Simulation and Automated Testing of Marvin Robot

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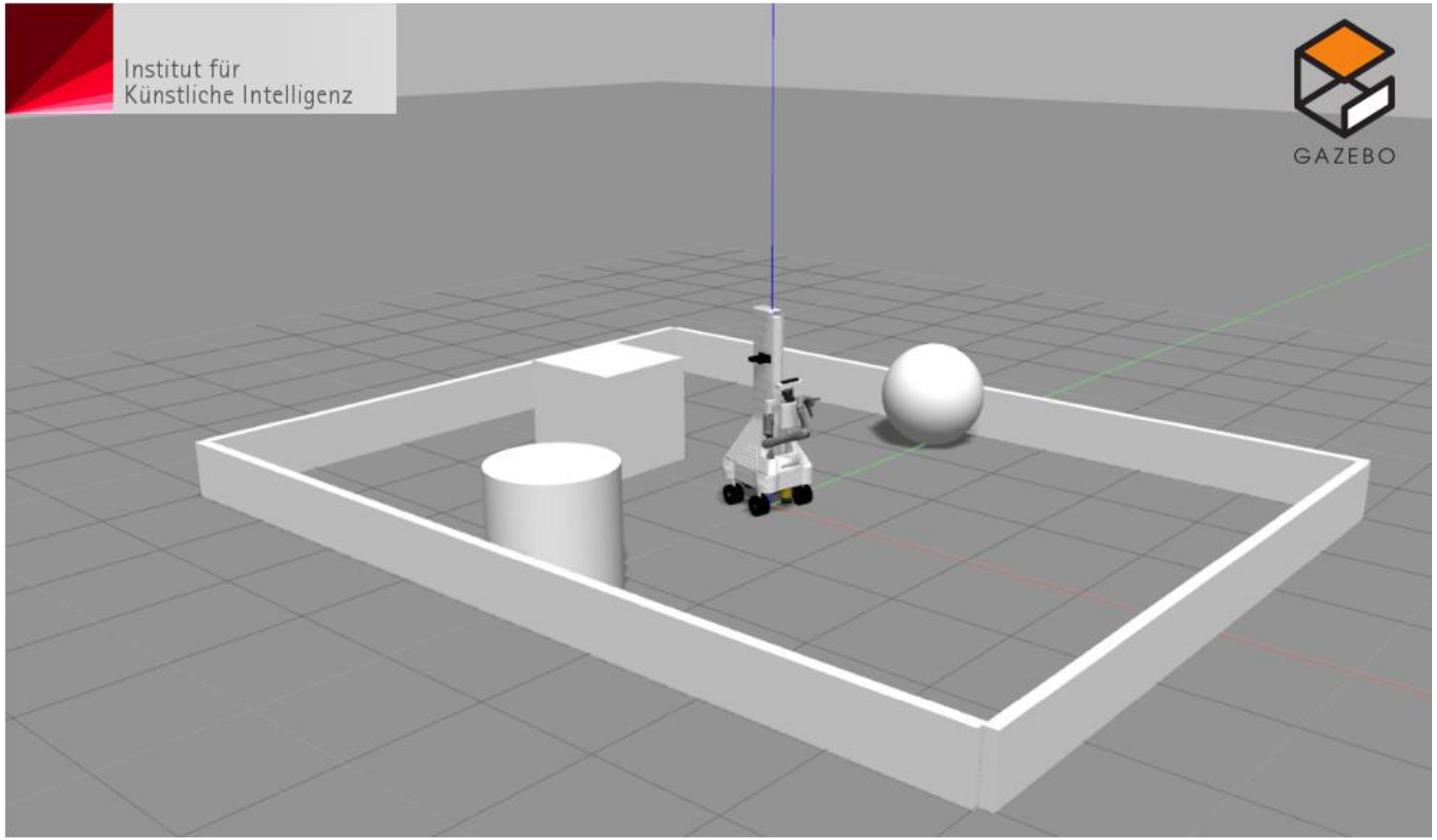
Contents

Gazebo [1]

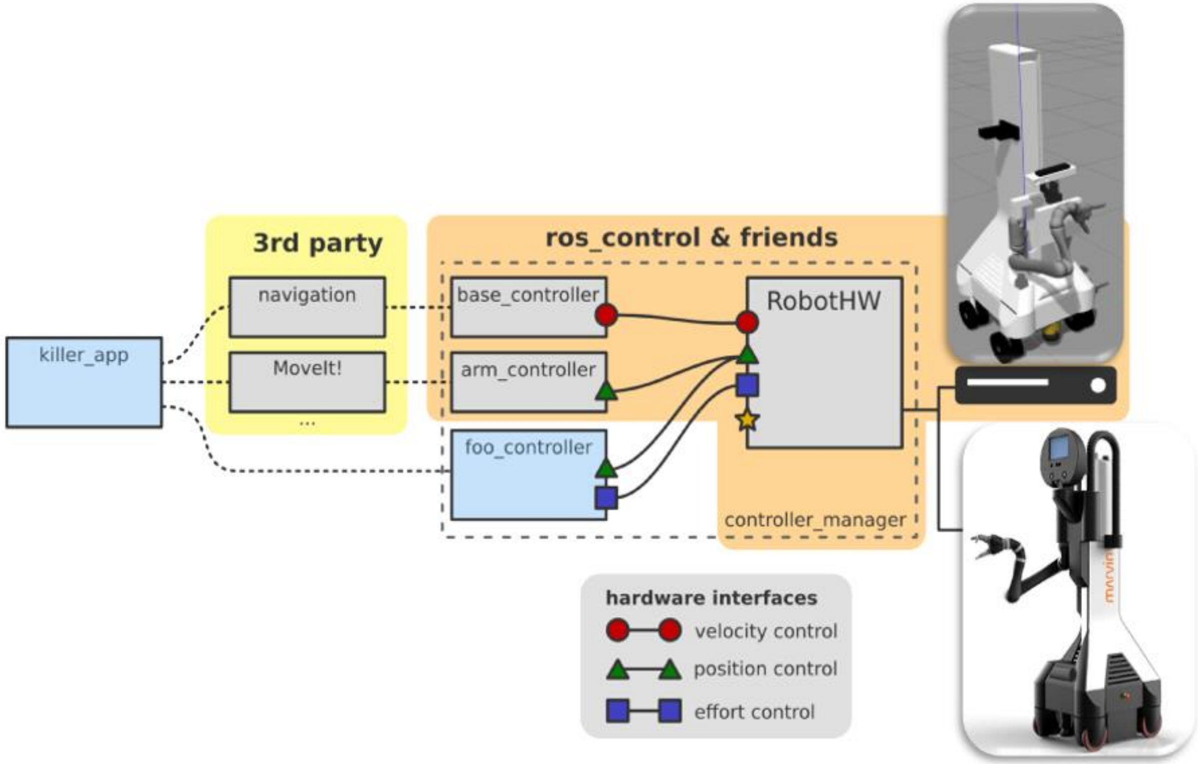
- 3D dynamic physics simulator
- Robot simulation environment
- Testing robot algorithms
- Reliable middleware



[1] Source: Simulation Testing of Marvin Robot

Joint controller [2]

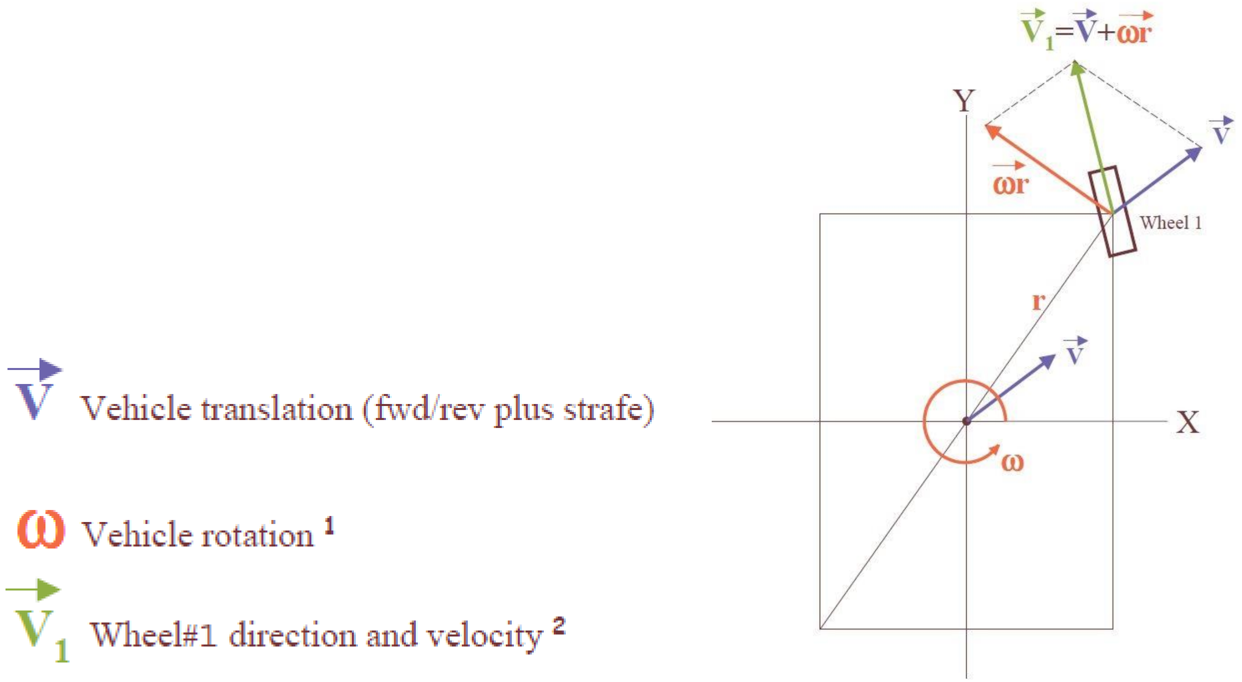
- Robot controllers linear actuator and pan-tilt controller
- Define joints in URDF (unified robot description)
- Configuration of ros_controller_pkg



[2] Source: ros_controllers

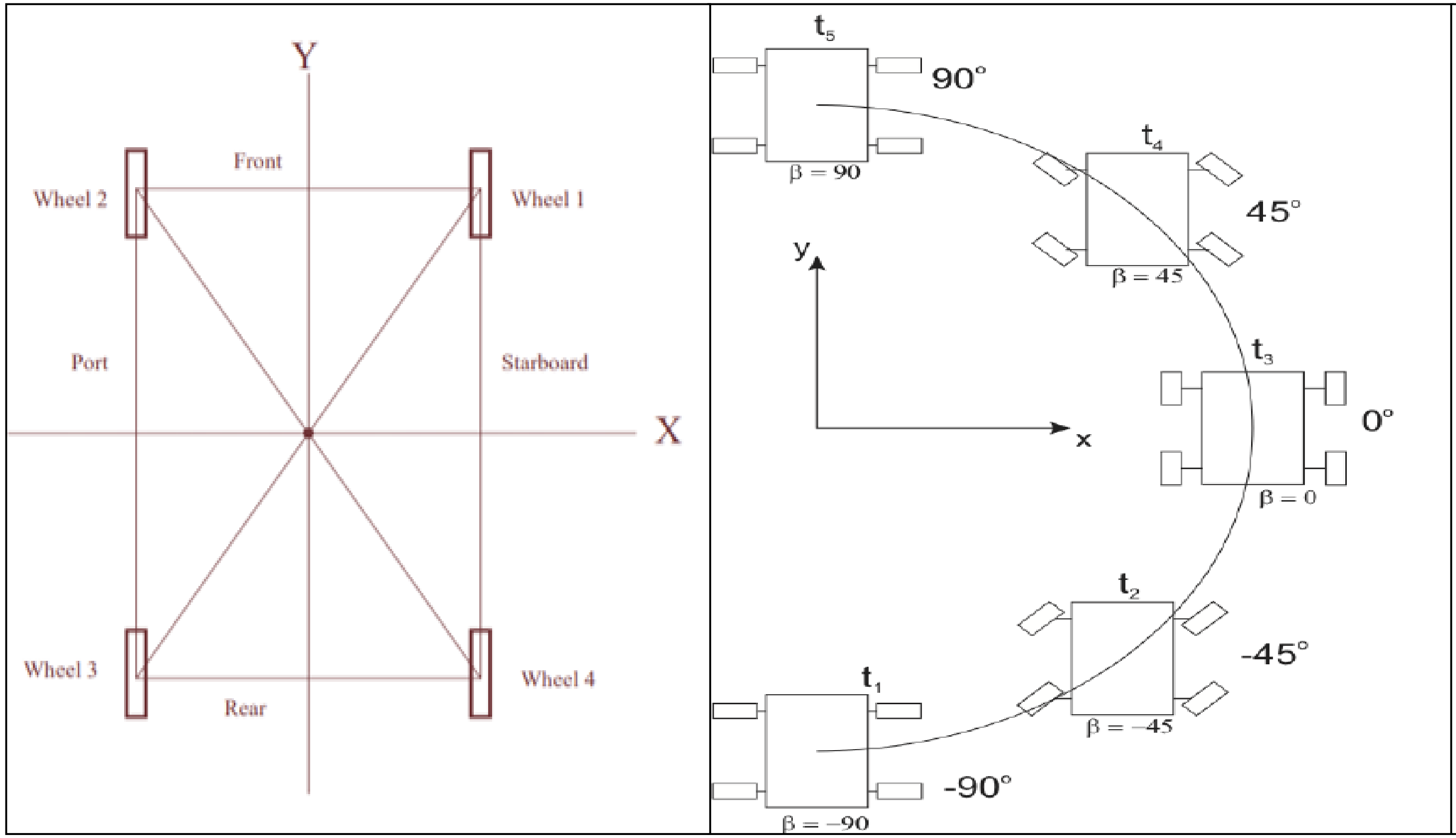
Omni-directional Controller

- Kinematics for omni-directional [3]
- 3 Degrees of freedom control
- 4 Wheels independent drive and independent steering

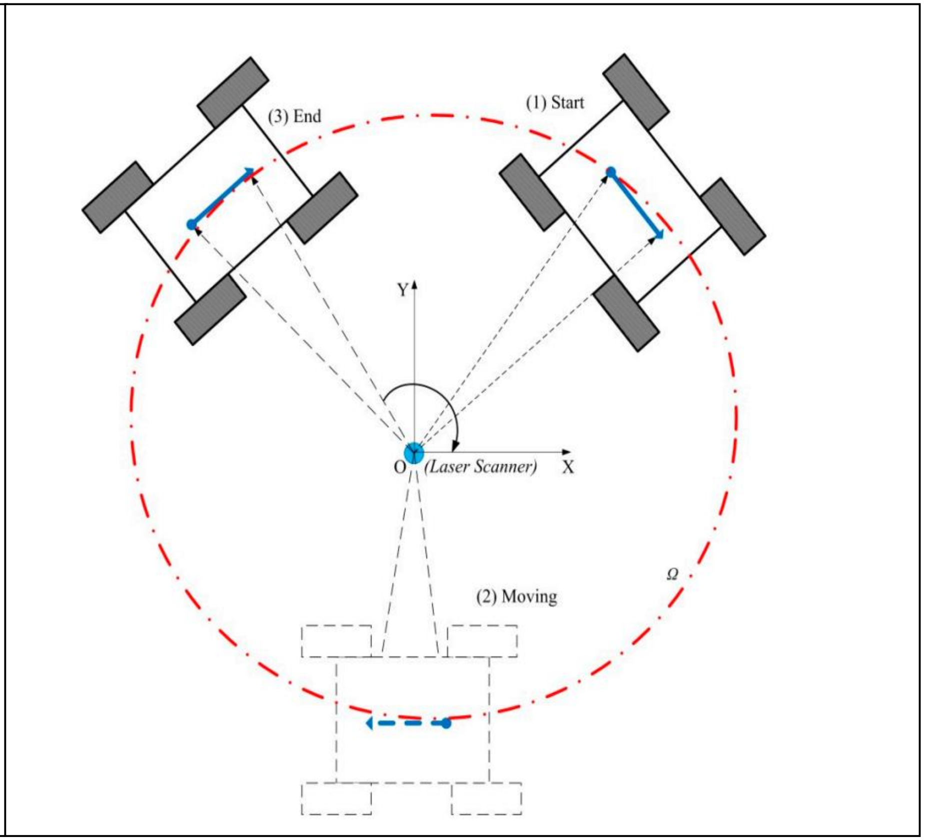


[5] Source: Inverse kinematics Calculation wheel speeds and angles

- Holonomic drive [3]
- Differential drive [4]



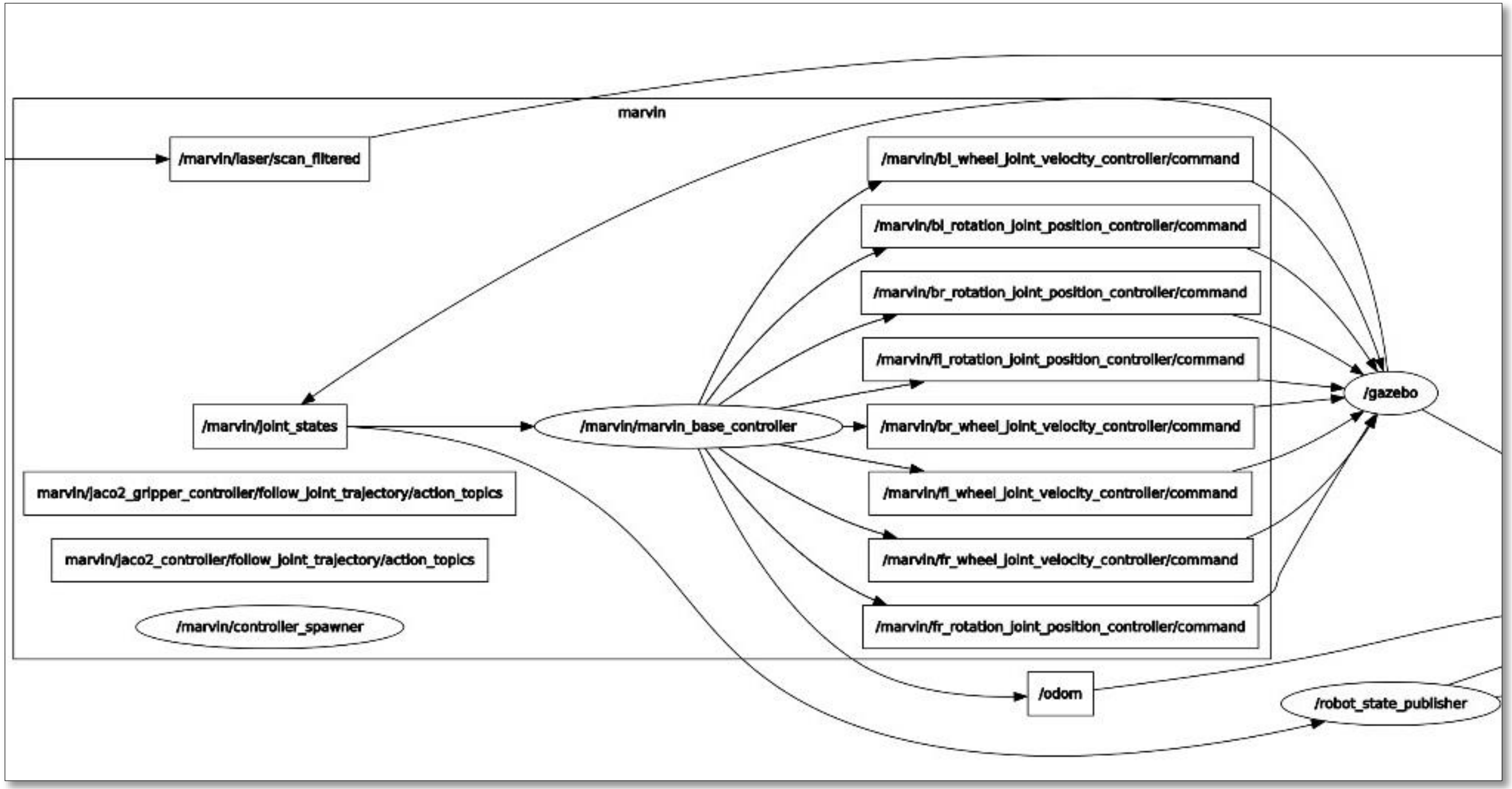
[3] Source: swerve drive chief delphi



[4] Source: Differential Drive

Wheel Controller

- Created mobile robot base
- Robot description 4 pivot joints and 4 wheel joints
- Configuration of joints ros_control_pkg



[6] rqt_graph of active topics

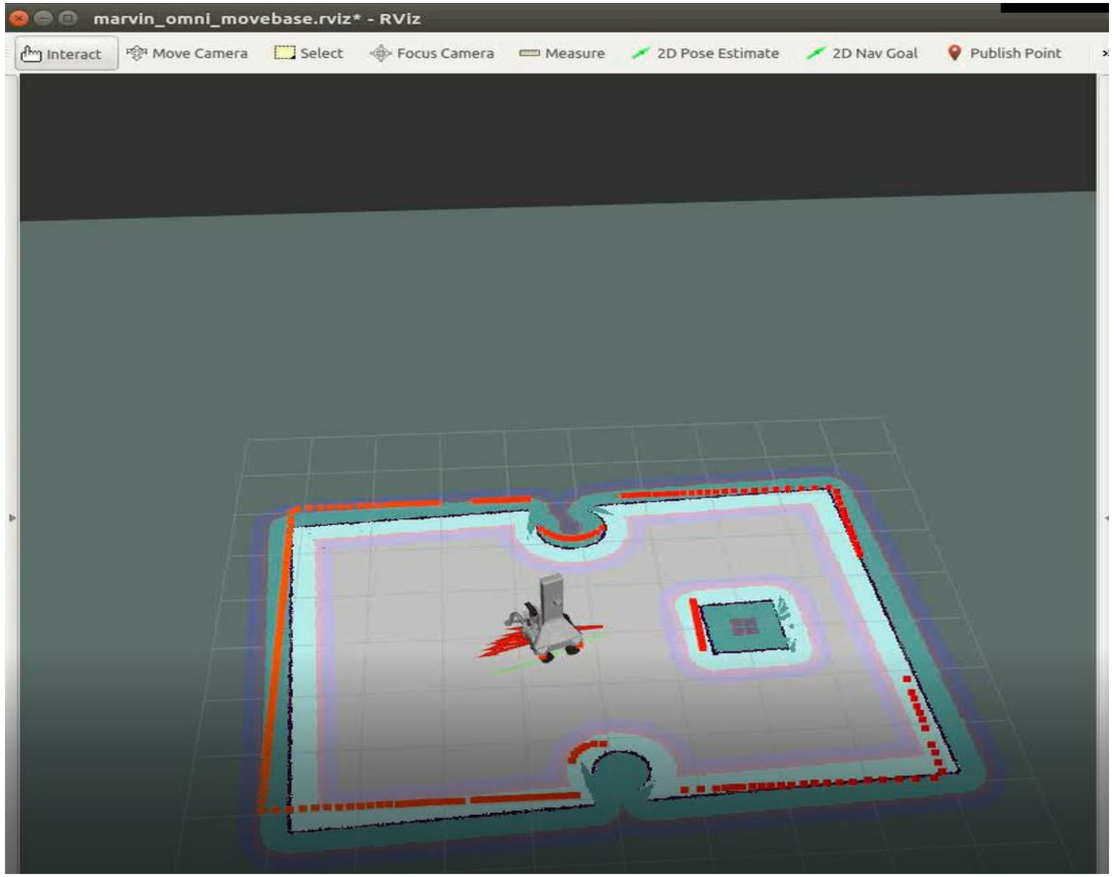
Omni-Directional

- Mobile robot base of the Marvin Robot simulation was optimised for omni-directional movement
- The ros node base controller is used to control the individual vertical pivot joints and horizontal wheel velocity at joints

Movement Direction	Synchronous Steer Angle Wheel
Forward and Backward	0 degree
LH and RH movement	0 to 90 degree
Diagonal Movement Right Hand	0 to -45 degree
Diagonal Movement Left Hand	0 to 45 degree

Navigation stack for Marvin

- Gmapping for mapping [5]
- AMCL for Localisation [5]
- Move_base for path planning and collision avoidance [5]



[7] robot path planning using movebase_pkg

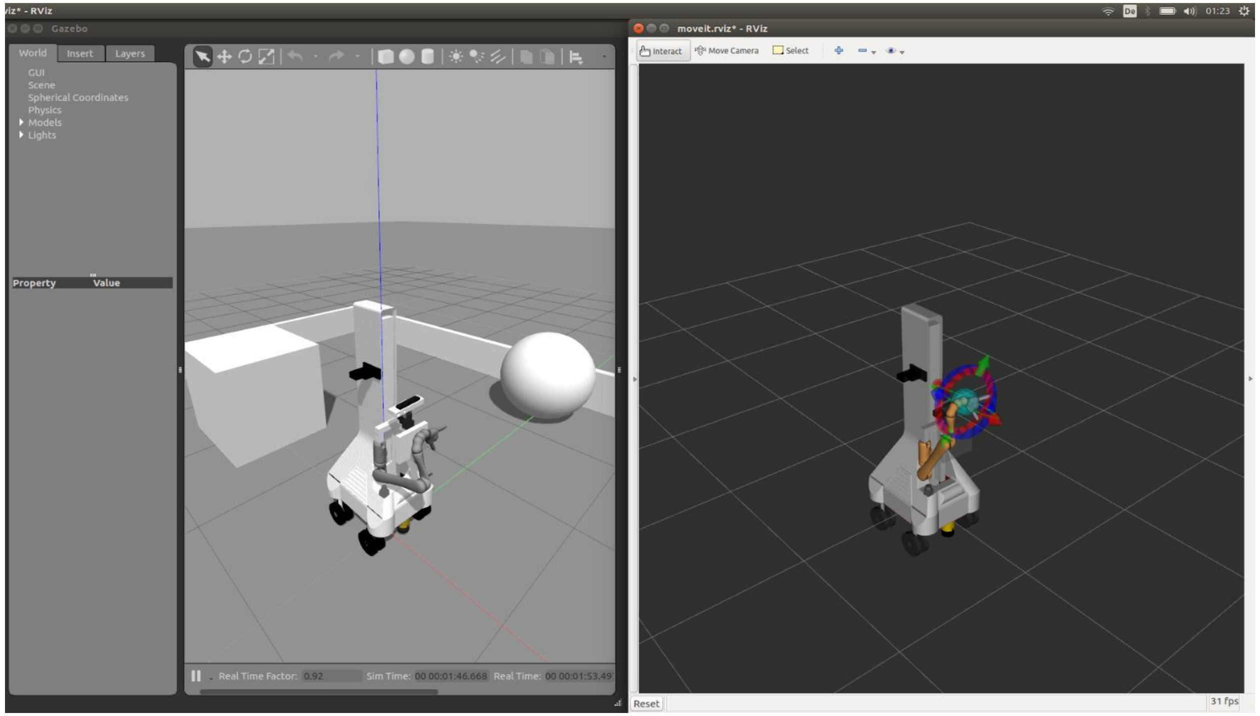
Manipulation – MoveIt!

- Mobile manipulation ros plugin for robot arm
- Performs the inverse kinematics calculations and publishes the joint state values

[8] Source : moveit.ros.org

Configuring the URDF with MoveIt!

- Configuring the robot urdf with MoveIt! setup assistant
- Interfacing the MoveIt! with Gazebo simulation



[9] Gazebo and rviz Pose marker moveit enabled

Marvin Test Cases

Distance Test Case

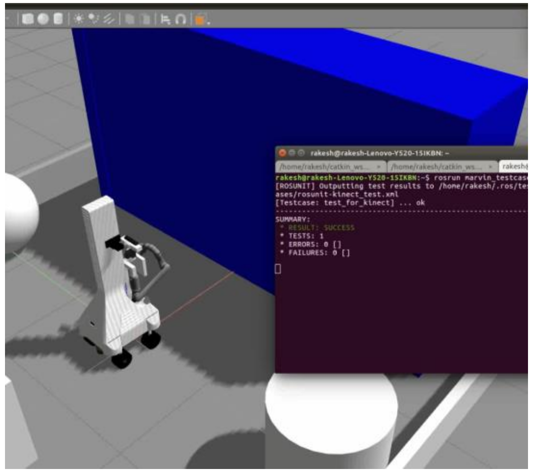
- To move the robot to a predefined distance and test if robot has reached the distance

Kinect Test

- To check the presence of the object in the vicinity of Robot using the Kinect

Laser Test

- To check if the object kept at known distance is found



[10] Kinect test with spawned object

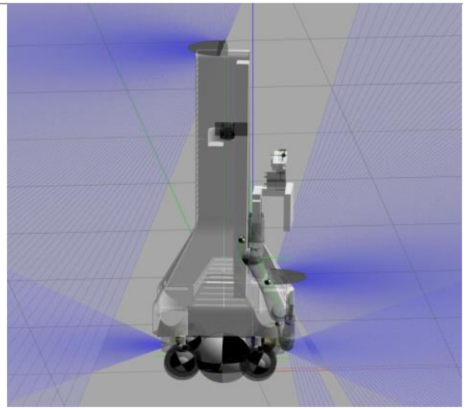
Marvin Test Cases

Linear Actuator Test

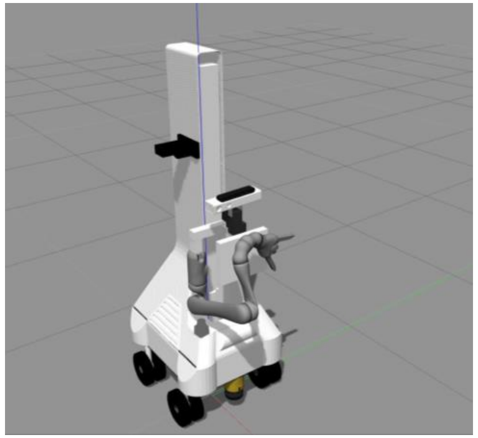
- The Linear actuator position is determined using the test case

PTU Pan/Tilt Test

- The Pan/Tilt rotation of the PTU is checked and tested.



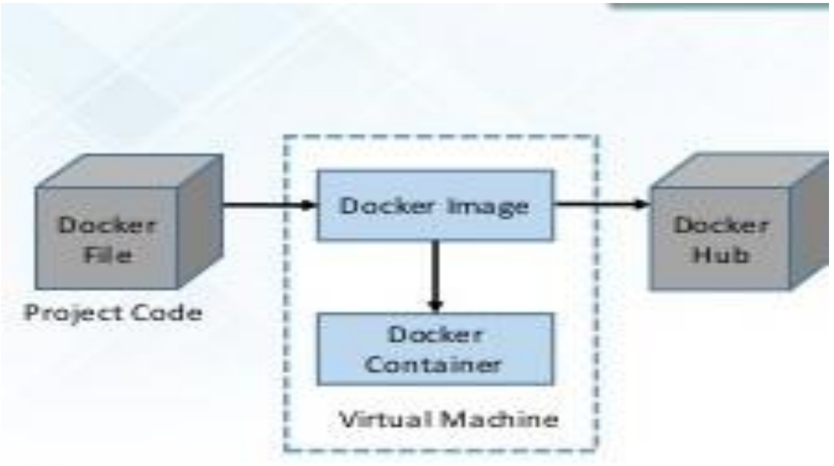
[11] Linear actuator positions



[12] PTU pan and tilit positions

Docker

- This dockerized image of Marvin Simulation Robot model is stored registry 141.69.58.19
- The base image of the Marvin robot was Integrated with Marvin simulation
- Image composed with all the necessary additional Dependencies



[13] Source: hub.docker.com/gazebo

Conclusion

- Enabled the capabilities of the Robot Model in simulation environment mimicking the actual robot
- The docker image for the Marvin simulation with gazebo and ros tools prepared
- Automated testing of the Functionalities of the Robot is performed

Scope for Future Work

- Further test cases such as navigation and manipulation tests on the robot can be performed
- Multiple goal publisher to the move_base and track total distance

Literature References

- [1] Kenta Takaya, Toshinori Asai, "*Simulation Environment for Mobile Robots Testing", Using ROS and Gazebo",* 2016 20th International Conference on System Theory, Control and Computing (ICSTCC)
- [2], Sachin Chitta, 11, Eitan Marder-Eppstein1, "*ros_control: A generic and simple control framework for ROS",* JOSS (Journal for Open Source Software),
- [3], [4] Ian Mackenzie , 2006 FIRST Robotics Conference (Updated 2010-02-21), "*omni-Directuional Drive systems"*
- [3], [4] http://www.chiefdelphi.com/media/photos/14646, "*Swerve with unpowered omni wheels"*
- [5] *Mastering ROS for Robotics Programming ,Second Edition by* Lentin Joseph and Jonathan Cacace.

THANK YOU