pi 5 and Jetson-nano motherboards run MoveIt2 related cases in a virtual machine. ROS on Orin motherboard runs directly on the motherboard, so users of Orin motherboard can run MoveIt2 related cases directly on the motherboard. The instructions are the same as running in a virtual machine.

The following content uses running on a virtual machine as an example.

1. Content Description

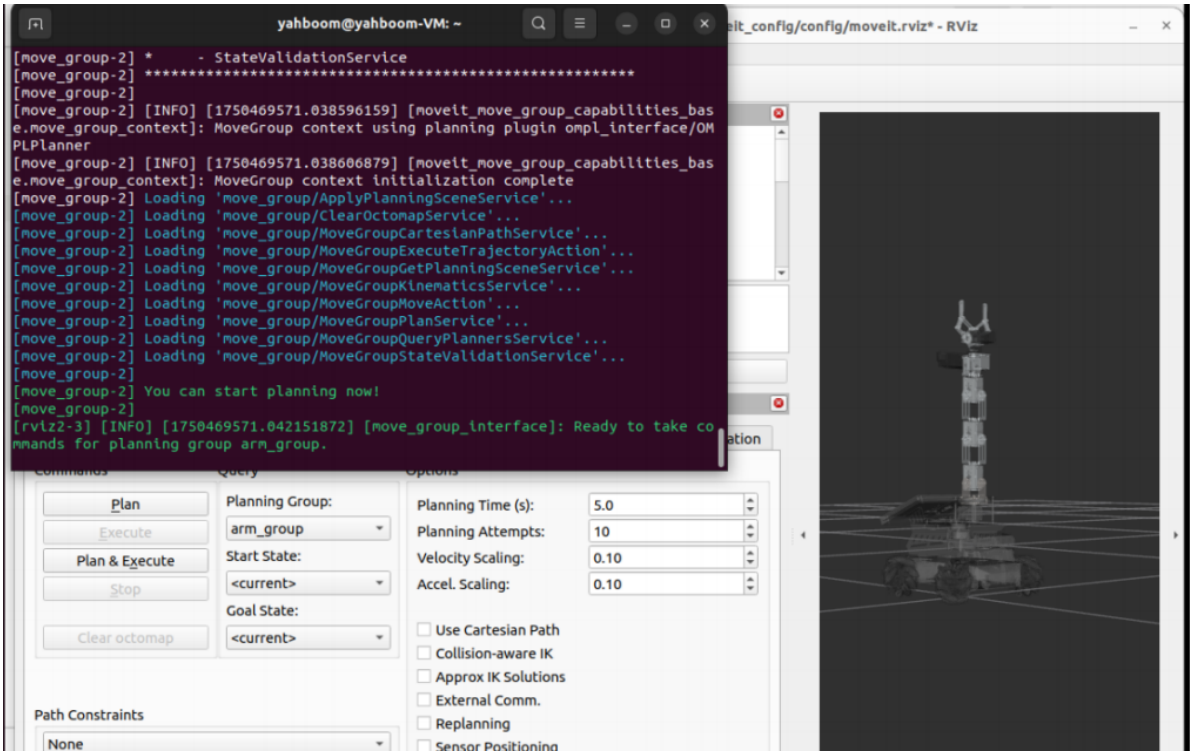
This section explains how to display the path planned by MoveIt. The robot arm moves along the planned path trajectory.

2. Start

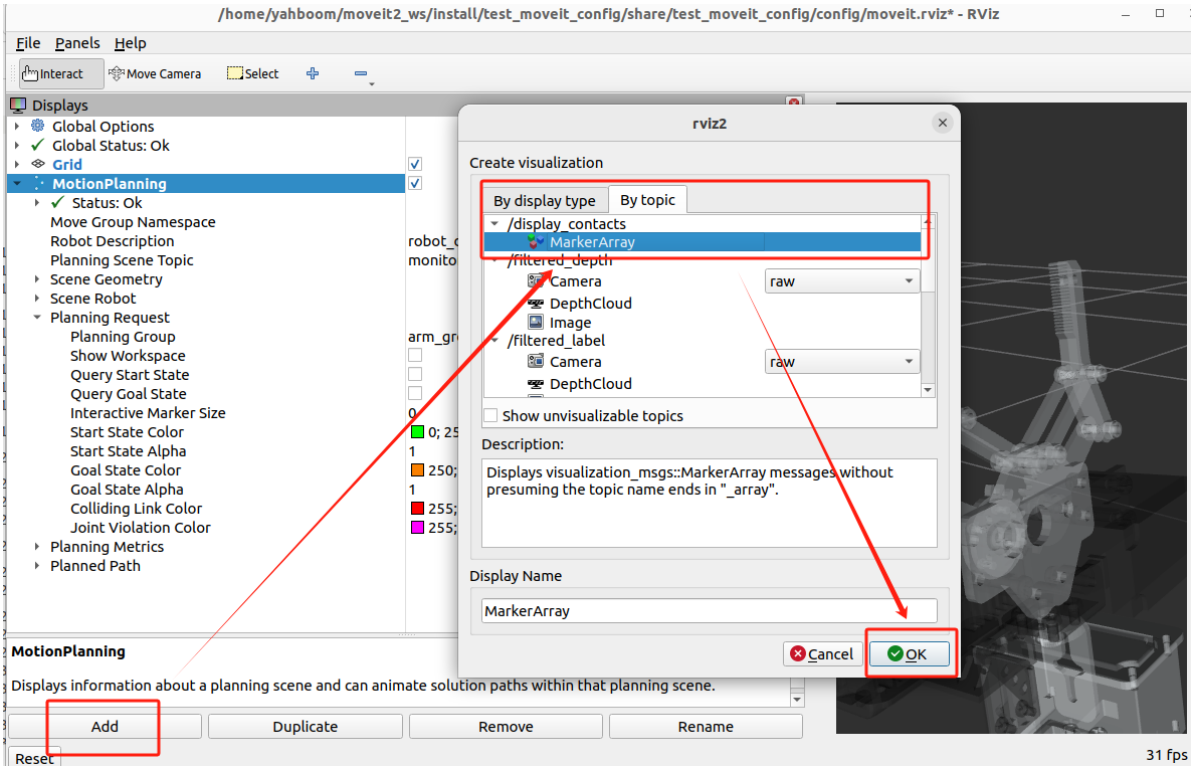
Open a terminal in the virtual machine and enter the following command to start MoveIt2.

```
ros2 launch test_moveit_config demo.launch.py
```

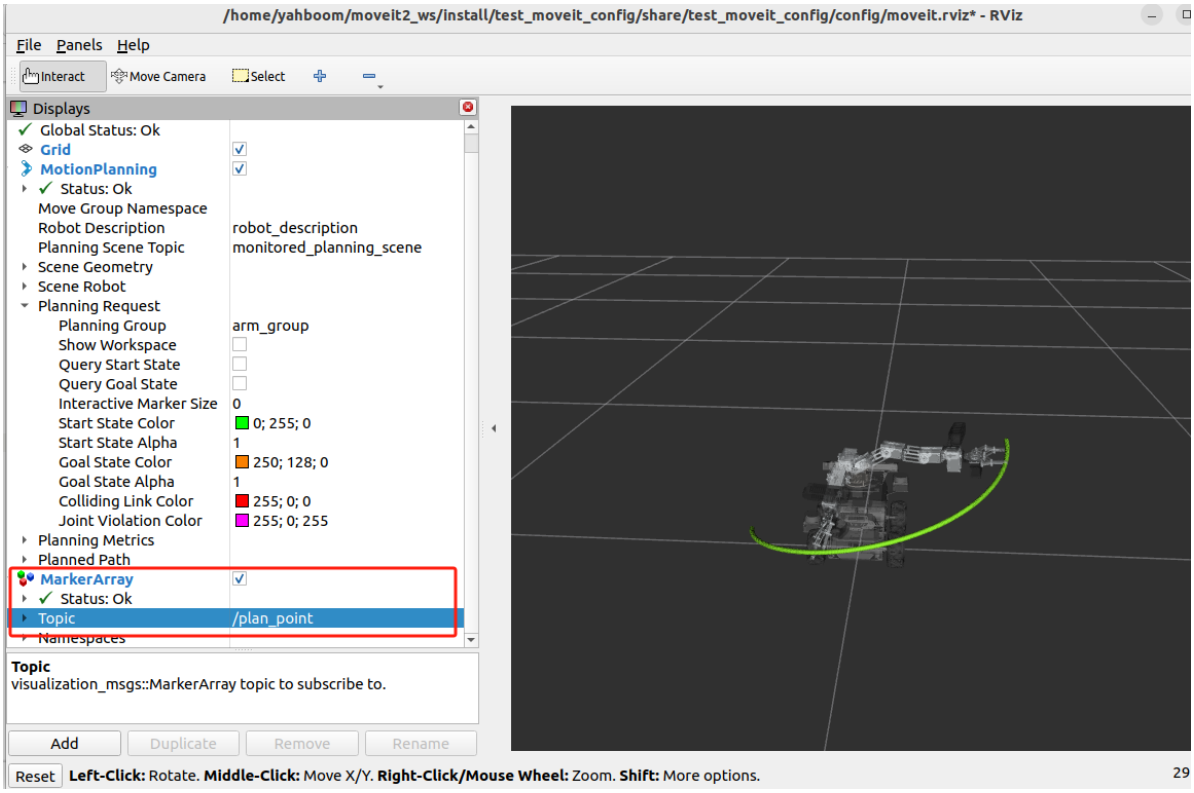
After the program is started, when the terminal displays **"You can start planning now!"** , it indicates that the program has been successfully started, as shown in the figure below.



Then, we need to add a plug-in to display the planned trajectory, and set it up as shown in the figure below.



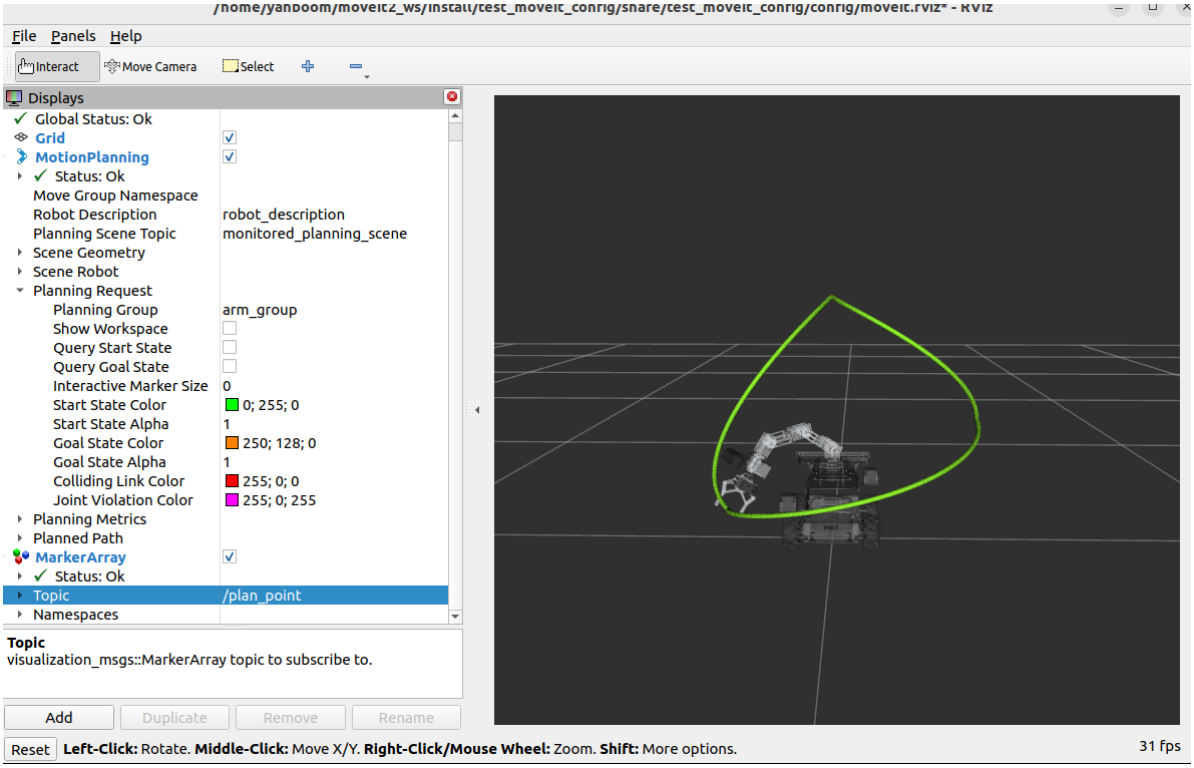
Next, we modify the topics that need to be displayed, as shown below.



Finally, we enter the following command in the virtual machine terminal to start the trajectory planning program,

```
ros2 run MoveIt_demo multi_track_motion
```

After the program runs, the trajectory is displayed in rviz and the robotic arm moves along the trajectory, as shown in the figure below.



3. Core code analysis

The code path in the virtual machine is:
/home/yahboom/moveit2_ws/src/MoveIt_demo/src/multi_track_motion.cpp

```
#include <rclcpp/rclcpp.hpp>
#include <moveit/move_group_interface/move_group_interface.h>
#include <moveit/planning_scene_interface/planning_scene_interface.h>
#include <moveit_visual_tools/moveit_visual_tools.h>
#include <moveit_msgs/msg/display_trajectory.hpp>
#include <vector>
#include <moveit/robot_trajectory/robot_trajectory.h>
#include <moveit/robot_state/robot_state.h>
#include <moveit/robot_model/robot_model.h>
#include <moveit/robot_model_loader/robot_model_loader.h>

class  RandomMoveIt2Control : public  rclcpp::Node
{
public :
  RandomMoveIt2Control ()
    : Node ( "random_moveit2_control" )
  {
    // Initialize other content
    RCLCPP_INFO ( this -> get_logger (), "Initializing RandomMoveIt2Control." );
  }

  void  initialize ()
  {
        // Use RobotModelLoader to load the robot model
    robot_model_loader::RobotModelLoader  robot_model_loader ( shared_from_this
(), "robot_description" );
    const  moveit::core::RobotModelPtr &  robot_model  =  robot_model_loader .
getModel ();
    // Initialize move_group_interface_ in this function and create a planning
group named arm_group
```

```
    move_group_interface_  =  std::make_shared <
moveit::planning_interface::MoveGroupInterface > ( shared_from_this (),
"arm_group" );

    const  moveit::core::JointModelGroup *  joint_model_group  =  robot_model ->
getJointModelGroup ( "arm_group" );
    // Initialize the coordinate system of the trajectory display to base_link,
the trajectory topic to plan_point, and the robot model to the planning group
model
    moveit_visual_tools::MoveItVisualTools  visual_tools_ ( shared_from_this (),
"base_link" , "plan_point" , move_group_interface_ -> getRobotModel ());
    move_group_interface _-> setNumPlanningAttempts ( 10 );   // Set the maximum
number of planning attempts to 10
    move_group_interface _-> setPlanningTime ( 5.0 );          // Set the maximum
time for each planning to 5 seconds

    // First target joint angle (unit: radians)
    std::vector < double >  target_joints  = { 1.57 , - 1.00 , - 0.61 , 0.20 ,
0.0 };
    //Set the joint angles of the first pose
    move_group_interface_ -> setJointValueTarget ( target_joints );

    // Plan the path
    moveit::planning_interface::MoveGroupInterface::Plan  my_plan ;
    bool  success  = ( move_group_interface_ -> plan ( my_plan ) ==
moveit::core::MoveItErrorCode::SUCCESS );
    //If the first path planning is successful, execute the planning
    if ( success )
    {
      // Visualize the trajectory in RViz. The trajectory parameters are the
planned path. Set the end execution link to Gripping. The point color of the
robot trajectory is green.
        visual_tools_ . publishTrajectoryLine ( my_plan . trajectory_ ,
move_group_interface_ -> getRobotModel () -> getLinkModel ( "Gripping" ),
joint_model_group , rviz_visual_tools::LIME_GREEN );
        visual_tools_ . trigger ();
        RCLCPP_INFO ( this -> get_logger (), "Planning succeeded, moving the
arm." );
        moveit::planning_interface::MoveItErrorCode  execute_result  =
move_group_interface_ -> execute ( my_plan );
        //If the first execution is successful, then execute the second plan
        if ( execute_result  ==  moveit::core::MoveItErrorCode::SUCCESS )
        {
            RCLCPP_INFO ( this -> get_logger (), "Trajectory executed
successfully." );
            // First target joint angle (unit: radians)
            std::vector < double >  target_joints  = { 0 ,      0 ,      0 ,
0 ,      0 };
            //Set the joint angles of the second pose
            move_group_interface_ -> setJointValueTarget ( target_joints );
            moveit::planning_interface::MoveGroupInterface::Plan  my_plan ;
            bool  success_two  = ( move_group_interface_ -> plan ( my_plan ) ==
moveit::core::MoveItErrorCode::SUCCESS );
            //If the second planning path is successful, execute the planning
            if ( success_two )
            {
```

```
                // Visualize the trajectory in RViz. The trajectory parameters
are the planned path. Set the end execution link to Gripping and the point color
of the trajectory is green.
                visual_tools_ . publishTrajectoryLine ( my_plan . trajectory_ ,
move_group_interface_ -> getRobotModel () -> getLinkModel ( "Gripping" ),
joint_model_group , rviz_visual_tools::LIME_GREEN );
                visual_tools_ . trigger ();
                RCLCPP_INFO ( this -> get_logger (), "Planning succeeded, moving
the arm 2nd." );
                moveit::planning_interface::MoveItErrorCode  execute_result_2nd
=  move_group_interface_ -> execute ( my_plan );
                //If the second execution is successful, then execute the third
plan
                if ( execute_result_2nd  ==
moveit::core::MoveItErrorCode::SUCCESS )
                {
                    RCLCPP_INFO ( this -> get_logger (), "Trajectory executed
successfully 2nd." );
                    std::vector < double >  target_joints  = { - 1.16 , - 0.97 ,
- 0.81 , - 0.79 , 1.57 };
                    move_group_interface_ -> setJointValueTarget ( target_joints
);
                    moveit::planning_interface::MoveGroupInterface::Plan  my_plan
;
                    bool  success_three  = ( move_group_interface_ -> plan (
my_plan ) ==  moveit::core::MoveItErrorCode::SUCCESS );
                    //If the third planning path is successful, execute the
planning
                    if ( success_three )
                    {
                          // Visualize the trajectory in RViz. The trajectory
parameters are the planned path. Set the end execution link to Gripping and the
point color of the trajectory is green.
                        visual_tools_ . publishTrajectoryLine ( my_plan .
trajectory_ , move_group_interface_ -> getRobotModel () -> getLinkModel (
"Gripping" ), joint_model_group , rviz_visual_tools::LIME_GREEN );
                        visual_tools_ . trigger ();
                        RCLCPP_INFO ( this -> get_logger (), "Planning succeeded,
moving the arm 3rd." );
                        moveit::planning_interface::MoveItErrorCode
execute_result_3rd  =  move_group_interface_ -> execute ( my_plan );
                        if ( execute_result_3rd  ==
moveit::core::MoveItErrorCode::SUCCESS )
                        {
                            RCLCPP_INFO ( this -> get_logger (), "Trajectory
executed successfully 3rd." );
                        }
                }
            }
        }
      }
      else
      {
        RCLCPP_ERROR ( this -> get_logger (), "Trajectory execution failed with
error code: %d" , execute_result . val );
      }
    }
    else
```

```
    {
        RCLCPP_ERROR ( this -> get_logger (), "Planning failed!" );
    }


  }

private :
  std::shared_ptr < moveit::planning_interface::MoveGroupInterface >
move_group_interface_ ;
  std::shared_ptr < moveit_visual_tools::MoveItVisualTools >  visual_tools_ ;
};

int  main ( int  argc , char  ** argv )
{
  rclcpp::init ( argc , argv );
  auto  node  =  std::make_shared < RandomMoveIt2Control > ();

  // Initialization
  node- > initialize ();

  rclcpp::spin ( node );
  rclcpp::shutdown ();
  return  0 ;
}
```