CSE2040 L13-L14

Drone Applications, Components & Assembly (Experiment 4)

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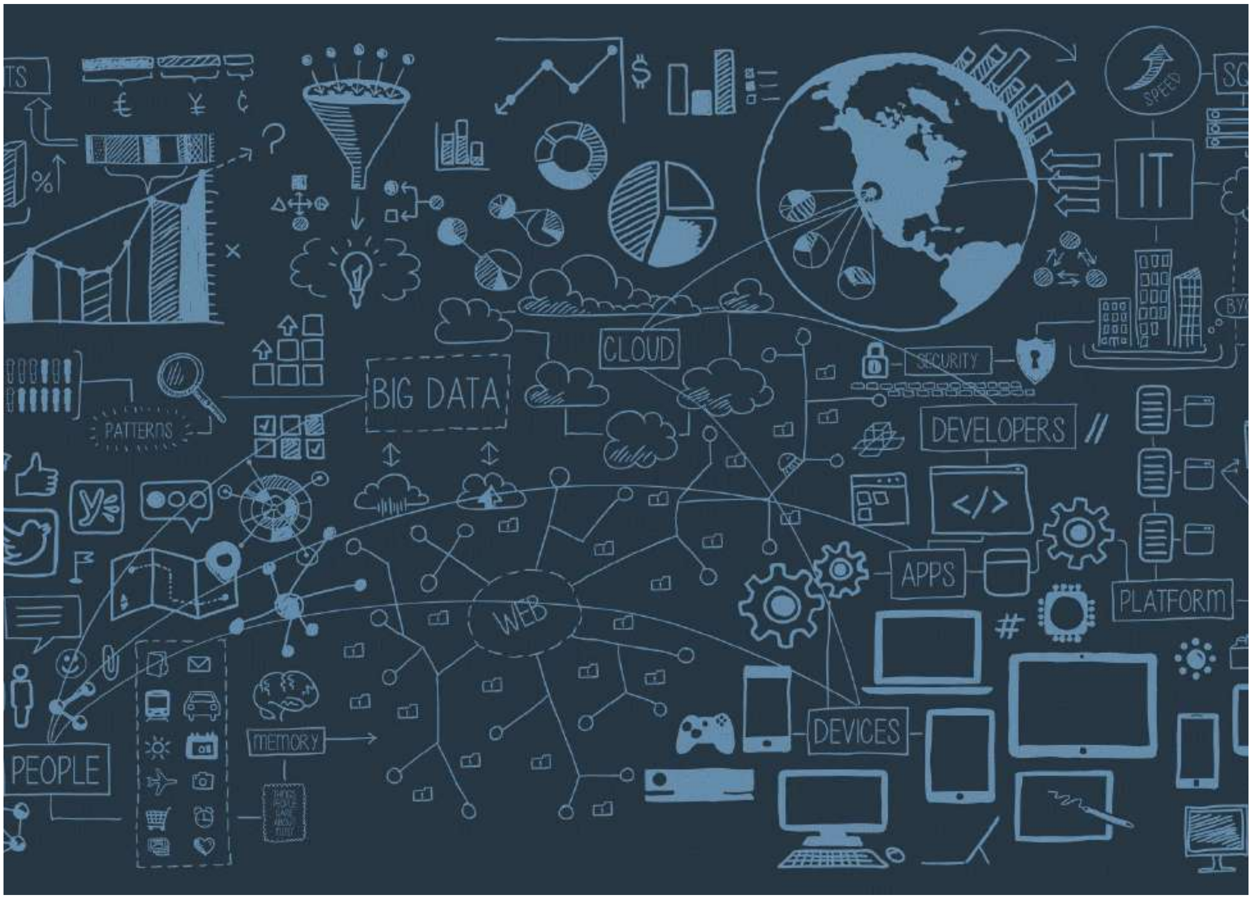


Introduction

Program to take off the drone and land in new location

PREREQUISITES:

- Mission Planner
- PX4 Autopilot SITL
- Unix based OS (eg. Ubuntu, MacOS)

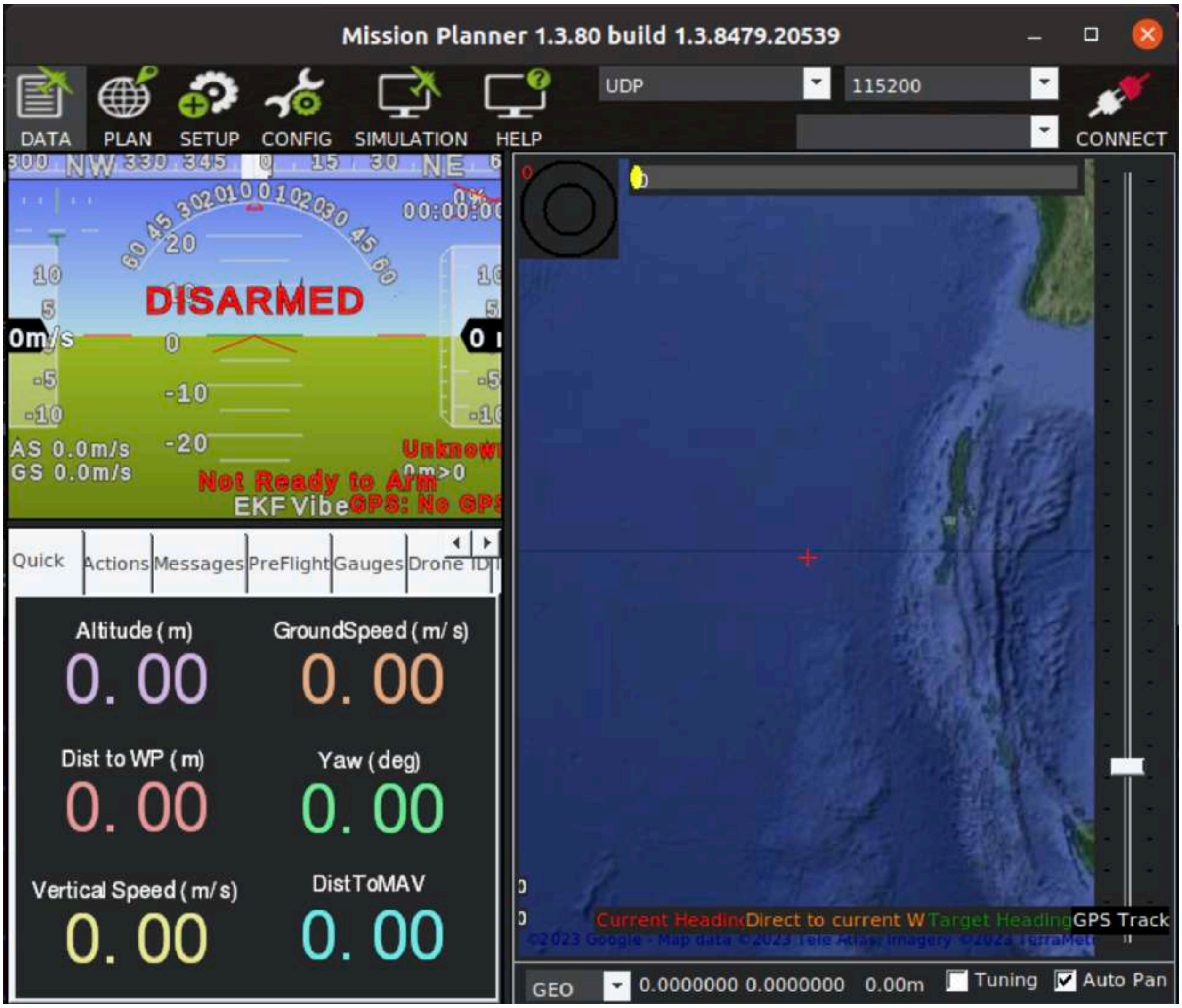
Program to take off the drone and land in a new location

```
from dronekit import connect, VehicleMode, 
LocationGlobalRelative
import time

# Connect to the vehicle
vehicle = connect('udp:127.0.0.1:14550')

# Arm and take off
vehicle.mode = VehicleMode("GUIDED")
vehicle.armed = True
vehicle.simple_takeoff(10)

# Wait for the drone to reach a certain altitude
while True:
    altitude = vehicle.location.global_relative_frame.alt
    if altitude >= 9.5:  # target altitude - 0.5 meters
        break
    time.sleep(1)

# Move the drone to a new location
new_location = LocationGlobalRelative(37.793105, -122.398768, 
20)
vehicle.simple_goto(new_location)

# Wait for the drone to reach the new location
while True:
    distance = 
vehicle.location.global_relative_frame.distance_to(new_location)
    if distance <= 1:  # target radius in meters
```

```
        break
    time.sleep(1)

# Land the drone
vehicle.mode = VehicleMode("LAND")

# Close the connection
vehicle.close()
```

Procedure:

- Launch Mission Planner



Mission Planner 1.3.80 build 1.3.8479.20539

UDP 115200

Altitude (m) 0.00

GroundSpeed (m/s) 0.00

Dist to WP (m) 0.00

Yaw (deg) 0.00

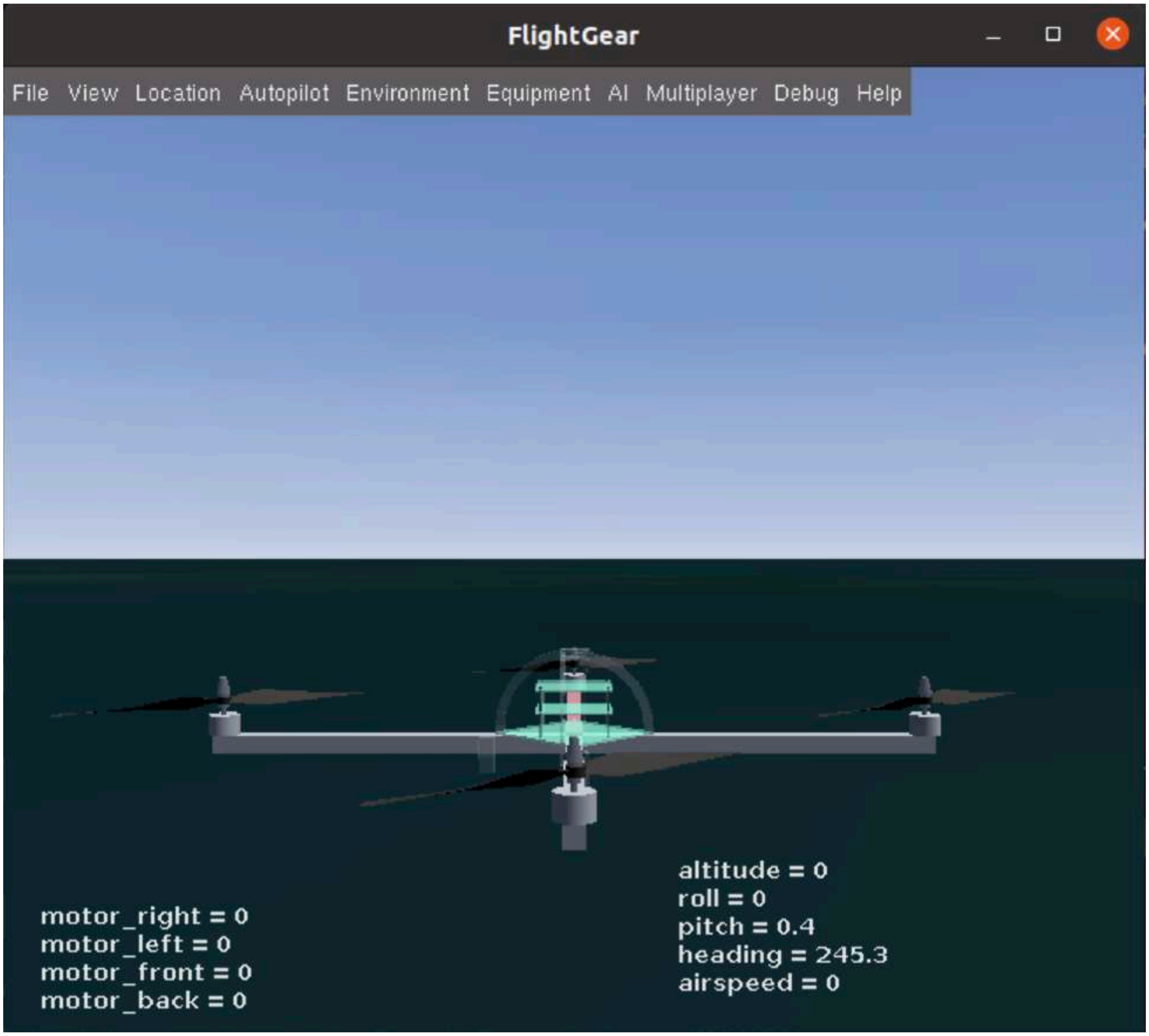
Vertical Speed (m/s) 0.00

DistToMAV 0.00

GEO 0.0000000 0.0000000 0.00m

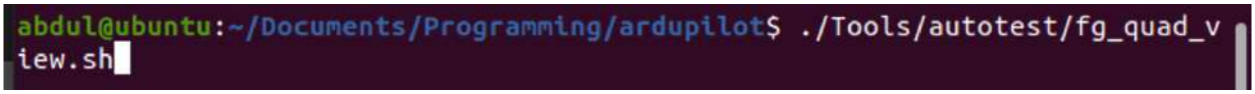
□ Tuning ☑ Auto Pan

- Launch FlightGear

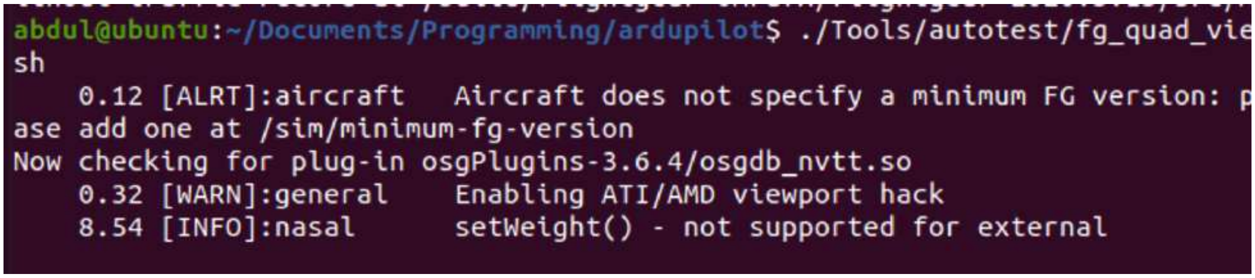


```
motor_right = 0
motor_left = 0
motor_front = 0
motor_back = 0
```

```
altitude = 0
roll = 0
pitch = 0.4
heading = 245.3
airspeed = 0
```

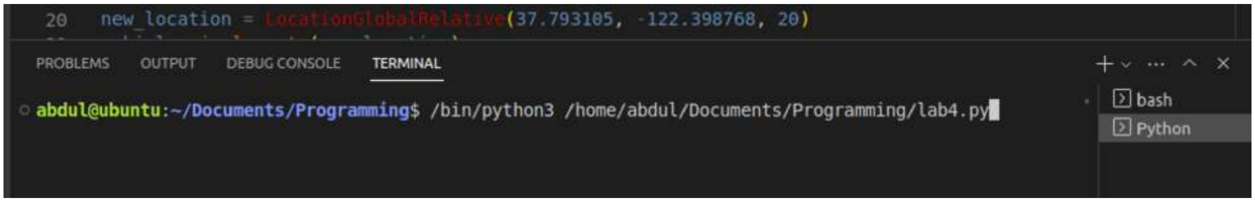


```
abdul@ubuntu:~/Documents/Programming/ardupilot$ ./Tools/autotest/fg_quad_v
iew.sh
```



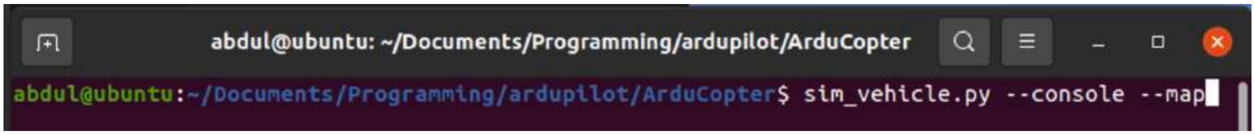
```
abdul@ubuntu:~/Documents/Programming/ardupilot$ ./Tools/autotest/fg_quad_vie
sh
    0.12 [ALRT]:aircraft   Aircraft does not specify a minimum FG version: p
ase add one at /sim/minimum-fg-version
Now checking for plug-in osgPlugins-3.6.4/osgdb_nvtt.so
    0.32 [WARN]:general    Enabling ATI/AMD viewport hack
    8.54 [INFO]:nasal      setWeight() - not supported for external
```

- Write the code in an IDE like Vscode and run it.

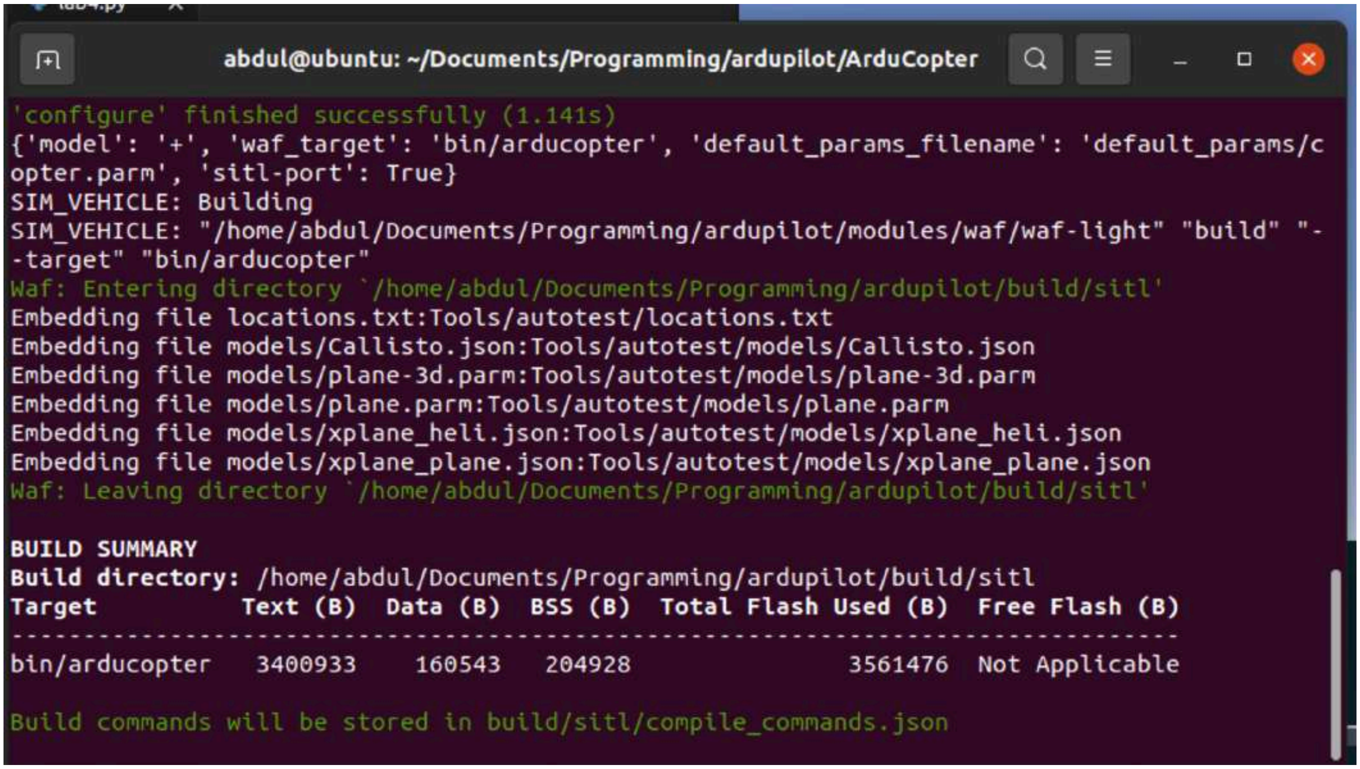


```
new_location = LocationGlobalRelative(37.793105, -122.398768, 20)
```

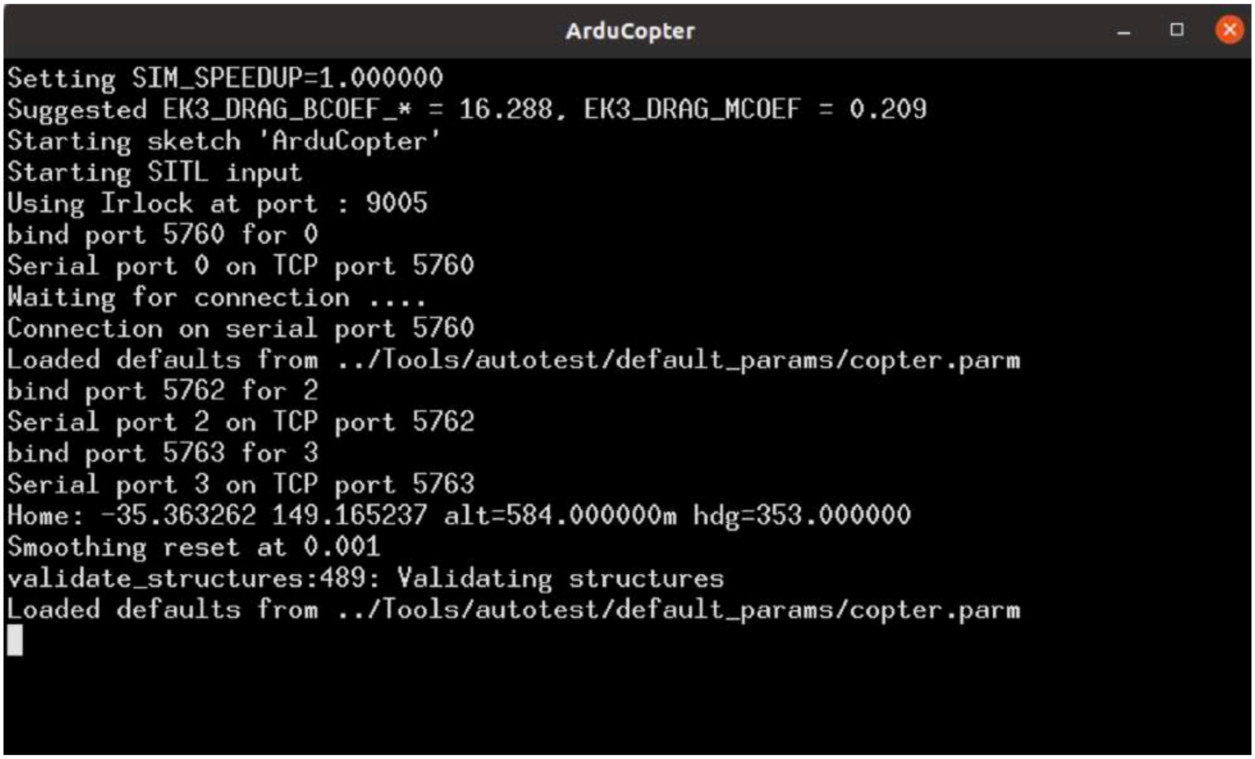
```
abdul@ubuntu:~/Documents/Programming$ /bin/python3 /home/abdul/Documents/Programming/lab4.py
```



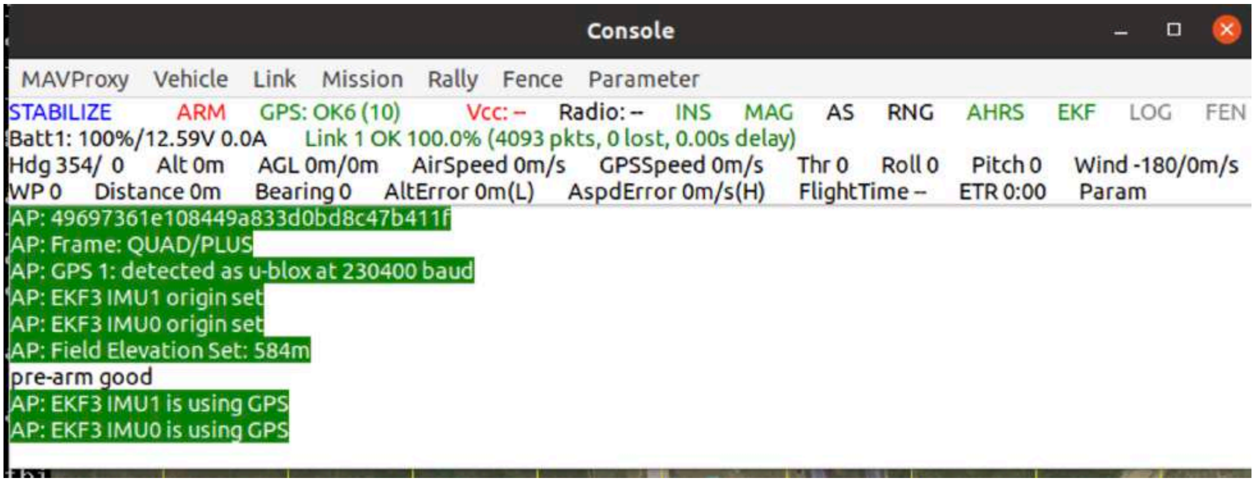
```
abdul@ubuntu:~/Documents/Programming/ardupilot/ArduCopter$ sim_vehicle.py --console --map
```



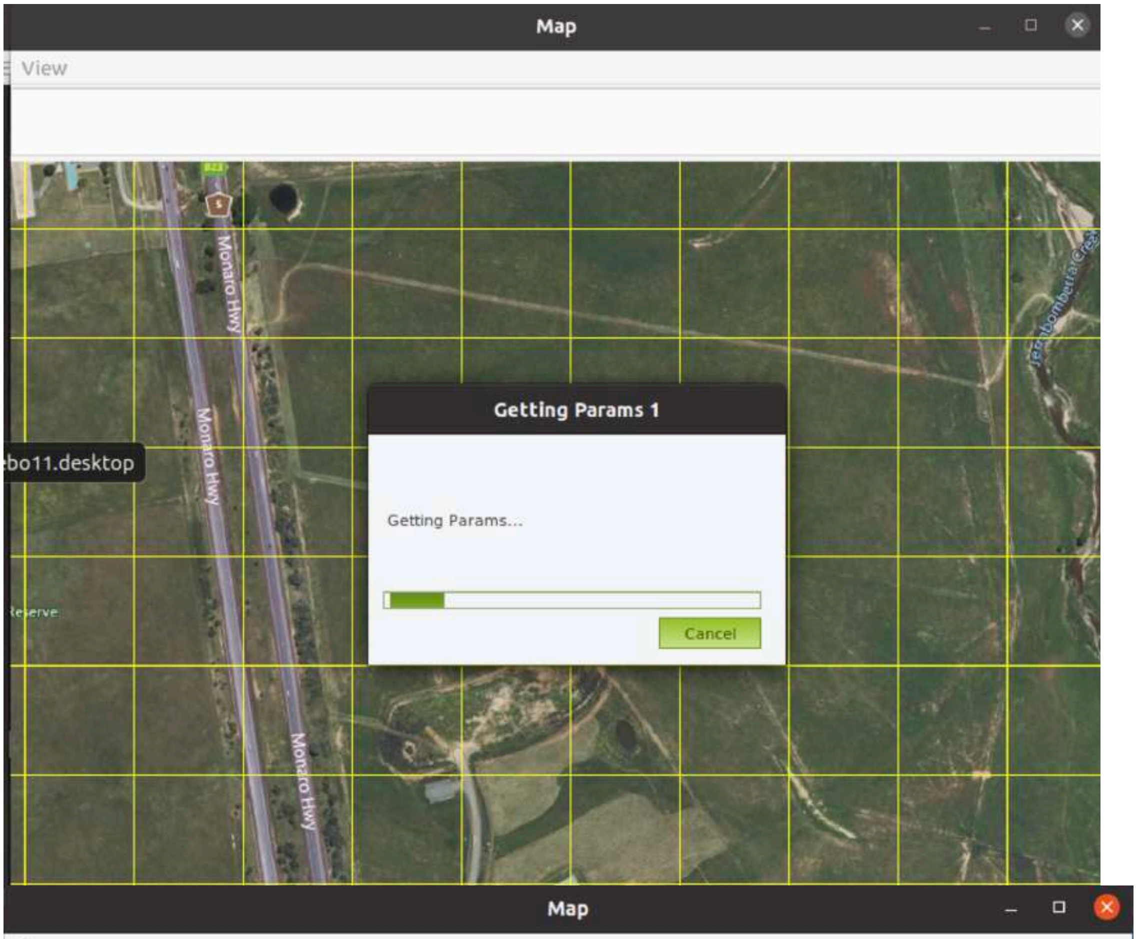
```
'configure' finished successfully (1.141s)
{'model': '+', 'waf_target': 'bin/arducopter', 'default_params_filename': 'default_params/c
opter.parm', 'sitl-port': True}
SIM_VEHICLE: Building
SIM_VEHICLE: "/home/abdul/Documents/Programming/ardupilot/modules/waf/waf-light" "build" "-
-target" "bin/arducopter"
Waf: Entering directory `/home/abdul/Documents/Programming/ardupilot/build/sitl'
Embedding file locations.txt:Tools/autotest/locations.txt
Embedding file models/Callisto.json:Tools/autotest/models/Callisto.json
Embedding file models/plane-3d.parm:Tools/autotest/models/plane-3d.parm
Embedding file models/plane.parm:Tools/autotest/models/plane.parm
Embedding file models/xplane_heli.json:Tools/autotest/models/xplane_heli.json
Embedding file models/xplane_plane.json:Tools/autotest/models/xplane_plane.json
Waf: Leaving directory `/home/abdul/Documents/Programming/ardupilot/build/sitl'

BUILD SUMMARY
Build directory: /home/abdul/Documents/Programming/ardupilot/build/sitl
Target          Text (B)  Data (B)  BSS (B)  Total Flash Used (B)  Free Flash (B)
---------------------------------------------------------------------------------
bin/arducopter   3400933    160543   204928               3561476  Not Applicable

Build commands will be stored in build/sitl/compile_commands.json
```



```
Setting SIM_SPEEDUP=1.000000
Suggested EK3_DRAG_BCOEF_* = 16.288, EK3_DRAG_MCOEF = 0.209
Starting sketch 'ArduCopter'
Starting SITL input
Using Irlock at port : 9005
bind port 5760 for 0
Serial port 0 on TCP port 5760
Waiting for connection ....
Connection on serial port 5760
Loaded defaults from ../Tools/autotest/default_params/copter.parm
bind port 5762 for 2
Serial port 2 on TCP port 5762
bind port 5763 for 3
Serial port 3 on TCP port 5763
Home: -35.363262 149.165237 alt=584.000000m hdg=353.000000
Smoothing reset at 0.001
validate_structures:489: Validating structures
Loaded defaults from ../Tools/autotest/default_params/copter.parm
```

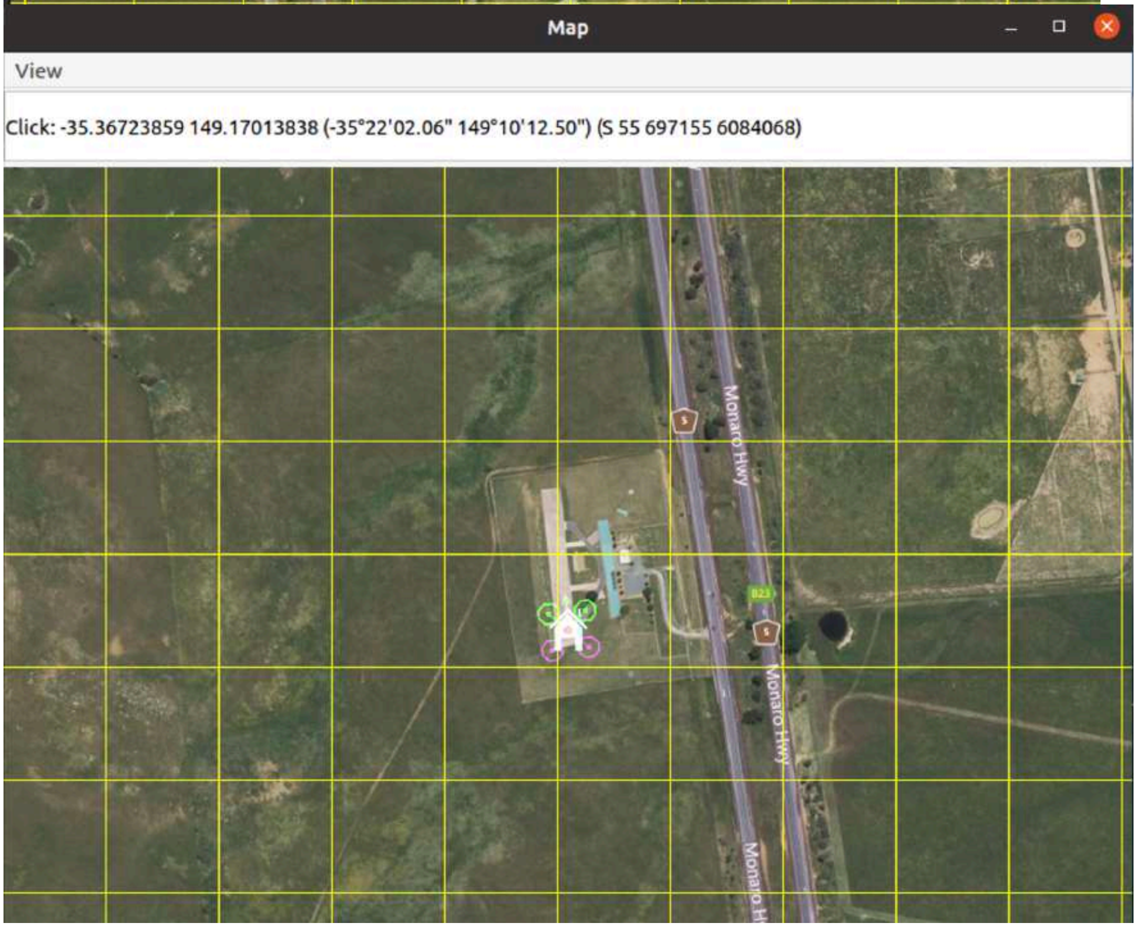


```
STABILIZE     ARM    GPS: OK6 (10)      Vcc: --    Radio: --   INS    MAG    AS    RNG    AHRS    EKF    LOG    FEN
Batt1: 100%/12.59V 0.0A     Link 1 OK 100.0% (4093 pkts, 0 lost, 0.00s delay)
Hdg 354/ 0    Alt 0m    AGL 0m/0m    AirSpeed 0m/s    GPSSpeed 0m/s    Thr 0    Roll 0    Pitch 0    Wind -180/0m/s
WP 0    Distance 0m    Bearing 0    AltError 0m(L)    AspdError 0m/s(H)    FlightTime --    ETR 0:00    Param
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
AP: GPS 1: detected as u-blox at 230400 baud
AP: EKF3 IMU1 origin set
AP: EKF3 IMU0 origin set
AP: Field Elevation Set: 584m
pre-arm good
AP: EKF3 IMU1 is using GPS
AP: EKF3 IMU0 is using GPS
```



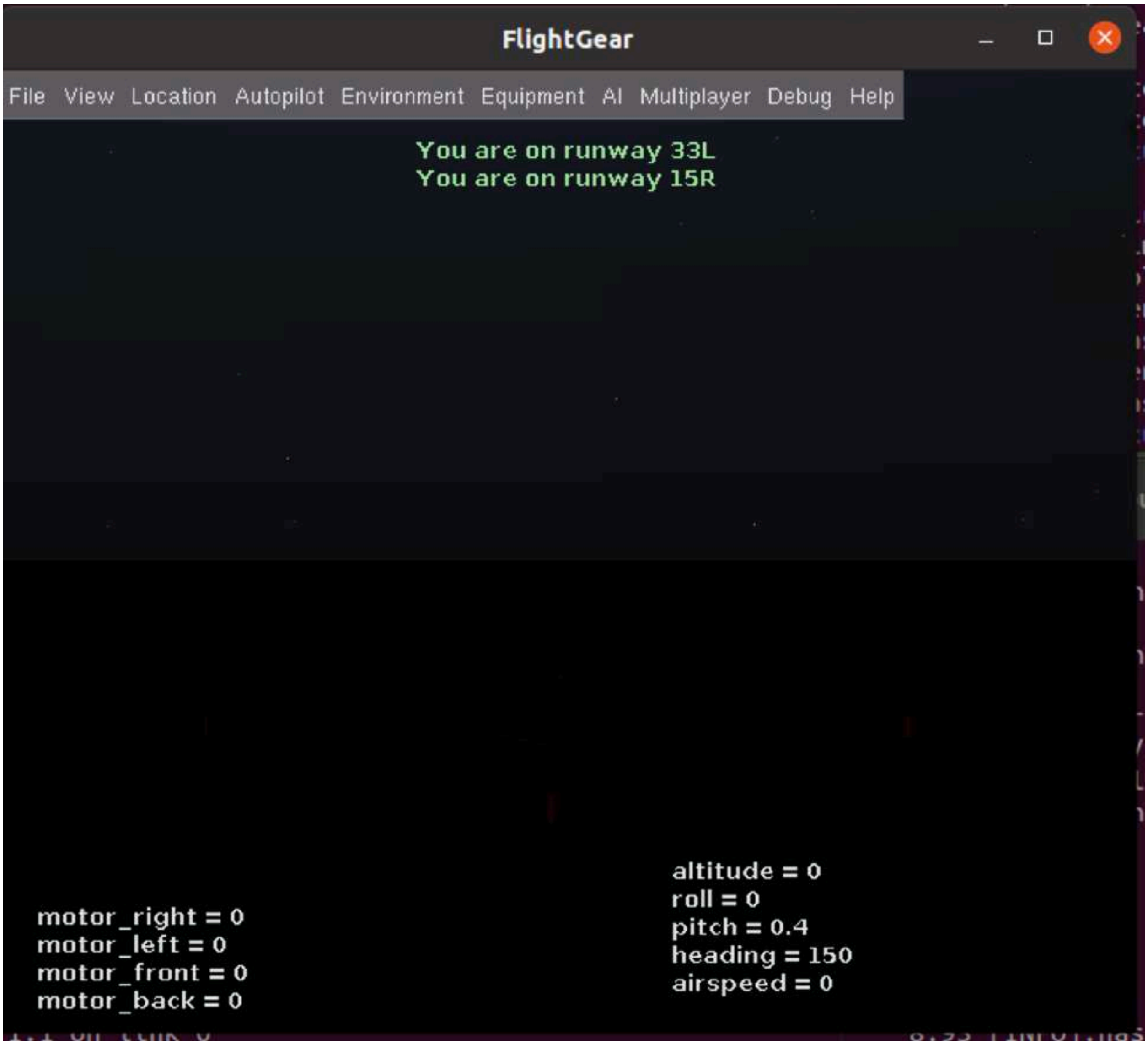
Getting Params 1

Getting Params...



```
Click: -35.36723859 149.17013838 (-35°22'02.06" 149°10'12.50") (S 55 697155 6084068)
```

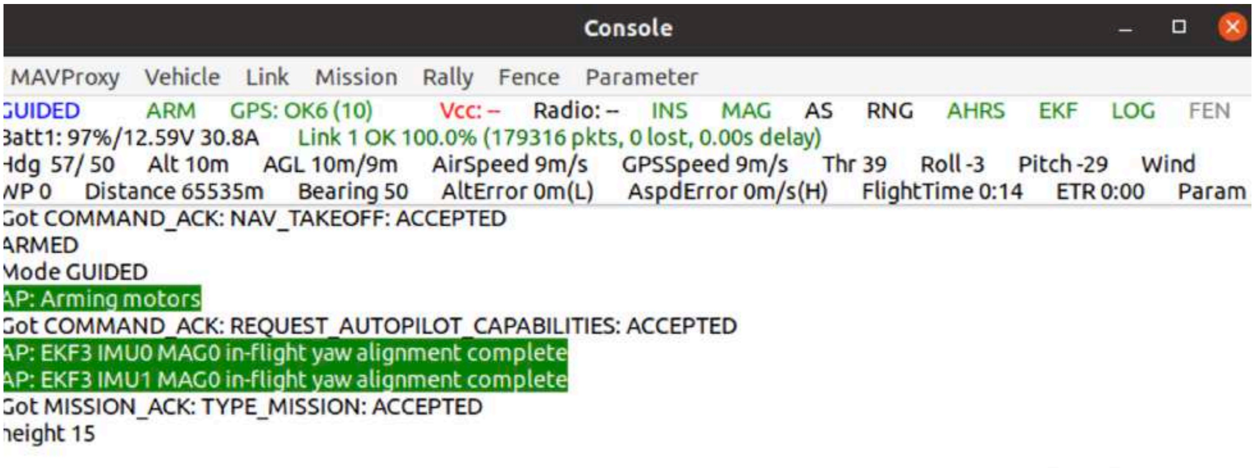
Changing airport on flightgear



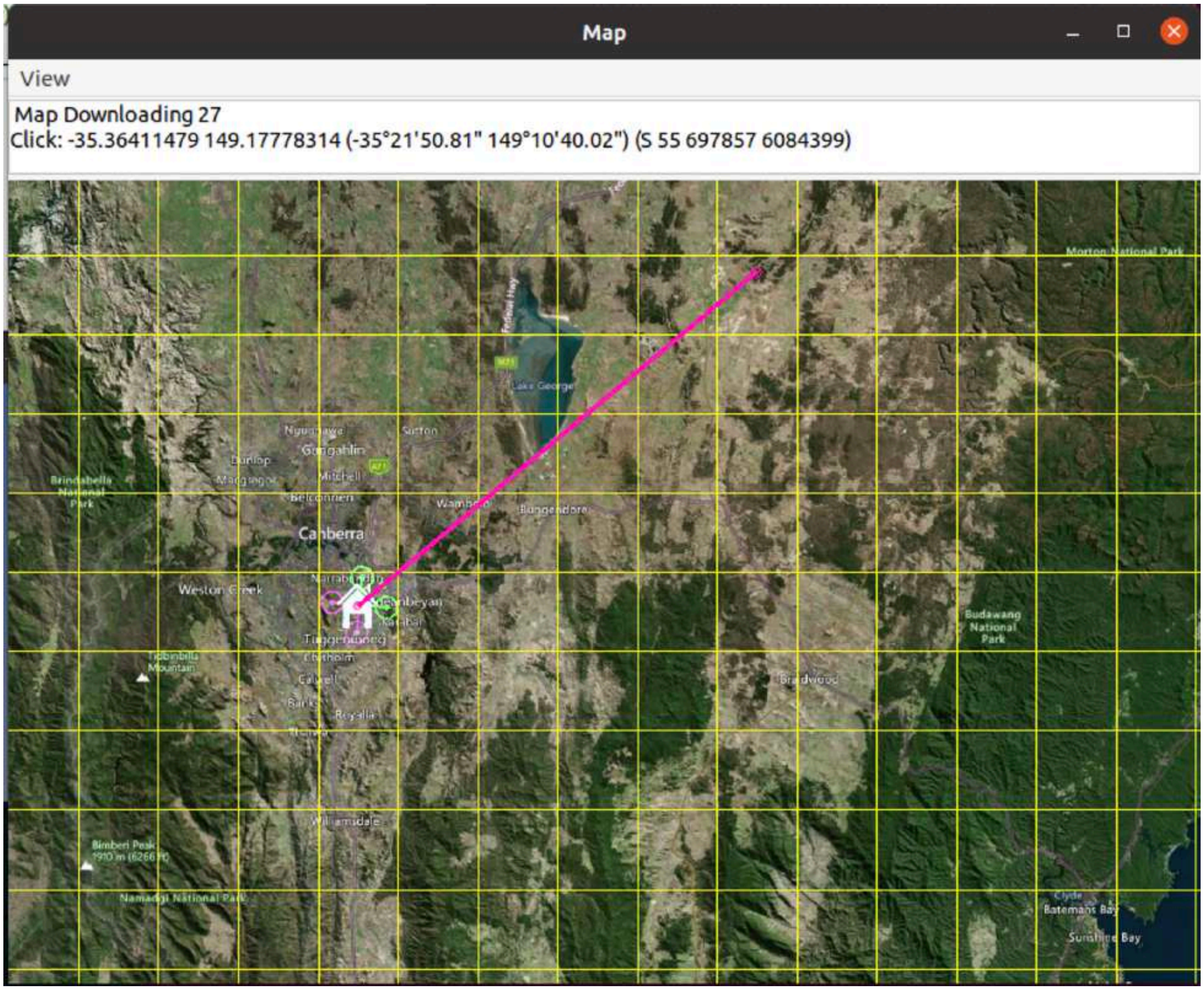
```
You are on runway 33L
You are on runway 15R
```

```
motor_right = 0
motor_left = 0
motor_front = 0
motor_back = 0
```

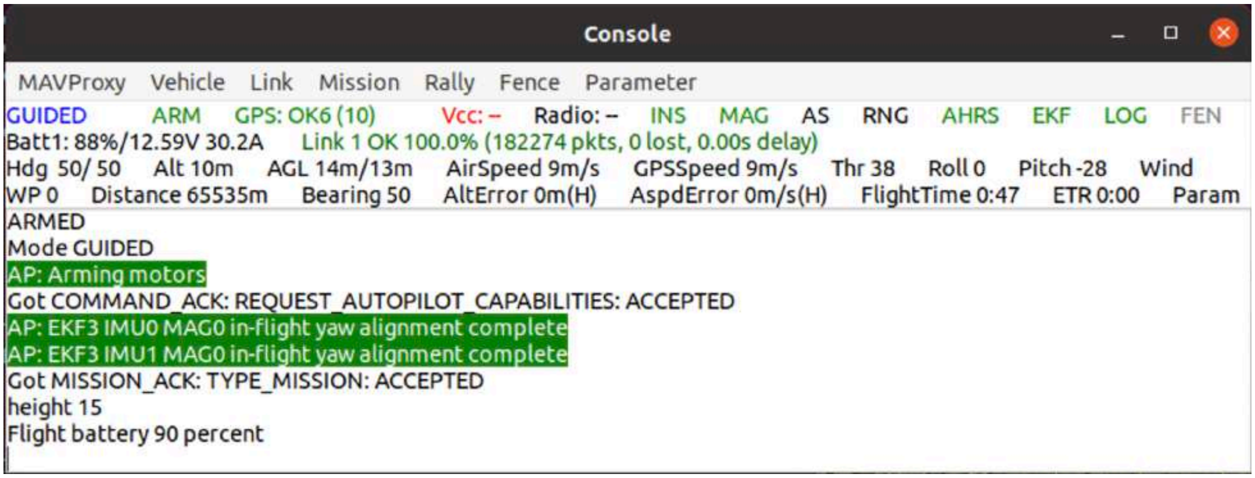
```
altitude = 0
roll = 0
pitch = 0.4
heading = 150
airspeed = 0
```



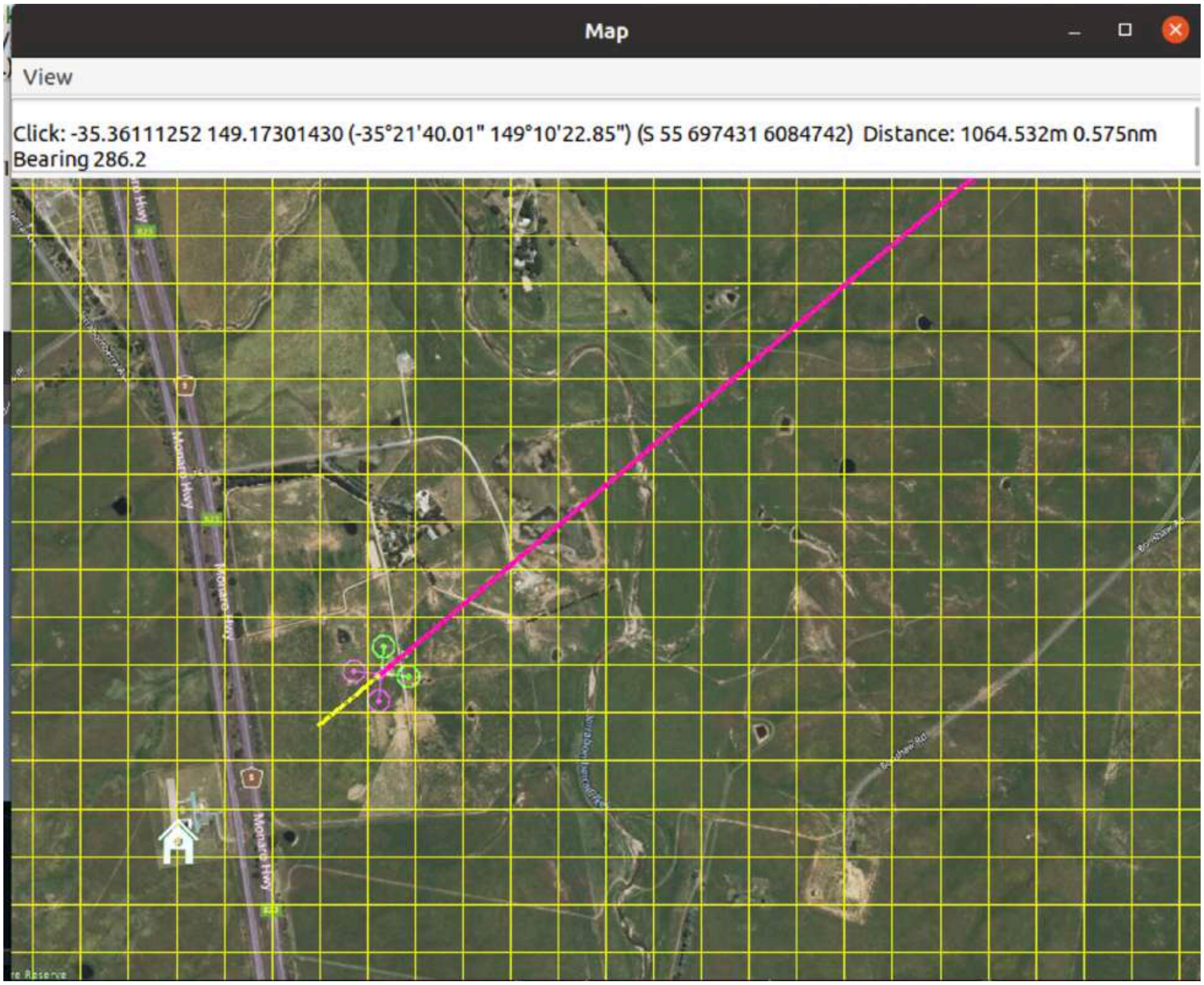
```
GUIDED      ARM    GPS: OK6 (10)     Vcc: --    Radio: --    INS    MAG    AS    RNG    AHRS    EKF    LOG    FEN
Batt1: 97%/12.59V 30.8A     Link 1 OK 100.0% (179316 pkts, 0 lost, 0.00s delay)
Hdg 57/ 50    Alt 10m    AGL 10m/9m    AirSpeed 9m/s    GPSSpeed 9m/s    Thr 39    Roll -3    Pitch -29    Wind
WP 0    Distance 65535m    Bearing 50    AltError 0m(L)    AspdError 0m/s(H)    FlightTime 0:14    ETR 0:00    Param
Got COMMAND_ACK: NAV_TAKEOFF: ACCEPTED
ARMED
Mode GUIDED
AP: Arming motors
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: ACCEPTED
AP: EKF3 IMU0 MAG0 in-flight yaw alignment complete
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
```



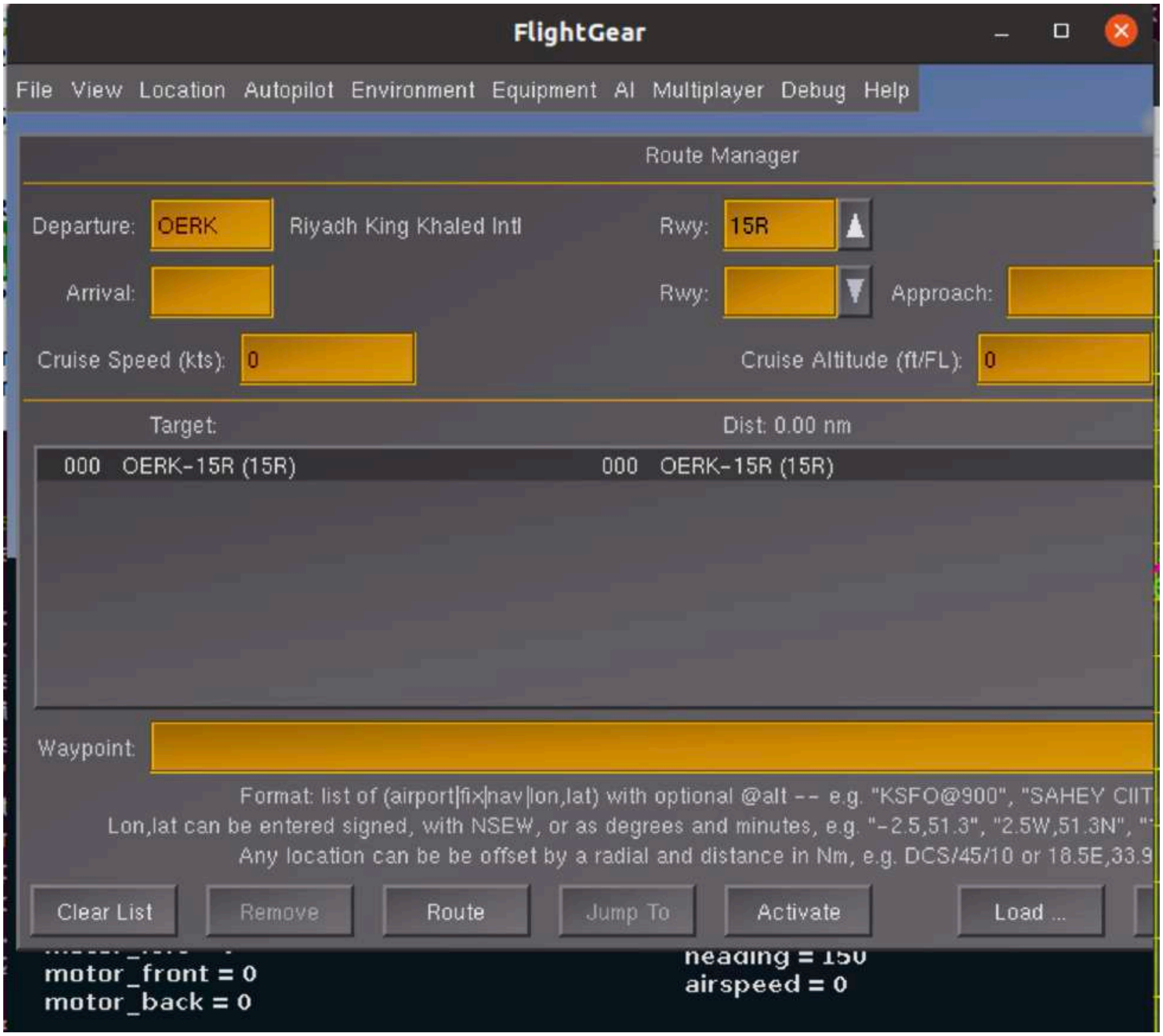
```
Map Downloading 27
Click: -35.36411479 149.17778314 (-35°21'50.81" 149°10'40.02") (S 55 697857 6084399)
```



```
GUIDED      ARM    GPS: OK6 (10)     Vcc: --    Radio: --    INS    MAG    AS    RNG    AHRS    EKF    LOG    FEN
Batt1: 88%/12.59V 30.2A     Link 1 OK 100.0% (182274 pkts, 0 lost, 0.00s delay)
Hdg 50/ 50    Alt 10m    AGL 14m/13m    AirSpeed 9m/s    GPSSpeed 9m/s    Thr 38    Roll 0    Pitch -28    Wind
WP 0    Distance 65535m    Bearing 50    AltError 0m(H)    AspdError 0m/s(H)    FlightTime 0:47    ETR 0:00    Param
ARMED
Mode GUIDED
AP: Arming motors
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: ACCEPTED
AP: EKF3 IMU0 MAG0 in-flight yaw alignment complete
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
Flight battery 90 percent
```



Click: -35.36111252 149.17301430 (-35°21'40.01" 149°10'22.85") (S 55 697431 6084742) Distance: 1064.532m 0.575nm
Bearing 286.2


FlightGear
File View Location Autopilot Environment Equipment AI Multiplayer Debug Help
Route Manager
Clear List
Remove
Route
Jump To
Activate
Load ...

Departure: OERK Riyadh King Khaled Intl Rwy: 15R

Arrival: Rwy: Approach:

Cruise Speed (kts): 0 Cruise Altitude (ft/FL): 0

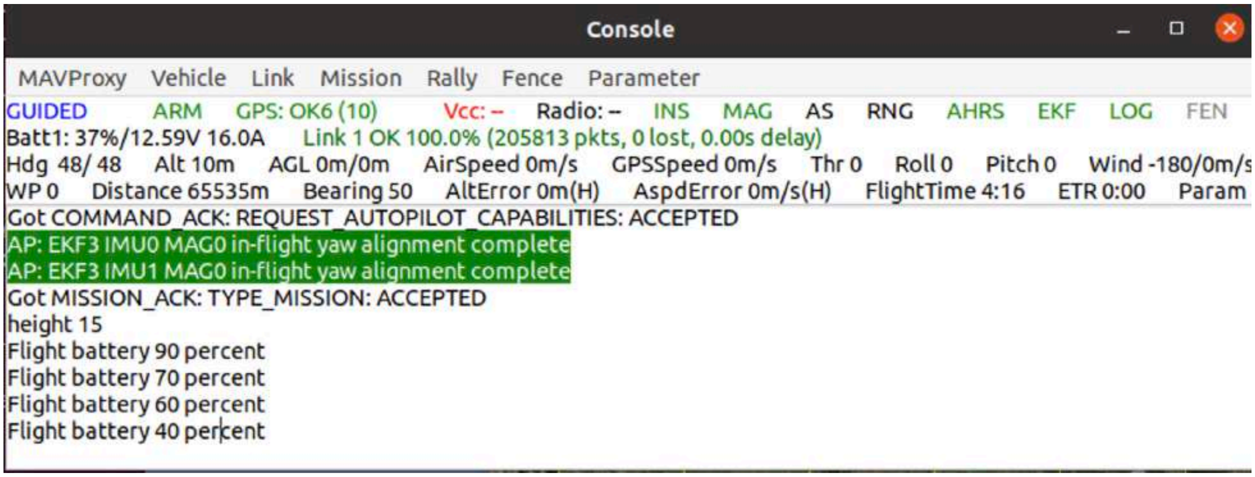
Target: Dist: 0.00 nm

```
000   OERK-15R (15R)                       000   OERK-15R (15R)
```

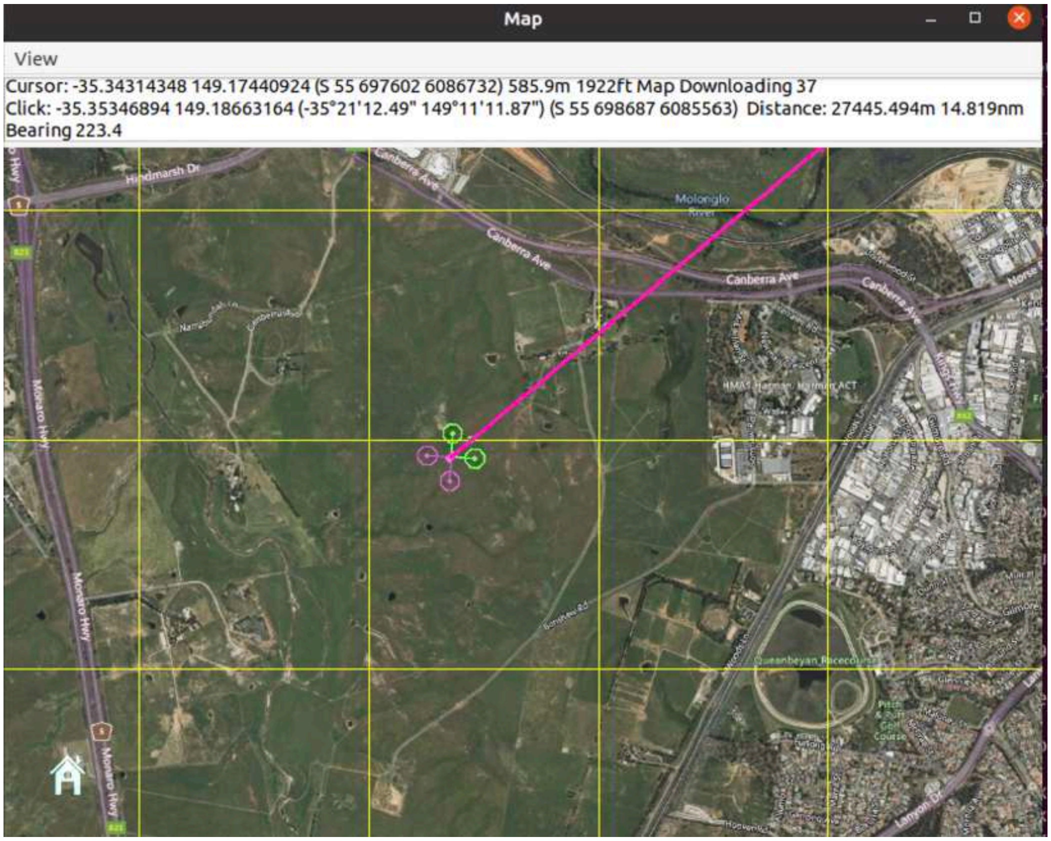
Waypoint:

Format: list of (airport|fix|nav|lon,lat) with optional @alt -- e.g. "KSFO@900", "SAHEY CIIT
Lon,lat can be entered signed, with NSEW, or as degrees and minutes, e.g. "-2.5,51.3", "2.5W,51.3N", "
Any location can be be offset by a radial and distance in Nm, e.g. DCS/45/10 or 18.5E,33.9

```
motor_front = 0                 heading = 150
motor_back = 0                  airspeed = 0
```



```
GUIDED      ARM    GPS: OK6 (10)     Vcc: --    Radio: --    INS    MAG    AS    RNG    AHRS    EKF    LOG    FEN
Batt1: 37%/12.59V 16.0A     Link 1 OK 100.0% (205813 pkts, 0 lost, 0.00s delay)
Hdg 48/ 48    Alt 10m    AGL 0m/0m    AirSpeed 0m/s    GPSSpeed 0m/s    Thr 0    Roll 0    Pitch 0    Wind -180/0m/s
WP 0    Distance 65535m    Bearing 50    AltError 0m(H)    AspdError 0m/s(H)    FlightTime 4:16    ETR 0:00    Param
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: ACCEPTED
AP: EKF3 IMU0 MAG0 in-flight yaw alignment complete
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
Flight battery 90 percent
Flight battery 70 percent
Flight battery 60 percent
Flight battery 40 percent
```

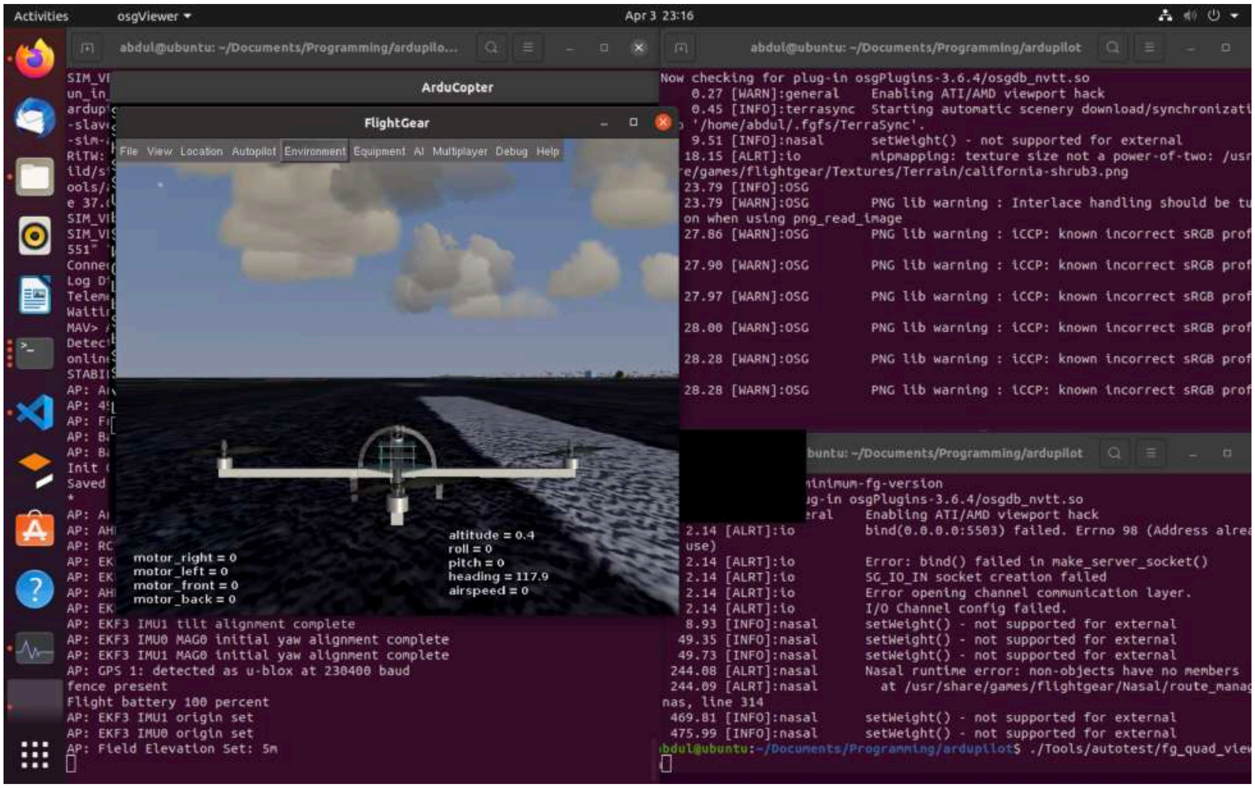


Map

View

Cursor: -35.34314348 149.17440924 (S 55 697602 6086732) 585.9m 1922ft Map Downloading 37
Click: -35.35346894 149.18663164 (-35°21'12.49" 149°11'11.87") (S 55 698687 6085563) Distance: 27445.494m 14.819nm
Bearing 223.4

Run flight gear first and then the sim_vehicle.py -L KSFO



Activities
osgViewer
Apr 3 23:16
abdul@ubuntu: ~/Documents/Programming/ardupilo...
ArduCopter
FlightGear
File View Location Autopilot Environment Equipment AI Multiplayer Debug Help

```
motor_right = 0
motor_left = 0
motor_front = 0
motor_back = 0
```

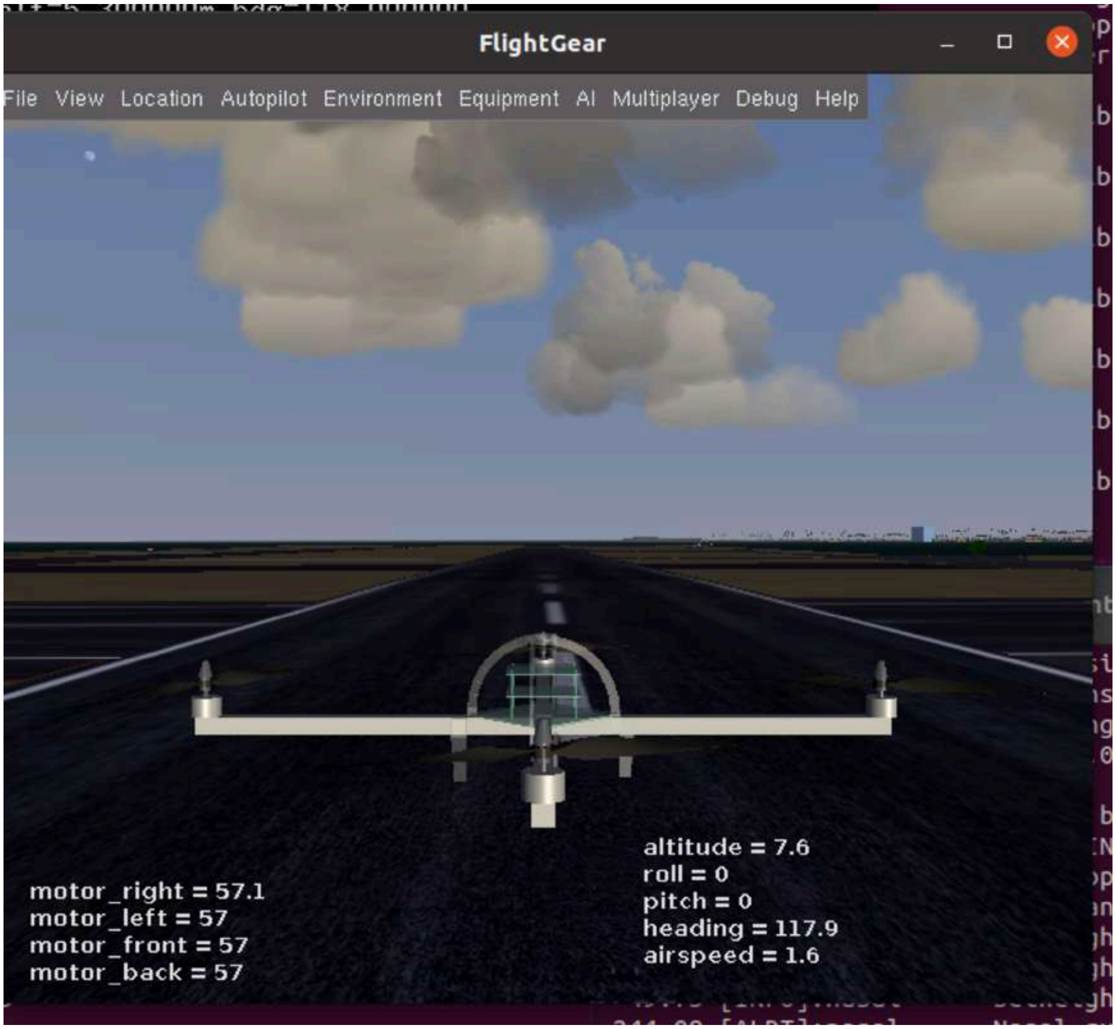
```
altitude = 0.4
roll = 0
pitch = 0
heading = 117.9
airspeed = 0
```

```
SIM_VI
un_in
ardup
-slav
-sim-
RiTW:
ild/s
ools/
e 37.
SIM_VI
SIM_VI
551"
Conne
Log D
Telem
Waiti
MAV> A
Detec
onlin
STABI
AP: A
AP: 4
AP: F
AP: B
AP: B
Init
Saved
*
AP: A
AP: AH
AP: RC
AP: EK
AP: EK
AP: AH
AP: EK
AP: EKF3 IMU1 tilt alignment complete
AP: EKF3 IMU0 MAG0 initial yaw alignment complete
AP: EKF3 IMU1 MAG0 initial yaw alignment complete
AP: GPS 1: detected as u-blox at 230400 baud
fence present
Flight battery 100 percent
AP: EKF3 IMU1 origin set
AP: EKF3 IMU0 origin set
AP: Field Elevation Set: 5m
```

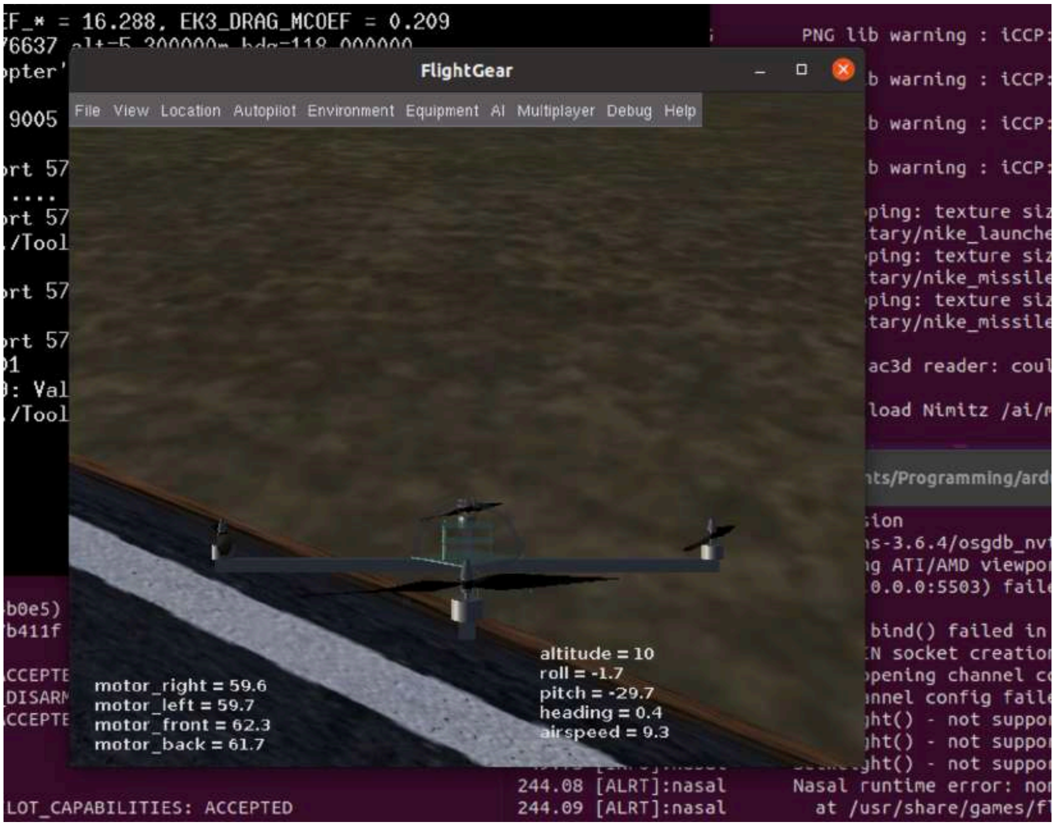
```
Now checking for plug-in osgPlugins-3.6.4/osgdb_nvtt.so
    0.27 [WARN]:general     Enabling ATI/AMD viewport hack
    0.45 [INFO]:terrasync   Starting automatic scenery download/synchronizati
o '/home/abdul/.fgfs/TerraSync'.
    9.51 [INFO]:nasal       setWeight() - not supported for external
   18.15 [ALRT]:io          mipmapping: texture size not a power-of-two: /usr
re/games/flightgear/Textures/Terrain/california-shrub3.png
   23.79 [INFO]:OSG
   23.79 [WARN]:OSG         PNG lib warning : Interlace handling should be tu
   on when using png_read_image
   27.86 [WARN]:OSG         PNG lib warning : iCCP: known incorrect sRGB prof

   27.90 [WARN]:OSG         PNG lib warning : iCCP: known incorrect sRGB prof

   27.97 [WARN]:OSG         PNG lib warning : iCCP: known incorrect sRGB prof

   28.00 [WARN]:OSG         PNG lib warning : iCCP: known incorrect sRGB prof

   28.28 [WARN]:OSG         PNG lib warning : iCCP: known incorrect sRGB prof

   28.28 [WARN]:OSG         PNG lib warning : iCCP: known incorrect sRGB prof
```

[redacted]

```
minimum-fg-version
ug-in osgPlugins-3.6.4/osgdb_nvtt.so
eral        Enabling ATI/AMD viewport hack
   2.14 [ALRT]:io          bind(0.0.0.0:5503) failed. Errno 98 (Address alrea
   use)
   2.14 [ALRT]:io          Error: bind() failed in make_server_socket()
   2.14 [ALRT]:io          SG_IO_IN socket creation failed
   2.14 [ALRT]:io          Error opening channel communication layer.
   2.14 [ALRT]:io          I/O Channel config failed.
   8.93 [INFO]:nasal       setWeight() - not supported for external
  49.35 [INFO]:nasal       setWeight() - not supported for external
  49.73 [INFO]:nasal       setWeight() - not supported for external
 244.08 [ALRT]:nasal       Nasal runtime error: non-objects have no members
 244.09 [ALRT]:nasal         at /usr/share/games/flightgear/Nasal/route_manag
nas, line 314
 469.81 [INFO]:nasal       setWeight() - not supported for external
 475.99 [INFO]:nasal       setWeight() - not supported for external
bdul@ubuntu:~/Documents/Programming/ardupilot$ ./Tools/autotest/fg_quad_view
```

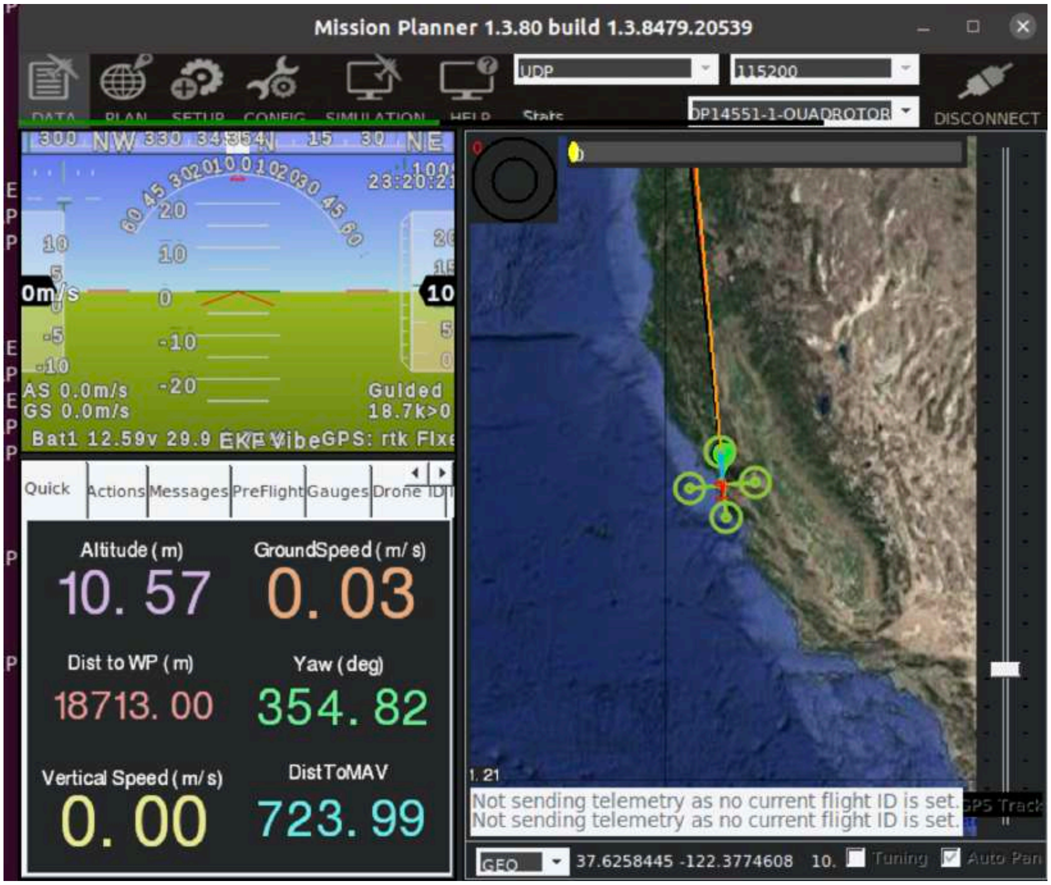

FlightGear
File View Location Autopilot Environment Equipment AI Multiplayer Debug Help

```
motor_right = 57.1
motor_left = 57
motor_front = 57
motor_back = 57

altitude = 7.6
roll = 0
pitch = 0
heading = 117.9
airspeed = 1.6
```


FlightGear
File View Location Autopilot Environment Equipment AI Multiplayer Debug Help

```
EF_* = 16.288, EK3_DRAG_MCOEF = 0.209
PNG lib warning : iCCP:
b warning : iCCP:
b warning : iCCP:
b warning : iCCP:
ping: texture siz
tary/nike_launche
ping: texture siz
tary/nike_missile
ping: texture siz
tary/nike_missile
ac3d reader: coul
load Nimitz /ai/m
LOT_CAPABILITIES: ACCEPTED
244.08 [ALRT]:nasal   Nasal runtime error: no
244.09 [ALRT]:nasal    at /usr/share/games/f
```

```
motor_right = 59.6
motor_left = 59.7
motor_front = 62.3
motor_back = 61.7

altitude = 10
roll = -1.7
pitch = -29.7
heading = 0.4
airspeed = 9.3
```



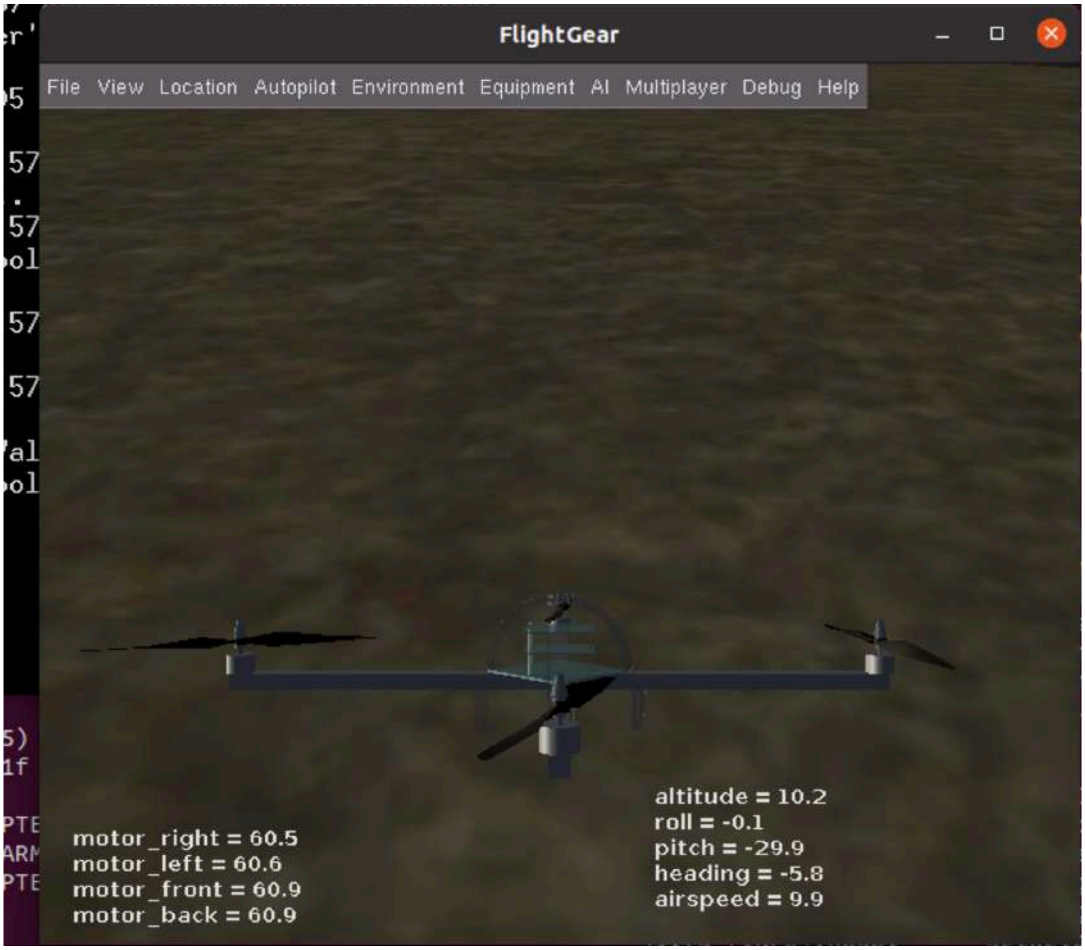
UDP
115200
DP14551-1-QUADROTOR

AS 0.0m/s
GS 0.0m/s
Guided
18.7k>0
23:20:21
Bat1 12.59v 29.9 EKF Vibe GPS: rtk Fixed

Altitude (m) 10. 57
GroundSpeed (m/ s) 0. 03
Dist to WP (m) 18713. 00
Yaw (deg) 354. 82
Vertical Speed (m/ s) 0. 00
DistToMAV 723. 99

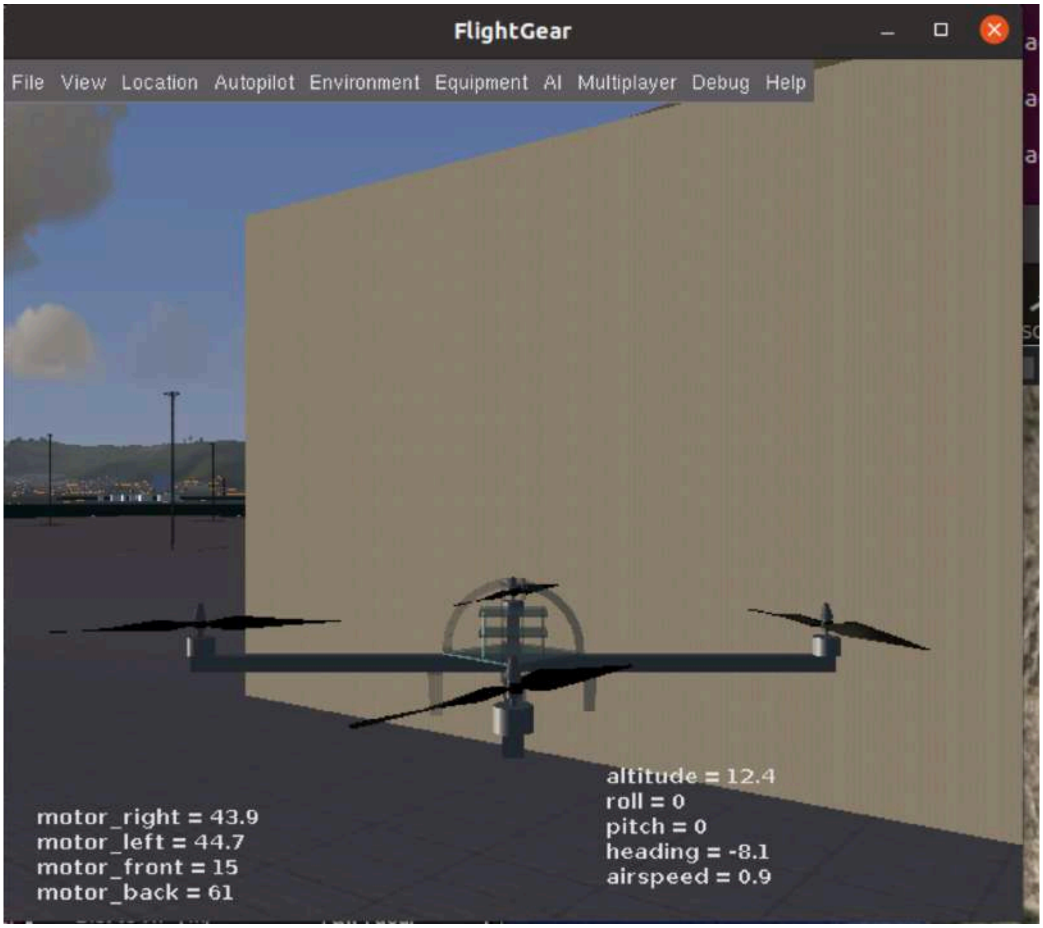
Not sending telemetry as no current flight ID is set.
Not sending telemetry as no current flight ID is set.

GEO 37.6258445 -122.3774608 10. □ Tuning ☑ Auto Pan



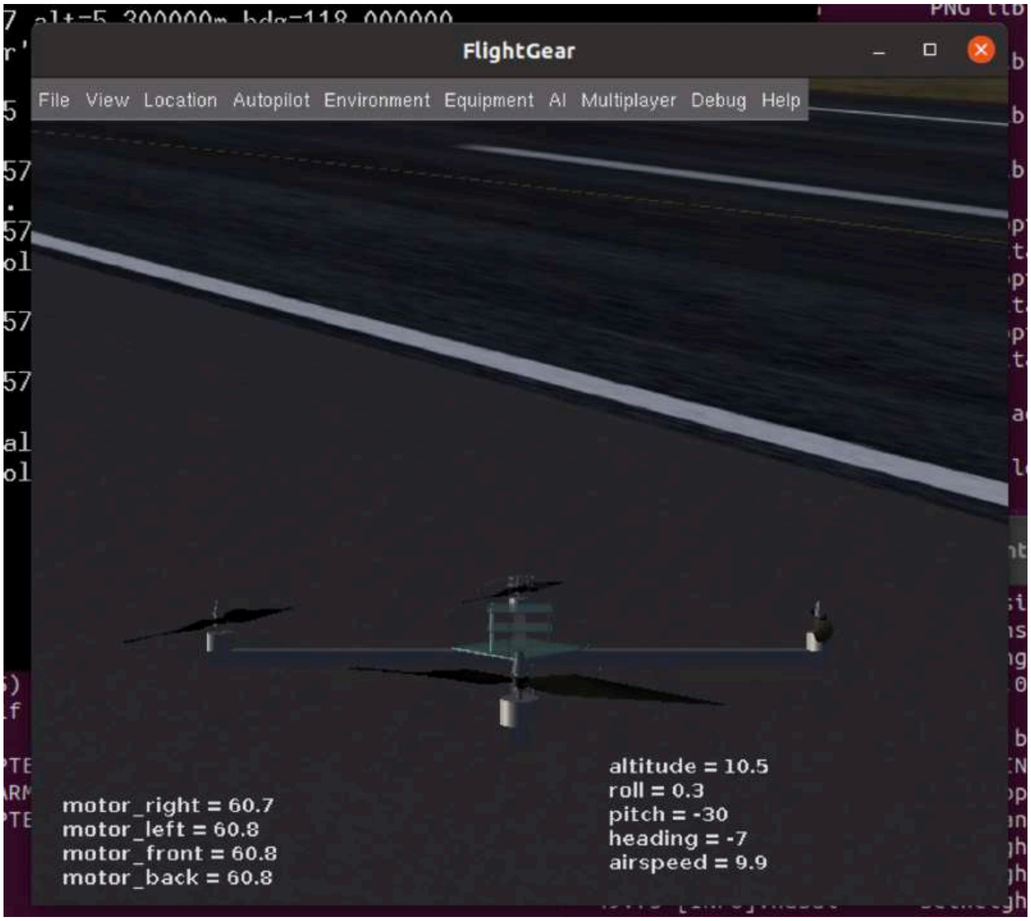
```
motor_right = 60.5
motor_left = 60.6
motor_front = 60.9
motor_back = 60.9
```

```
altitude = 10.2
roll = -0.1
pitch = -29.9
heading = -5.8
airspeed = 9.9
```


FlightGear
File View Location Autopilot Environment Equipment AI Multiplayer Debug Help

```
motor_right = 43.9
motor_left = 44.7
motor_front = 15
motor_back = 61
```

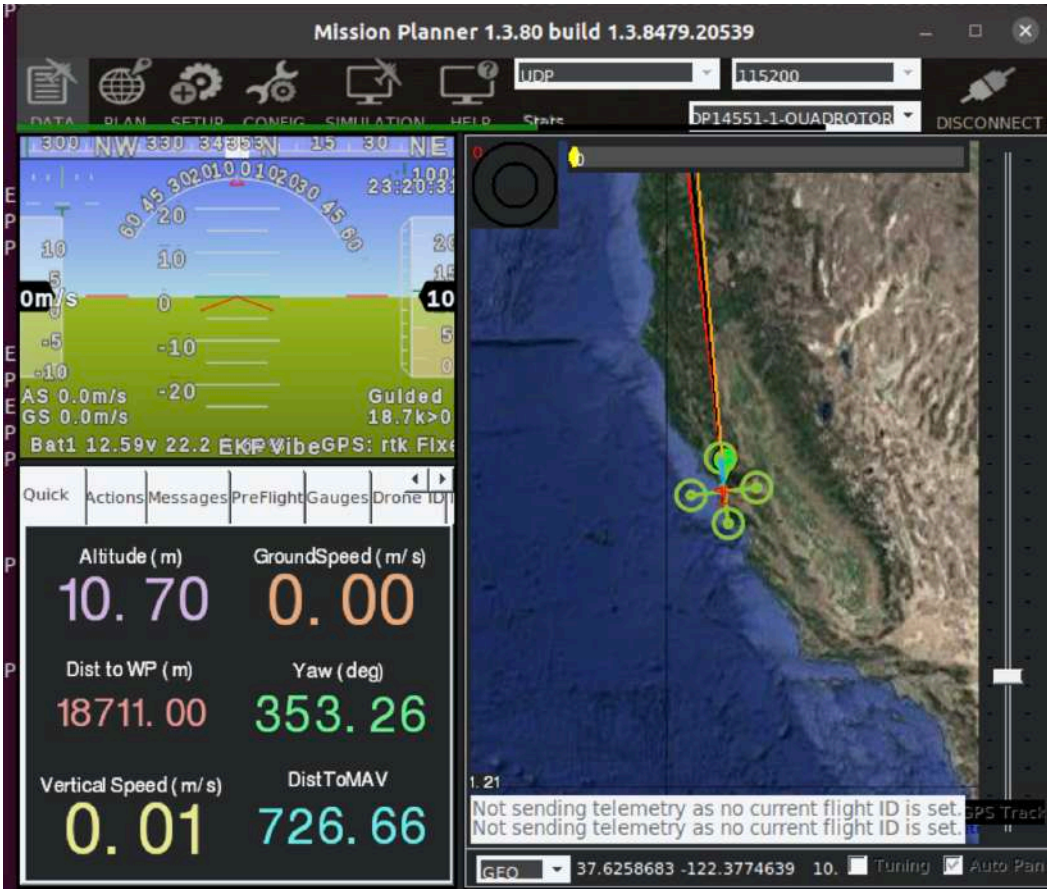
```
altitude = 12.4
roll = 0
pitch = 0
heading = -8.1
airspeed = 0.9
```


FlightGear
File View Location Autopilot Environment Equipment AI Multiplayer Debug Help

```
7 alt=5.300000m hdg=118.000000
```

```
motor_right = 60.7
motor_left = 60.8
motor_front = 60.8
motor_back = 60.8
```

```
altitude = 10.5
roll = 0.3
pitch = -30
heading = -7
airspeed = 9.9
```



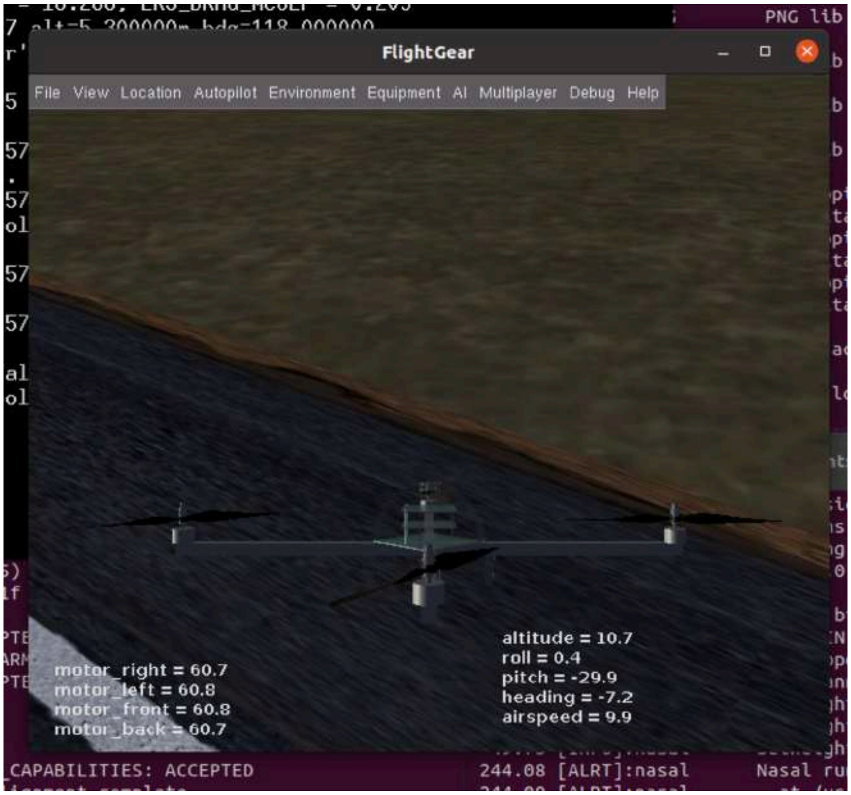
UDP
115200
DP14551-1-QUADROTOR

AS 0.0m/s
GS 0.0m/s
Guided
18.7k>0
Bat1 12.59v 22.2 EKF Vibe GPS: rtk Fixe

Altitude (m) 10.70
GroundSpeed (m/s) 0.00
Dist to WP (m) 18711.00
Yaw (deg) 353.26
Vertical Speed (m/s) 0.01
DistToMAV 726.66

Not sending telemetry as no current flight ID is set.
Not sending telemetry as no current flight ID is set.

GEO 37.6258683 -122.3774639 10. □ Tuning ☑ Auto Pan

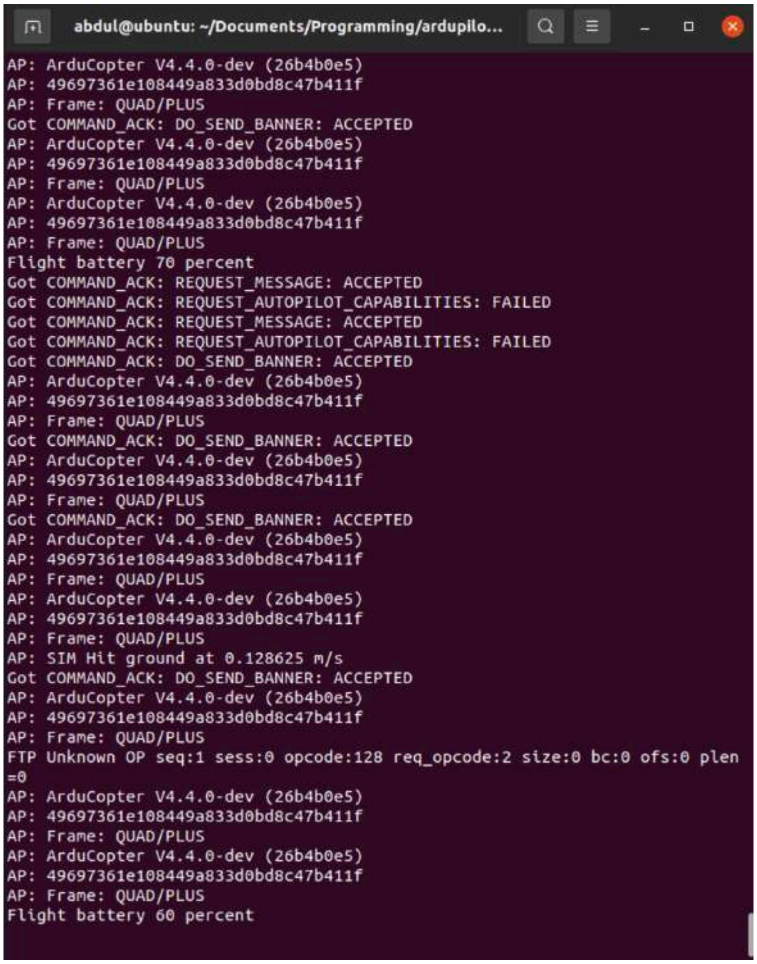


```
7 alt=5.300000m hdg=118.000000
```

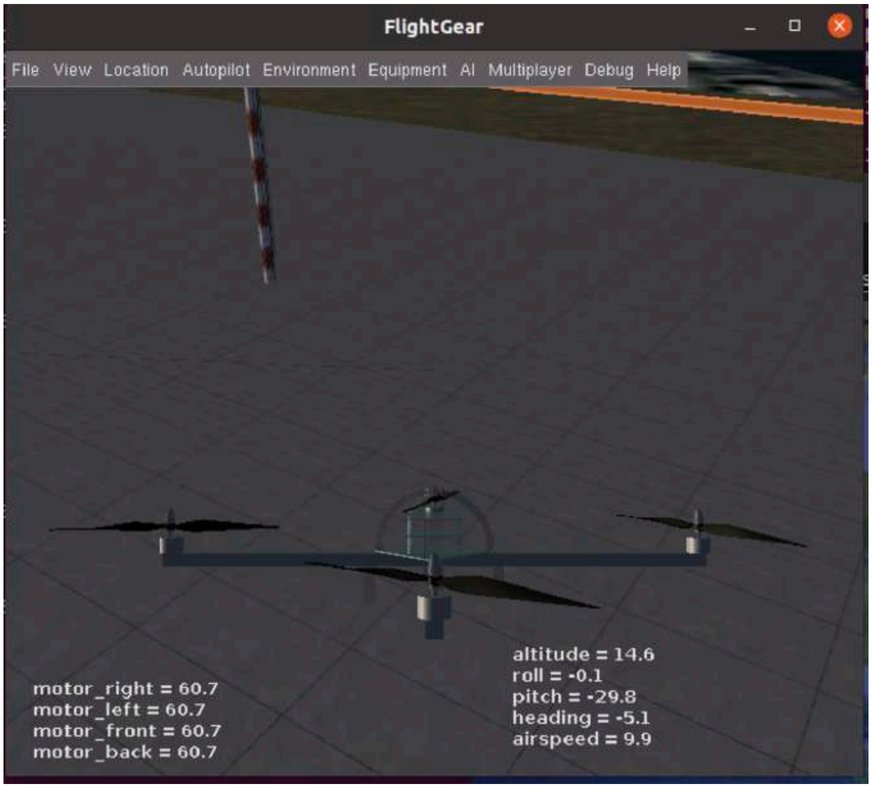
```
motor_right = 60.7
motor_left = 60.8
motor_front = 60.8
motor_back = 60.7
```

```
altitude = 10.7
roll = 0.4
pitch = -29.9
heading = -7.2
airspeed = 9.9
```

```
CAPABILITIES: ACCEPTED
244.08 [ALRT]:nasal
```

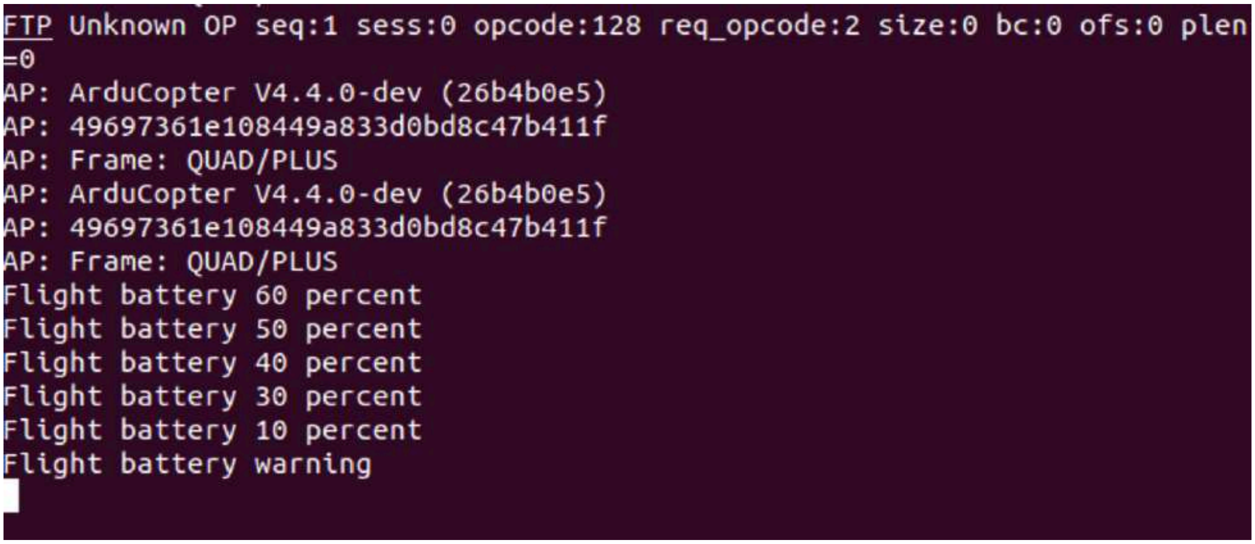


```
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
Got COMMAND_ACK: DO_SEND_BANNER: ACCEPTED
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
Flight battery 70 percent
Got COMMAND_ACK: REQUEST_MESSAGE: ACCEPTED
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: FAILED
Got COMMAND_ACK: REQUEST_MESSAGE: ACCEPTED
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: FAILED
Got COMMAND_ACK: DO_SEND_BANNER: ACCEPTED
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
Got COMMAND_ACK: DO_SEND_BANNER: ACCEPTED
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
Got COMMAND_ACK: DO_SEND_BANNER: ACCEPTED
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
AP: SIM Hit ground at 0.128625 m/s
Got COMMAND_ACK: DO_SEND_BANNER: ACCEPTED
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
FTP Unknown OP seq:1 sess:0 opcode:128 req_opcode:2 size:0 bc:0 ofs:0 plen
=0
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
Flight battery 60 percent
```



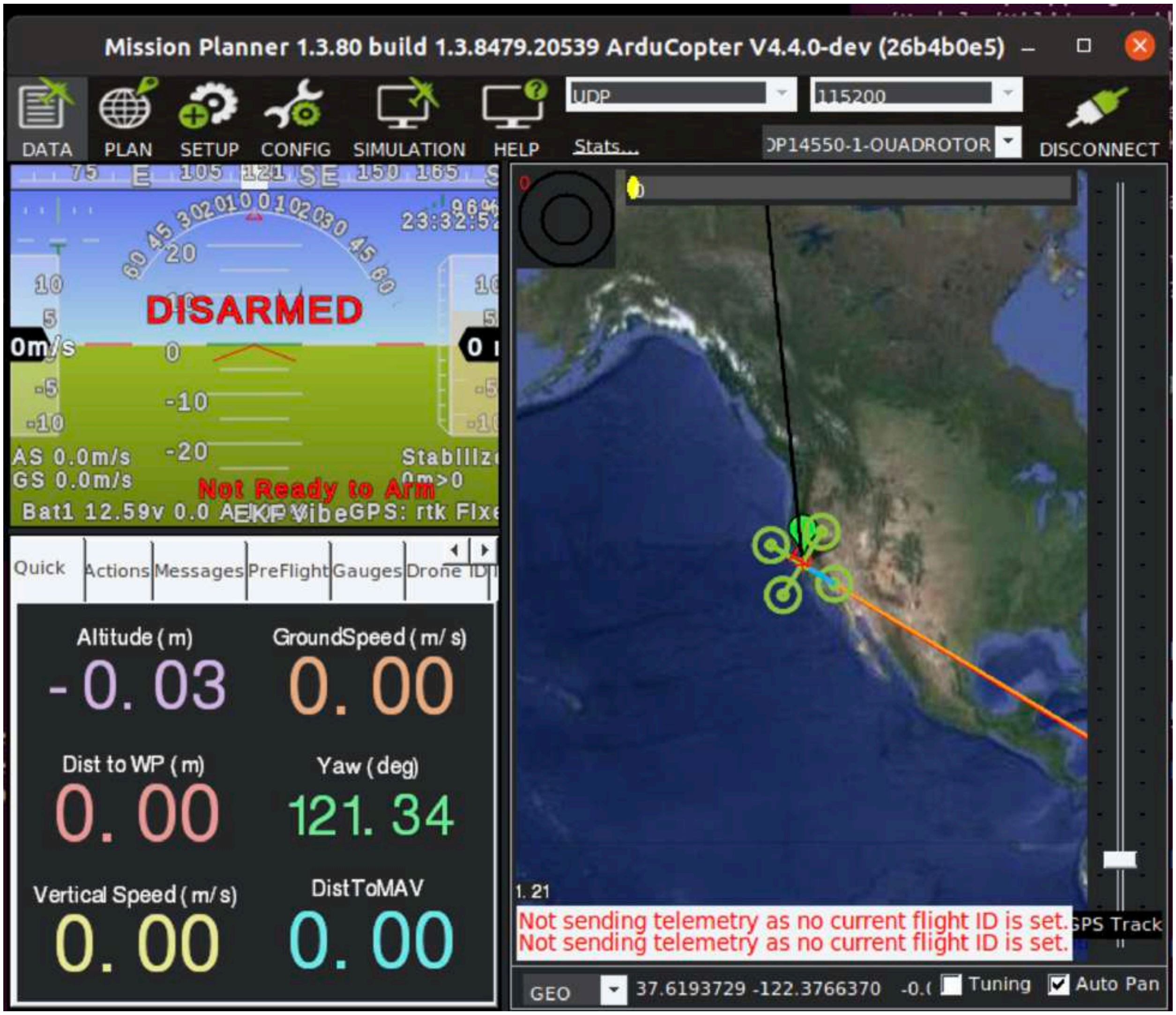
```
motor_right = 60.7
motor_left = 60.7
motor_front = 60.7
motor_back = 60.7
```

```
altitude = 14.6
roll = -0.1
pitch = -29.8
heading = -5.1
airspeed = 9.9
```



```
FTP Unknown OP seq:1 sess:0 opcode:128 req_opcode:2 size:0 bc:0 ofs:0 plen
=0
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
AP: ArduCopter V4.4.0-dev (26b4b0e5)
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
Flight battery 60 percent
Flight battery 50 percent
Flight battery 40 percent
Flight battery 30 percent
Flight battery 10 percent
Flight battery warning
```

Landed and disarmed



Mission Planner 1.3.80 build 1.3.8479.20539 ArduCopter V4.4.0-dev (26b4b0e5)

UDP

115200

0P14550-1-QUADROTOR

DISARMED

Not Ready to Arm

AS 0.0m/s

GS 0.0m/s

Bat1 12.59v 0.0 A

EKF Vibe GPS: rtk Fixe

Stabilize

23:32:52

Altitude (m) -0.03

GroundSpeed (m/s) 0.00

Dist to WP (m) 0.00

Yaw (deg) 121.34

Vertical Speed (m/s) 0.00

DistToMAV 0.00

Not sending telemetry as no current flight ID is set.

Not sending telemetry as no current flight ID is set.

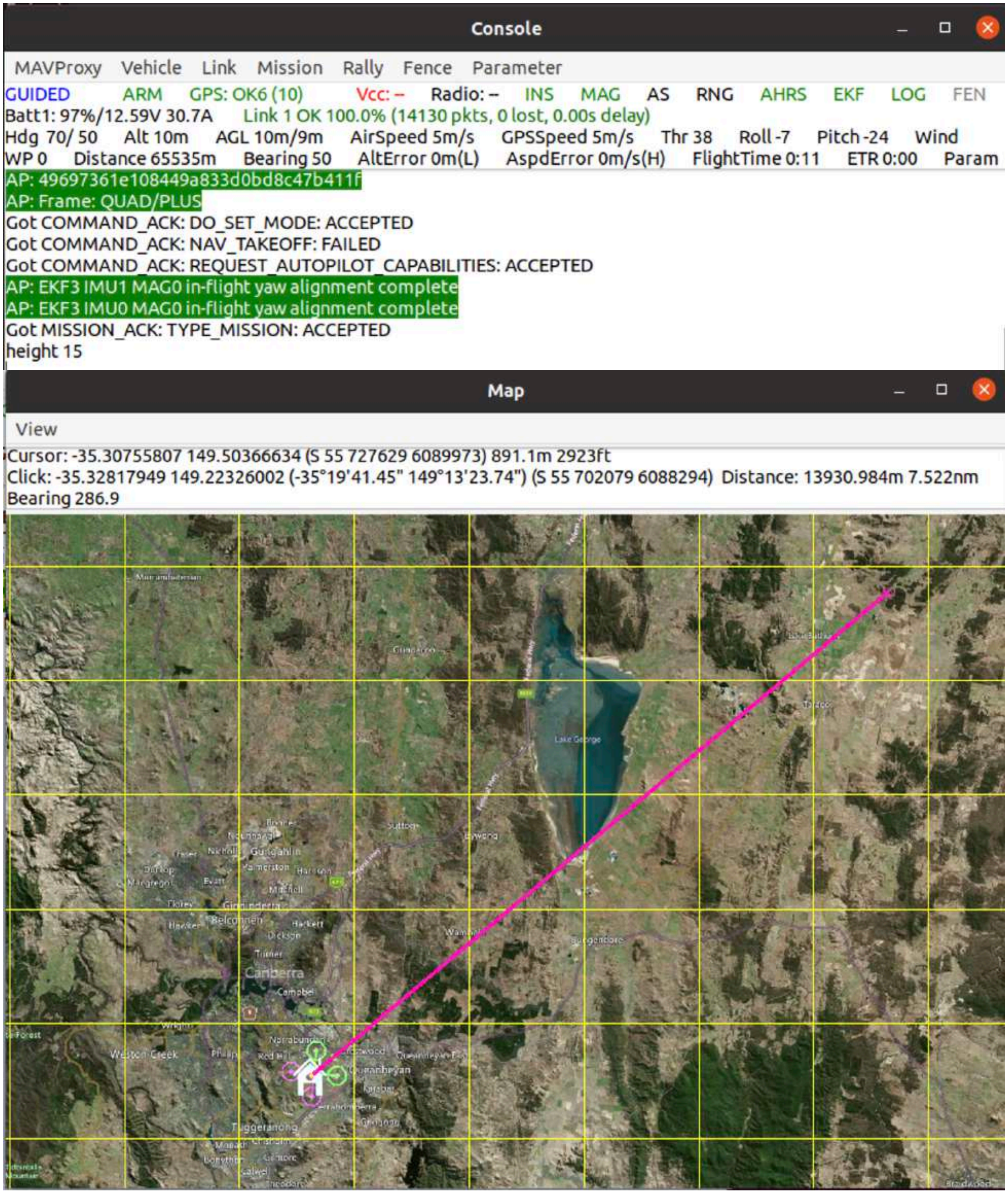
GEO 37.6193729 -122.3766370 -0.(

□ Tuning ☑ Auto Pan

Program to simulate a mission using a series of waypoints

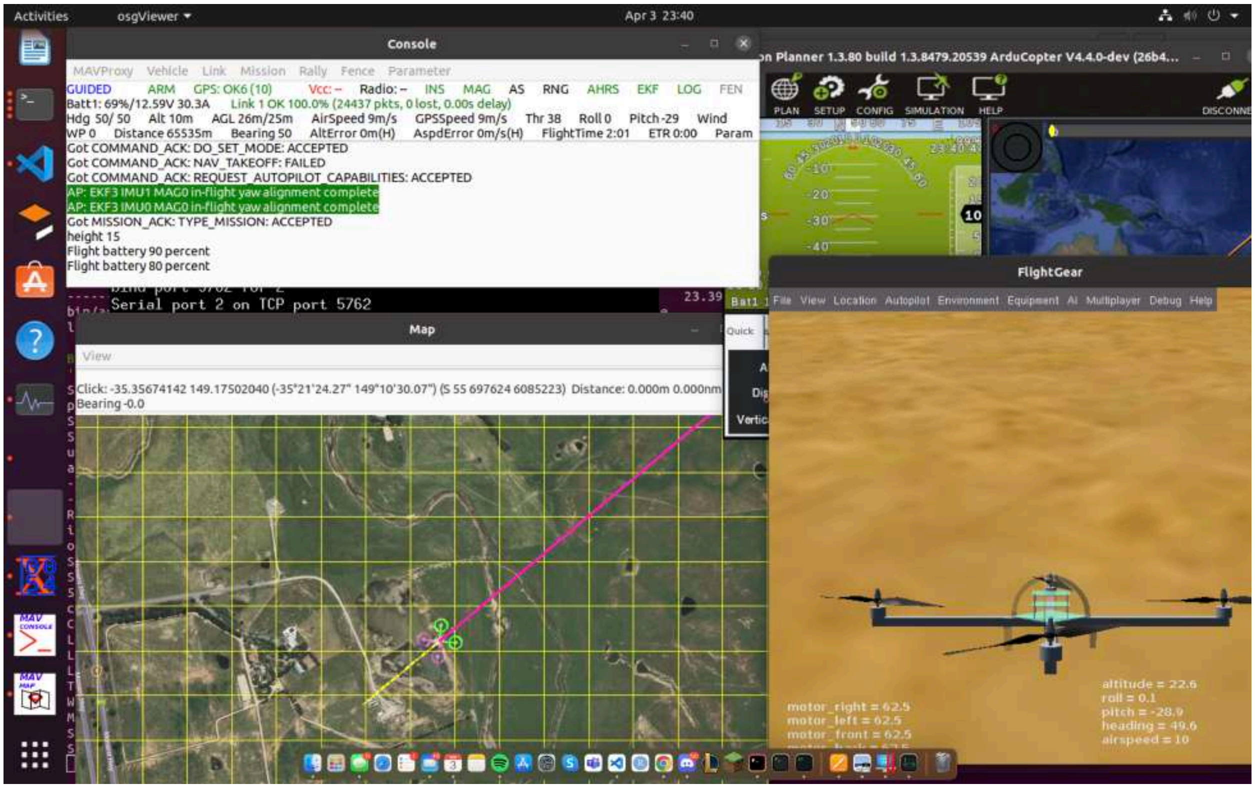
```
from dronekit import connect, VehicleMode,
LocationGlobalRelative
import time

# Connect to the vehicle
vehicle = connect('udp:127.0.0.1:14550')

# Arm and take off
vehicle.mode = VehicleMode("GUIDED")
vehicle.armed = True
vehicle.simple_takeoff(10)

# Wait for the drone to reach a certain altitude
while True:
    altitude = vehicle.location.global_relative_frame.alt
    if altitude >= 9.5:  # target altitude - 0.5 meters
        break
    time.sleep(1)

# Define the mission waypoints
waypoints = [
    LocationGlobalRelative(37.793105, -122.398768, 20),
    LocationGlobalRelative(37.793109, -122.398824, 20),
    LocationGlobalRelative(37.793095, -122.398857, 20),
    LocationGlobalRelative(37.793057, -122.398843, 20),
    LocationGlobalRelative(37.793042, -122.398797, 20),
    LocationGlobalRelative(37.793050, -122.398751, 20),
    LocationGlobalRelative(37.793084, -122.398722, 20),
    LocationGlobalRelative(37.793119, -122.398724, 20)
]

# Fly the mission
for wp in waypoints:
    vehicle.simple_goto(wp)
    while True:
        distance =
vehicle.location.global_relative_frame.distance_to(wp)
        if distance <= 1:  # target radius in meters
            break
        time.sleep(1)

# Land the drone
vehicle.mode = VehicleMode("LAND")
```

```
# Close the connection
vehicle.close()
```



```
GUIDED    ARM    GPS: OK6 (10)    Vcc: --    Radio: --    INS    MAG    AS    RNG    AHRS    EKF    LOG    FEN
Batt1: 97%/12.59V 30.7A    Link 1 OK 100.0% (14130 pkts, 0 lost, 0.00s delay)
Hdg 70/ 50    Alt 10m    AGL 10m/9m    AirSpeed 5m/s    GPSSpeed 5m/s    Thr 38    Roll -7    Pitch -24    Wind
WP 0    Distance 65535m    Bearing 50    AltError 0m(L)    AspdError 0m/s(H)    FlightTime 0:11    ETR 0:00    Param
AP: 49697361e108449a833d0bd8c47b411f
AP: Frame: QUAD/PLUS
Got COMMAND_ACK: DO_SET_MODE: ACCEPTED
Got COMMAND_ACK: NAV_TAKEOFF: FAILED
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: ACCEPTED
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
AP: EKF3 IMU0 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
```

```
Cursor: -35.30755807 149.50366634 (S 55 727629 6089973) 891.1m 2923ft
Click: -35.32817949 149.22326002 (-35°19'41.45" 149°13'23.74") (S 55 702079 6088294)  Distance: 13930.984m 7.522nm
Bearing 286.9
```


Activities
osgViewer
Apr 3 23:40
Console
MAVProxy Vehicle Link Mission Rally Fence Parameter
Map
View
on Planner 1.3.80 build 1.3.8479.20539 ArduCopter V4.4.0-dev (26b4...
PLAN SETUP CONFIG SIMULATION HELP
DISCONNE
FlightGear
File View Location Autopilot Environment Equipment AI Multiplayer Debug Help

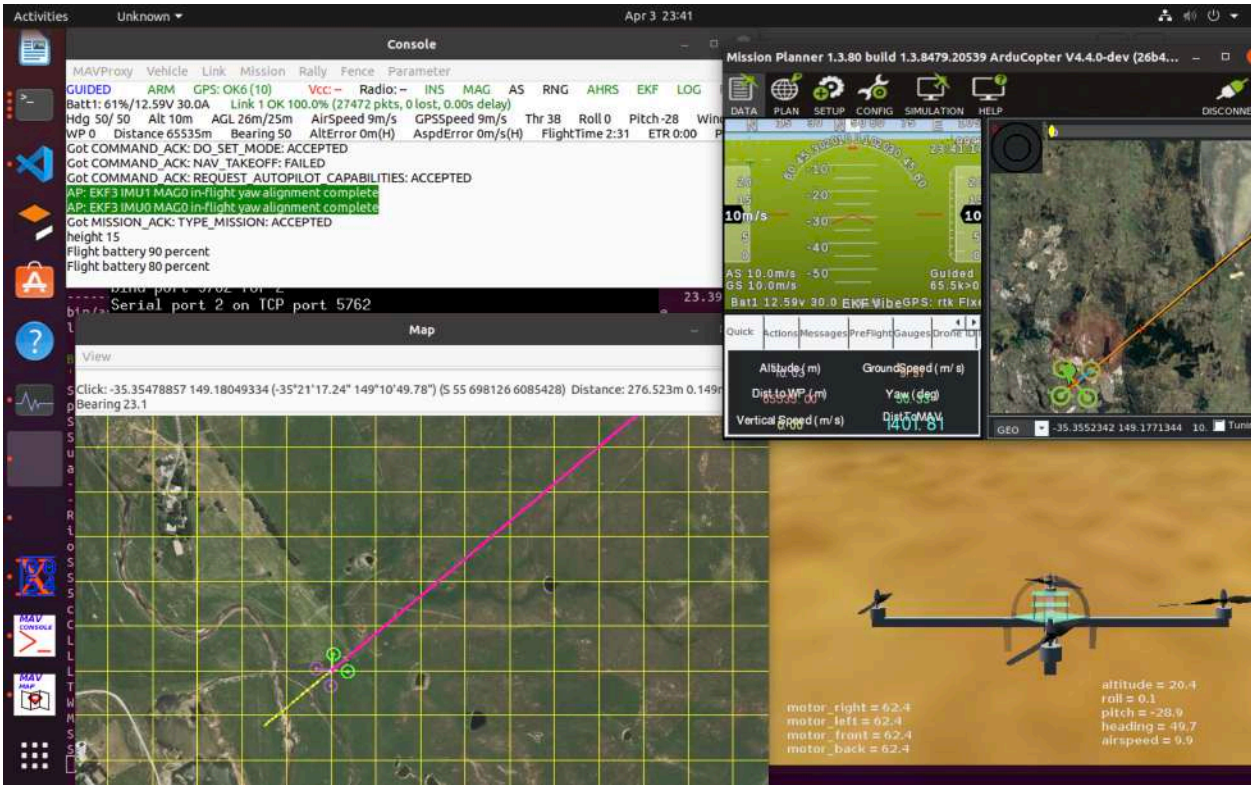
```
GUIDED   ARM   GPS: OK6 (10)   Vcc: --   Radio: --   INS   MAG   AS   RNG   AHRS   EKF   LOG   FEN
Batt1: 69%/12.59V 30.3A    Link 1 OK 100.0% (24437 pkts, 0 lost, 0.00s delay)
Hdg 50/ 50   Alt 10m   AGL 26m/25m   AirSpeed 9m/s   GPSSpeed 9m/s   Thr 38   Roll 0   Pitch -29   Wind
WP 0   Distance 65535m   Bearing 50   AltError 0m(H)   AspdError 0m/s(H)   FlightTime 2:01   ETR 0:00   Param
Got COMMAND_ACK: DO_SET_MODE: ACCEPTED
Got COMMAND_ACK: NAV_TAKEOFF: FAILED
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: ACCEPTED
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
AP: EKF3 IMU0 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
Flight battery 90 percent
Flight battery 80 percent
```

```
Serial port 2 on TCP port 5762
```

```
Click: -35.35674142 149.17502040 (-35°21'24.27" 149°10'30.07") (S 55 697624 6085223)  Distance: 0.000m 0.000nm
Bearing -0.0
```

```
motor_right = 62.5
motor_left = 62.5
motor_front = 62.5
```

```
altitude = 22.6
roll = 0.1
pitch = -28.9
heading = 49.6
airspeed = 10
```


Activities
Unknown
Apr 3 23:41
Console
MAVProxy Vehicle Link Mission Rally Fence Parameter
Map
View
Mission Planner 1.3.80 build 1.3.8479.20539 ArduCopter V4.4.0-dev (26b4...
DATA PLAN SETUP CONFIG SIMULATION HELP
DISCONNE
Quick Actions Messages PreFlight Gauges Drone
Altitude (m)
GroundSpeed (m/s)
Dist to WP (m)
Yaw (deg)
Vertical Speed (m/s)
DistToMAV
1401.81
GEO

```
GUIDED   ARM   GPS: OK6 (10)   Vcc: --   Radio: --   INS   MAG   AS   RNG   AHRS   EKF   LOG
Batt1: 61%/12.59V 30.0A    Link 1 OK 100.0% (27472 pkts, 0 lost, 0.00s delay)
Hdg 50/ 50   Alt 10m   AGL 26m/25m   AirSpeed 9m/s   GPSSpeed 9m/s   Thr 38   Roll 0   Pitch -28   Win
WP 0   Distance 65535m   Bearing 50   AltError 0m(H)   AspdError 0m/s(H)   FlightTime 2:31   ETR 0:00   P
Got COMMAND_ACK: DO_SET_MODE: ACCEPTED
Got COMMAND_ACK: NAV_TAKEOFF: FAILED
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: ACCEPTED
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
AP: EKF3 IMU0 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
Flight battery 90 percent
Flight battery 80 percent
```

```
Serial port 2 on TCP port 5762
```

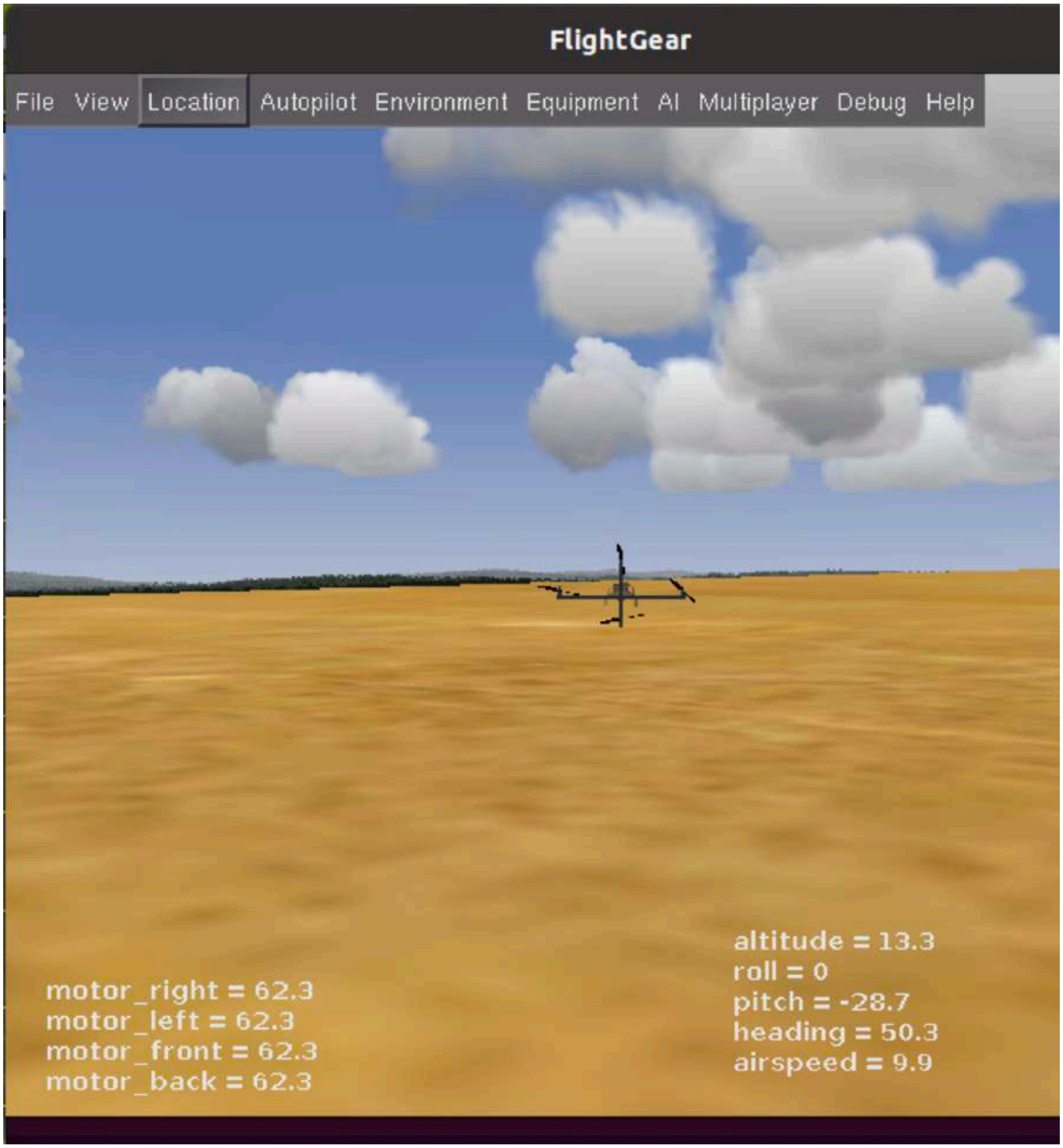
```
Click: -35.35478857 149.18049334 (-35°21'17.24" 149°10'49.78") (S 55 698126 6085428)  Distance: 276.523m 0.149n
Bearing 23.1
```

```
AS 10.0m/s
GS 10.0m/s
Bat1 12.59v 30.0 EKF Vibe GPS: rtk Fix
Guided
```

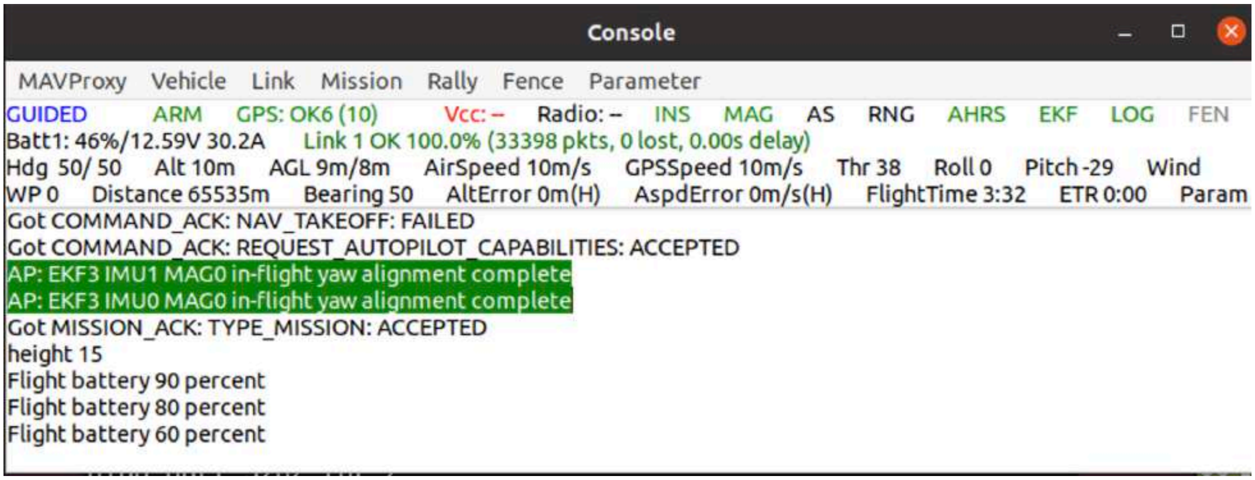
```
-35.3552342 149.1771344
```

```
motor_right = 62.4
motor_left = 62.4
motor_front = 62.4
motor_back = 62.4
```

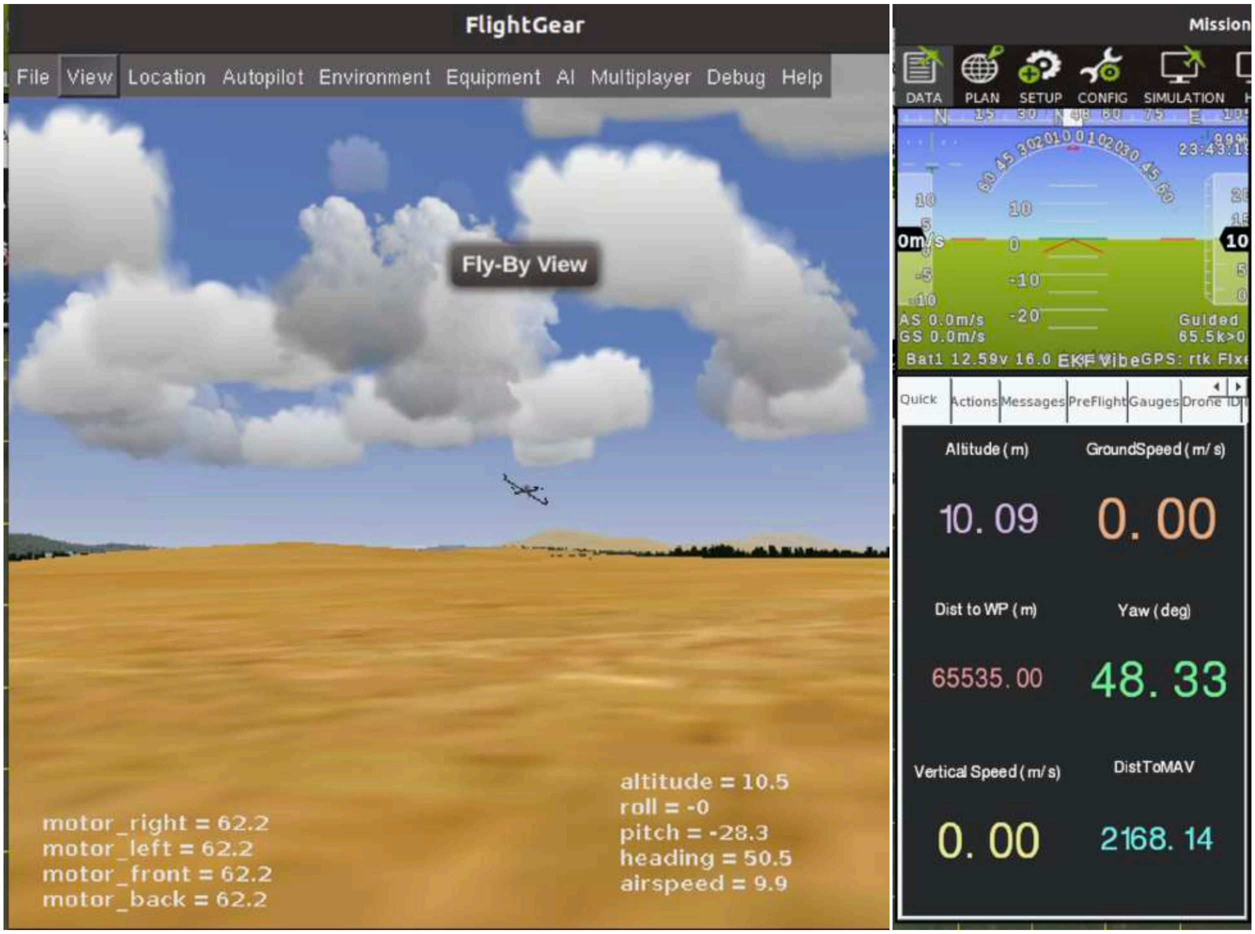
```
altitude = 20.4
roll = 0.1
pitch = -28.9
heading = 49.7
airspeed = 9.9
```



```
altitude = 13.3
roll = 0
pitch = -28.7
heading = 50.3
airspeed = 9.9

motor_right = 62.3
motor_left = 62.3
motor_front = 62.3
motor_back = 62.3
```



```
GUIDED      ARM    GPS: OK6 (10)       Vcc: --     Radio: --    INS    MAG    AS    RNG    AHRS    EKF    LOG    FEN
Batt1: 46%/12.59V 30.2A      Link 1 OK 100.0% (33398 pkts, 0 lost, 0.00s delay)
Hdg 50/ 50    Alt 10m    AGL 9m/8m    AirSpeed 10m/s    GPSSpeed 10m/s    Thr 38    Roll 0    Pitch -29    Wind
WP 0    Distance 65535m    Bearing 50    AltError 0m(H)    AspdError 0m/s(H)    FlightTime 3:32    ETR 0:00    Param
Got COMMAND_ACK: NAV_TAKEOFF: FAILED
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: ACCEPTED
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
AP: EKF3 IMU0 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
Flight battery 90 percent
Flight battery 80 percent
Flight battery 60 percent
```

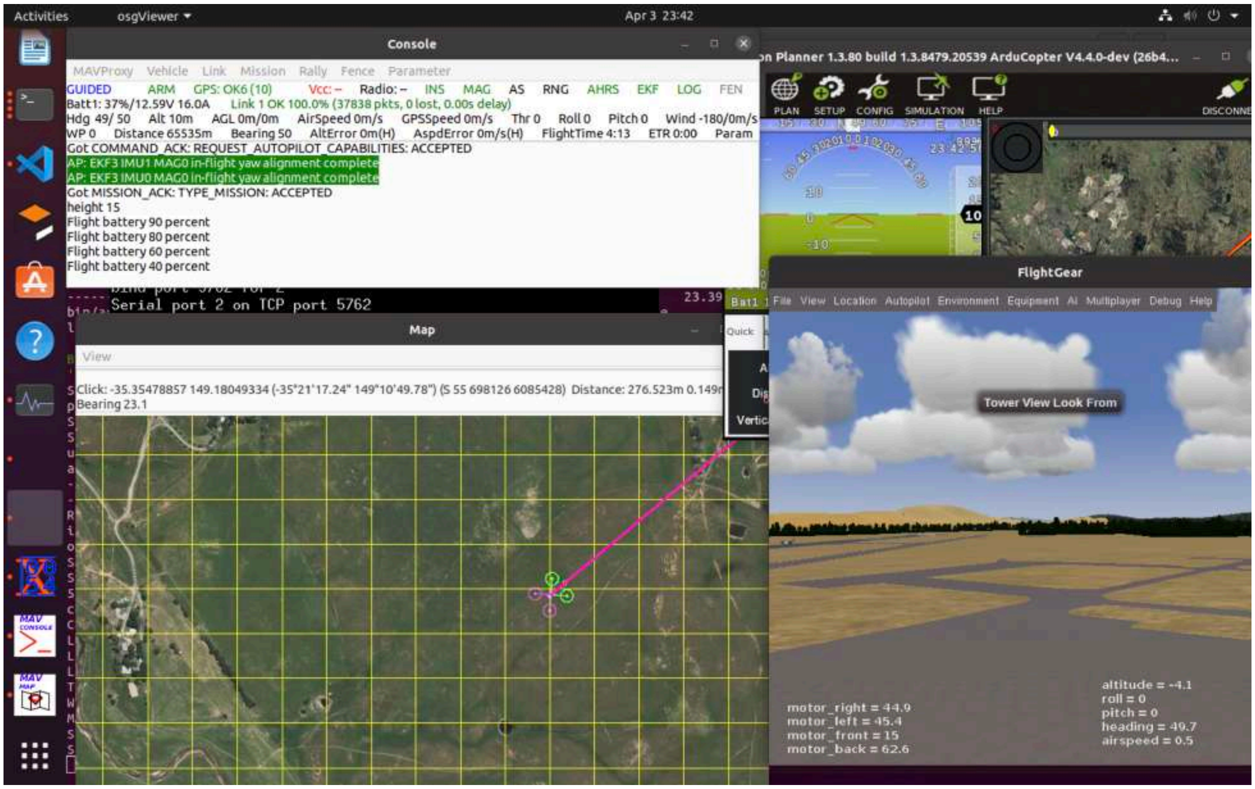

FlightGear
File View Location Autopilot Environment Equipment AI Multiplayer Debug Help
Fly-By View
Mission
DATA PLAN SETUP CONFIG SIMULATION
Quick Actions Messages PreFlight Gauges Drone ID

```
motor_right = 62.2
motor_left = 62.2
motor_front = 62.2
motor_back = 62.2
```

```
altitude = 10.5
roll = -0
pitch = -28.3
heading = 50.5
airspeed = 9.9
```

```
AS 0.0m/s
GS 0.0m/s
Bat1 12.59v 16.0 EKF Vibe GPS: rtk Fixe
Guided
```

Altitude (m)	GroundSpeed (m/ s)
10. 09	0. 00
Dist to WP (m)	Yaw (deg)
65535. 00	48. 33
Vertical Speed (m/ s)	DistToMAV
0. 00	2168. 14


Activities
osgViewer
Apr 3 23:42
Console
MAVProxy Vehicle Link Mission Rally Fence Parameter
Map
View
PLAN SETUP CONFIG SIMULATION HELP DISCONNE
FlightGear
File View Location Autopilot Environment Equipment AI Multiplayer Debug Help
Tower View Look From

```
GUIDED    ARM    GPS: OK6 (10)    Vcc: --    Radio: --    INS    MAG    AS    RNG    AHRS    EKF    LOG    FEN
Batt1: 37%/12.59V 16.0A    Link 1 OK 100.0% (37838 pkts, 0 lost, 0.00s delay)
Hdg 49/ 50    Alt 10m    AGL 0m/0m    AirSpeed 0m/s    GPSSpeed 0m/s    Thr 0    Roll 0    Pitch 0    Wind -180/0m/s
WP 0    Distance 65535m    Bearing 50    AltError 0m(H)    AspdError 0m/s(H)    FlightTime 4:13    ETR 0:00    Param
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: ACCEPTED
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
AP: EKF3 IMU0 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
Flight battery 90 percent
Flight battery 80 percent
Flight battery 60 percent
Flight battery 40 percent
```

```
Serial port 2 on TCP port 5762
```

```
Click: -35.35478857 149.18049334 (-35°21'17.24" 149°10'49.78") (S 55 698126 6085428)  Distance: 276.523m 0.149r
Bearing 23.1
```

```
on Planner 1.3.80 build 1.3.8479.20539 ArduCopter V4.4.0-dev (26b4...
```

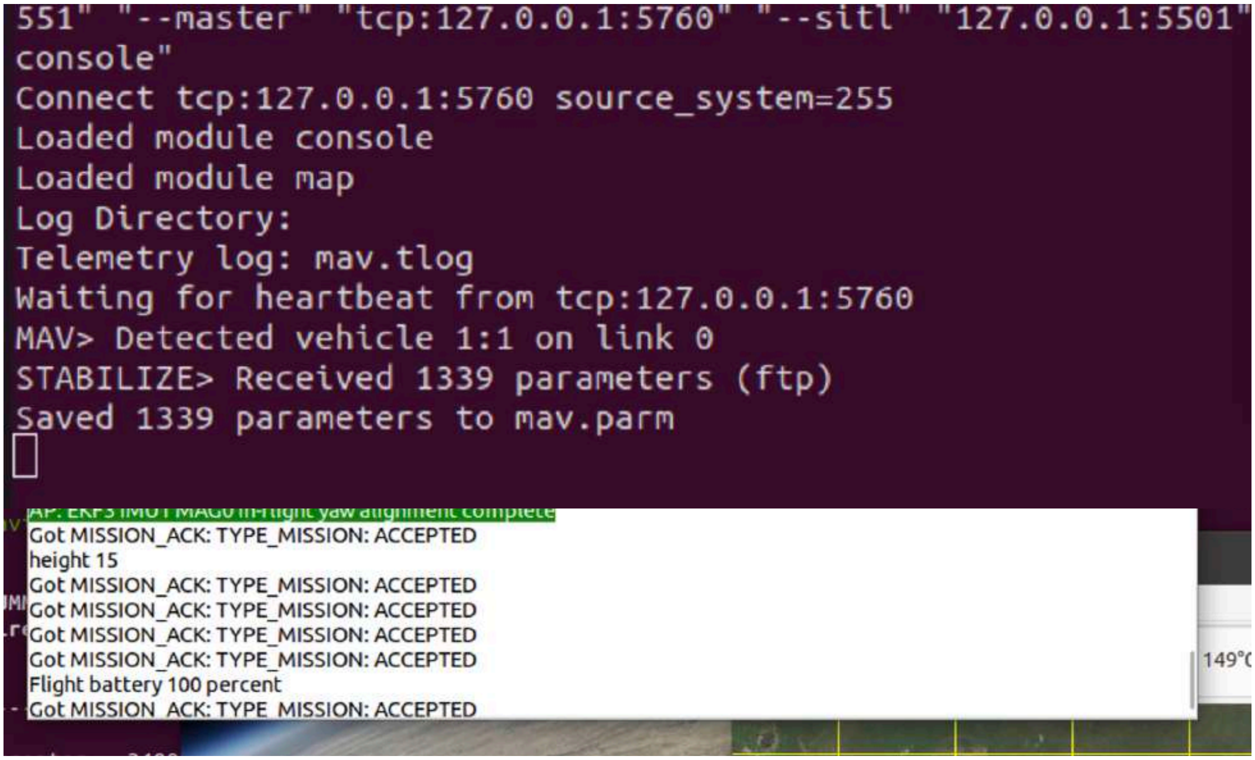
```
motor_right = 44.9
motor_left = 45.4
motor_front = 15
motor_back = 62.6
```

```
altitude = -4.1
roll = 0
pitch = 0
heading = 49.7
airspeed = 0.5
```

Program to test the control algorithm using PID algorithm

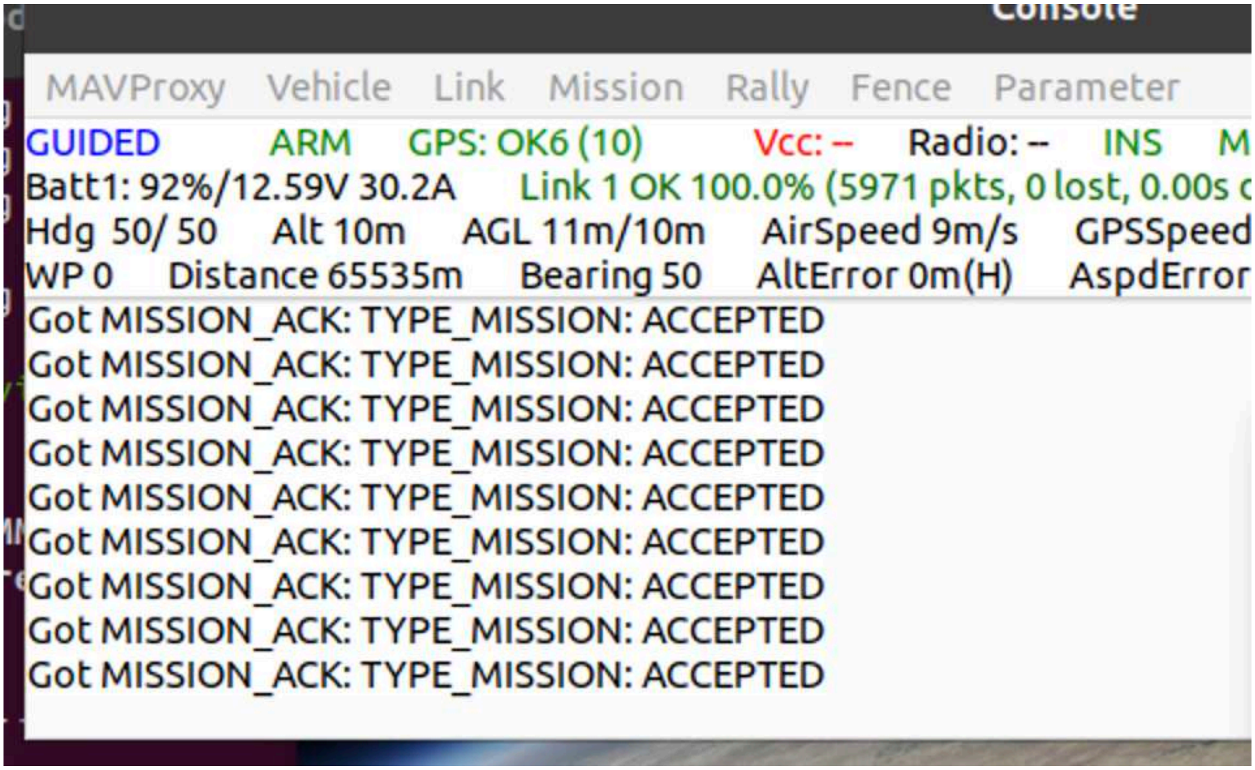
```
from dronekit import connect, VehicleMode, 
LocationGlobalRelative
import time

# Connect to the vehicle
vehicle = connect('udp:127.0.0.1:14550')

# Arm and take off
vehicle.mode = VehicleMode("GUIDED")
vehicle.armed = True
vehicle.simple_takeoff(10)

# Wait for the drone to reach a certain altitude
while True:
    altitude = vehicle.location.global_relative_frame.alt
    if int.altitude >= 9.5:  # target altitude - 0.5 meters
        break
    time.sleep(1)

# Define the PID controller
class PIDController:
    def __init__(self, kp, ki, kd, setpoint):
        self.kp = kp
        self.ki = ki
        self.kd = kd
        self.setpoint = setpoint
        self.error = 0
        self.error_integral = 0
        self.error_derivative = 0
        self.last_error = 0
        self.last_time = time.time()

    def update(self, measured_value):
        current_time = time.time()
        elapsed_time = current_time - self.last_time

        self.error = self.setpoint - measured_value
        self.error_integral += self.error * elapsed_time
        self.error_derivative = (self.error - self.last_error) / 
elapsed_time

        output = self.kp * self.error + self.ki * 
self.error_integral + self.kd * self.error_derivative
```

```
        self.last_error = self.error
        self.last_time = current_time

        return output

# Define the control algorithm
def control_algorithm(wp):
    pid = PIDController(0.1, 0.05, 0.01, wp.alt)

    while True:
        altitude = vehicle.location.global_relative_frame.alt
        output = pid.update(altitude)

        vehicle.simple_goto(LocationGlobalRelative(wp.lat, 
wp.lon, output))
        time.sleep(1)

        if abs(altitude - wp.alt) <= 0.5:  # target altitude - 
0.5 meters
            break

# Test PID control
waypoints = [
    LocationGlobalRelative(37.793105, -122.398768, 20),
    LocationGlobalRelative(37.793109, -122.398824, 30),
    LocationGlobalRelative(37.793095, -122.398857, 25),
    LocationGlobalRelative(37.793057, -122.398843, 35),
    LocationGlobalRelative(37.793042, -122.398797, 30),
    LocationGlobalRelative(37.793050, -122.398751, 25),
    LocationGlobalRelative(37.793084, -122.398722, 35),
    LocationGlobalRelative(37.793119, -122.398724, 30)
]

for wp in waypoints:
    control_algorithm(wp)

# Land the drone
vehicle.mode = VehicleMode("LAND")

# Close the connection
vehicle.close()
```



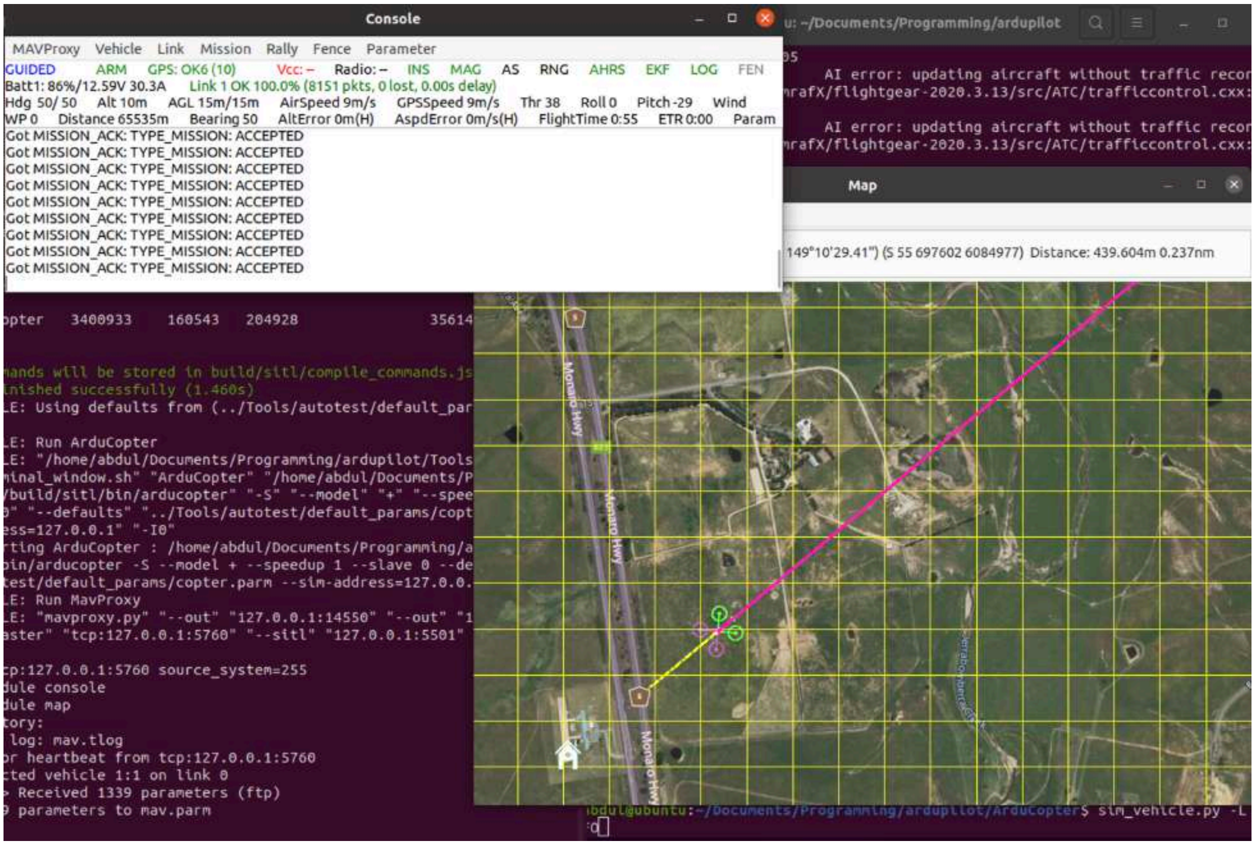
```
551" "--master" "tcp:127.0.0.1:5760" "--sitl" "127.0.0.1:5501"
console"
Connect tcp:127.0.0.1:5760 source_system=255
Loaded module console
Loaded module map
Log Directory:
Telemetry log: mav.tlog
Waiting for heartbeat from tcp:127.0.0.1:5760
MAV> Detected vehicle 1:1 on link 0
STABILIZE> Received 1339 parameters (ftp)
Saved 1339 parameters to mav.parm
```

```
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Flight battery 100 percent
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
```



```
GUIDED        ARM     GPS: OK6 (10)       Vcc: --     Radio: --     INS     M
Batt1: 92%/12.59V 30.2A     Link 1 OK 100.0% (5971 pkts, 0 lost, 0.00s c
Hdg 50/ 50     Alt 10m     AGL 11m/10m     AirSpeed 9m/s     GPSSpeed
WP 0     Distance 65535m     Bearing 50     AltError 0m(H)     AspdError
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
```

As we can see, the mission keeps getting updated and getting accepted as it progresses cause of the PID program where the mission is iteratively updated at each instance.



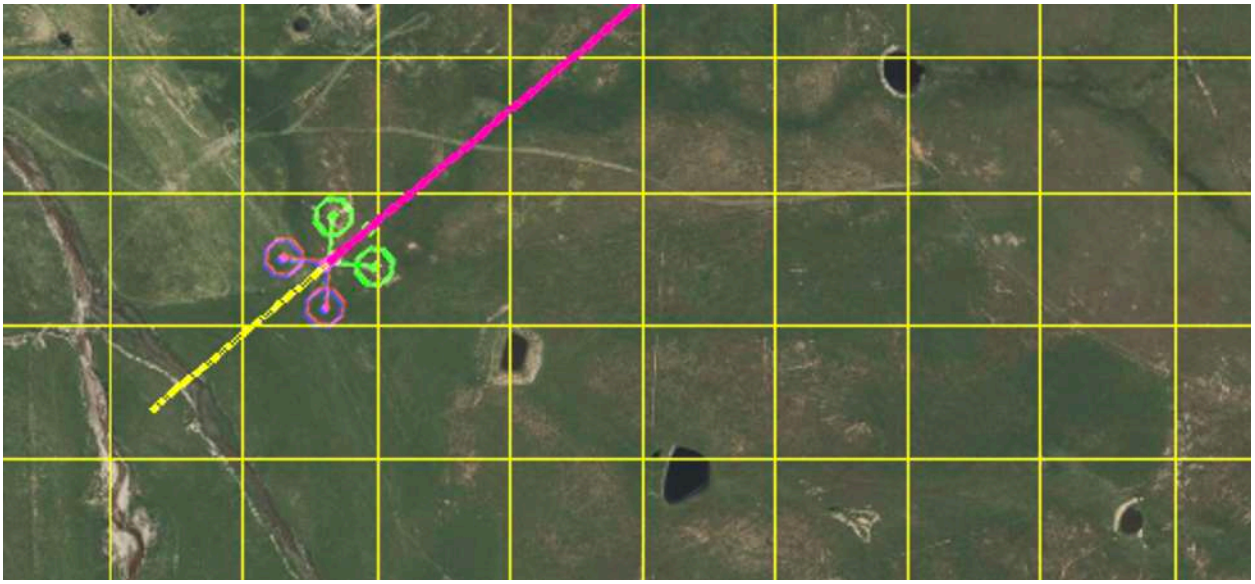
```
GUIDED     ARM     GPS: OK6 (10)     Vcc: --     Radio: --     INS     MAG     AS     RNG     AHRS     EKF     LOG     FEN
Batt1: 86%/12.59V 30.3A     Link 1 OK 100.0% (8151 pkts, 0 lost, 0.00s delay)
Hdg 50/ 50     Alt 10m     AGL 15m/15m     AirSpeed 9m/s     GPSSpeed 9m/s     Thr 38     Roll 0     Pitch -29     Wind
WP 0     Distance 65535m     Bearing 50     AltError 0m(H)     AspdError 0m/s(H)     FlightTime 0:55     ETR 0:00     Param
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
```

```
opter   3400933    160543   204928               35614

mands will be stored in build/sitl/compile_commands.js
inished successfully (1.460s)
LE: Using defaults from (../Tools/autotest/default_par

LE: Run ArduCopter
LE: "/home/abdul/Documents/Programming/ardupilot/Tools
minal_window.sh" "ArduCopter" "/home/abdul/Documents/P
/build/sitl/bin/arducopter" "-S" "--model" "+" "--spee
0" "--defaults" "../Tools/autotest/default_params/copt
ess=127.0.0.1" "-I0"
rting ArduCopter : /home/abdul/Documents/Programming/a
bin/arducopter -S --model + --speedup 1 --slave 0 --de
test/default_params/copter.parm --sim-address=127.0.0.
LE: Run MavProxy
LE: "mavproxy.py" "--out" "127.0.0.1:14550" "--out" "1
aster" "tcp:127.0.0.1:5760" "--sitl" "127.0.0.1:5501"

cp:127.0.0.1:5760 source_system=255
dule console
dule map
tory:
 log: mav.tlog
or heartbeat from tcp:127.0.0.1:5760
cted vehicle 1:1 on link 0
> Received 1339 parameters (ftp)
9 parameters to mav.parm
```

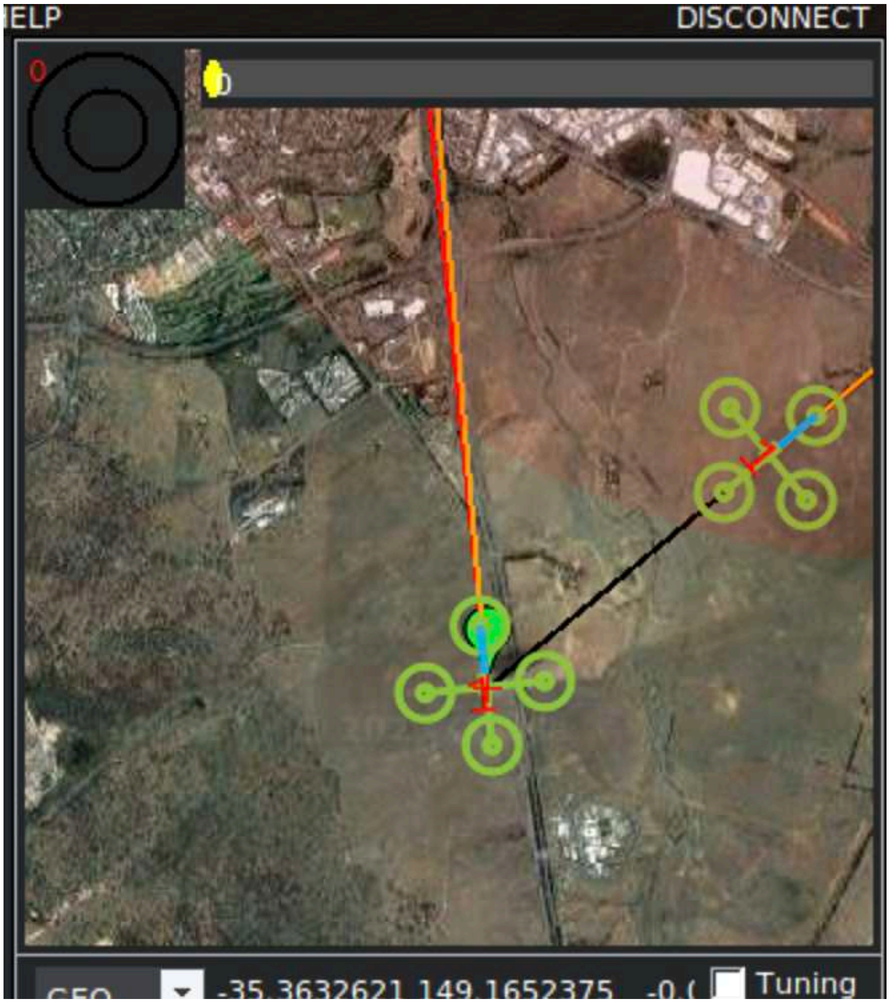
```
05
    AI error: updating aircraft without traffic recor
mrafX/flightgear-2020.3.13/src/ATC/trafficcontrol.cxx:

    AI error: updating aircraft without traffic recor
mrafX/flightgear-2020.3.13/src/ATC/trafficcontrol.cxx:
```

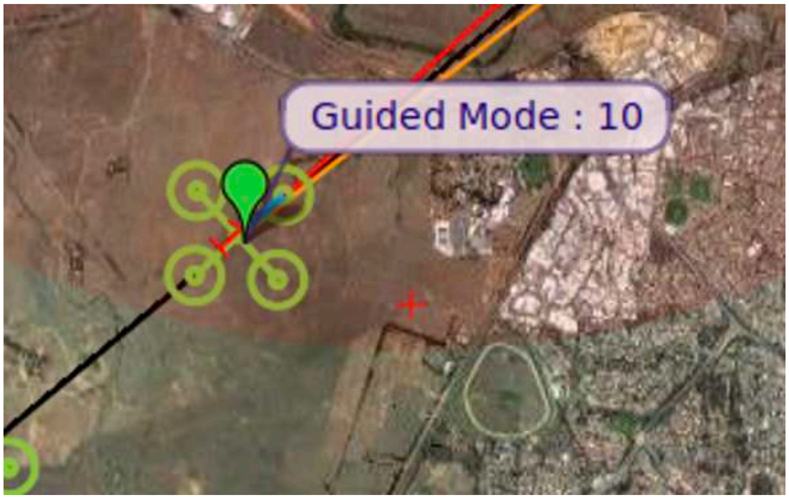
```
149°10'29.41") (S 55 697602 6084977)  Distance: 439.604m 0.237nm
```

```
abdul@ubuntu:~/Documents/Programming/ardupilot/ArduCopter$ sim_vehicle.py -L
:0
```



A new waypoint trail follows the drone as the mission progresses until the drone dies of battery.


ELP
DISCONNECT
0
0
GEO
-35.3632621 149.1652375 -0.(
Tuning


Guided Mode : 10

Conclusion

In conclusion, we have successfully simulated flight missions using ardupilot.

Overall, this experiment has demonstrated the power and flexibility of ardupilot simulation, and how it can be used to accelerate the development and testing of robotics systems.

Thank you! >.<

Abdul Aziz A.B (20BRS1185)