

9장. 세계 지도 구축

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목차

- ROS 지도 정보
- rosbag 사용법
- 지도 구축: gmapping & map_server 패키지
- 지도 보기: map_server 패키지

ROS 지도 정보

- URL: http://wiki.ros.org/map_server
- YAML 형식

```
image: testmap.png
resolution: 0.1
origin: [0.0, 0.0, 0.0]
occupied_thresh: 0.65
free_thresh: 0.196
negate: 0
```

Required fields:

- **image** : Path to the image file containing the occupancy data; can be absolute, or relative to the location of the YAML file
- **resolution** : Resolution of the map, meters / pixel
- **origin** : The 2-D pose of the lower-left pixel in the map, as (x, y, yaw), with yaw as counterclockwise rotation (yaw=0 means no rotation). Many parts of the system currently ignore yaw.
- **occupied_thresh** : Pixels with occupancy probability greater than this threshold are considered completely occupied.
- **free_thresh** : Pixels with occupancy probability less than this threshold are considered completely free.
- **negate** : Whether the white/black free/occupied semantics should be reversed (interpretation of thresholds is unaffected)

Optional parameter:

- **mode** : Can have one of three values: trinary, scale, or raw. Trinary is the default. More information on how this changes the value interpretation is in the next section.

rosvag 명령어

- ROS 메시지를 저장하고 재생해주는 도구: record, play, info 등
- URL: <http://wiki.ros.org/rosvag/Commandline>
- 사용 목적: 로봇 기능 개발 시 한 번의 하드웨어 조작으로 bag file을 생성하면 그 다음부터는 소프트웨어적으로 반복하여 효과적인 기능 개발 가능
- 카메라 영상 정보를 저장할 경우 저장 공간이 충분히 커야 함.

```
jongmin@ubuntu:~$ rosvag -h
Usage: rosvag <subcommand> [options] [args]

A bag is a file format in ROS for storing ROS message data. The rosvag command can record, replay and manipulate bags.

Available subcommands:
  check      Determine whether a bag is playable in the current system, or if it can be migrated.
  compress   Compress one or more bag files.
  decompress Decompress one or more bag files.
  filter      Filter the contents of the bag.
  fix        Repair the messages in a bag file so that it can be played in the current system.
  help
  info       Summarize the contents of one or more bag files.
  play       Play back the contents of one or more bag files in a time-synchronized fashion.
  record     Record a bag file with the contents of specified topics.
  reindex    Reindexes one or more bag files.

For additional information, see http://wiki.ros.org/rosvag
```

rosvag 사용 예

Terminal 1:

```
$ roscore
```

Terminal 2:

```
$ roslaunch turtlebot_gazebo turtlebot_world.launch
```

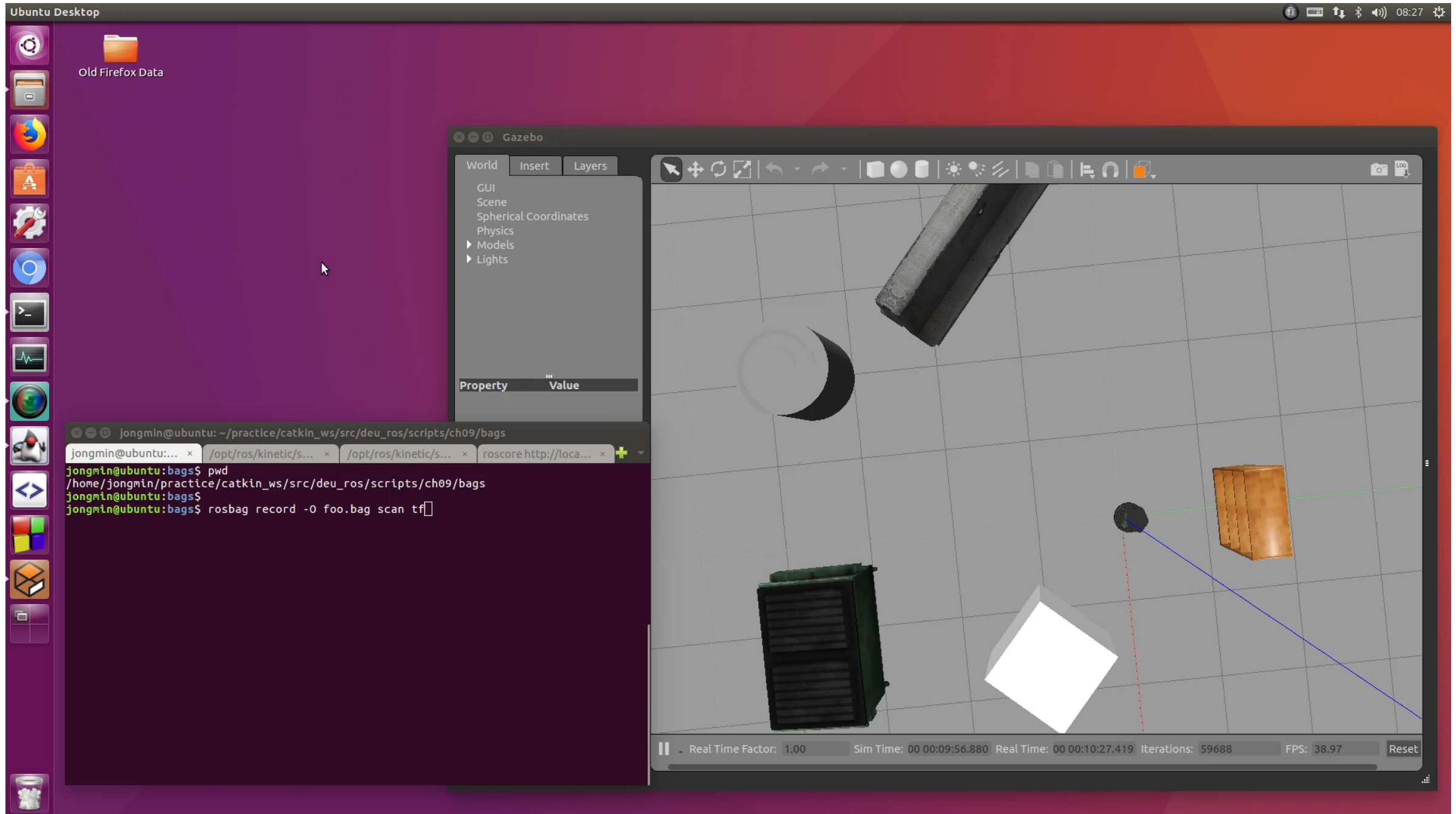
Terminal 3:

```
$ roslaunch turtlebot_teleop keyboard_teleop.launch
```

Terminal 4:

```
$ roscd deu_ros/scripts && mkdir -p ch09/bags && cd ch09/bags
```

```
$ rosvag record -O foo.bag scan tf
```



rosvag info

- 메시지 모음(bag) 파일에 있는 메시지 요약

```
jongmin@ubuntu:bags$ rosvag info foo.bag
path:          foo.bag
version:       2.0
duration:      54.2s
start:         Jan 01 1970 09:10:06.85 (606.85)
end:           Jan 01 1970 09:11:01.03 (661.03)
size:          2.3 MB
messages:      7190
compression:   none [3/3 chunks]
types:         sensor_msgs/LaserScan [90c7ef2dc6895d81024acba2ac42f369]
               tf2_msgs/TFMessage    [94810edda583a504dfda3829e70d7eec]
topics:        scan      461 msgs      : sensor_msgs/LaserScan
               tf         6729 msgs     : tf2_msgs/TFMessage      (2 connections)
jongmin@ubuntu:bags$
```

rosvag record & play

- rosvag record
 - ROS 메시지를 수집하여 bag 파일 생성
 - 수집하기 원하는 메시지 이름을 나열
 - 사용법
 - \$ rosvag record [-O foo.bag] scan tf
- rosvag play
 - 한 개 이상의 bag 파일을 재생
 - --clock: 시뮬레이션 시각 발행
 - 사용법
 - \$ rosvag play --clock foo.bag

gmapping 패키지

- OpenSLAM의 Gmapping 에 대한 ROS wrapper
- laser-based SLAM (Simultaneous Localization and Mapping)
- URL: <http://wiki.ros.org/gmapping>

- ROS 노드: slam_gmapping

- 구독 토픽

`tf (tf/tfMessage)`

Transforms necessary to relate frames for laser, base, and odometry (see below)

`scan (sensor_msgs/LaserScan)`

Laser scans to create the map from

- 발행 토픽

`map_metadata (nav_msgs/MapMetaData)`

Get the map data from this topic, which is latched, and updated periodically.

`map (nav_msgs/OccupancyGrid)`

Get the map data from this topic, which is latched, and updated periodically

`~entropy (std_msgs/Float64)`

Estimate of the entropy of the distribution over the robot's pose (a higher value indicates greater uncertainty). New in 1.1.0.

- ROS 노드: slam_gmapping (계속)

- 매개변수

`~inverted_laser (string, default: "false")`

(REMOVED in 1.1.1; transform data is used instead) Is the laser right side up (scans are ordered CCW), or upside down (scans are ordered CW)?

`~throttle_scans (int, default: 1)`

Process 1 out of every this many scans (set it to a higher number to skip more scans)

`~base_frame (string, default: "base_link")`

The frame attached to the mobile base.

`~map_frame (string, default: "map")`

The frame attached to the map.

`~odom_frame (string, default: "odom")`

The frame attached to the odometry system.

`~map_update_interval (float, default: 5.0)`

How long (in seconds) between updates to the map. Lowering this number updates the occupancy grid more often, at the expense of greater computational load.

`~maxUrange (float, default: 80.0)`

The maximum usable range of the laser. A beam is cropped to this value.

• ROS 노드: slam_gmapping (계속)

• 매개변수

`~sigma (float, default: 0.05)`

The sigma used by the greedy endpoint matching

`~kernelSize (int, default: 1)`

The kernel in which to look for a correspondence

`~lstep (float, default: 0.05)`

The optimization step in translation

`~astep (float, default: 0.05)`

The optimization step in rotation

`~iterations (int, default: 5)`

The number of iterations of the scanmatcher

`~lsigma (float, default: 0.075)`

The sigma of a beam used for likelihood computation

`~ogain (float, default: 3.0)`

Gain to be used while evaluating the likelihood, for smoothing the resampling effects

`~lskip (int, default: 0)`

Number of beams to skip in each scan. Take only every (n+1)th laser ray for computing a match (0 = take all rays)

`~minimumScore (float, default: 0.0)`

Minimum score for considering the outcome of the scan matching good. Can avoid jumping pose estimates in large open spaces when using laser scanners with limited range (e.g. 5m). Scores go up to 600+, try 50 for example when experiencing jumping estimate issues.

- ROS 노드: slam_gmapping (계속)
 - 매개변수

`~particles (int, default: 30)`
 Number of particles in the filter

`~xmin (float, default: -100.0)`
 Initial map size (in metres)

`~ymin (float, default: -100.0)`
 Initial map size (in metres)

`~xmax (float, default: 100.0)`
 Initial map size (in metres)

`~ymax (float, default: 100.0)`
 Initial map size (in metres)

`~delta (float, default: 0.05)`
 Resolution of the map (in metres per occupancy grid block)

`~maxRange (float)`
 The maximum range of the sensor. If regions with no obstacles within the range of the sensor should appear as free space in the map, set `maxUrange < maximum range of the real sensor <= maxRange`.

bag 파일 이용한 지도 구축: bag 파일 생성

Terminal 1:

```
$ roslaunch turtlebot_stage turtlebot_in_stage.launch
```

Terminal 2: (키보드 주행 시 rviz 화면은 이상해 지므로 stage 시뮬레이터의 로봇 위치 봐야 함)

```
$ roslaunch turtlebot_teleop keyboard_teleop.launch
```

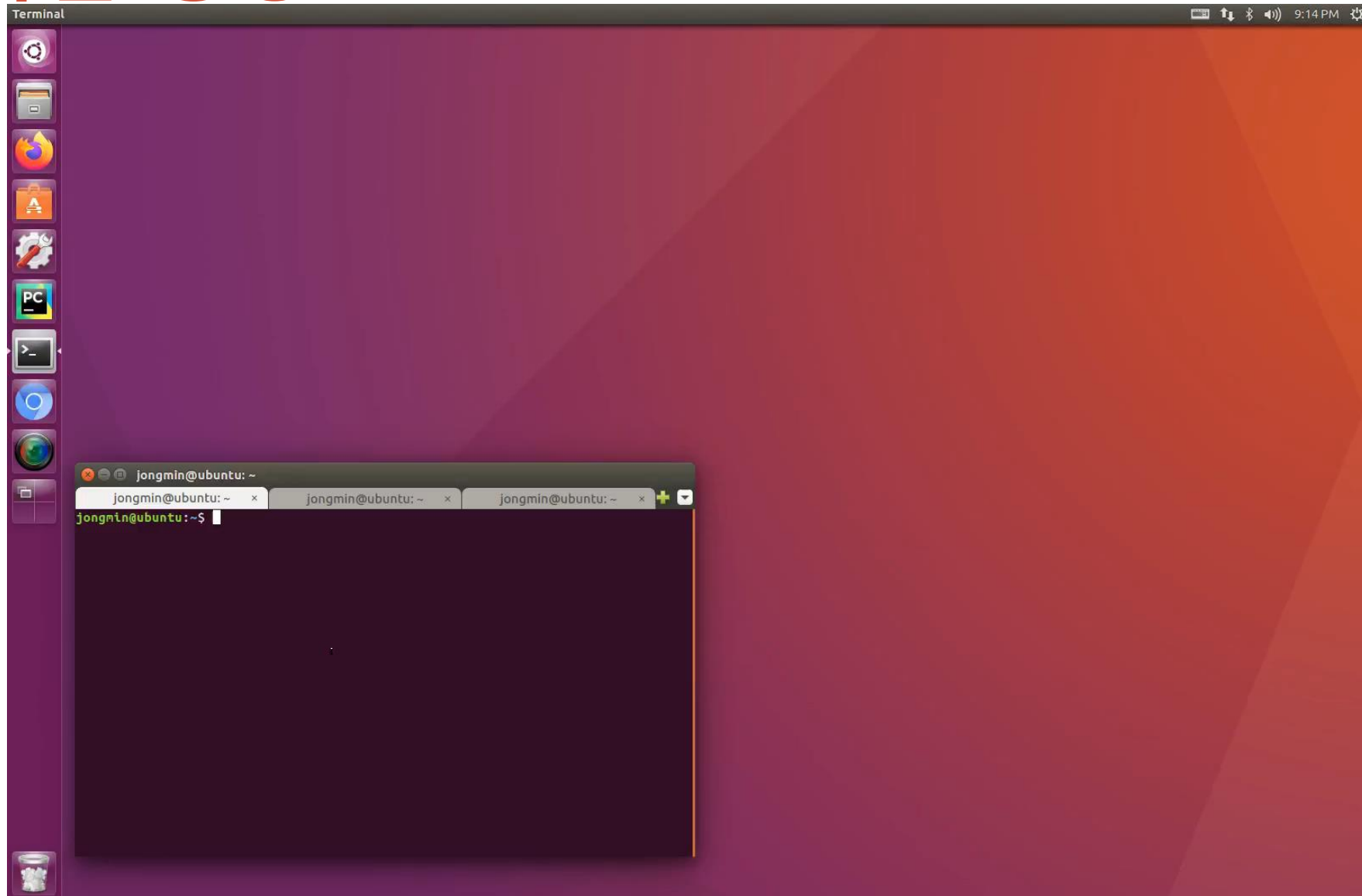
Terminal 3: (지도 생성 원하는 구역을 키보드 주행 후 Ctrl-C 눌러 rosbag record 실행 중단)

```
$ rosbag record -O data.bag /scan /tf
```

```
$ rosbag info data.bag
```

```
jongmin@ubuntu:bags$ rosbag info data.bag
path:          data.bag
version:       2.0
duration:      2:38s (158s)
start:         Jan 01 1970 09:01:27.00 (87.00)
end:           Jan 01 1970 09:04:05.70 (245.70)
size:          9.1 MB
messages:      8738
compression:   none [12/12 chunks]
types:         sensor_msgs/LaserScan [90c7ef2dc6895d81024acba2ac42f369]
               tf2_msgs/TFMessage    [94810edda583a504dfda3829e70d7eec]
topics:        /scan    1589 msgs   : sensor_msgs/LaserScan
               /tf      7149 msgs   : tf2_msgs/TFMessage    (3 connections)
```

bag 파일 생성



bag 파일 이용한 지도 구축: gmapping 사용

Terminal 1:

```
$ roscore
```

Terminal 2:

```
$ rosparam set use_sim_time true
```

```
$ roslaunch gmapping slam_gmapping
```

Terminal 3:

```
$ roslaunch deu_ros/scripts/ch09/bags && roslaunch play --clock data.bag
```

Terminal 4: (roslaunch play 완료 후 실행하면 됨)

```
$ roslaunch deu_ros/scripts/ch09/maps && roslaunch map_server map_saver [-f map]
```

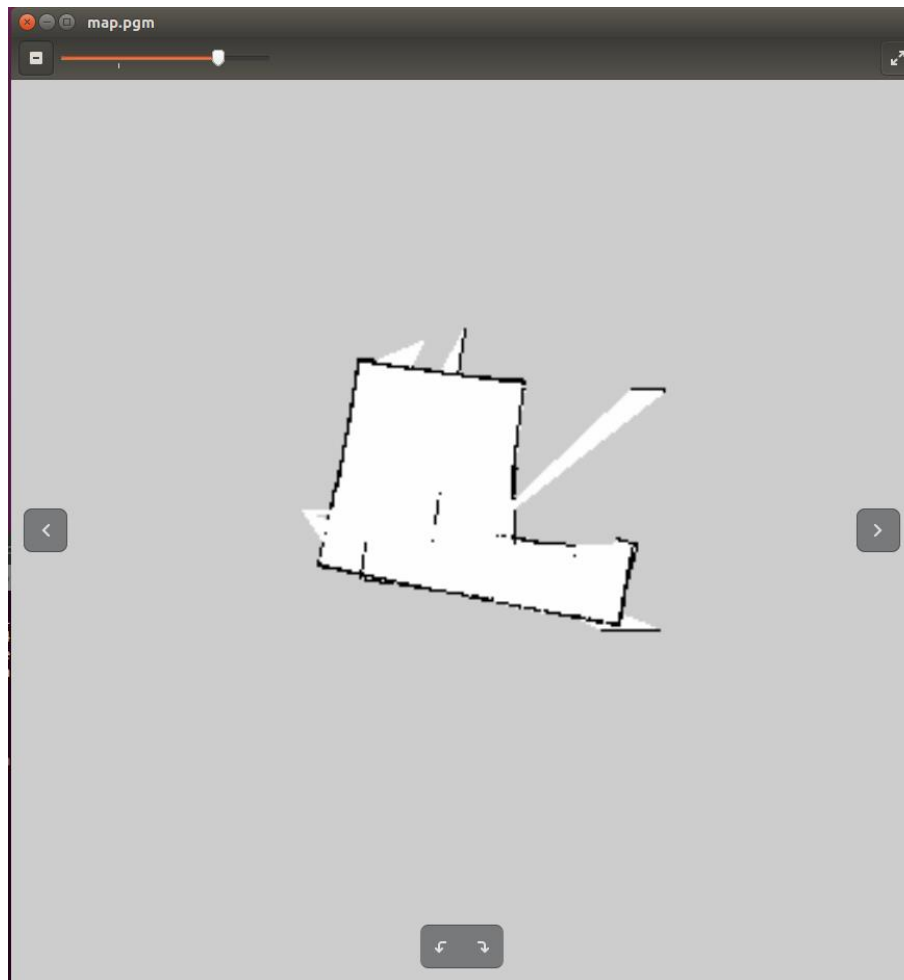
```
$ eog map.pgm
```

지도 생성 결과

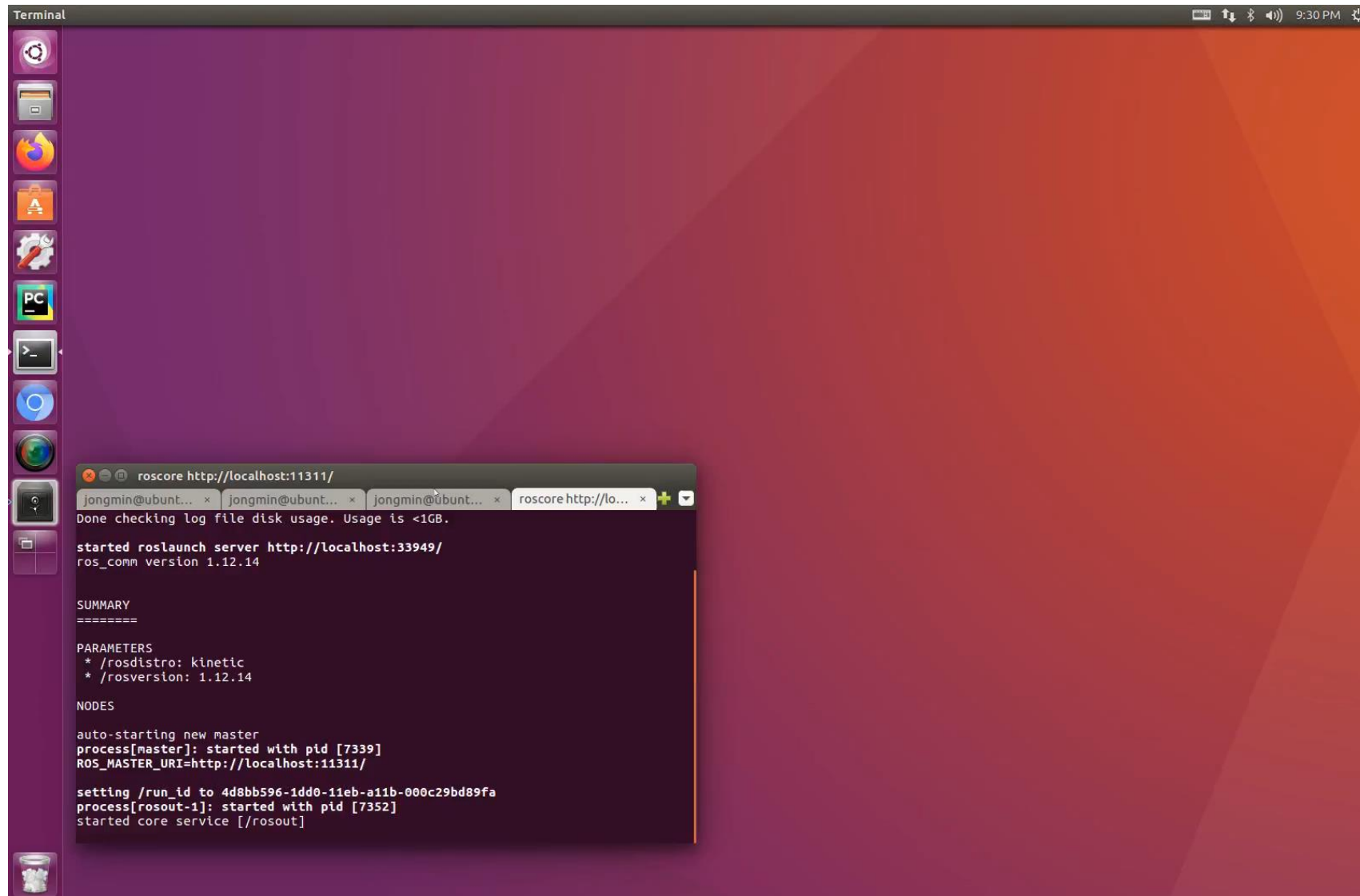
- map.yaml

```
jongmin@ubuntu:maps$ cat map.yaml
image: map.pgm
resolution: 0.050000
origin: [-100.000000, -100.000000, 0.000000]
negate: 0
occupied_thresh: 0.65
free_thresh: 0.196
```

map.pgm (\$ eog map.pgm)



지도 생성



지도 생성 품질 향상

- gmapping 매개변수 값 변경

```
user@hostname$ rosparam set /slam_gmapping/angularUpdate 0.1
user@hostname$ rosparam set /slam_gmapping/linearUpdate 0.1
user@hostname$ rosparam set /slam_gmapping/lskip 10
user@hostname$ rosparam set /slam_gmapping/xmax 10
user@hostname$ rosparam set /slam_gmapping/xmin -10
user@hostname$ rosparam set /slam_gmapping/ymax 10
user@hostname$ rosparam set /slam_gmapping/ymin -10
```

rviz로 지도 보기

Terminal 1:

```
$ roscore
```

Terminal 2:

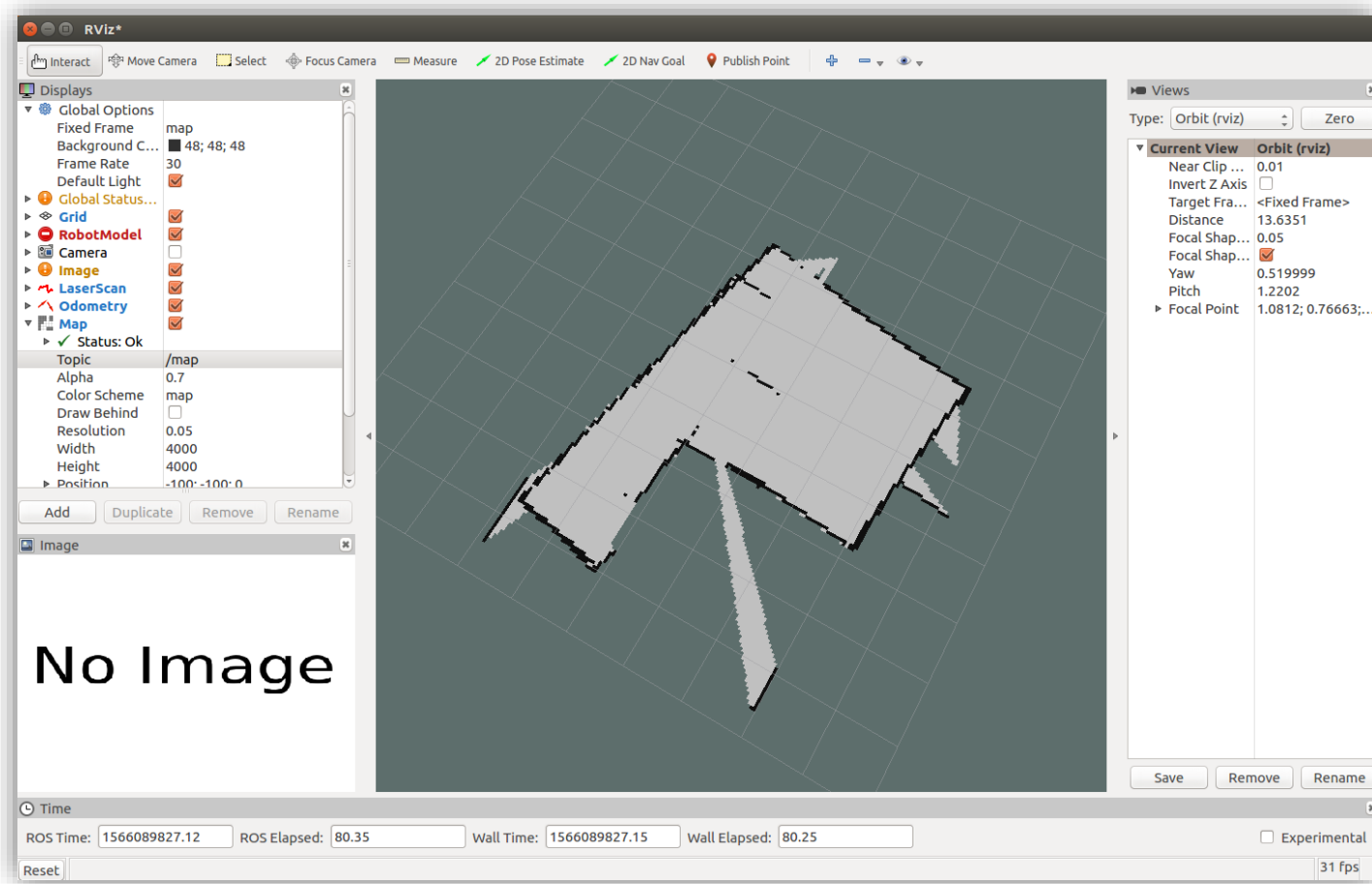
```
$ roscd deu_ros/scripts/maps && rosrune map_server map_server map.yaml
```

Terminal 3:

```
$ rviz
```

지도 보기 결과

- Fixed Frame: map
- Map: Topic - /map, Color Scheme - map



turtlebot_navigation 패키지 이용한 지도 구축

Terminal 1:

```
$ roslaunch turtlebot_stage turtlebot_in_stage.launch
```

Terminal 2: (키보드 주행 시 rviz 화면은 이상해 지므로 stage 시뮬레이터의 로봇 위치 봐야 함)

```
$ roslaunch turtlebot_teleop keyboard_teleop.launch
```

Terminal 3:

```
$ roslaunch turtlebot_navigation gmapping_demo.launch
```

Terminal 4: (Terminal 2에서 벽 따라서 주행 완료한 후 실행)

```
$ rosrun map_server map_saver -f my_map2
```

```
$ eog gmapping_map.pgm
```

```
jongmin@ubuntu:bags$ cat my_map2.yaml
image: my_map2.pgm
resolution: 0.050000
origin: [-1.000000, -12.200000, 0.000000]
negate: 0
occupied_thresh: 0.65
free_thresh: 0.196

jongmin@ubuntu:bags$
```

