UNIVERSITÄT SIEGEN

Faculty of Natural Sciences and Engineering
University of Siegen

STUDIENARBEIT

3D SLAM-Based Navigation of an Autonomous Mobile Robot Using Kinect Camera and ROS

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Agenda

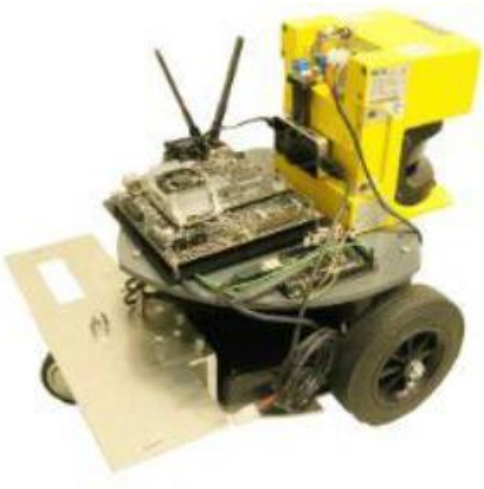
- Motivation
- System Architecture
- System Implementation
- Results
- Conclusion
- Future Work

Motivation

Previous work: SLAM- based navigation of an Autonomous mobile robot using 2D Lidar and ROS by Harsha

Drawbacks :

- Only 2D mapping .
- Less accuracy of Robot's Pose.

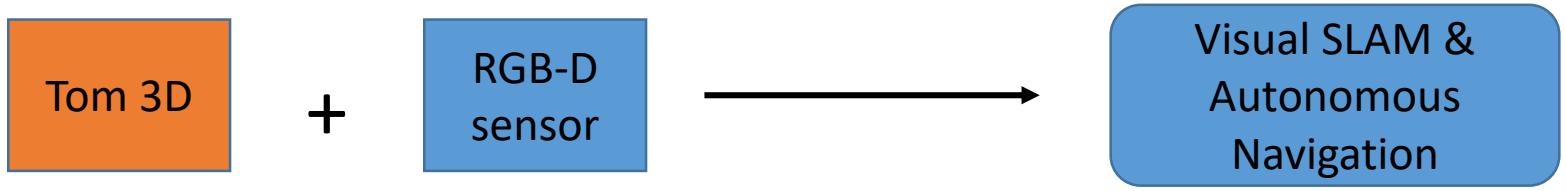


Tom 3D with LIDAR

Objective

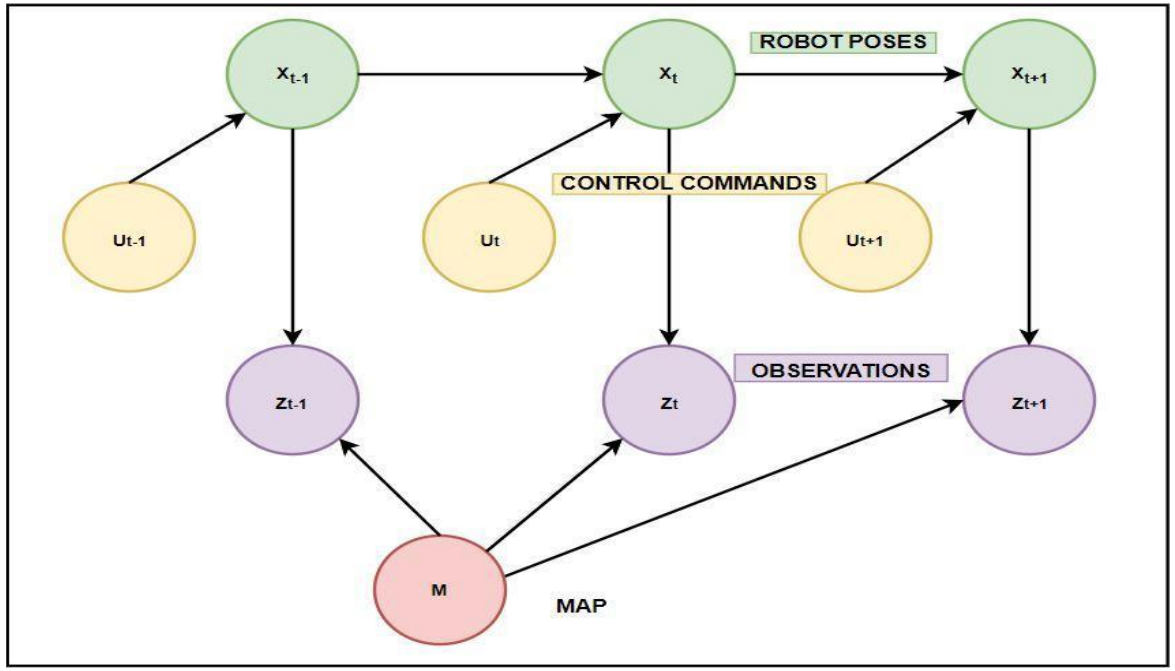
TOM3D - Tele Operated Machine is a differential drive mobile robot developed by the chair of automatic control and engineering, University of Siegen

“The main objective of this project is to enhance Tele Operated Machine Robot (TOM3D-Robot) navigation system to autonomously navigate using visual SLAM by a Kinect RGB-D Camera and ROS framework. “



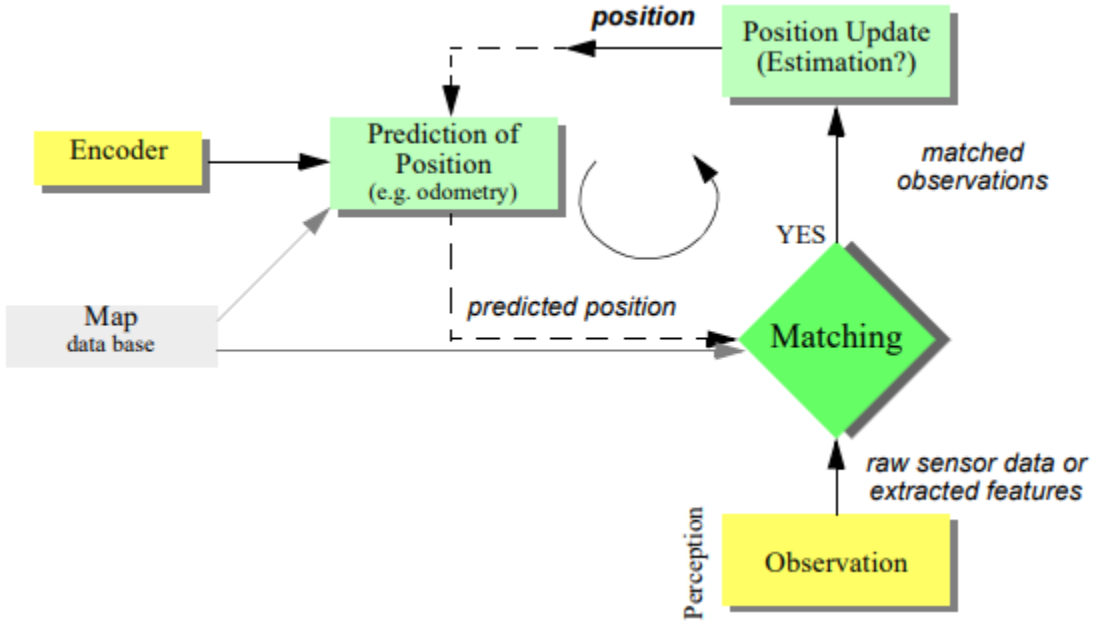
SLAM

Simultaneous Localization and Mapping



Schematic model of SLAM [4]

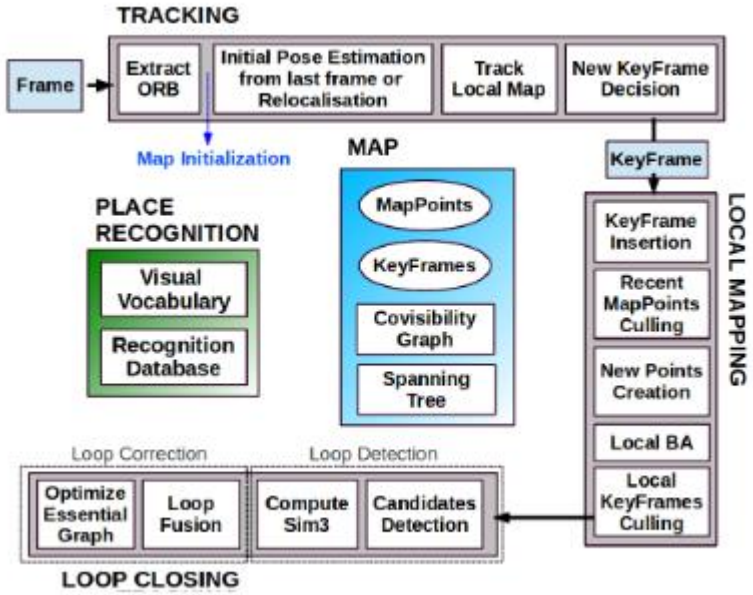
Localization



Schematic of localization [5]

Visual SLAM

Visual SLAM (vSLAM) uses sensor data from a vision based RGB-D sensor and performs Mapping and Localization tasks.

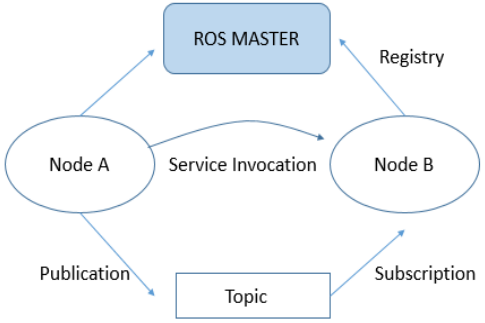


Schematic of vSLAM [6]

ROS

The Robot Operating System (ROS) is a framework used for robot software development.

- Nodes.
- Topics.
- Messages.



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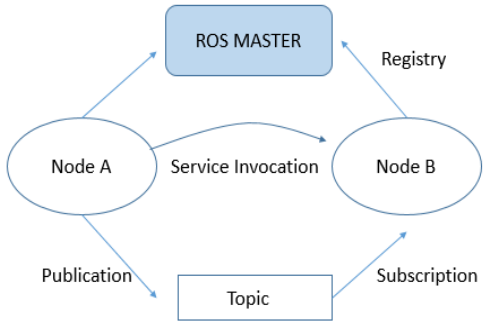
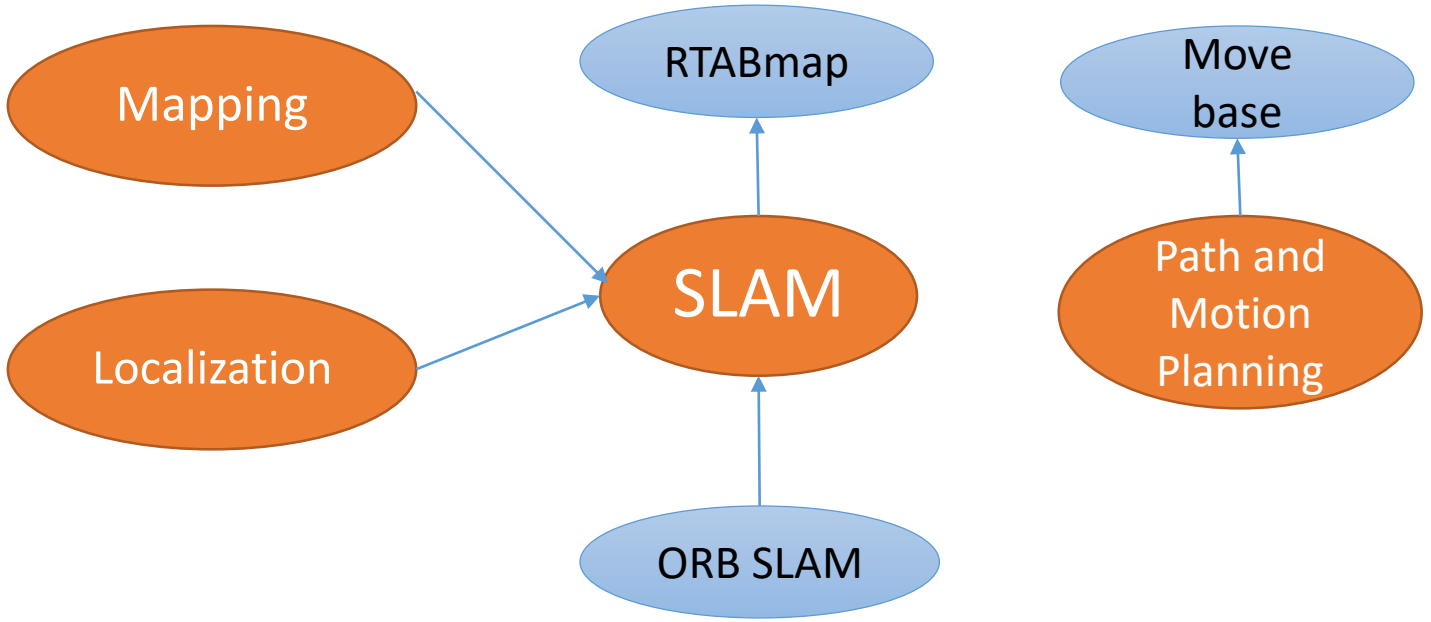
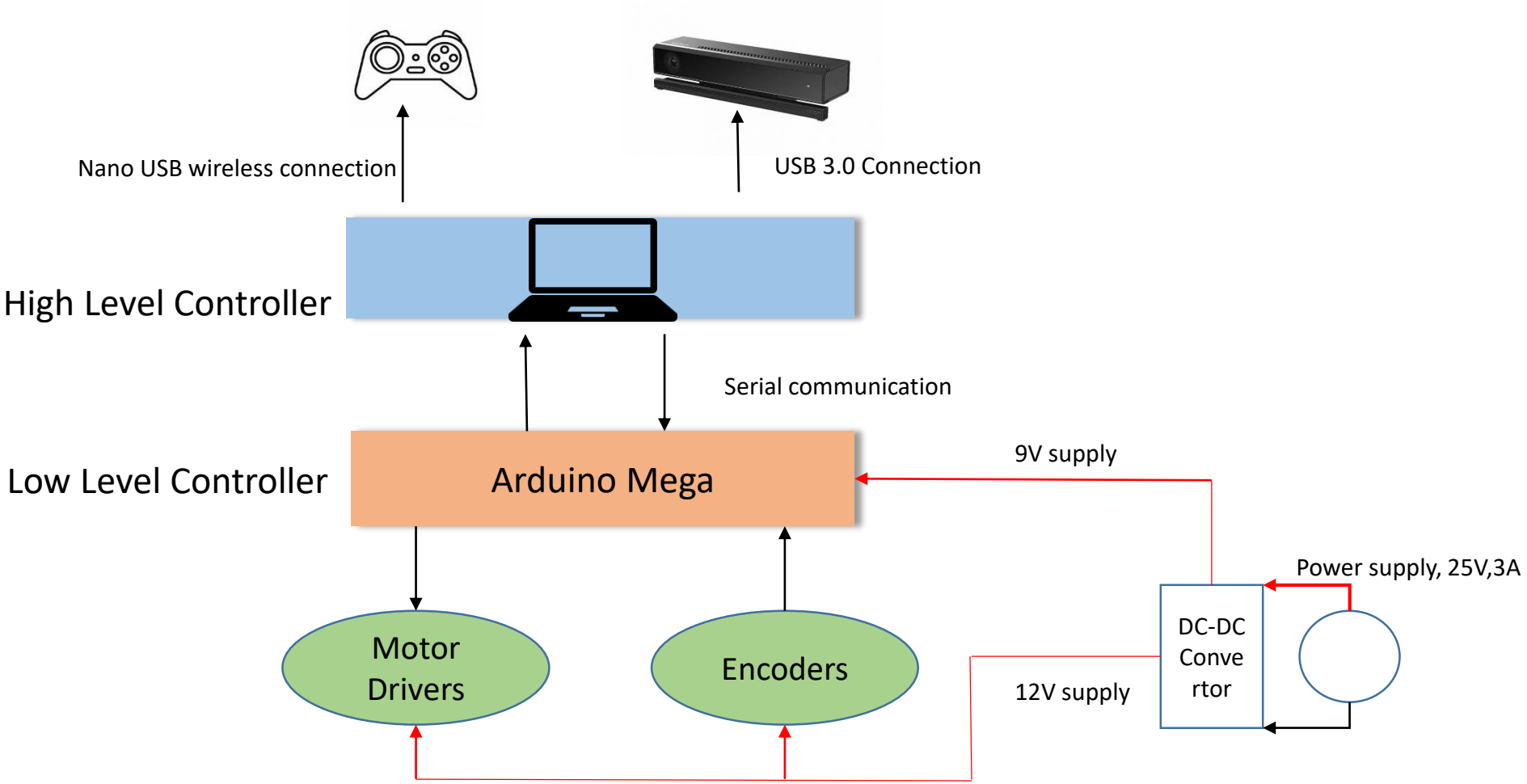




Packages used in Project

System Architecture

System Architecture



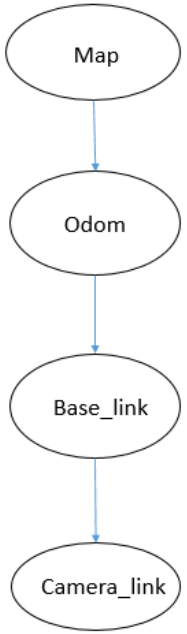
Kinect V2 camera

Kinect is an RGB-D camera developed by PrimeSense - an expert company in high-performance 3D machine vision technologies and licensed by Microsoft.

- RGB Data and
- Depth Data

Camera Integration

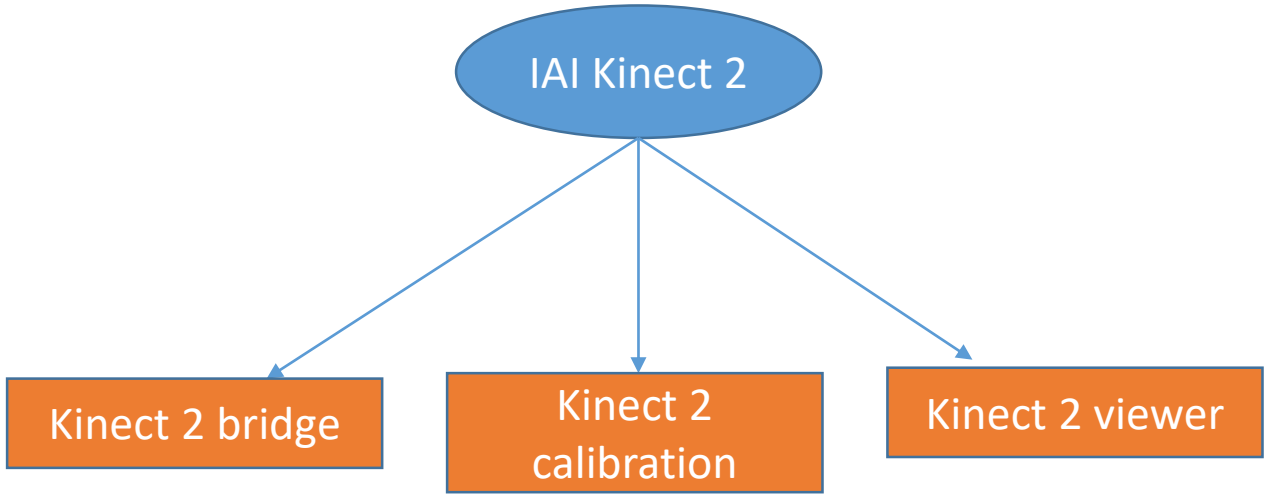
Kinect Camera is mounted on the TOM3D robot . Camera is programmatically integrated through Tf Frames.



Kinect-ROS Interface

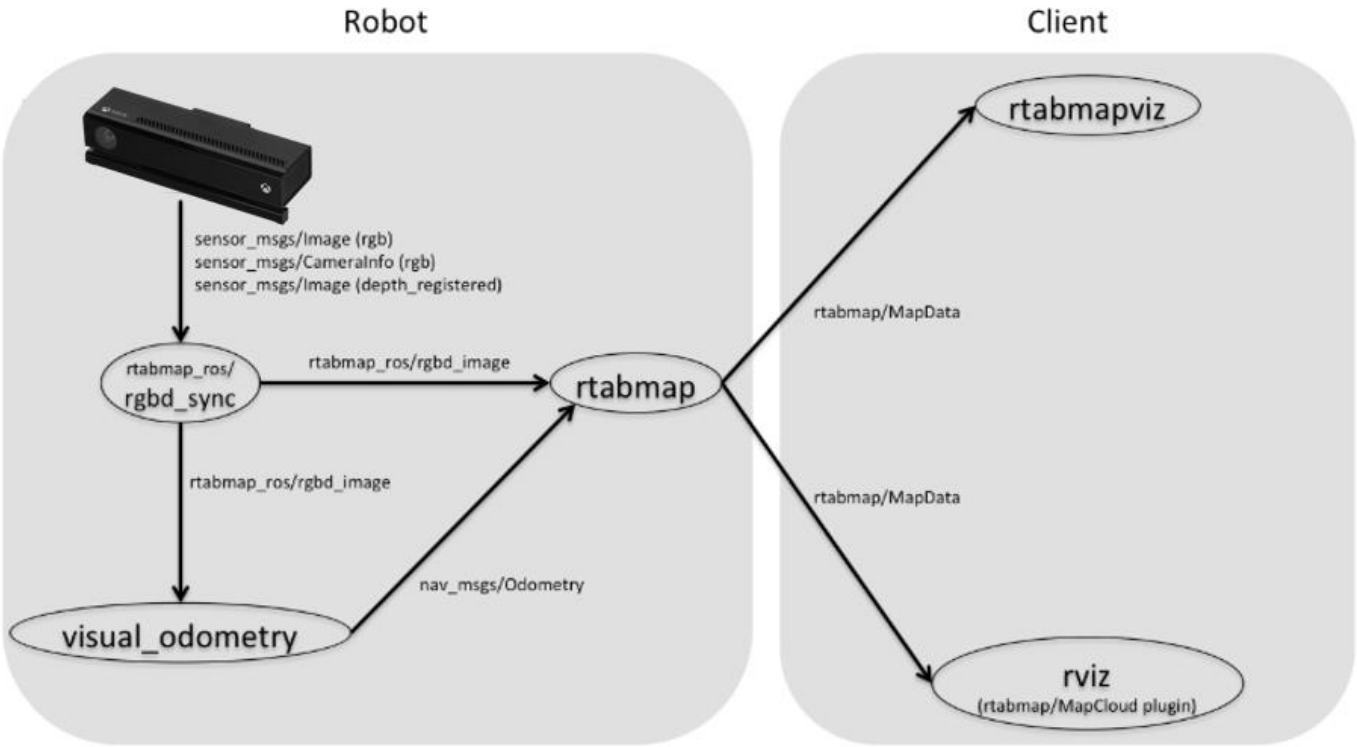
Kinect V2 RGB-D camera

- *libfreenect2* - Kinect driver.
- IAI Kinect 2 ROS wrapper.



Rtabmap

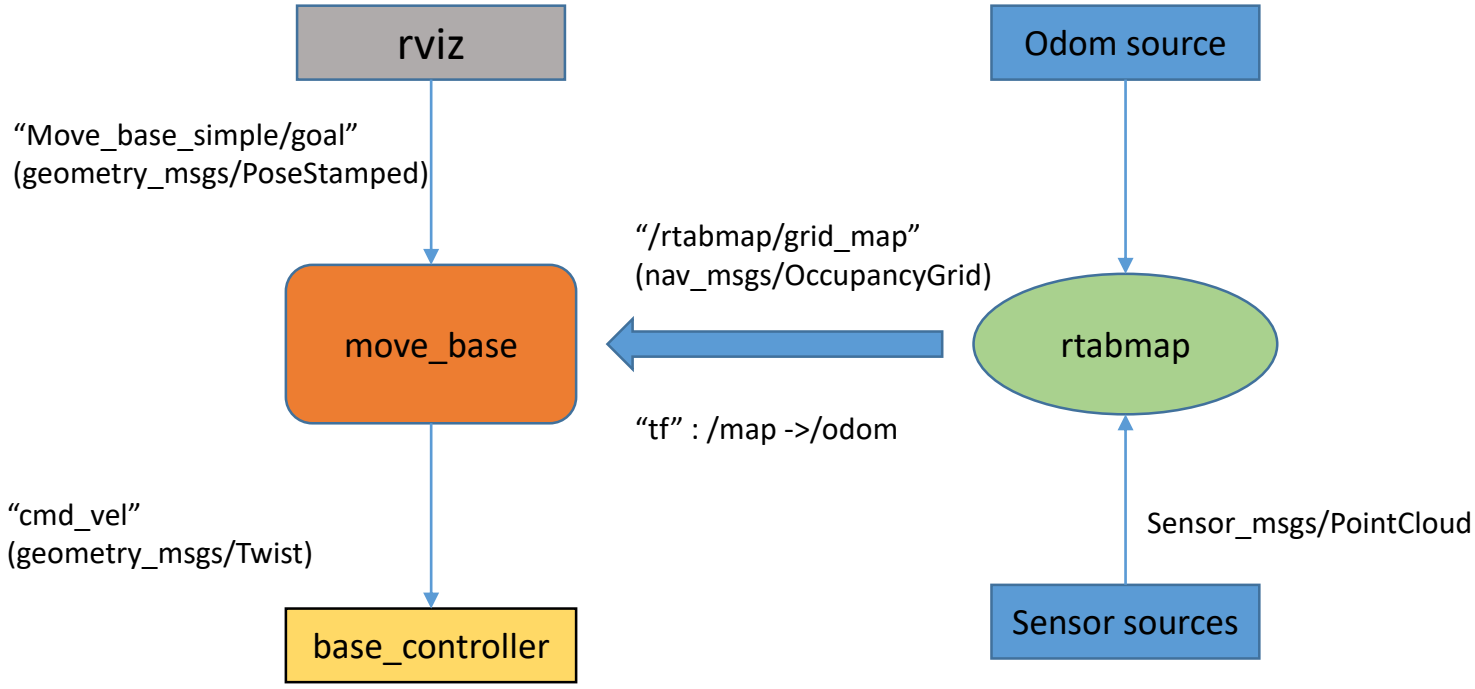
Rtabmap is the package used for SLAM in this project



Rtabmap node [7]

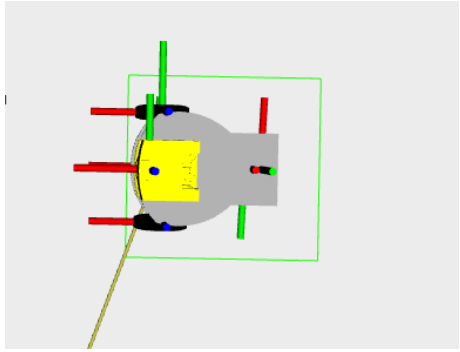
System Implementation

ROS Navigation package

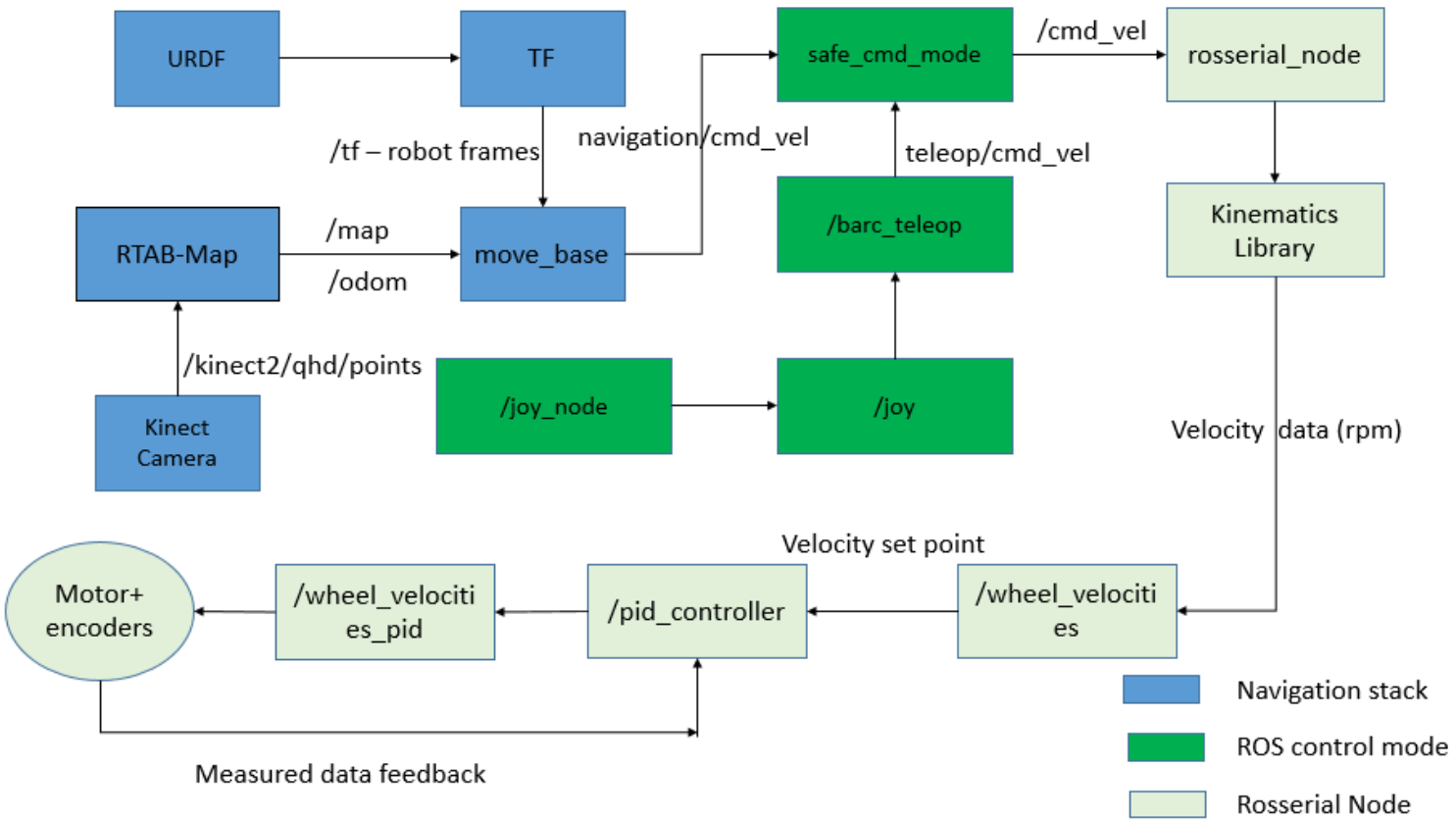


Navigation system setup

- Global planner
  - Navfn global planner.
  - Path depends on cost value of grid.
- Local planner
  - Eband local planner
- Local costmap parameters
  - Footprint
  - Inflation layer
  - Costmap resolution
  - Obstacle layer



Software Architecture



System software architecture

Results

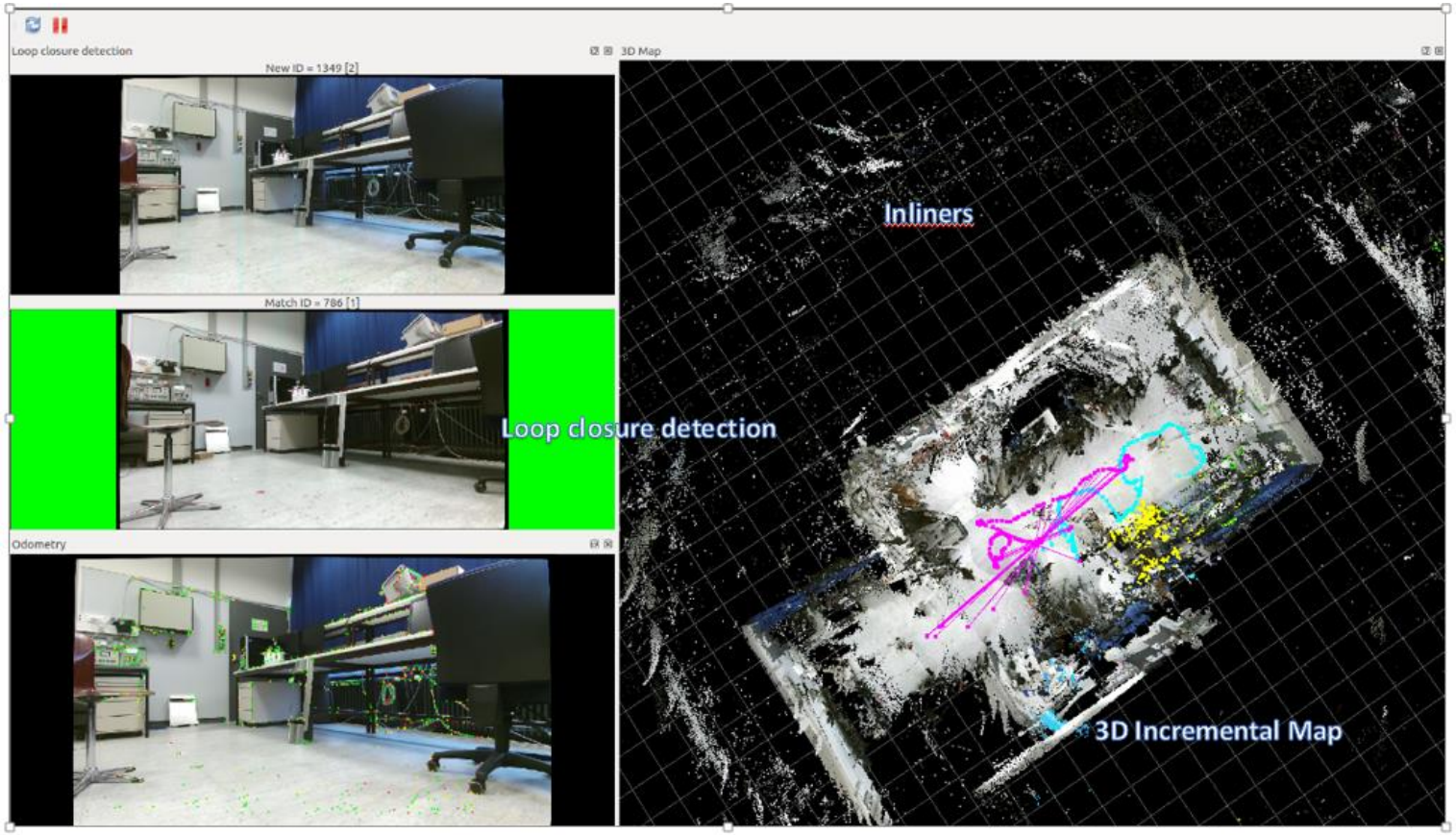
Results

- Areas Mapped with the Tom3D robot using Kinect V2 camera.

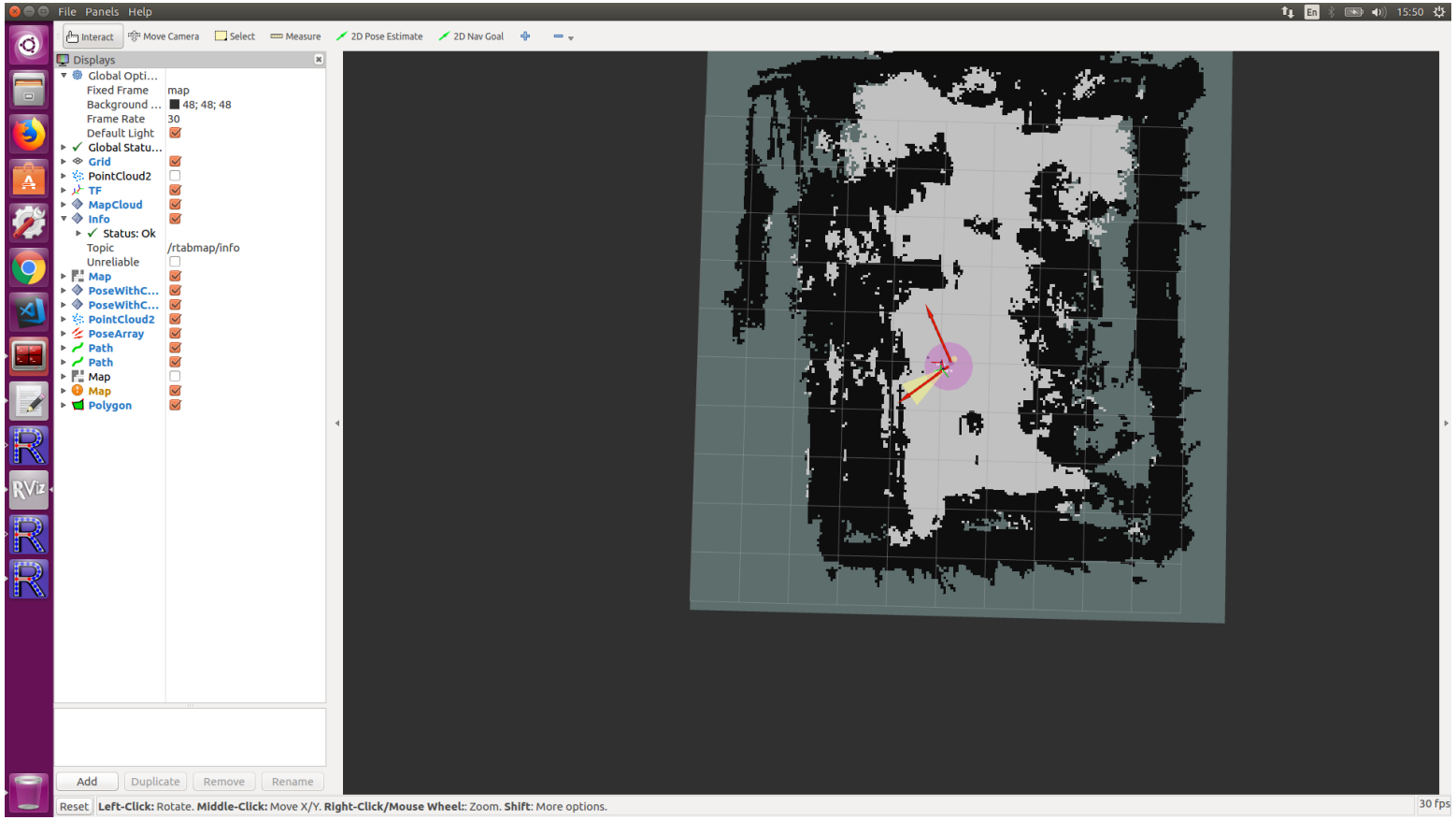
- Localization accuracy.
  - Case 1: Started at (0,0) and transverse to different (x,y).
  - Case 2: Robot is moved to random locations in the lab.

- Autonomous navigation performance of TOM3D robot.

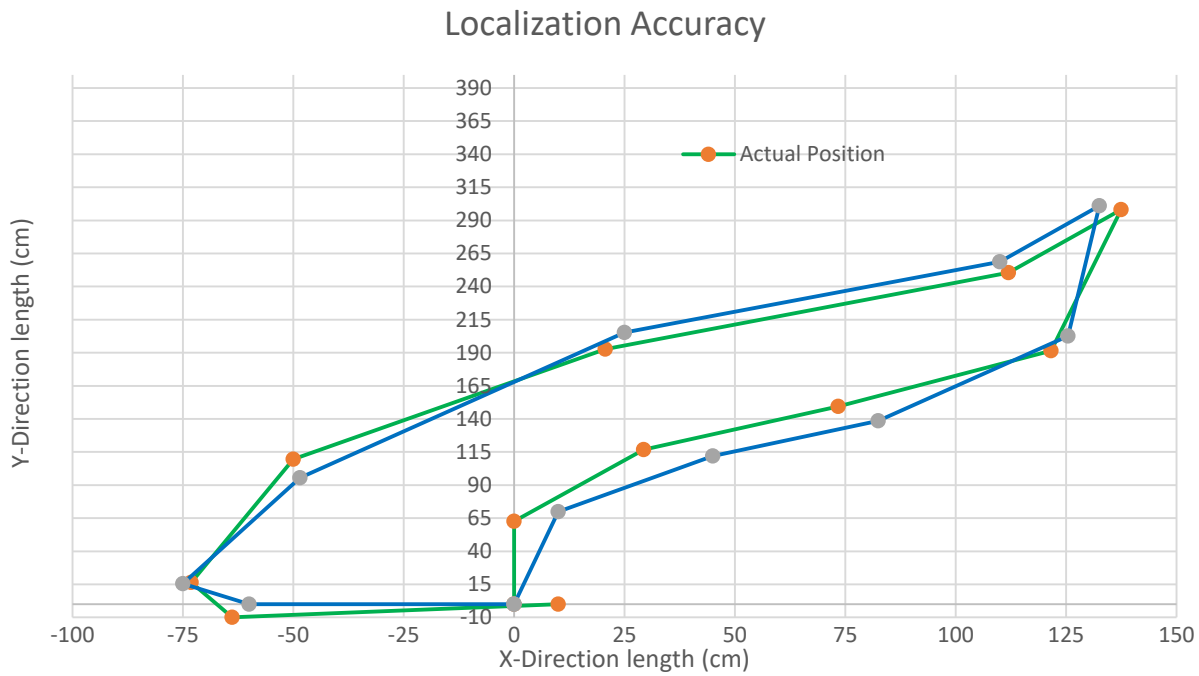
Map generation



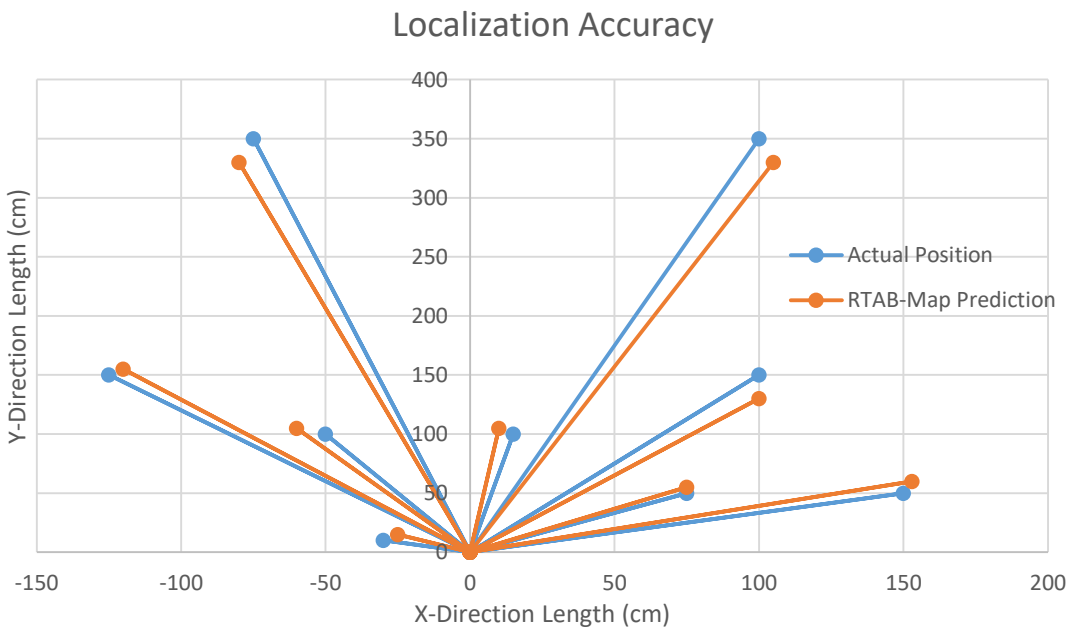
Grid Map


File Panels Help
Interact
Move Camera
Select
Measure
2D Pose Estimate
2D Nav Goal
Displays
Global Opti...
Fixed Frame
map
Background ...
48; 48; 48
Frame Rate
30
Default Light
Global Statu...
Grid
PointCloud2
TF
MapCloud
Info
Status: Ok
Topic
/rtabmap/info
Unreliable
Map
PoseWithC...
PoseWithC...
PointCloud2
PoseArray
Path
Path
Map
Map
Polygon
Add
Duplicate
Remove
Rename
Reset
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel:: Zoom. Shift: More options.
30 fps

Localization accuracy Case1



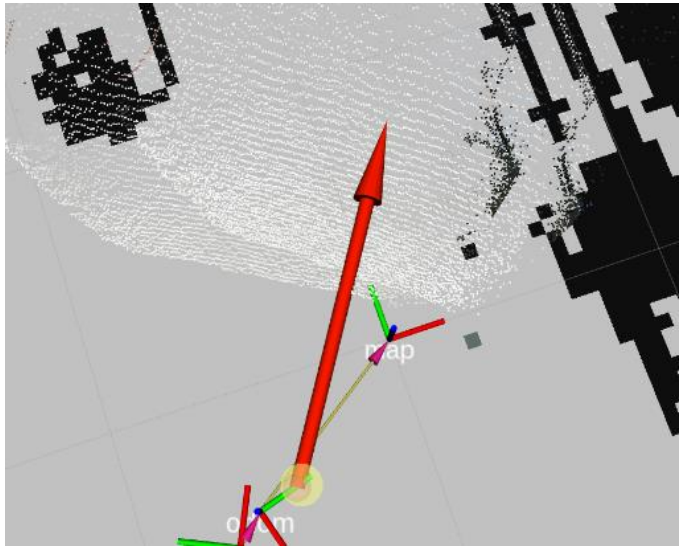
Localization accuracy Case2



Dynamic obstacle test

Obstacles are places dynamically while the robot is moving autonomously.

Dynamic obstacles are placed



Costmap not updated

Conclusion

- Developed SLAM based autonomous navigation system.
- Tested in different environments.
- Used system implementation is unable to detect dynamic obstacles.

Future work

- Sensor fusion of 2D laser scan data with 3D point cloud data.
- Fusion of visual odometry with IMU and wheel encoder odometry.

References

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[4] C. Stachniss, „SLAM,“ [Online]. Available: http://ais.informatik.unifreiburg.de/teaching/ws12/mapping/pdf/slam10-fastslam-4.pdf.

[5] A. M. B. Pradeep, „Construction of a 3D Map of Indoor Environment,“ *6th International Conference on Smart Computing and Communications, ICSCC 2017,* 2017.

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[6] R. M. J. M. M. &. T. J. D. (. Mur-Artal, „ORB-SLAM: a versatile and accurate monocular SLAM system," *IEEE transactions on robotics, 31(5),* pp. 1147-1163.

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THANK YOU