Multi-Robot Control (MRC)

Assignment 5
Assignment 5 Notes

• Time Synchronization
• tf : Coordinate frame transforms
• Mapping
• navigation stack
  – Localization (amcl)
  – Path Planning (move_base)
Time Sync

Distributed system: Laptop and Turtlebot
- Need to keep system time in sync

Network Time Protocol (NTP)
- Local GPS time server on lab wifi (192.168.11.148)
Time Sync

Turtlebot
- Manual: `sudo ntpdate 192.168.11.148`
- Automatic – via cron job, every 5 minutes
  - `sudo crontab -e`
  - `*/5 * * * * /usr/sbin/ntpdate 192.168.11.148`  
    `>/var/log/ntpdate.log 2>&1`

Laptop
- Manual
  - `sudo service ntp stop`
  - `sudo ntpdate 192.168.11.148`
  -
tf Coordinate frame transforms

Teleoperation – Location relative to arbitrary “odom” coordinate frame.
rosrun rqt_tf_tree rqt_tf_tree

Recorded at time: 1556723397.18

`odom`

- Broadcaster: /turtiebot3_core
- Average rate: 30.189
- Buffer length: 1.722
- Most recent transform: 1556723397.12
- Oldest transform: 1556723395.39

`base_footprint`

- Broadcaster: /robot_state_publisher
- Average rate: 10000.0
- Buffer length: 0.0
- Most recent transform: 0.0
- Oldest transform: 0.0

`base_link`

- Broadcaster: /robot_state_publisher
  - Average rate: 10000.0
  - Buffer length: 0.0
  - Most recent transform: 0.0
  - Oldest transform: 0.0

- Broadcaster: /robot_state_publisher
  - Average rate: 30.208
  - Buffer length: 1.754
  - Most recent transform: 1556723397.12
  - Oldest transform: 1556723395.36

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`base_scan`

`wheel_right_link`

`wheel_left_link`

`imu_link`

`caster_back_link`
tf Coordinate frame transforms

During Mapping:
• Gmapping provided localization solution relative to the “map” coordinate frame.

During Localization
• AMCL provides localization solution relative to a given “map” coordinate frame.
navigation

navigation stack

navigation: amcl | base_local_planner | carrot_planner | clear_costmap_recovery | costmap_2d | dwa_local_planner | fake_localization | global_planner | map_server | move_base | move_base_msgs | move_slow_and_clear | nav_core | navfn | rotate_recovery | voxel_grid

Package Summary

✓ Released  ✓ Continuous Integration: 91 / 91  ✓ Documented

A 2D navigation stack that takes in information from odometry, sensor streams, and a goal pose and outputs safe velocity commands that are sent to a mobile base.

- Maintainer status: maintained
- Maintainer: Michael Ferguson <mfergs7 AT gmail DOT com>, David V. Lu!!
Navigation stack rosgraph

```
/particlecloud

/initialpose
/amcl
/tf

/cmd_vel
/turtlebot3_core
/joint_states
/sensor_state
/firmware_version
/turtlebot3_diagnostics

/robot_state_publisher
/tf_static

/move_base

/move_base/simple
/move_base_simple/goal

/map_server
/map

/move_base
/move_base/local_costmap/costmap_updates
/move_base/global_costmap/global_plan
/move_base/DWAPlanerROS/global_plan
/move_base/local_costmap/footprint
/move_base/global_costmap/costmap
/move_base/local_costmap/costmap
/move_base/local_costmap/costmap
/move_base/global_costmap/costmap
/move_base/goal
/move_base/DWAPlanerROS/local_plan
/move_base/global_costmap/footprint
/move_base/global_costmap/costmap_updates
/move_base/DWAPlanerROS/local_plan

/turtlebot3_liquid
/scan
```
https://vimeo.com/333568064