

캡스톤 디자인

- Path Planning
9th Week Progress

A6 Blue

Path Planning

Search-based

- Dijkstra
- A* - Dijkstra + heuristic cost
- D* - Dynamic A*

Sampling-based

- RRT - Random Tree
- RRT* - RRT + rewire

Artificial Intelligence

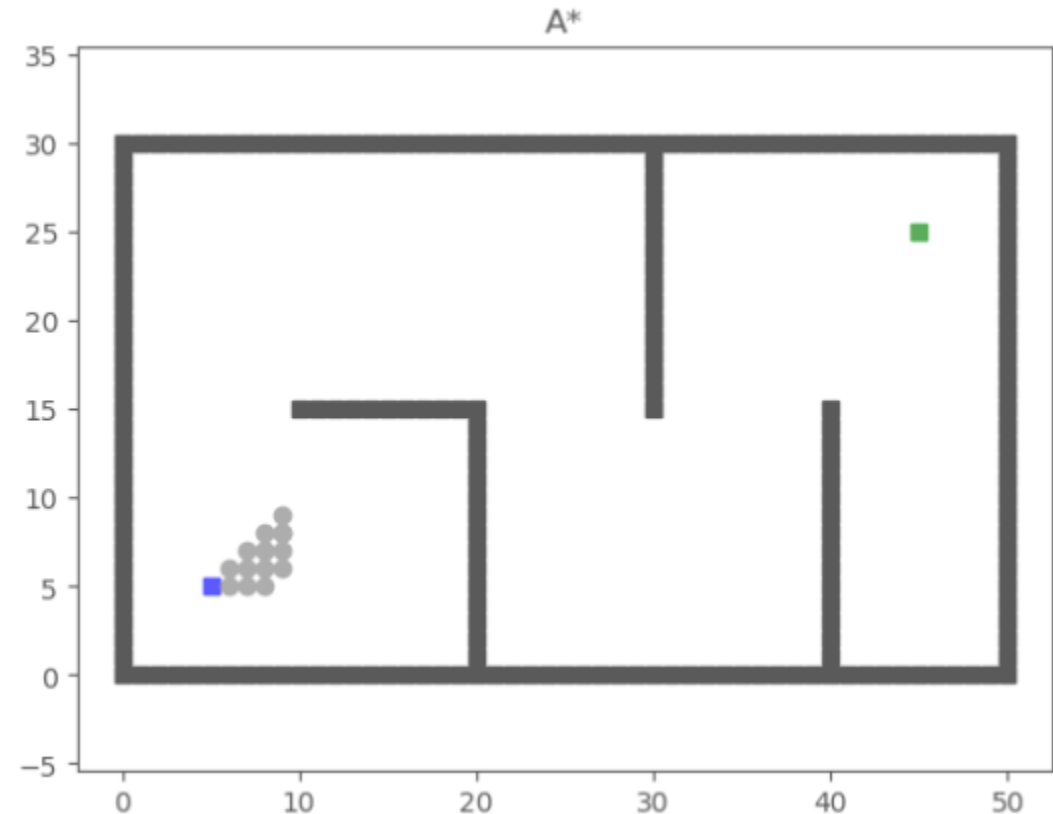
- ANN - Artificial Neural Network
- GA - Genetic Algorithm

Our Algorithm

- Design own algorithm
 - $A^*(D^*)$ 기반 : 장애물 회피
- Using python & ROS
 - Simulation
- Using drone
 - 3D path planning
 - Safety distance
 - Cost function optimization
 - : Distance(Euclidean) + ~~Power(battery)~~ + ~~Stability(?)~~

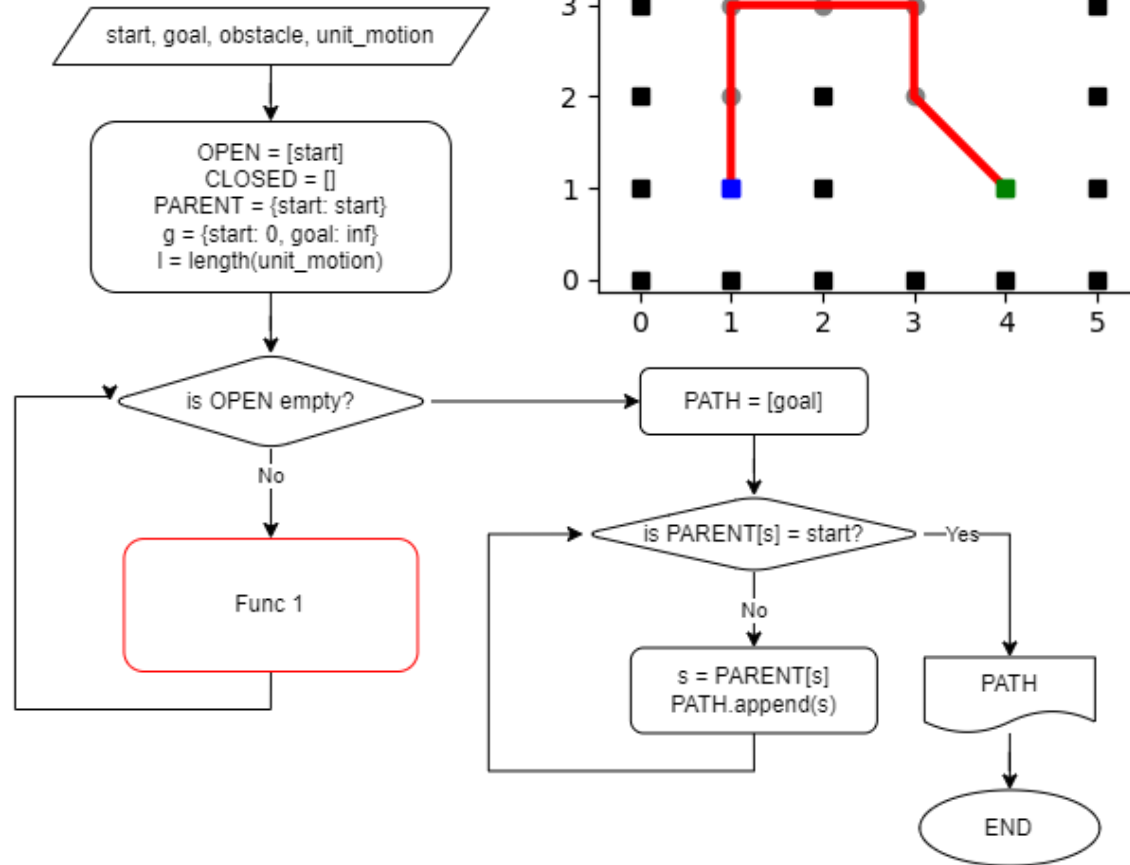
A* Algorithm

- Search-based algorithm
- Dijkstra + heuristic cost
- Cost function : $f(n) = g(n) + h(n)$
 - $g(n)$: 현재 node까지의 cost
 - $h(n)$: 현재 node부터 목표 node까지의 heuristic cost

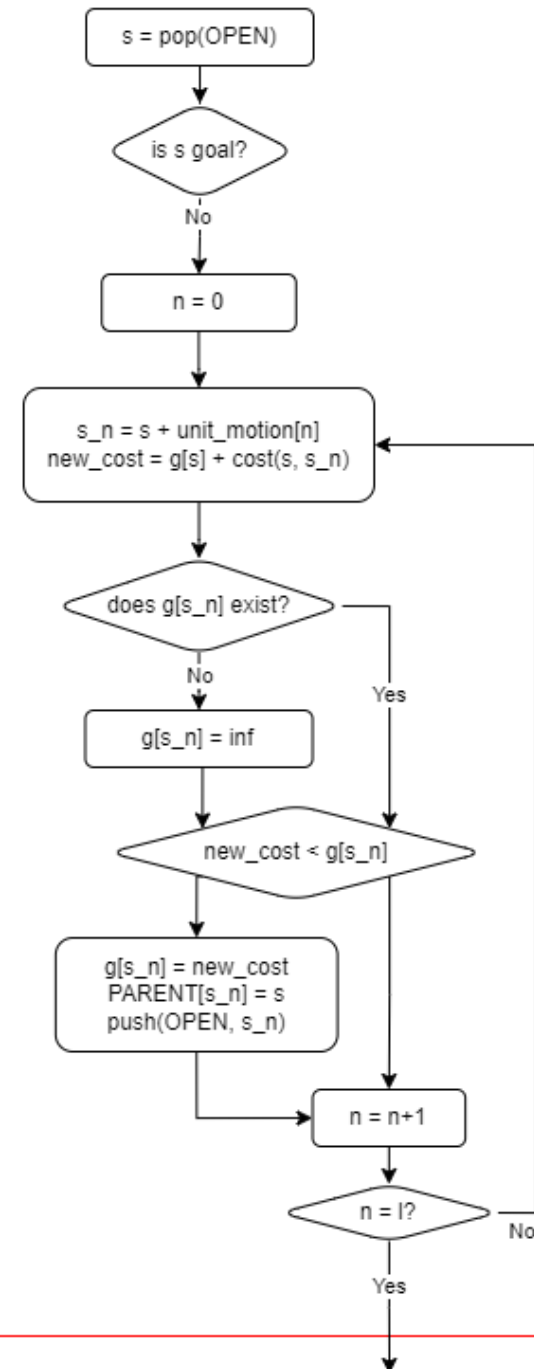


A* Algorithm

• Flowchart

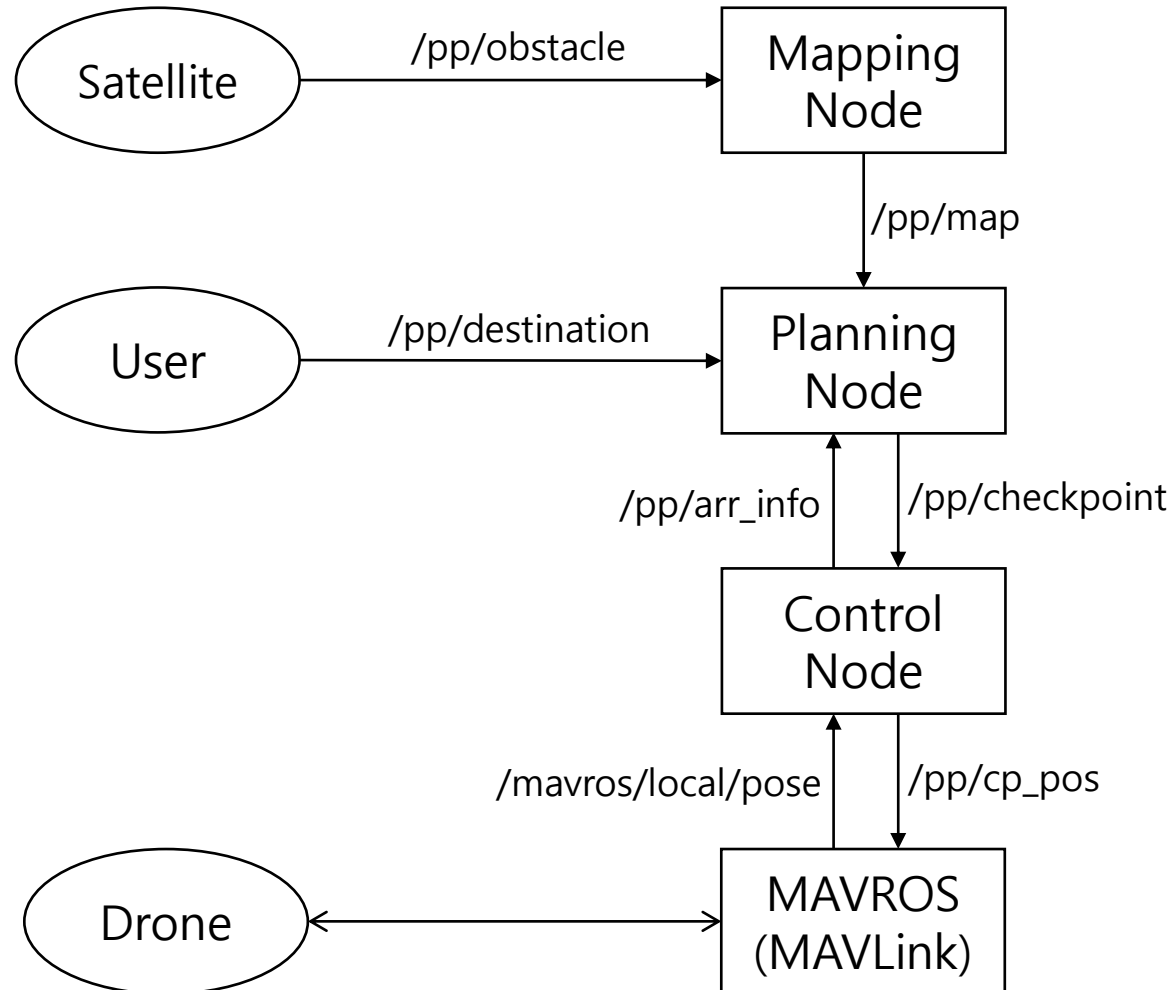


Func 1



A6 Blue

Schematic



3 IOs / 4 Nodes / 7 Topics

IOs:

Satellite: Detect and manage obstacles

User: Set destination point

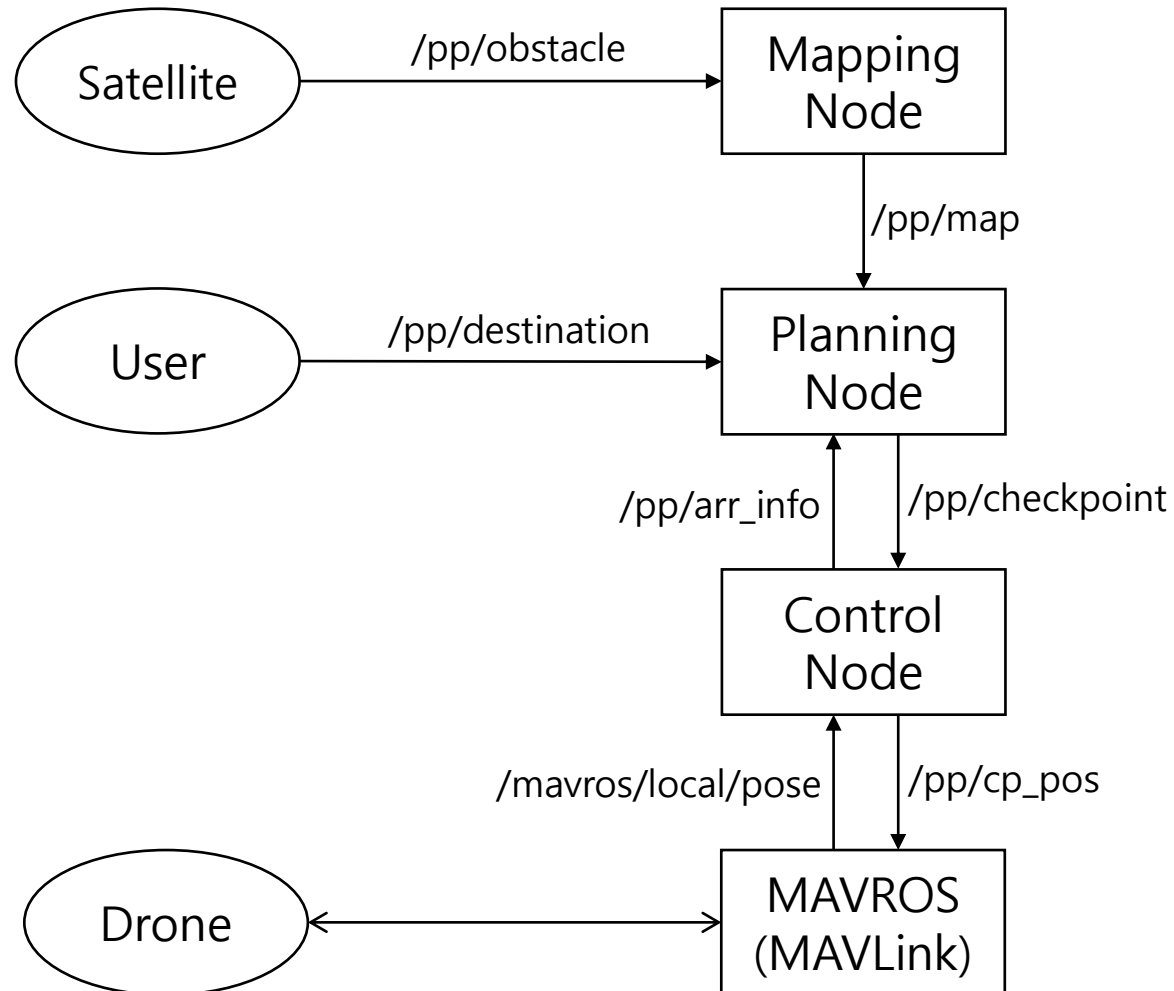
Nodes:

Mapping Node: Make map with obstacle

Planning Node: Path planning with current position, destination and map

Control Node: Transfer control signals and arrived trigger

Schematic



Topics:

/pp/obstacle: contains array of xyz coordinates of obstacle

/pp/map: contains array of xyz coordinates of map

/pp/destination: contains xyz coordinates of destination

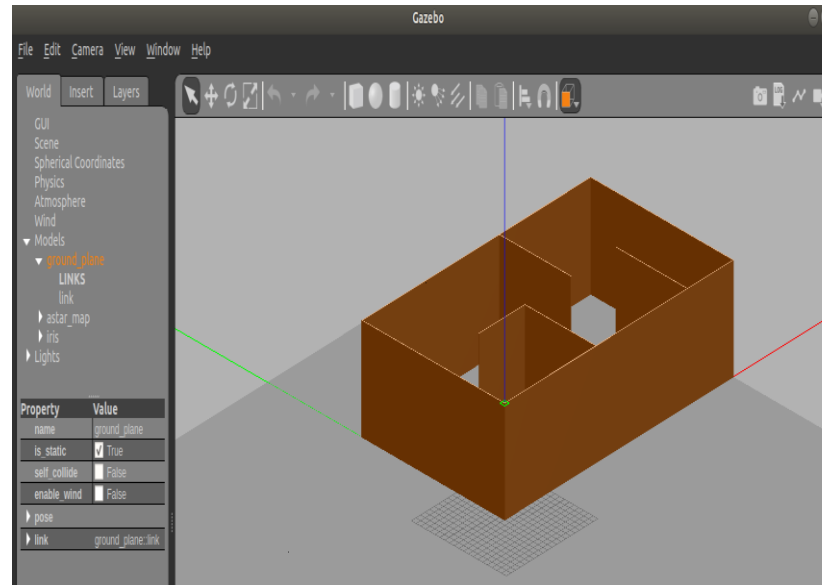
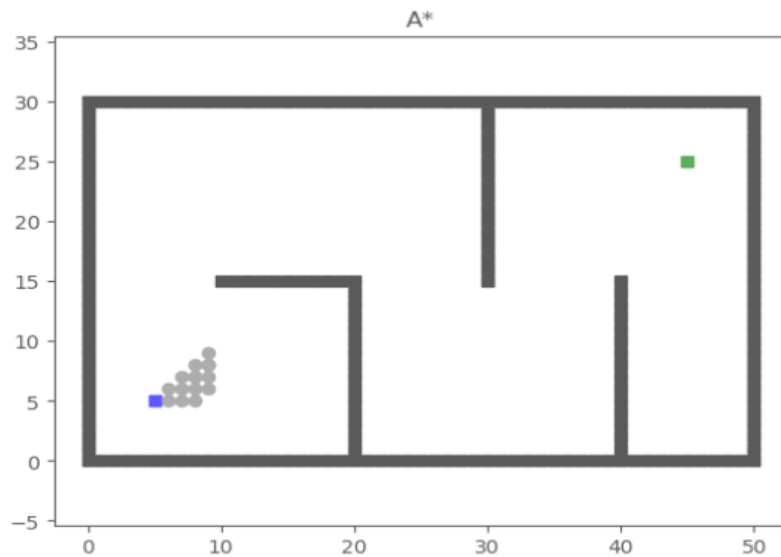
/pp/checkpoint: contains xyz coordinates of checkpoint, way to destination

/pp/cp_pos: contains xyz coordinates of checkpoint, way to destination

/pp/arr_info: contains bool if drone arrived checkpoint

/mavros/local/pose: contains xyz coordinates of drone's local position

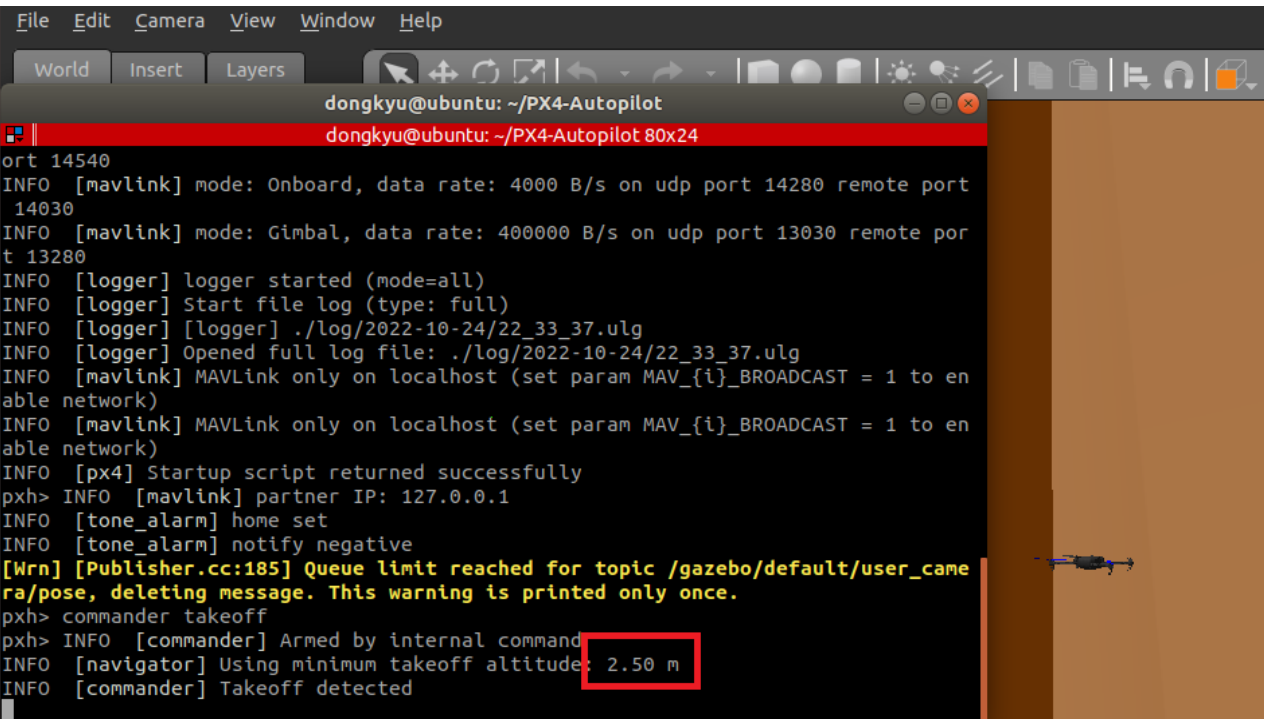
Mapping



Box size :
50m x 30m x 10m

condition :
Gravity acc : -9.8 m/s^2
atmosphere type : adiabatic
Wind velocity : 0 m/s

Mapping

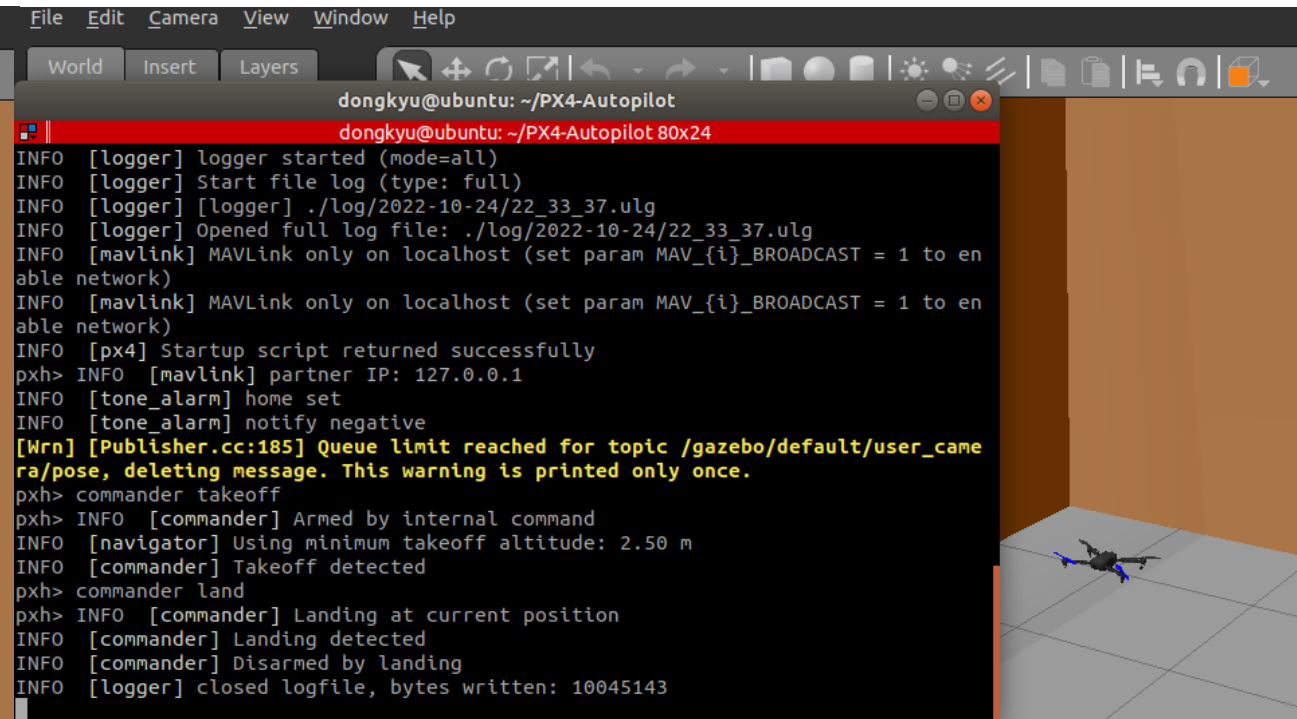


The screenshot shows the PX4 Autopilot terminal window with the following output:

```
ort 14540
INFO [mavlink] mode: Onboard, data rate: 4000 B/s on udp port 14280 remote port 14030
INFO [mavlink] mode: Gimbal, data rate: 400000 B/s on udp port 13030 remote port 13280
INFO [logger] logger started (mode=all)
INFO [logger] Start file log (type: full)
INFO [logger] [logger] ./log/2022-10-24/22_33_37.ulg
INFO [logger] Opened full log file: ./log/2022-10-24/22_33_37.ulg
INFO [mavlink] MAVLink only on localhost (set param MAV_{i}_BROADCAST = 1 to enable network)
INFO [mavlink] MAVLink only on localhost (set param MAV_{i}_BROADCAST = 1 to enable network)
INFO [px4] Startup script returned successfully
pxh> INFO [mavlink] partner IP: 127.0.0.1
INFO [tone_alarm] home set
INFO [tone_alarm] notify negative
[Wrn] [Publisher.cc:185] Queue limit reached for topic /gazebo/default/user_camera/pose, deleting message. This warning is printed only once.
pxh> commander takeoff
pxh> INFO [commander] Armed by internal command
INFO [navigator] Using minimum takeoff altitude: 2.50 m
INFO [commander] Takeoff detected
```

The Gazebo simulation window shows a drone taking off from the ground.

Successfully takeoff



The screenshot shows the PX4 Autopilot terminal window with the following output:

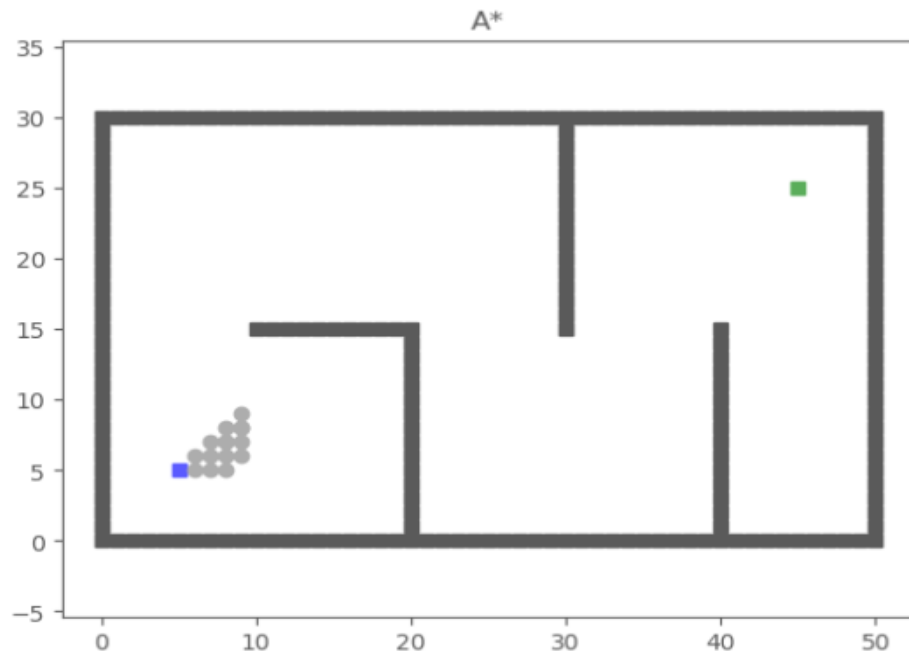
```
INFO [logger] logger started (mode=all)
INFO [logger] Start file log (type: full)
INFO [logger] [logger] ./log/2022-10-24/22_33_37.ulg
INFO [logger] Opened full log file: ./log/2022-10-24/22_33_37.ulg
INFO [mavlink] MAVLink only on localhost (set param MAV_{i}_BROADCAST = 1 to enable network)
INFO [mavlink] MAVLink only on localhost (set param MAV_{i}_BROADCAST = 1 to enable network)
INFO [px4] Startup script returned successfully
pxh> INFO [mavlink] partner IP: 127.0.0.1
INFO [tone_alarm] home set
INFO [tone_alarm] notify negative
[Wrn] [Publisher.cc:185] Queue limit reached for topic /gazebo/default/user_camera/pose, deleting message. This warning is printed only once.
pxh> commander takeoff
pxh> INFO [commander] Armed by internal command
INFO [navigator] Using minimum takeoff altitude: 2.50 m
INFO [commander] Takeoff detected
pxh> commander land
pxh> INFO [commander] Landing at current position
INFO [commander] Landing detected
INFO [commander] Disarmed by landing
INFO [logger] closed logfile, bytes written: 10045143
```

The Gazebo simulation window shows a drone landing on the ground.

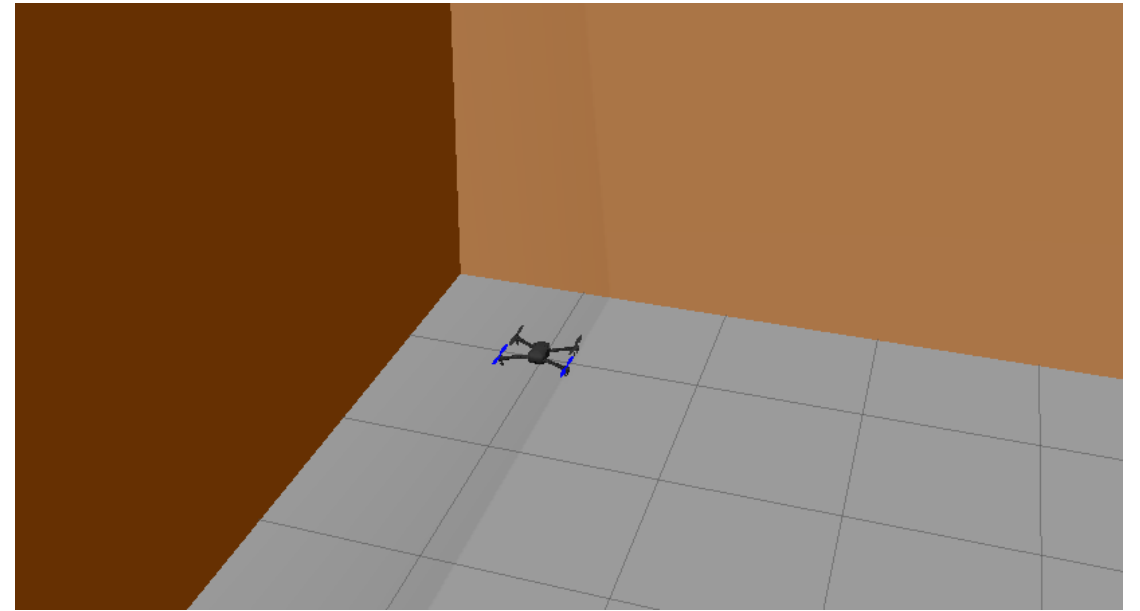
Successfully land

Flight altitude : 2.5m

Mapping(problem)



Start-point : [5,5]



Start-point : [1,1]

Mapping(summary)

Achievements:

Completed making example map in gazebo

Static map on Planning node implemented

- Mapping node not implemented

Dynamic mapping impossible

Challenges:

Real-time dynamic mapping with topic required in practice

Coordinate system is different in Gazebo

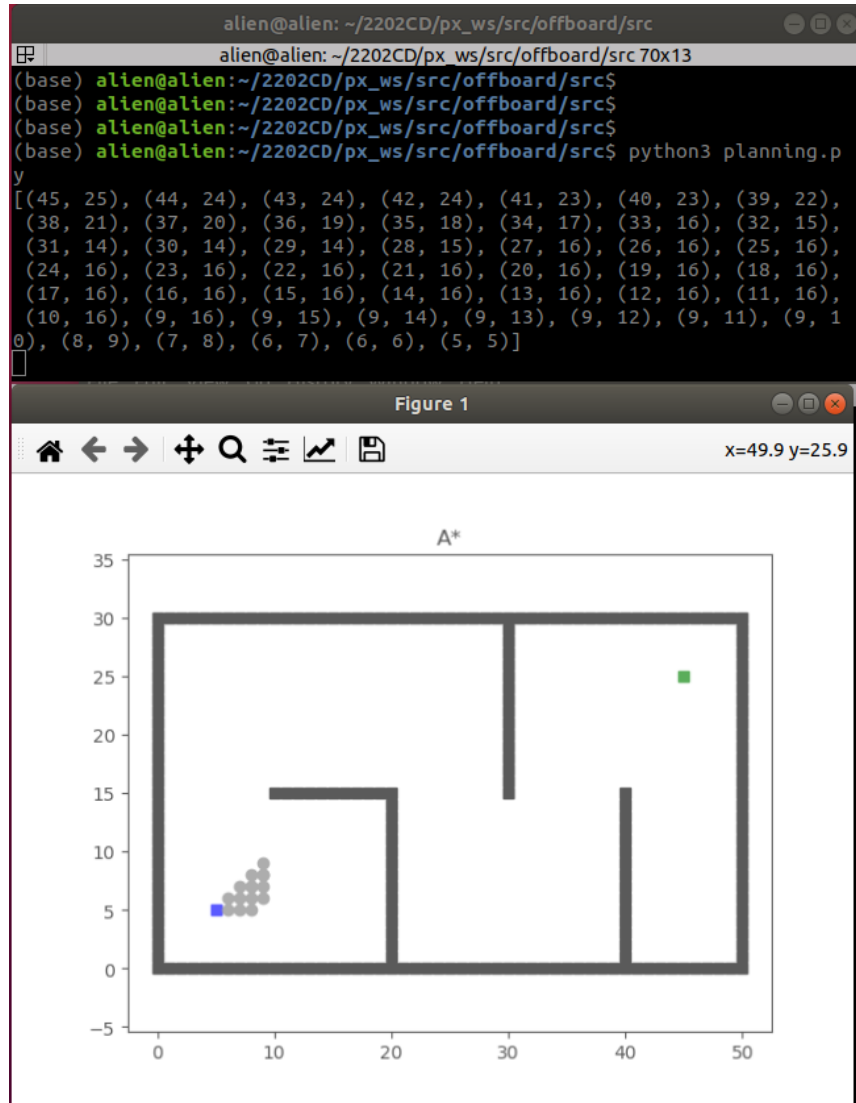
Plan for next week:

Solve problem about starting-point

Apply created code to map that we make

Make view-point in gazebo more comfortable

Planning



Achievements:

A* algorithm implemented

- input : map, start, destination
- output : route to destination

Challenges:

How to improve performance?

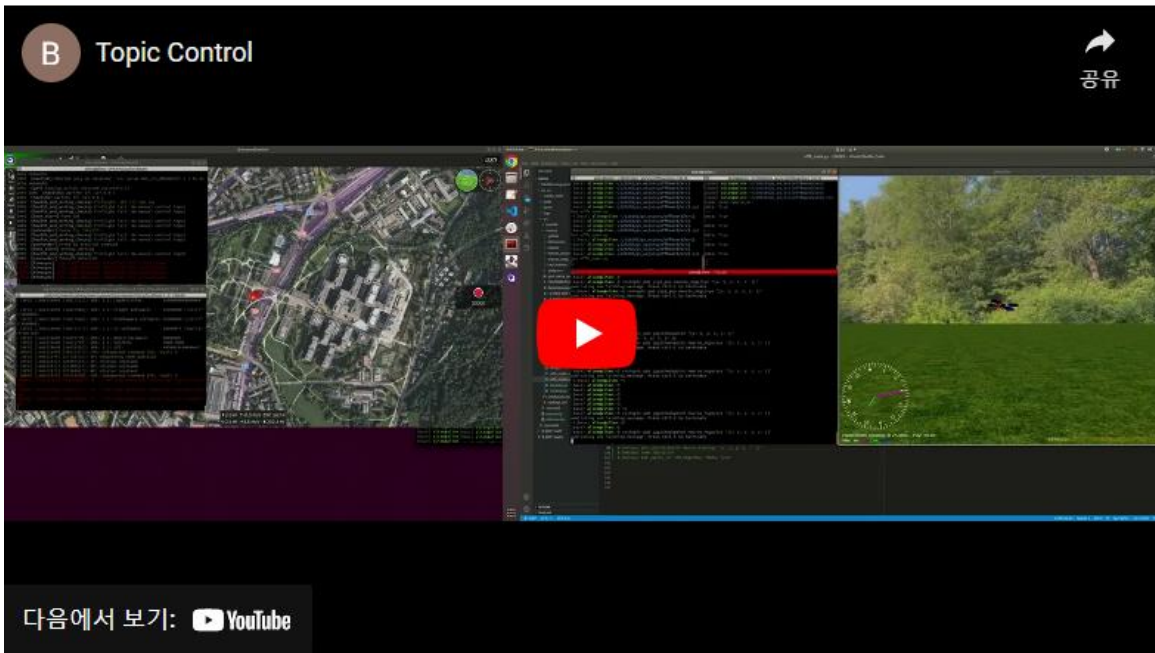
Planning node need to be changed for dynamic mapping

Plan for next week:

ROS embedding

- input : /pp/map, /pp/destination, /pp/arr_info
- output : /pp/checkpoint

Control



Achievements:

80% implemented

- drone controllable via topic
- sends /pp/arr_info True if distance between checkpoint and current position is under particular distance

Challenges:

Gazebo error occurred in control PC

Overshooting

- Acceleration control required

Plan for next week:

Check if drone works well with ROS embedded Planning node

Solve Gazebo error

Plan

1. Static path planning
2. Acceleration control
3. Dynamic mapping & path planning