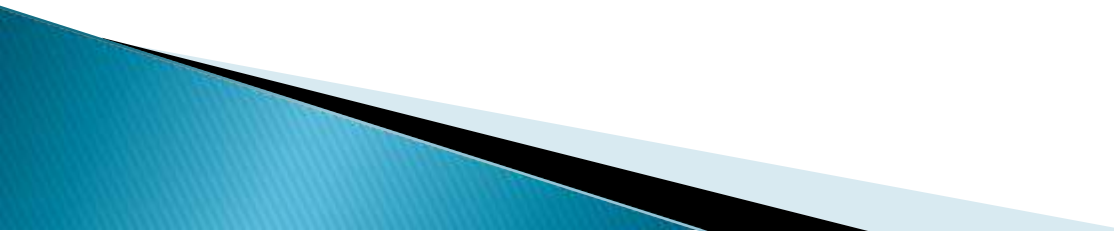


Drone simulation

Team members: Abya
Apurva

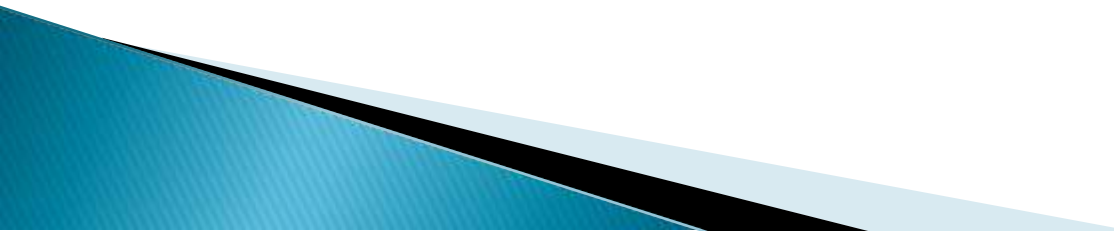
Installing Ubuntu,ROS

- ▶ Started off with installing Ubuntu 20.04 in our systems as we needed Linux to use ROS.
 - ▶ We need an operating system to run our model for which we use ROS.
 - ▶ ROS is basically an open source framework that helps people build and reuse code between robotics applications.
 - ▶ Installed noetic version of ROS.
- 

Setting up mavros

- ▶ MavROS is a ROS package that provides communication driver for various autopilots with MAVLink communication protocol.
- ▶ We next installed MavROS in our system.

Setting up PX4 and Autopilot

- ▶ An autopilot is required to transmit our command to the system. PX4 is a suitable source for that.
 - ▶ PX4 is an open source flight control software for drones and other unmanned vehicles. It provides the required set of tools for drone developers to share technologies to create proper solutions for drone applications.
 - ▶ We used iris model inbuilt drone.
- 

Gazebo

- ▶ Installed Gazebo9–3D dynamic simulator.
- ▶ It is a high class simulator that allows simulation of real-life environment. It allows us to include practical forces such as gravity and friction.

Writing scripts

- ▶ We needed a script for takeoff of our drone. Also, a launch file was needed for the obvious purpose.
- ▶ We created a python script in VS Code for this execution.

Take off script in python

```


using UnityEngine;

public class MyScript : MonoBehaviour
{
    void Start()
    {
        Debug.Log("Hello, World!");
    }

    void Update()
    {
    }

    void SendMessage()
    {
        Debug.Log("Hello, World!");
    }
}

```



The screenshot shows a Windows 10 desktop with a Visual Studio Code editor window open. The editor is displaying a C++ program that implements a simple calculator. The program takes two integers and an operator as input and performs the corresponding arithmetic operation. The code is written in C++ and uses the `std::cin` and `std::cout` functions for input and output. The program is compiled and run, and the output is displayed in the console window at the bottom of the editor.

```

1 // Simple calculator program
2 #include <iostream>
3 using namespace std;
4
5 int main()
6 {
7     int a, b;
8     char op;
9
10    cout << "Enter two integers and an operator: ";
11    cin >> a >> b >> op;
12
13    switch (op)
14    {
15        case '+':
16            cout << "Sum: " << a + b << endl;
17            break;
18        case '-':
19            cout << "Difference: " << a - b << endl;
20            break;
21        case '*':
22            cout << "Product: " << a * b << endl;
23            break;
24        case '/':
25            cout << "Quotient: " << a / b << endl;
26            break;
27        default:
28            cout << "Invalid operator" << endl;
29    }
30
31    return 0;
32 }

```

The output of the program is displayed in the console window at the bottom of the editor:

```

Enter two integers and an operator: 12 34 +
Sum: 46

```

```

1 // Sum of squares of first n natural numbers
2 // C++ program to find sum of squares
3 // of first n natural numbers
4
5 #include <iostream>
6 using namespace std;
7
8 // Function to calculate square of a number
9 int square(int n)
10 {
11     return n * n;
12 }
13
14 // Function to calculate sum of squares
15 int sumOfSquares(int n)
16 {
17     int sum = 0;
18     for (int i = 1; i <= n; i++)
19     {
20         sum += square(i);
21     }
22     return sum;
23 }
24
25 // Driver code
26 int main()
27 {
28     int n = 5;
29     cout << "Sum of squares of first "
30          << n << " natural numbers is: "
31          << sumOfSquares(n) << endl;
32     return 0;
33 }

```

```

1 // Sum of squares of first n natural numbers
2 // C++ program to find sum of squares
3 // of first n natural numbers
4
5 #include <iostream>
6 using namespace std;
7
8 // Function to find sum of squares
9 // of first n natural numbers
10 int sumOfSquares(int n)
11 {
12     int sum = 0;
13     for (int i = 1; i <= n; i++)
14         sum += i * i;
15     return sum;
16 }
17
18 // Driver code
19 int main()
20 {
21     int n = 10;
22     cout << "Sum of squares of first "
23          << n << " natural numbers is: "
24          << sumOfSquares(n) << endl;
25     return 0;
26 }

```

Starting PX4

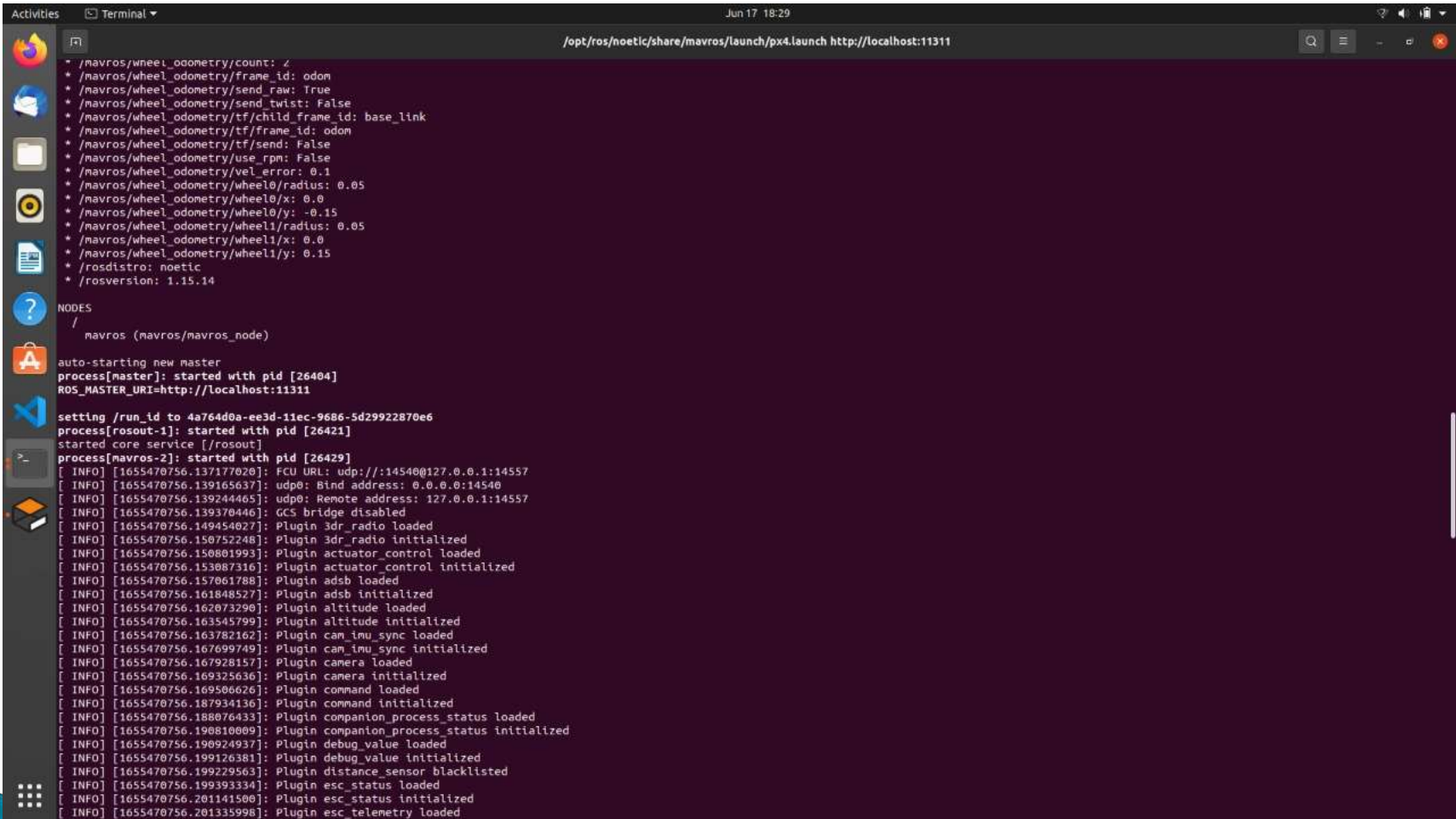
```
Activities Terminal Jun 17 18:27
abya@abya-Inspiron-15-3511: ~/Firmware
GAZEBO_PLUGIN_PATH /usr/lib/x86_64-linux-gnu/gazebo-11/plugins:/usr/lib/x86_64-linux-gnu/gazebo-11/plugins::/home/abya/Firmware/build/px4_sitl_default/build_gazebo
GAZEBO_MODEL_PATH /usr/share/gazebo-11/models:/home/abya/ardupilot_gazebo/models:/home/abya/Firmware/Tools/sitl_gazebo/models
LD_LIBRARY_PATH /home/abya/catkin_ws/devel/lib:/opt/ros/noetic/lib:/usr/lib/x86_64-linux-gnu/gazebo-11/plugins:/usr/lib/x86_64-linux-gnu/gazebo-11/plugins::/h
ome/abya/Firmware/build/px4_sitl_default/build_gazebo
empty world, setting empty.world as default
Using: /home/abya/Firmware/Tools/sitl_gazebo/models/iris/iris.sdf
Warning [parser.cc:833] XML Attribute[version] in element[sdf] not defined in SOF, ignoring.
SITL COMMAND: "/home/abya/Firmware/build/px4_sitl_default/bin/px4" "/home/abya/Firmware/build/px4_sitl_default/etc -s etc/init.d-posix/rcS -t "/home/abya/Firmware"/test_data
Creating symlink /home/abya/Firmware/build/px4_sitl_default/etc -> /home/abya/Firmware/build/px4_sitl_default/tmp/rootf

PX4

px4 starting.
INFO [px4] Calling startup script: /bin/sh etc/init.d-posix/rcS 0
INFO [init] found model autostart file as SYS_AUTOSTART=10016
INFO [param] selected parameter default file eeprom/parameters_10016
INFO [parameters] BSON document size 333 bytes, decoded 333 bytes (INT32:14, FLOAT:3)
[param] Loaded: eeprom/parameters_10016
INFO [dataman] data manager file './dataman' size is 7866640 bytes
PX4 SIM HOST: localhost
INFO [simulator] Waiting for simulator to accept connection on TCP port 4560
INFO [simulator] Simulator connected on TCP port 4560.
Gazebo multi-robot simulator, version 11.11.0
Copyright (C) 2012 Open Source Robotics Foundation.
Released under the Apache 2 License.
http://gazebo.org

[Msg] Waiting for master.
[Msg] Connected to gazebo master @ http://127.0.0.1:11345
[Msg] Publicized address: 192.168.120.218
INFO [commander] LED: open /dev/led0 failed (22)
INFO [init] Mixer: etc/mixers/quad_w.main.mix on /dev/pwm_output0
INFO [init] setting PWM_AUX_OUT none
INFO [mavlink] mode: Normal, data rate: 4000000 B/s on udp port 18570 remote port 14550
INFO [mavlink] mode: Onboard, data rate: 4000000 B/s on udp port 14580 remote port 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/2022-06-17/12_57_38.ulg
INFO [logger] Opened full log file: ./log/2022-06-17/12_57_38.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
px4: ./src/intel/isl/isl.c:2105: FINISHME: ./src/intel/isl/isl.c:isl_surf_supports_ccs: CCS for 3D textures is disabled, but a workaround is available.
INFO [tone_alarm] notify positive
INFO [tone_alarm] home set
INFO [tone_alarm] notify negative
```


Starting mavros



A terminal window titled "/opt/ros/noetic/share/mavros/launch/px4.launch http://localhost:11311" is shown. The terminal output displays the configuration of the mavros node, the starting of the ROS master, and the initialization of various mavros plugins. The left sidebar of the terminal window shows the Ubuntu desktop environment with icons for Firefox, Mail, Files, and other applications.

```
Activities Terminal Jun 17 18:29
/opt/ros/noetic/share/mavros/launch/px4.launch http://localhost:11311

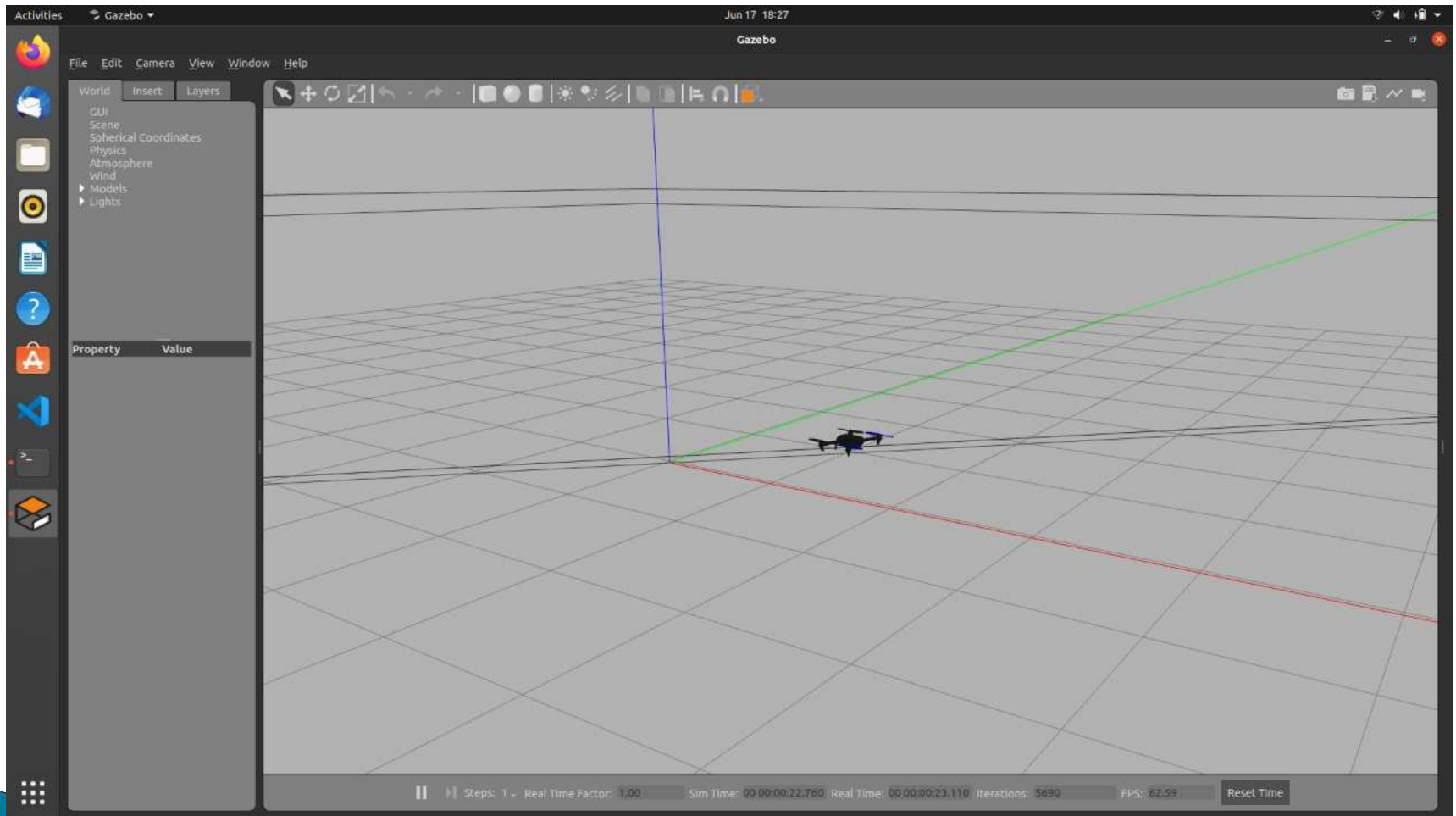
* /mavros/wheel_odometry/count: 4
* /mavros/wheel_odometry/frame_id: odom
* /mavros/wheel_odometry/send_raw: True
* /mavros/wheel_odometry/send_twist: False
* /mavros/wheel_odometry/tf/child_frame_id: base_link
* /mavros/wheel_odometry/tf/frame_id: odom
* /mavros/wheel_odometry/tf/send: False
* /mavros/wheel_odometry/use_rpm: False
* /mavros/wheel_odometry/vel_error: 0.1
* /mavros/wheel_odometry/wheel0/radius: 0.05
* /mavros/wheel_odometry/wheel0/x: 0.0
* /mavros/wheel_odometry/wheel0/y: -0.15
* /mavros/wheel_odometry/wheel1/radius: 0.05
* /mavros/wheel_odometry/wheel1/x: 0.0
* /mavros/wheel_odometry/wheel1/y: 0.15
* /roscpp: noetic
* /rosversion: 1.15.14

NODES
/
  mavros (mavros/mavros_node)

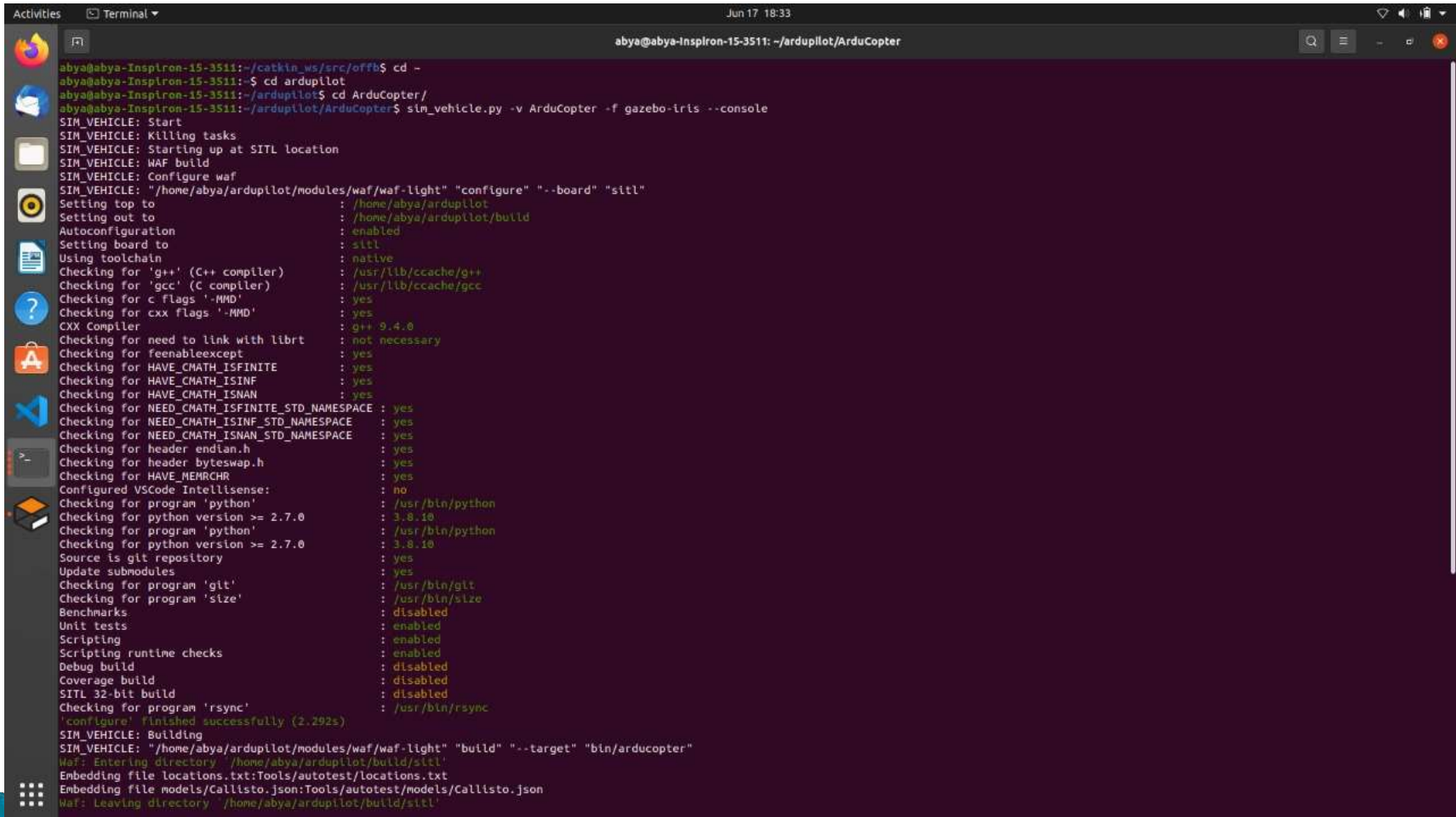
auto-starting new master
process[master]: started with pid [26404]
ROS_MASTER_URI=http://localhost:11311

setting /run_id to 4a764d0a-ee3d-11ec-9686-5d29922870e6
process[rosout-1]: started with pid [26421]
started core service [/rosout]
process[mavros-2]: started with pid [26429]
[ INFO] [1655470756.137177020]: FCU URL: udp://:14540@127.0.0.1:14557
[ INFO] [1655470756.139165637]: udp0: Bind address: 0.0.0.0:14540
[ INFO] [1655470756.139244465]: udp0: Remote address: 127.0.0.1:14557
[ INFO] [1655470756.139370446]: GCS bridge disabled
[ INFO] [1655470756.149454027]: Plugin 3dr_radio loaded
[ INFO] [1655470756.150752248]: Plugin 3dr_radio initialized
[ INFO] [1655470756.150801993]: Plugin actuator_control loaded
[ INFO] [1655470756.153087316]: Plugin actuator_control initialized
[ INFO] [1655470756.157061788]: Plugin adsb loaded
[ INFO] [1655470756.161848527]: Plugin adsb initialized
[ INFO] [1655470756.162073290]: Plugin altitude loaded
[ INFO] [1655470756.163545799]: Plugin altitude initialized
[ INFO] [1655470756.163782162]: Plugin cam_inu_sync loaded
[ INFO] [1655470756.167699749]: Plugin cam_inu_sync initialized
[ INFO] [1655470756.167928157]: Plugin camera loaded
[ INFO] [1655470756.169325636]: Plugin camera initialized
[ INFO] [1655470756.169506626]: Plugin command loaded
[ INFO] [1655470756.187934136]: Plugin command initialized
[ INFO] [1655470756.188076433]: Plugin companion_process_status loaded
[ INFO] [1655470756.190810009]: Plugin companion_process_status initialized
[ INFO] [1655470756.190924937]: Plugin debug_value loaded
[ INFO] [1655470756.199126381]: Plugin debug_value initialized
[ INFO] [1655470756.199229563]: Plugin distance_sensor blacklisted
[ INFO] [1655470756.199393334]: Plugin esc_status loaded
[ INFO] [1655470756.201141500]: Plugin esc_status initialized
[ INFO] [1655470756.201335998]: Plugin esc_telemetry loaded
```

Simulation of drone

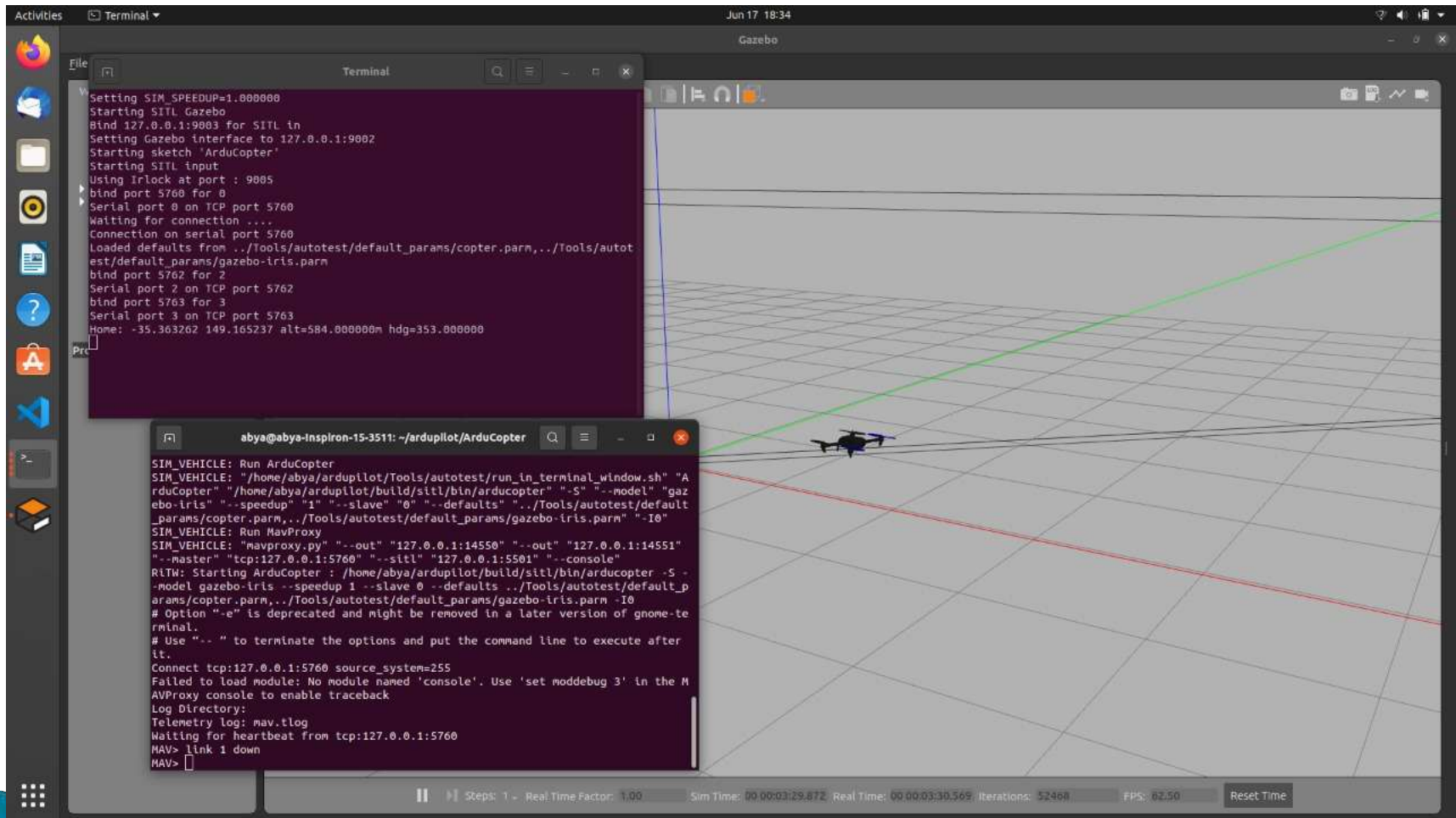


Launching sim_vehicle



```
Activities Terminal Jun 17 18:33
abya@abya-Inspiron-15-3511: ~/ardupilot/ArduCopter
abya@abya-Inspiron-15-3511:~/catkin_ws/src/offb$ cd -
abya@abya-Inspiron-15-3511:~/ardupilot$ cd ArduCopter/
abya@abya-Inspiron-15-3511:~/ardupilot/ArduCopter$ sim_vehicle.py -v ArduCopter -f gazebo-iris --console
SIM_VEHICLE: Start
SIM_VEHICLE: Killing tasks
SIM_VEHICLE: Starting up at SITL location
SIM_VEHICLE: WAF build
SIM_VEHICLE: Configure waf
SIM_VEHICLE: "/home/abya/ardupilot/modules/waf/waf-light" "configure" "--board" "sittl"
Setting top to : /home/abya/ardupilot
Setting out to : /home/abya/ardupilot/build
Autoconfiguration : enabled
Setting board to : sittl
Using toolchain : native
Checking for 'g++' (C++ compiler) : /usr/lib/ccache/g++
Checking for 'gcc' (C compiler) : /usr/lib/ccache/gcc
Checking for c flags '-MMO' : yes
Checking for cxx flags '-MMO' : yes
CXX Compiler : g++ 9.4.0
Checking for need to link with librt : not necessary
Checking for feenableexcept : yes
Checking for HAVE_CMATH_ISFINITE : yes
Checking for HAVE_CMATH_ISINF : yes
Checking for HAVE_CMATH_ISNAN : yes
Checking for NEED_CMATH_ISFINITE_STD_NAMESPACE : yes
Checking for NEED_CMATH_ISINF_STD_NAMESPACE : yes
Checking for NEED_CMATH_ISNAN_STD_NAMESPACE : yes
Checking for header endian.h : yes
Checking for header byteswap.h : yes
Checking for HAVE_MERCHR : yes
Configured VSCode Intellisense: : no
Checking for program 'python' : /usr/bin/python
Checking for python version >= 2.7.0 : 3.8.10
Checking for program 'python' : /usr/bin/python
Checking for python version >= 2.7.0 : 3.8.10
Source is git repository : yes
Update submodules : yes
Checking for program 'git' : /usr/bin/git
Checking for program 'size' : /usr/bin/size
Benchmarks : disabled
Unit tests : enabled
Scripting : enabled
Scripting runtime checks : enabled
Debug build : disabled
Coverage build : disabled
SITL 32-bit build : disabled
Checking for program 'rsync' : /usr/bin/rsync
'configure' finished successfully (2.292s)
SIM_VEHICLE: Building
SIM_VEHICLE: "/home/abya/ardupilot/modules/waf/waf-light" "build" "--target" "bin/arducopter"
Waf: Entering directory '/home/abya/ardupilot/build/sittl'
Embedding file locations.txt:Tools/autotest/locations.txt
Embedding file models/Callisto.json:Tools/autotest/models/Callisto.json
Waf: Leaving directory '/home/abya/ardupilot/build/sittl'
```

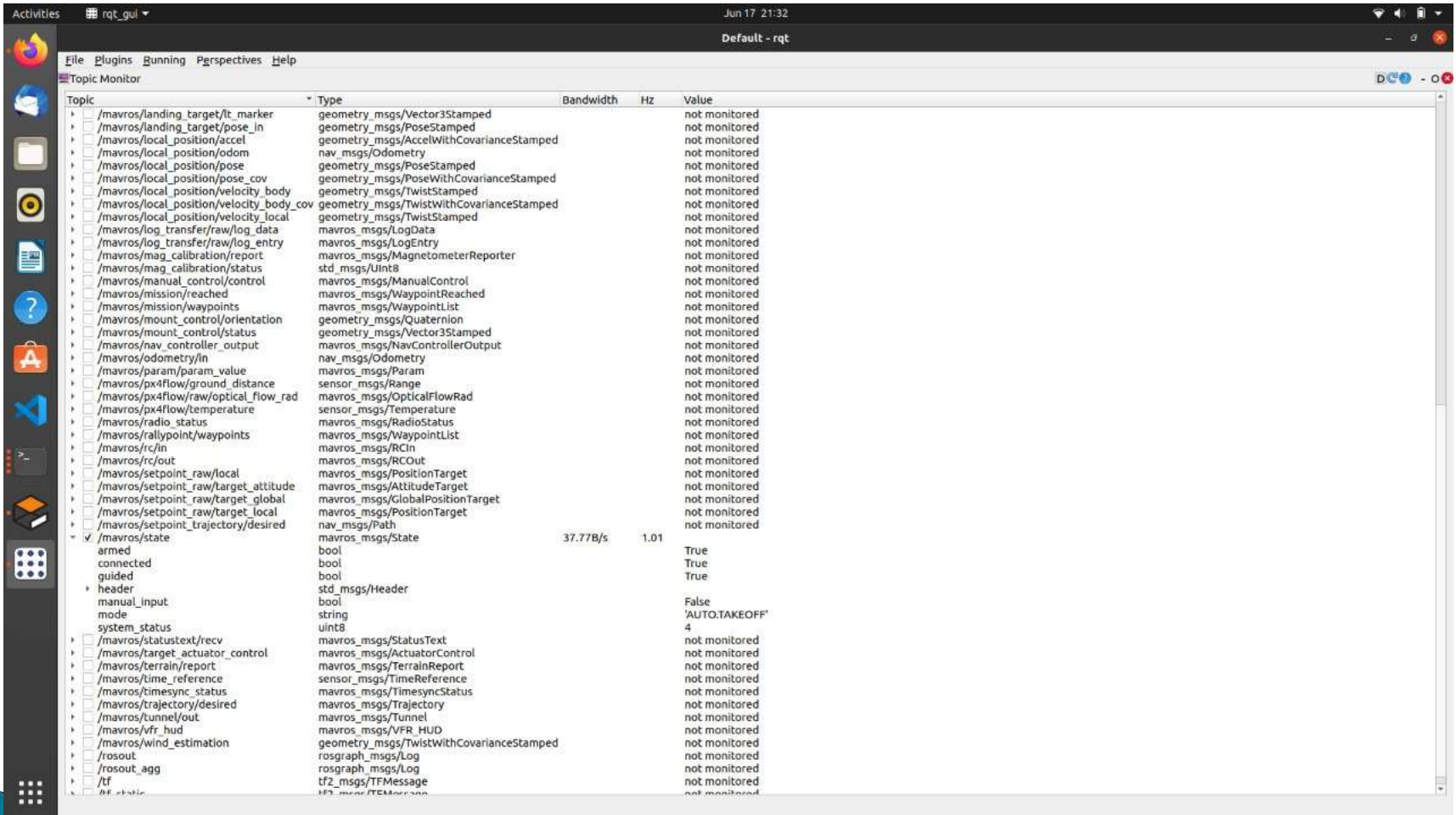
Running launch files and scripts



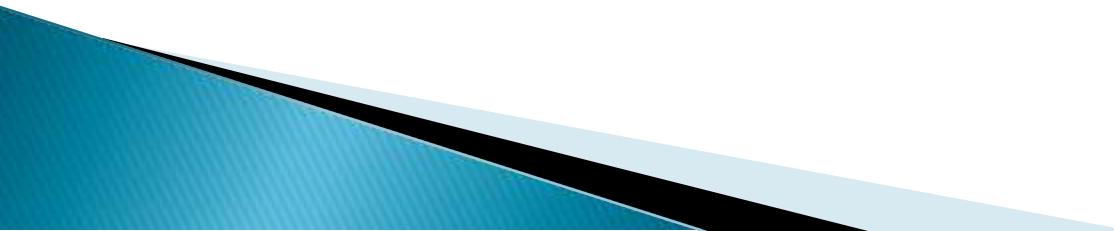


WhatsApp Video 2022-06-17 at 6.47.07 PM.mp4

All the commands are working in the right manner



Topic	Type	Bandwidth	Hz	Value
/mavros/landing_target/ft_marker	geometry_msgs/Vector3Stamped			not monitored
/mavros/landing_target/pose_in	geometry_msgs/PoseStamped			not monitored
/mavros/local_position/accel	geometry_msgs/AccelWithCovarianceStamped			not monitored
/mavros/local_position/odom	nav_msgs/Odometry			not monitored
/mavros/local_position/pose	geometry_msgs/PoseStamped			not monitored
/mavros/local_position/pose_cov	geometry_msgs/PoseWithCovarianceStamped			not monitored
/mavros/local_position/velocity_body	geometry_msgs/TwistStamped			not monitored
/mavros/local_position/velocity_body_cov	geometry_msgs/TwistWithCovarianceStamped			not monitored
/mavros/local_position/velocity_local	geometry_msgs/TwistStamped			not monitored
/mavros/log_transfer/raw/log_data	mavros_msgs/LogData			not monitored
/mavros/log_transfer/raw/log_entry	mavros_msgs/LogEntry			not monitored
/mavros/mag_calibration/report	mavros_msgs/MagnetometerReporter			not monitored
/mavros/mag_calibration/status	std_msgs/UInt8			not monitored
/mavros/manual_control/control	mavros_msgs/ManualControl			not monitored
/mavros/mission/reached	mavros_msgs/WaypointReached			not monitored
/mavros/mission/waypoints	mavros_msgs/WaypointList			not monitored
/mavros/mount_control/orientation	geometry_msgs/Quaternion			not monitored
/mavros/mount_control/status	geometry_msgs/Vector3Stamped			not monitored
/mavros/nav_controller_output	mavros_msgs/NavControllerOutput			not monitored
/mavros/odometry/in	nav_msgs/Odometry			not monitored
/mavros/param/param_value	mavros_msgs/Param			not monitored
/mavros/pix4flow/ground_distance	sensor_msgs/Range			not monitored
/mavros/pix4flow/raw/optical_flow_rad	mavros_msgs/OpticalFlowRad			not monitored
/mavros/pix4flow/temperature	sensor_msgs/Temperature			not monitored
/mavros/radio_status	mavros_msgs/RadioStatus			not monitored
/mavros/rallypoint/waypoints	mavros_msgs/WaypointList			not monitored
/mavros/rc/in	mavros_msgs/RcIn			not monitored
/mavros/rc/out	mavros_msgs/RcOut			not monitored
/mavros/setpoint_raw/local	mavros_msgs/PositionTarget			not monitored
/mavros/setpoint_raw/target_attitude	mavros_msgs/AttitudeTarget			not monitored
/mavros/setpoint_raw/target_global	mavros_msgs/GlobalPositionTarget			not monitored
/mavros/setpoint_raw/target_local	mavros_msgs/PositionTarget			not monitored
/mavros/setpoint_trajectory/desired	nav_msgs/Path			not monitored
✓ /mavros/state	mavros_msgs/State	37.77B/s	1.01	
armed	bool			True
connected	bool			True
guided	bool			True
header	std_msgs/Header			
manual_input	bool			False
mode	string			'AUTO.TAKEOFF'
system_status	uint8			4
/mavros/status/text/recv	mavros_msgs/StatusText			not monitored
/mavros/target_actuator_control	mavros_msgs/ActuatorControl			not monitored
/mavros/terrain/report	mavros_msgs/TerrainReport			not monitored
/mavros/time_reference	sensor_msgs/TimeReference			not monitored
/mavros/timesync_status	mavros_msgs/TimesyncStatus			not monitored
/mavros/trajectory/desired	mavros_msgs/Trajectory			not monitored
/mavros/tunnel/out	mavros_msgs/Tunnel			not monitored
/mavros/vfr_hud	mavros_msgs/VFR_HUD			not monitored
/mavros/wind_estimation	geometry_msgs/TwistWithCovarianceStamped			not monitored
/rosout	roscpp_msgs/Log			not monitored
/rosout_agg	roscpp_msgs/Log			not monitored
/tf	tf2_msgs/TFMessage			not monitored
/tf_static	tf2_msgs/TFMessage			not monitored

- ▶ In the previous slide, it was visible that the drone is in right environment.
 - ▶ Drone is being simulated in gazebo using mavros package
 - ▶ It is armed and ready to take off
 - ▶ All the necessary commands are working fine
- 

Future improvements

- ▶ Guided and machine modes in noetic version of ROS.
- ▶ We came to know that our system was working in auto mode which is not compatible with take off command
- ▶ In future,we'll be exploring the different modes in noetic version of ROS.