

Bachelors of Engineering

Project presentation



**Department of Electronics Engineering
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UNIVERSITY OF MUMBAI
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A PRESENTATION ON

ROBOT DEVELOPMENT USING ROS

By

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Problem Statement

To explore the ROS framework and implementing a quadcopter running ROS to create a 3D map of the real time environment that it sees using a depth sensor (Microsoft Kinect).

Abstract

This project deals with exploring the ROS framework for

- Development of a robotic system with various sensors and actuators
- To develop a quadcopter capable of forming a 3D map of an indoor environment using a depth camera (Microsoft Kinect)

Introduction

What is ROS?

What is Microsoft Kinect?

What are the challenges?

Project Objectives

- Learn the ROS framework
- Understand and implement SLAM algorithms for 3D mapping
- Understand the interfacing of different hardware components with ROS packages
- Combine the software and hardware components to create a stand-alone quadcopter for 3D mapping

Literature Survey

- Huang et al. (2011). *Visual Odometry For GPS-Denied Flight And Mapping Using A Kinect*. MIT, University of Washington. [Website](#).
- Shen S., Michael N., Kumar V. (2010). *Autonomous aerial navigation in confined indoor environments*. University of Pennsylvania. [YouTube](#).
- Alessio Tonioni (2015). *Autonomous quadcopter flight in ROS*. [GitHub Source](#).
- Will Selby (2016). *3D Mapping & Navigation with ROS*. [Website](#).
- Belavadi S., Beri R. (2017). *Indoor Environments Mapping using UAV*. [GitHub Source](#).

Software Requirements

- Ubuntu 16.04 (Xenial Xerus)
- ROS Kinetic Kame

Hardware Requirements

- RGB-D Camera (Microsoft Kinect)
- Quadcopter capable of lifting payload upto 1kgs
- Single Board Computer capable of running Ubuntu and ROS

Project Plan

Week	Objective
1 to 3	Installing ROS, Understanding the underlying concepts.
4 to 5	Interfacing the Microsoft Kinect sensor on Gazebo simulator.
6 to 8	Understanding Pointclouds and RTAB Map for real time environment mapping.
9	Interface the Kinect sensor for mapping of real world environments.

Results

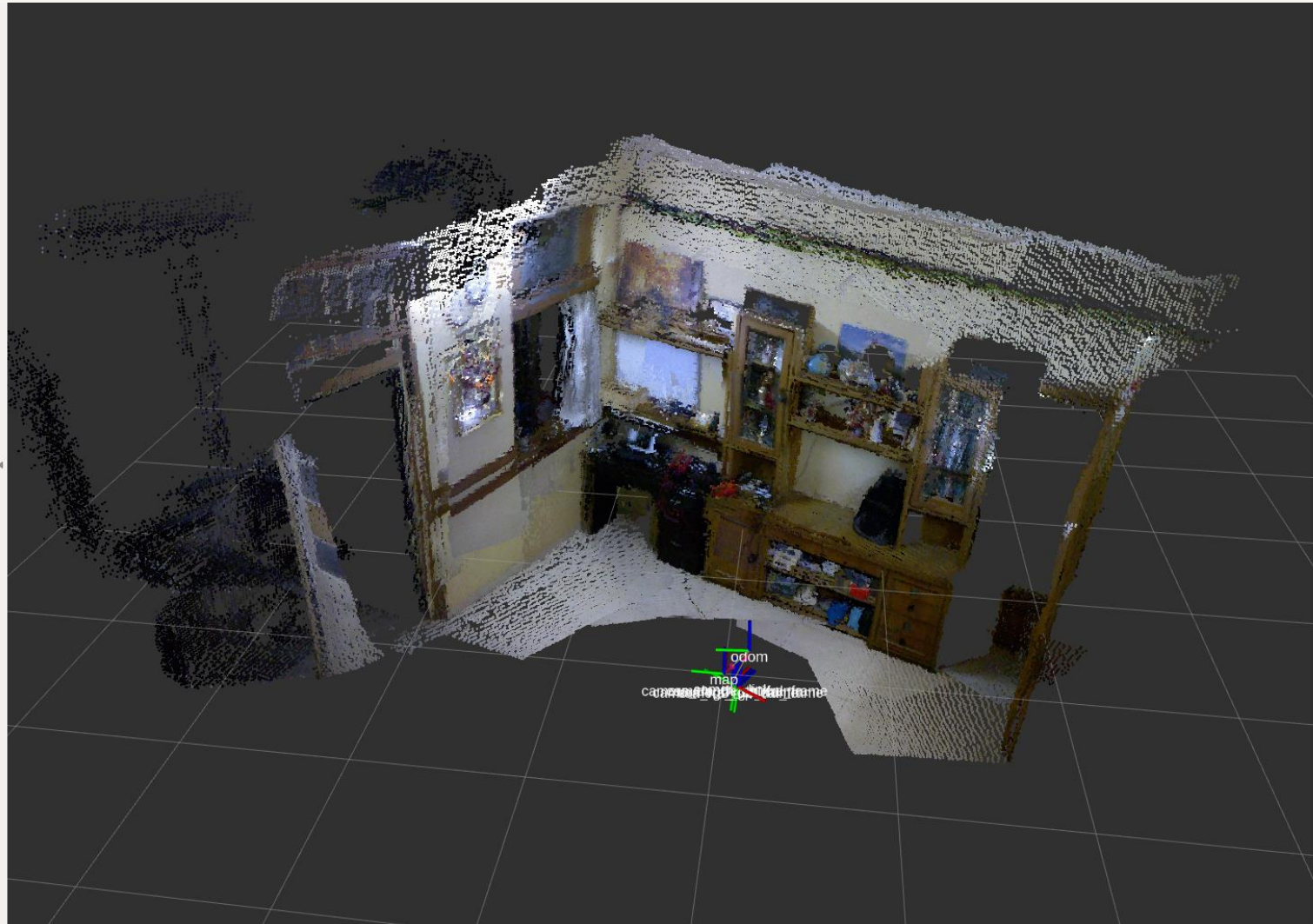
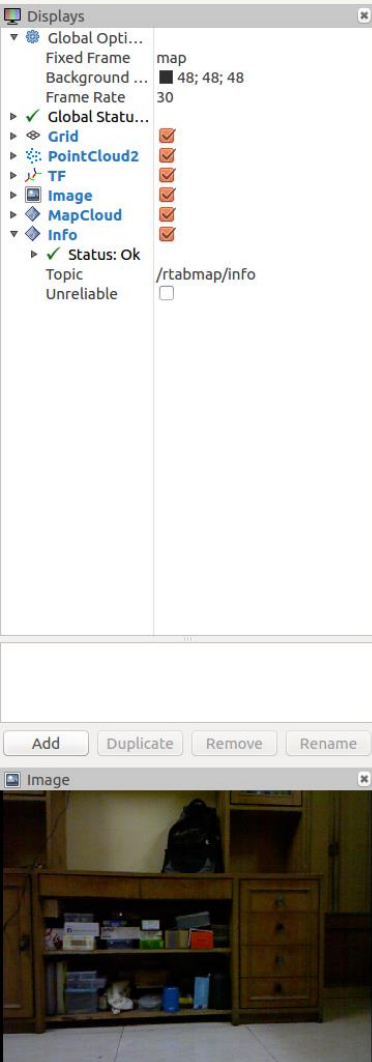
Work done up till now involves (August 4, 2017)

- Reading and understanding the framework of ROS
- Practicing ROS commands by following the official ROS wiki
- RTAB installation

- *“Give me six hours to chop down a tree and I will spend the first four sharpening the axe.”*
- Abraham Lincoln

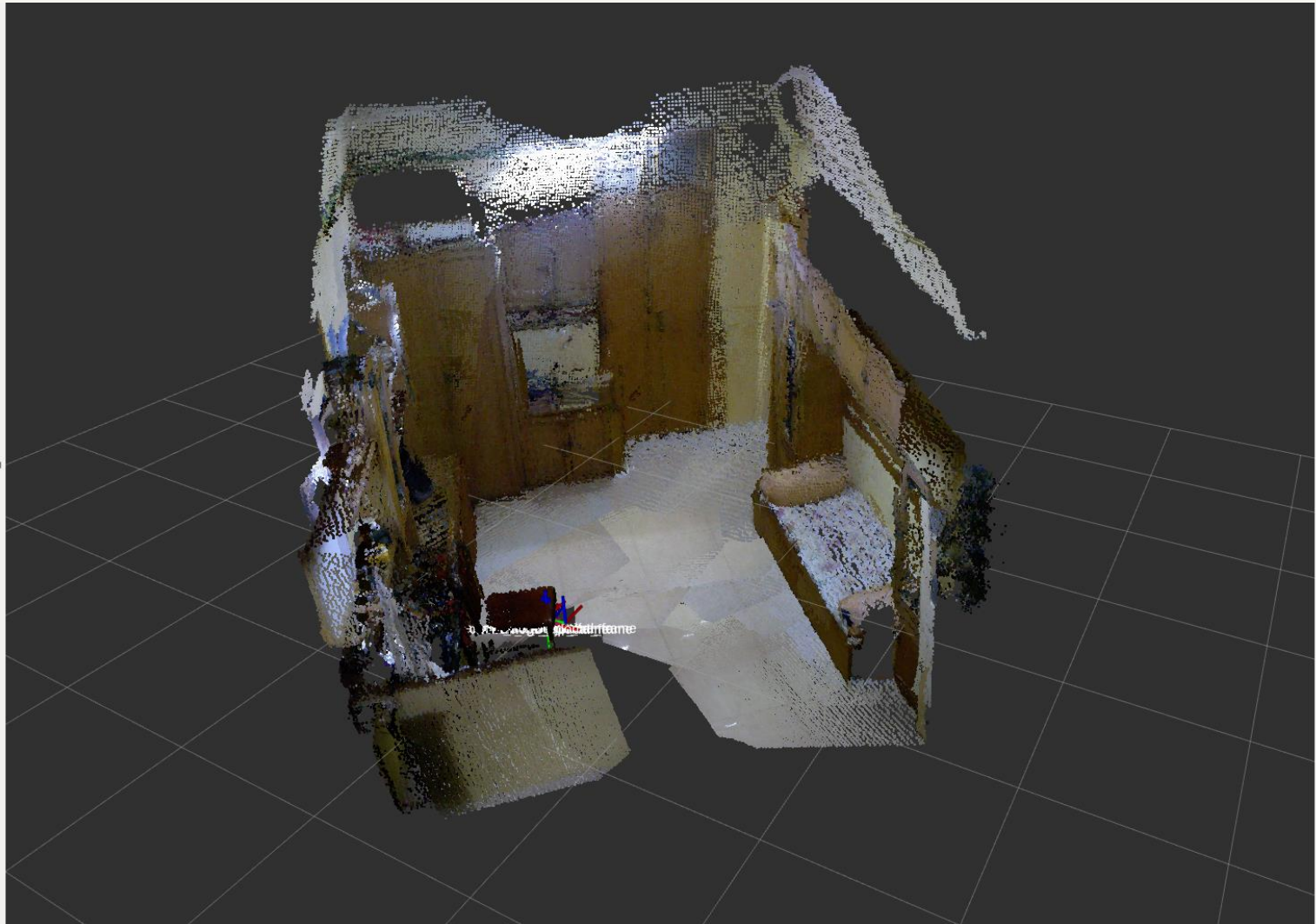
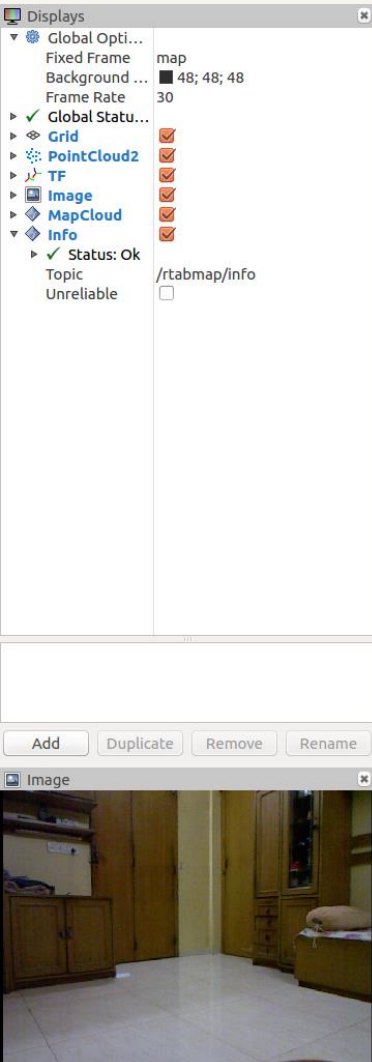
Results

Mapping using hand-held Kinect



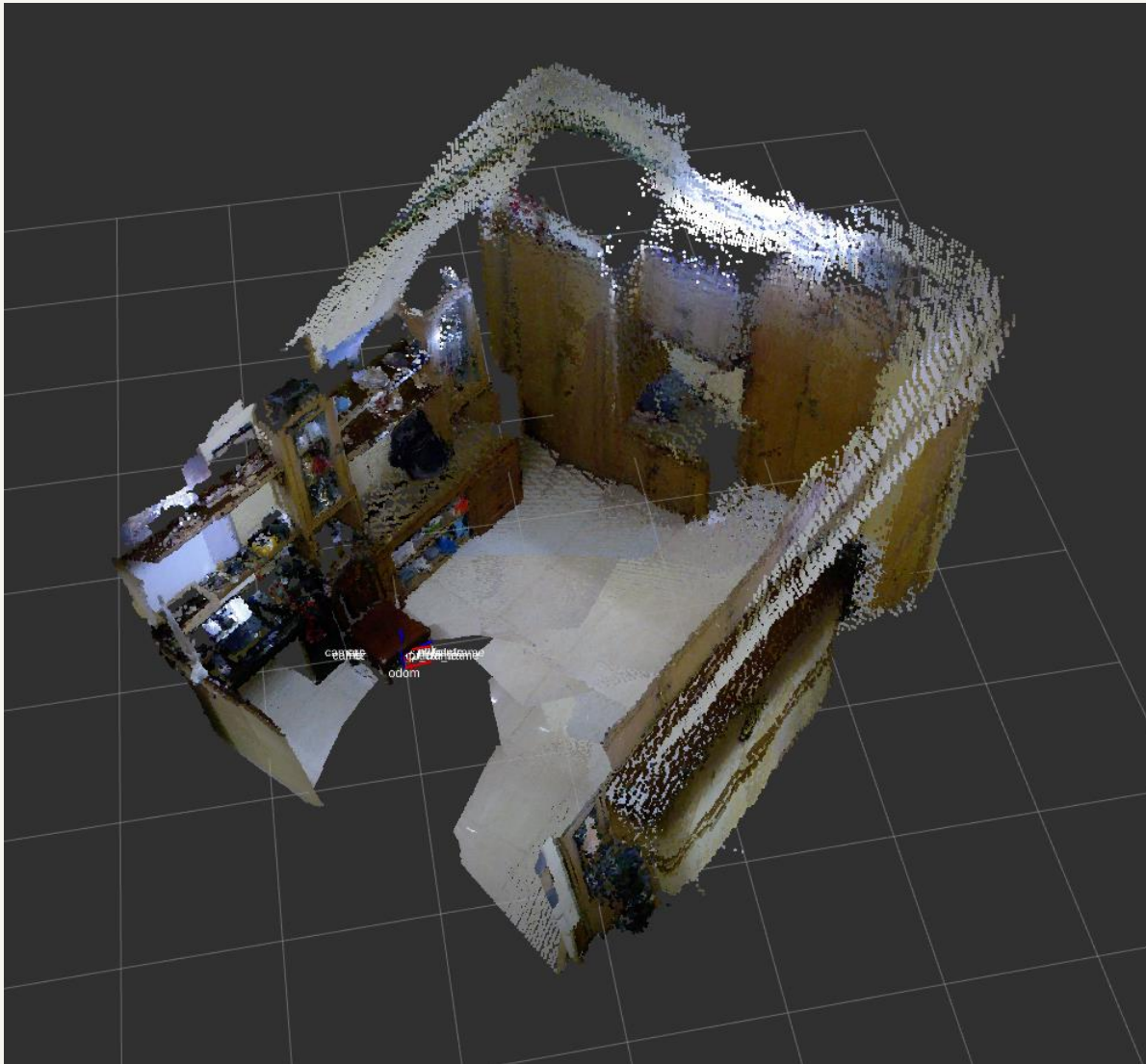
Results

Mapping using hand-held Kinect



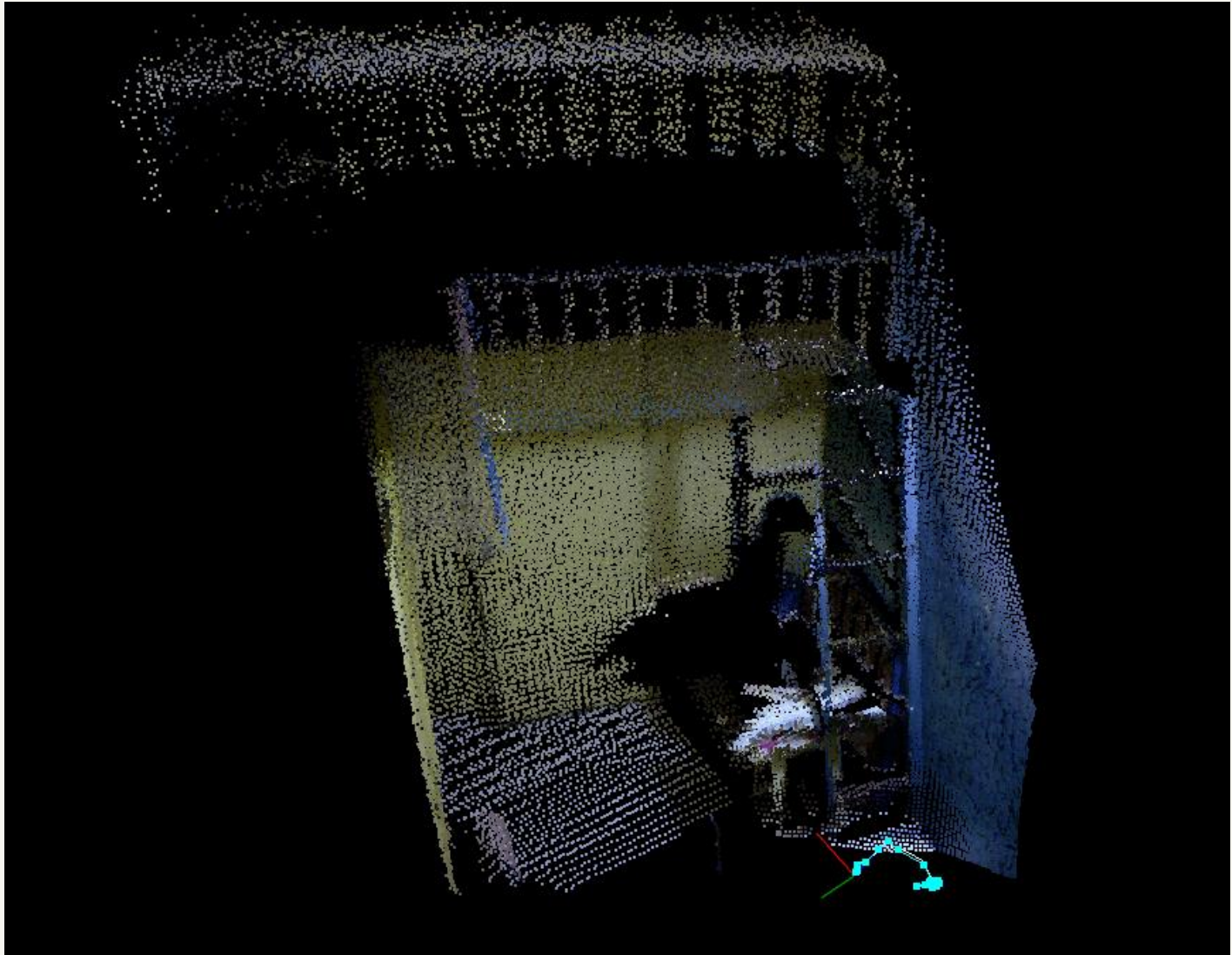
Results

Mapping using hand-held Kinect



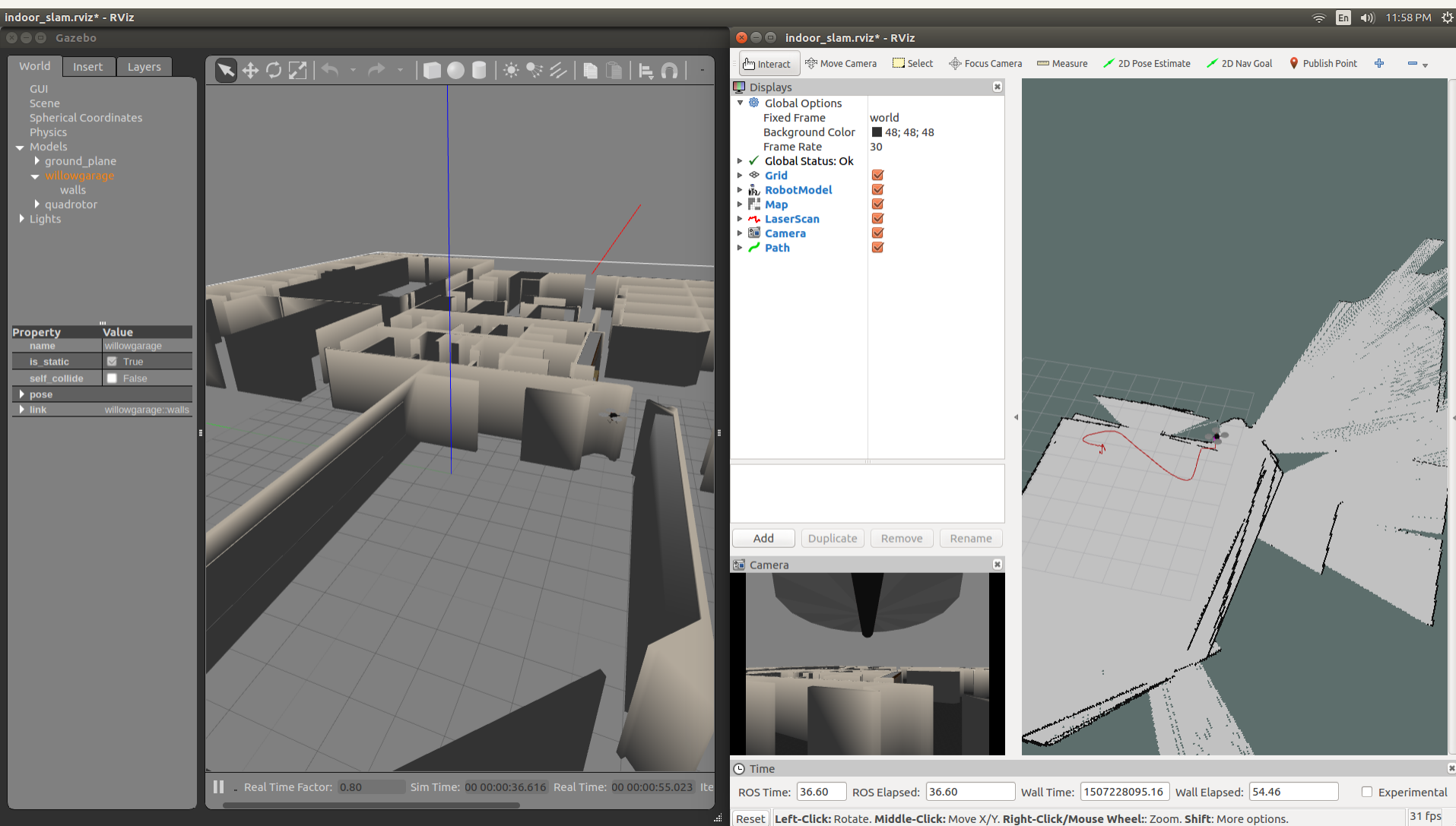
Results

Mapping using hand-held Kinect on RPi with mapping streamed to a PC



Results

Simulation using hector_quadrotor package on ROS Gazebo and RViz



Results

Interfacing RC Transmitter with ROS



Results

Quadrotor configuration planning

54R

Member Full Version

Quadrotor for 3D mapping

all data without guarantee - Accuracy: +/-15%

Calc

xcopterCalc - Multicopter Calculator

News | Toolbox | Easy View | Help | Tutorial | Submit Specs | Language: english

Welcome Srijal

Membership Expiry: 06/11/17

Logout - Profile

General

Cooling: good # of Rotors: 4
flat

Model Weight: 1500 g Incl. Drive: 17.72 inch

Frame Size: 450 mm

FCU Tilt Limit: no limit

Field Elevation: 500 m ASL 1640 ft ASL

Air Temperature: 25 °C 77 °F

Pressure (QNH): 1013 hPa 29.91 inHg

Battery Cell

Type (Cont. / max. C) - charge state: LiPo 5000mAh - 65/100C - normal

Configuration: 4 S 2 P

Cell Capacity: 5000 mAh 10000 mAh total

max. discharge: 65%

Resistance: 0.0022 Ohm

Voltage: 3.7 V

C-Rate: 65 C cont. 140 g 100 C max. 4.9 oz

Weight: 140 g 4.9 oz

Controller

Type: Turnigy 40 A max

Current: 40 A cont. 40 A max

Resistance: 0.006 Ohm

Weight: 50 g 1.8 oz

Accessories

Current drain: 1 A

Weight: 1000 g 35.3 oz

Motor

Manufacturer - Type (KV) Multistar 4108-600 (600)

KV (w/o torque): 600 rpm/V

no-load Current: 0.9 A @ 110 V

Limit (up to 15s): 400 W

Resistance: 0.095 Ohm

Case Length: 25 mm 1.02 inch

mag. Poles: 22

Weight: 111 g 3.9 oz

Propeller

Type - pitch twist APC Electric E 0°

Diameter: 12 inch 304.8 mm

Pitch: 4.5 inch 114.3 mm

Blades: 2

PConst / TConst: 1.08 / 1.0

Gear Ratio: 1 : 1

calculate

Load: 5.88 C

Hover Flight Time: 20.1 min

electric Power: 208.8 W

est. Temperature: 43 °C

Thrust-Weight: 1.7

specific Thrust: 6.99 g/W

Configuration

Remarks:

Battery

Load: 5.88 C

Voltage: 14.54 V

Rated Voltage: 14.80 V

Energy: 148 Wh

Total Capacity: 10000 mAh

Used Capacity: 8500 mAh

min. Flight Time: 8.7 min

Mixed Flight Time: 16.3 min

Hover Flight Time: 20.1 min

Weight: 1120 g 39.5 oz

Motor @ Optimum Efficiency

Current: 12.63 A

Voltage: 14.50 V

Revolutions*: 7855 rpm

electric Power: 183.1 W

mech. Power: 151.0 W

Efficiency: 82.5 %

Motor @ Maximum

Current: 14.45 A

Voltage: 14.45 V

Revolutions*: 7750 rpm

electric Power: 208.8 W

mech. Power: 172.0 W

Power-Weight: 334.1 W/kg

151.5 W/lb

Efficiency: 82.4 %

est. Temperature: 43 °C 109 °F

Motor @ Hover

Current: 6.11 A

Voltage: 14.65 V

Revolutions*: 1596 rpm

Throttle (log): 53 %

66 %

electric Power: 89.5 W

73.2 W

mech. Power: 144.6 W/kg

65.6 W/lb

Efficiency: 81.8 %

33 °C 91 °F

specific Thrust: 6.99 g/W 0.25 oz/W

Total Drive

Drive Weight: 1940 g 68.4 oz

Thrust-Weight: 1.7

Current @ Hover: 24.43 A

P(in) @ Hover: 361.5 W

P(out) @ Hover: 292.6 W

Efficiency @ Hover: 81.0 %

Current @ max: 57.79 A

P(in) @ max: 855.2 W

P(out) @ max: 688.1 W

Efficiency @ max: 80.5 %

Multicopter

All-up Weight: 2500 g 88.2 oz

add Payload: 1268 g 44.7 oz

max Tilt: 48 °

max. Speed: 32 km/h 19.9 mph

est. rate of climb: 4.6 m/s 906 ft/min

Total Disc Area: 29.19 dm² 452.45 in²

with Rotor fail: ❌

Wattmeter readings

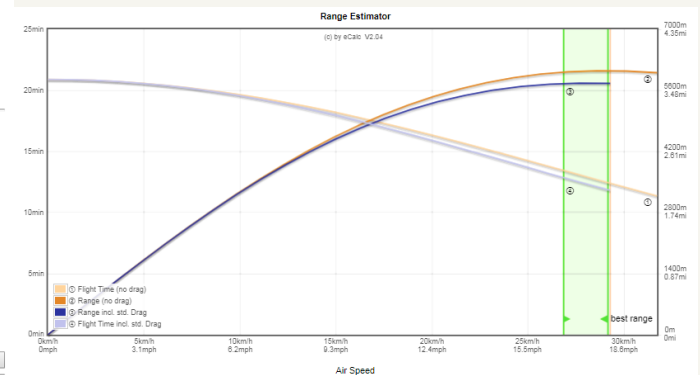
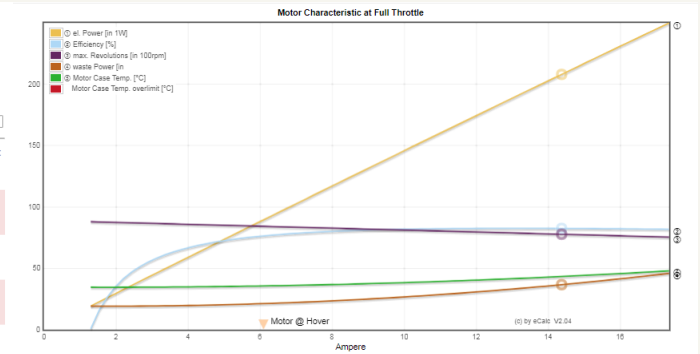
Current: 57.8 A

Voltage: 14.54 V

Power: 840.4 W

share

add to >> Download .csv (0) << clear



Challenges Faced

- Insufficient documentation of most packages.
- Difficulty in debugging when things go wrong.
- Lack of fundamentals and terminology in Robotics

Ongoing work

- Wireless streaming of map data over the ROS network.
- Selecting a light weight and small form-factor computer which can handle the required computations.
(RPi, ODROID XU4)
- Designing the quadrotor.

References

- Official ROS Documentation : <http://wiki.ros.org/>
- ROS Forums : <https://answers.ros.org>
- Quigley, M., Gerkey, B. and Smart, W. (2015). *Programming robots with ROS*. Sebastopol, California: O'Reilly Media.

THANK YOU