CSE2040 - EXERCISE 5&6

Drone Applications, Components and Assembly

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AIM

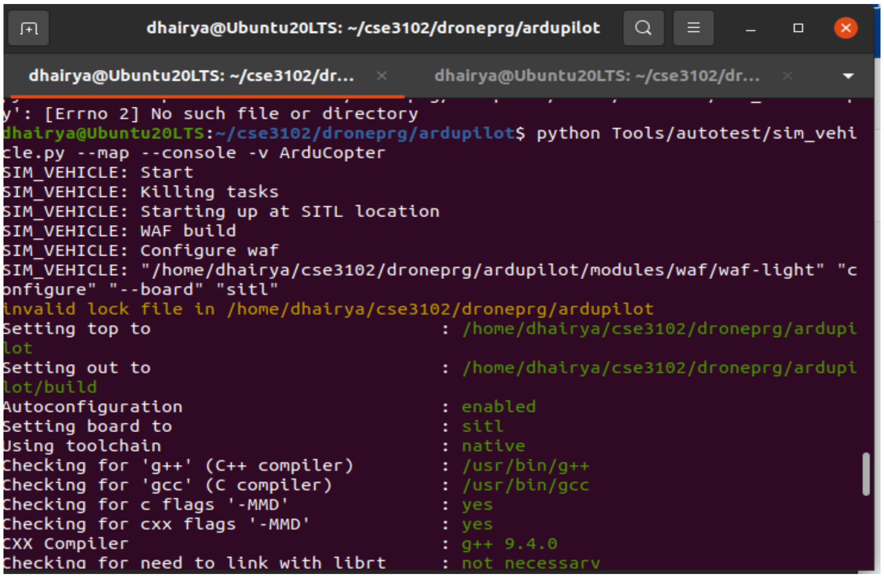
To write python programs to take off the drone and land in new location, simulate a mission using series of waypoints and test the control algorithm using PID algorithm.

TOOLS

Ubuntu 20.04, Mission Planner, Gazebo 11, ROS 1 Noetic.

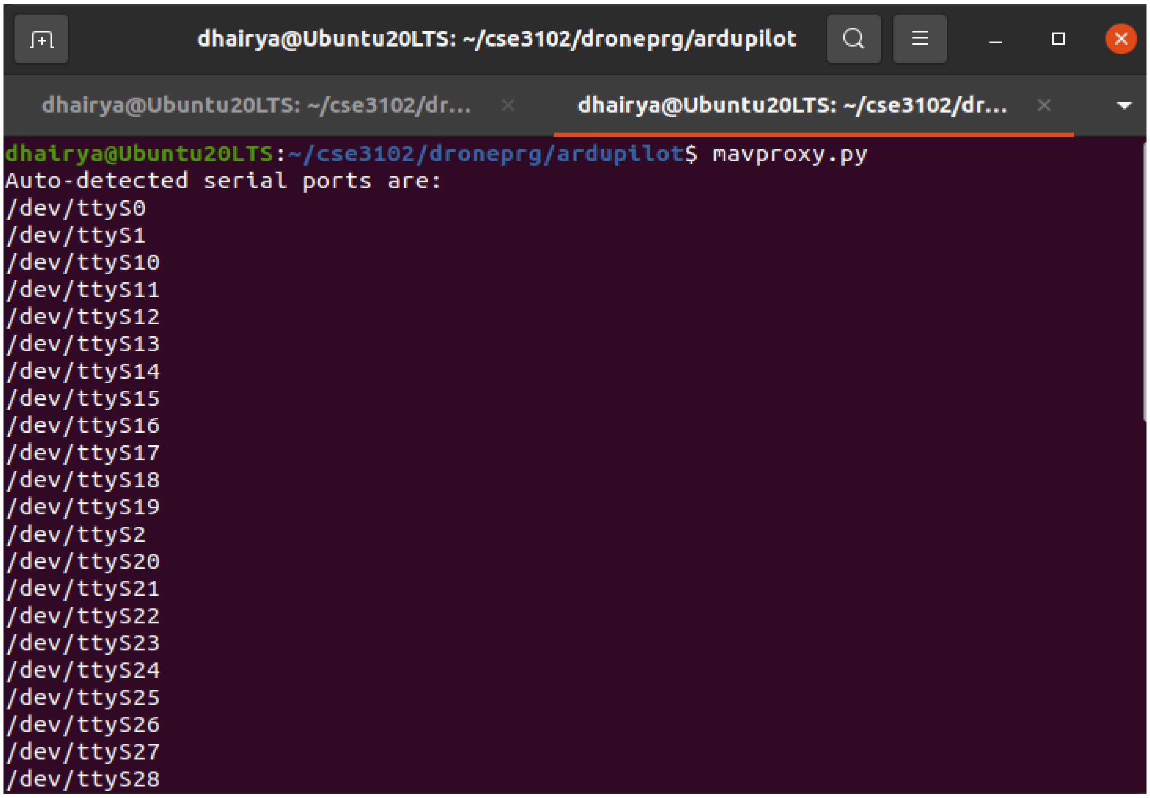
PROCEDURE

1. Create the python files that demonstrate how to take off the drone and land in new location, simulate a mission using series of waypoints and test the control algorithm using PID algorithm.
2. Install the appropriate SITL application to run the simulation of the drones powered by the python file (in this case, ardupilot-sitl).
3. Install mavproxy to connect with SITL software to send the python commands to the drone.
4. Install the dronekit python library that provides the necessary functionality of drones in python for the utilization in our python code.
5. In a terminal, run the SITL startup command for a copter: **python sim_vehicle.py --map --console -v ArduCopter**


dhairya@Ubuntu20LTS: ~/cse3102/droneprg/ardupilot
dhairya@Ubuntu20LTS: ~/cse3102/dr...
dhairya@Ubuntu20LTS: ~/cse3102/dr...

```
y': [Errno 2] No such file or directory
dhairya@Ubuntu20LTS:~/cse3102/droneprg/ardupilot$ python Tools/autotest/sim_vehi
cle.py --map --console -v ArduCopter
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/dhairya/cse3102/droneprg/ardupilot/modules/waf/waf-light" "c
onfigure" "--board" "sitl"
invalid lock file in /home/dhairya/cse3102/droneprg/ardupilot
Setting top to                           : /home/dhairya/cse3102/droneprg/ardupi
lot
Setting out to                           : /home/dhairya/cse3102/droneprg/ardupi
lot/build
Autoconfiguration                        : enabled
Setting board to                         : sitl
Using toolchain                          : native
Checking for 'g++' (C++ compiler)        : /usr/bin/g++
Checking for 'gcc' (C compiler)          : /usr/bin/gcc
Checking for c flags '-MMD'              : yes
Checking for cxx flags '-MMD'            : yes
CXX Compiler                             : g++ 9.4.0
Checking for need to link with librt     : not necessary
```

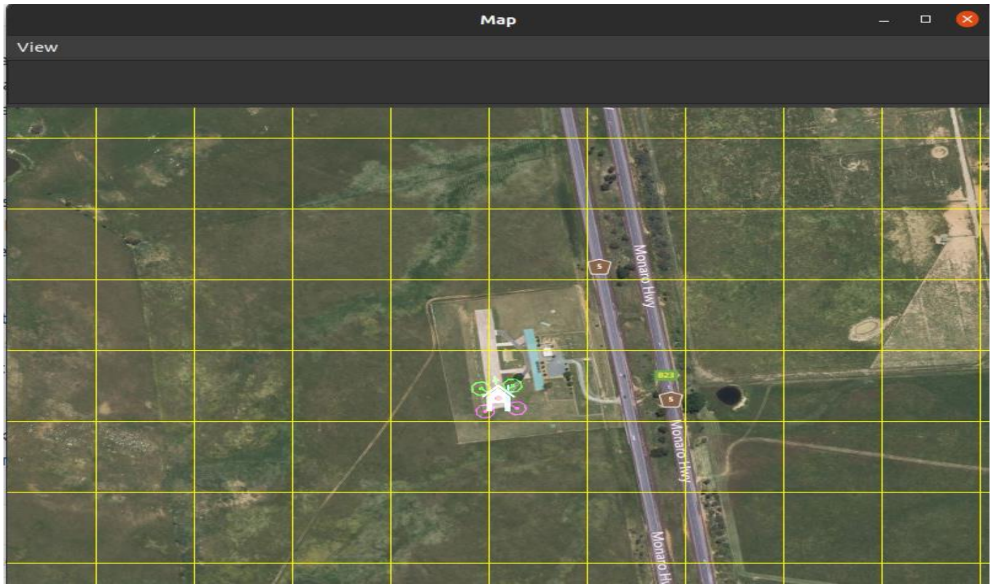
6. In another terminal, run mavproxy: -
   mavproxy.py --master tcp:127.0.0.1:5760 --sitl 127.0.0.1:5501 --out 127.0.0.1:14550 --out 127.0.0.1:14551


dhairya@Ubuntu20LTS: ~/cse3102/droneprg/ardupilot
dhairya@Ubuntu20LTS: ~/cse3102/dr...
dhairya@Ubuntu20LTS: ~/cse3102/dr...

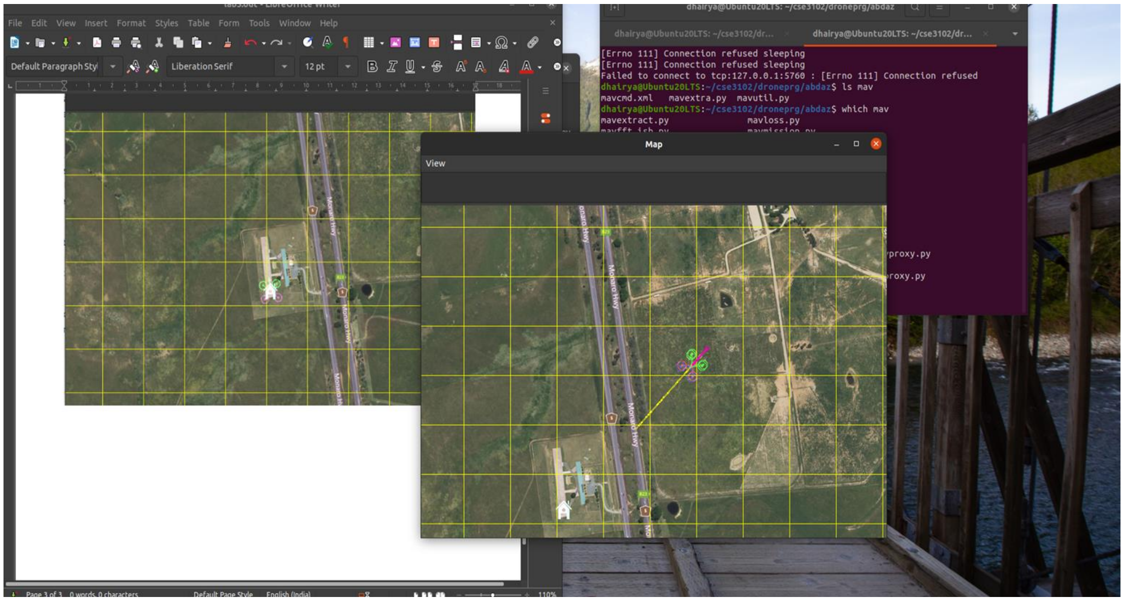
```
dhairya@Ubuntu20LTS:~/cse3102/droneprg/ardupilot$ mavproxy.py
Auto-detected serial ports are:
/dev/ttyS0
/dev/ttyS1
/dev/ttyS10
/dev/ttyS11
/dev/ttyS12
/dev/ttyS13
/dev/ttyS14
/dev/ttyS15
/dev/ttyS16
/dev/ttyS17
/dev/ttyS18
/dev/ttyS19
/dev/ttyS2
/dev/ttyS20
/dev/ttyS21
/dev/ttyS22
/dev/ttyS23
/dev/ttyS24
/dev/ttyS25
/dev/ttyS26
/dev/ttyS27
/dev/ttyS28
```

7. In yet another terminal, run the python file needed to control the drone.
8. Observe the movement and functionality of the drone as demonstrated in the SITL.

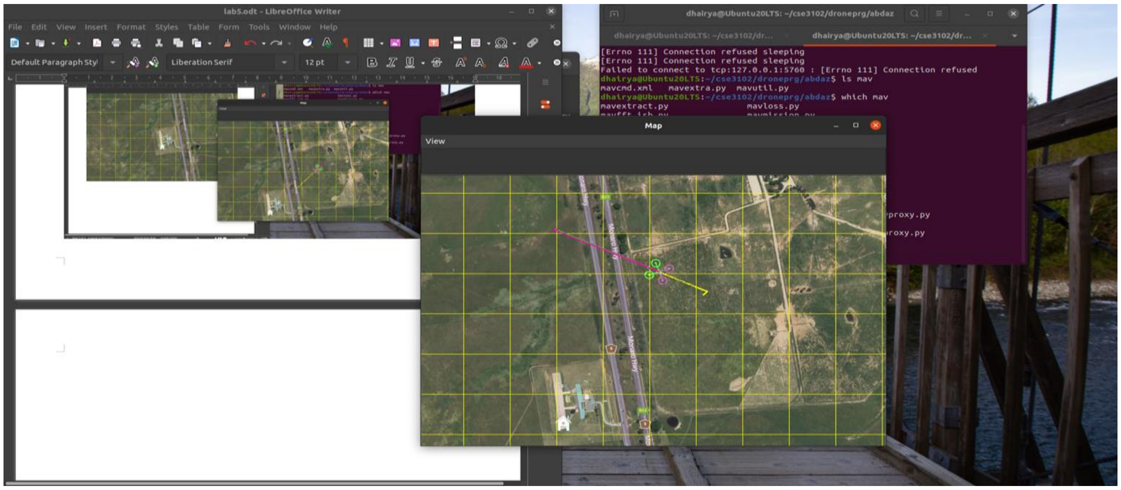
SCREENSHOTS



DRONE2.py


lab5.odt - LibreOffice Writer
File Edit View Insert Format Styles Table Form Tools Window Help
Default Paragraph Styl
Liberation Serif
12 pt
dhairya@Ubuntu20LTS: ~/cse3102/droneprg/abdaz
Map
View
Morgan Hwy

```
[Errno 111] Connection refused sleeping
[Errno 111] Connection refused sleeping
Failed to connect to tcp:127.0.0.1:5760 : [Errno 111] Connection refused
dhairya@Ubuntu20LTS:~/cse3102/droneprg/abdaz$ ls mav
mavcmd.xml   mavextra.py  mavutil.py
dhairya@Ubuntu20LTS:~/cse3102/droneprg/abdaz$ which mav
mavextract.py                mavloss.py
```


lab5.odt - LibreOffice Writer
File Edit View Insert Format Styles Table Form Tools Window Help
Default Paragraph Styl
Liberation Serif
12 pt
dhairya@Ubuntu20LTS: ~/cse3102/droneprg/abdaz
Map
View

```
[Errno 111] Connection refused sleeping
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Failed to connect to tcp:127.0.0.1:5760 : [Errno 111] Connection refused
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mavcmd.xml   mavextra.py  mavutil.py
dhairya@Ubuntu20LTS:~/cse3102/droneprg/abdaz$ which mav
mavextract.py                mavloss.py
```
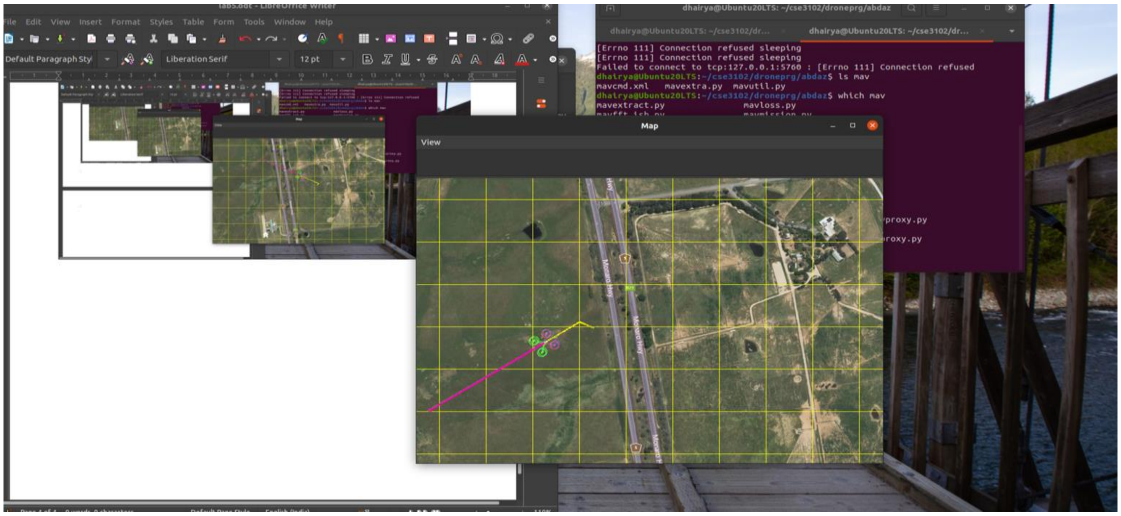
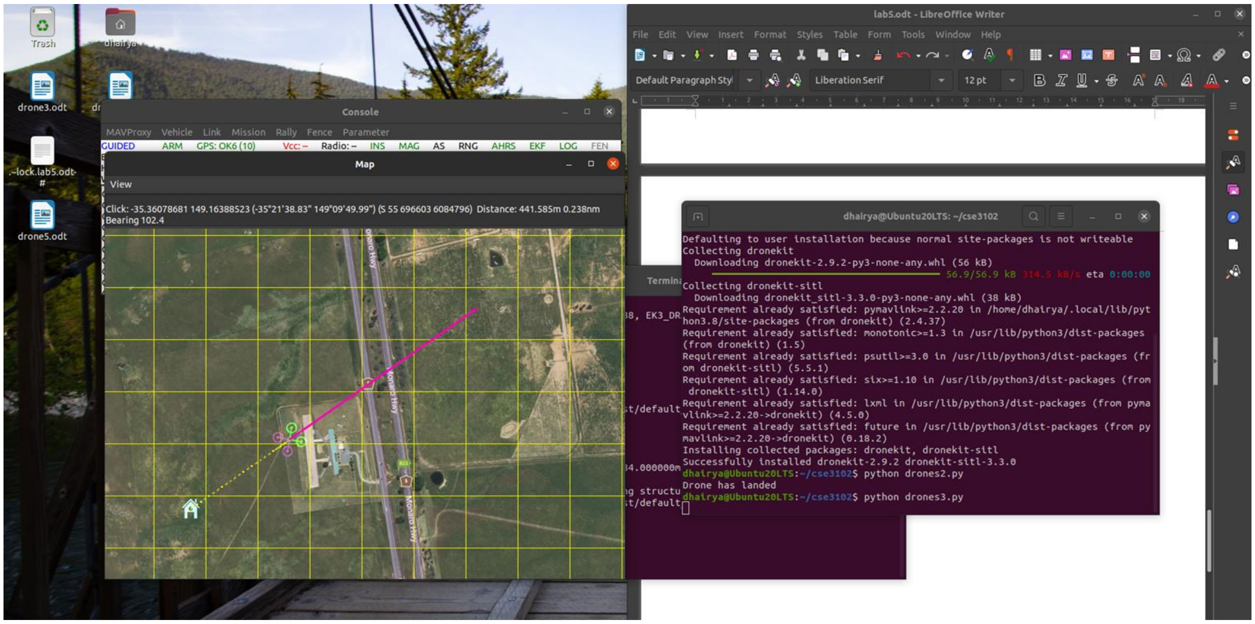


lab5.odt - LibreOffice Writer
File Edit View Insert Format Styles Table Form Tools Window Help
Default Paragraph Styl
Liberation Serif
12 pt
dhairya@Ubuntu20LTS: ~/cse3102/droneprg/abdaz
Map
View

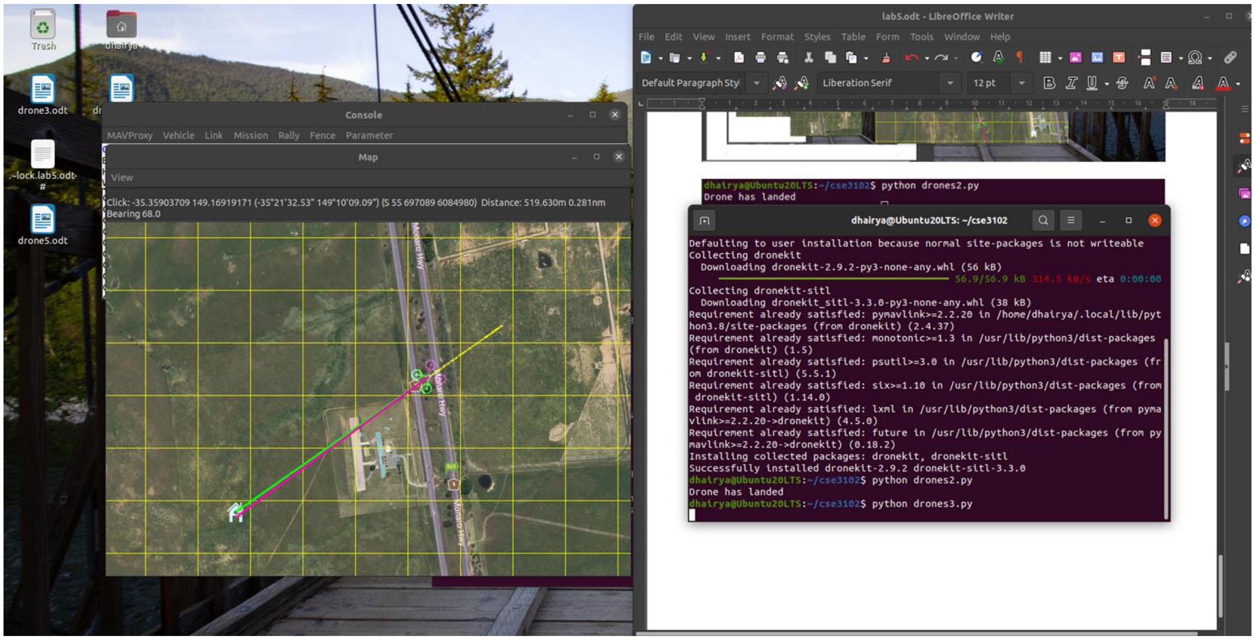
```
[Errno 111] Connection refused sleeping
[Errno 111] Connection refused sleeping
Failed to connect to tcp:127.0.0.1:5760 : [Errno 111] Connection refused
dhairya@Ubuntu20LTS:~/cse3102/droneprg/abdaz$ ls mav
mavcmd.xml   mavextra.py  mavutil.py
dhairya@Ubuntu20LTS:~/cse3102/droneprg/abdaz$ which mav
mavextract.py                mavloss.py
```

DRONE3.py


Trash
dhairya
drone3.odt
.~lock.lab5.odt#
drone5.odt
Console
MAVProxy Vehicle Link Mission Rally Fence Parameter
GUIDED ARM GPS: OK6 (10) Vcc: -- Radio: -- INS MAG AS RNG AHRS EKF LOG FEN
Map
View
Monaro Hwy
lab5.odt - LibreOffice Writer
File Edit View Insert Format Styles Table Form Tools Window Help
Default Paragraph Styl
Liberation Serif
12 pt
dhairya@Ubuntu20LTS: ~/cse3102

Click: -35.36078681 149.16388523 (-35°21'38.83" 149°09'49.99") (S 55 696603 6084796) Distance: 441.585m 0.238nm
Bearing 102.4

```
Defaulting to user installation because normal site-packages is not writeable
Collecting dronekit
  Downloading dronekit-2.9.2-py3-none-any.whl (56 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 56.9/56.9 kB 314.5 kB/s eta 0:00:00
Collecting dronekit-sitl
  Downloading dronekit_sitl-3.3.0-py3-none-any.whl (38 kB)
Requirement already satisfied: pymavlink>=2.2.20 in /home/dhairya/.local/lib/pyt
hon3.8/site-packages (from dronekit) (2.4.37)
Requirement already satisfied: monotonic>=1.3 in /usr/lib/python3/dist-packages
(from dronekit) (1.5)
Requirement already satisfied: psutil>=3.0 in /usr/lib/python3/dist-packages (fr
om dronekit-sitl) (5.5.1)
Requirement already satisfied: six>=1.10 in /usr/lib/python3/dist-packages (from
 dronekit-sitl) (1.14.0)
Requirement already satisfied: lxml in /usr/lib/python3/dist-packages (from pyma
vlink>=2.2.20->dronekit) (4.5.0)
Requirement already satisfied: future in /usr/lib/python3/dist-packages (from py
mavlink>=2.2.20->dronekit) (0.18.2)
Installing collected packages: dronekit, dronekit-sitl
Successfully installed dronekit-2.9.2 dronekit-sitl-3.3.0
dhairya@Ubuntu20LTS:~/cse3102$ python drones2.py
Drone has landed
dhairya@Ubuntu20LTS:~/cse3102$ python drones3.py
```

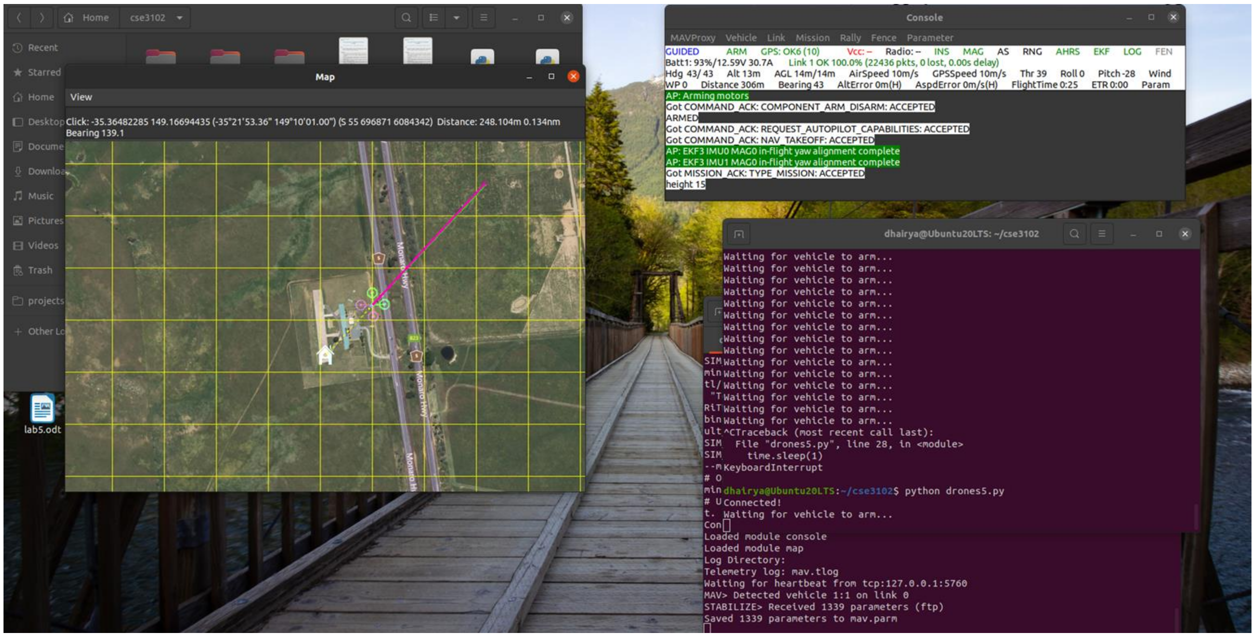

Trash
dhairya
drone3.odt
.~lock.lab5.odt#
drone5.odt
Console
MAVProxy Vehicle Link Mission Rally Fence Parameter
Map
View
Monaro Hwy
lab5.odt - LibreOffice Writer
File Edit View Insert Format Styles Table Form Tools Window Help
Default Paragraph Styl
Liberation Serif
12 pt
dhairya@Ubuntu20LTS: ~/cse3102

Click: -35.35903709 149.16919171 (-35°21'32.53" 149°10'09.09") (S 55 697089 6084980) Distance: 519.630m 0.281nm
Bearing 68.0

```
dhairya@Ubuntu20LTS:~/cse3102$ python drones2.py
Drone has landed
```

```
Defaulting to user installation because normal site-packages is not writeable
Collecting dronekit
  Downloading dronekit-2.9.2-py3-none-any.whl (56 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 56.9/56.9 kB 314.5 kB/s eta 0:00:00
Collecting dronekit-sitl
  Downloading dronekit_sitl-3.3.0-py3-none-any.whl (38 kB)
Requirement already satisfied: pymavlink>=2.2.20 in /home/dhairya/.local/lib/pyt
hon3.8/site-packages (from dronekit) (2.4.37)
Requirement already satisfied: monotonic>=1.3 in /usr/lib/python3/dist-packages
(from dronekit) (1.5)
Requirement already satisfied: psutil>=3.0 in /usr/lib/python3/dist-packages (fr
om dronekit-sitl) (5.5.1)
Requirement already satisfied: six>=1.10 in /usr/lib/python3/dist-packages (from
 dronekit-sitl) (1.14.0)
Requirement already satisfied: lxml in /usr/lib/python3/dist-packages (from pyma
vlink>=2.2.20->dronekit) (4.5.0)
Requirement already satisfied: future in /usr/lib/python3/dist-packages (from py
mavlink>=2.2.20->dronekit) (0.18.2)
Installing collected packages: dronekit, dronekit-sitl
Successfully installed dronekit-2.9.2 dronekit-sitl-3.3.0
dhairya@Ubuntu20LTS:~/cse3102$ python drones2.py
Drone has landed
dhairya@Ubuntu20LTS:~/cse3102$ python drones3.py
```

DRONE5.py



Click: -35.36482285 149.16694435 (-35°21'53.36" 149°10'01.00") (S 55 696871 6084342) Distance: 248.104m 0.134nm
Bearing 139.1

```
GUIDED    ARM    GPS: OK6 (10)    Vcc: --    Radio: --    INS    MAG    AS    RNG    AHRS    EKF    LOG    FEN
Batt1: 93%/12.59V 30.7A    Link 1 OK 100.0% (22436 pkts, 0 lost, 0.00s delay)
Hdg 43/ 43    Alt 13m    AGL 14m/14m    AirSpeed 10m/s    GPSSpeed 10m/s    Thr 39    Roll 0    Pitch -28    Wind
WP 0    Distance 306m    Bearing 43    AltError 0m(H)    AspdError 0m/s(H)    FlightTime 0:25    ETR 0:00    Param
AP: Arming motors
Got COMMAND_ACK: COMPONENT_ARM_DISARM: ACCEPTED
ARMED
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: ACCEPTED
Got COMMAND_ACK: NAV_TAKEOFF: 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
```

```
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
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Waiting for vehicle to arm...
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Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
^CTraceback (most recent call last):
  File "drones5.py", line 28, in <module>
    time.sleep(1)
KeyboardInterrupt

dhairya@Ubuntu20LTS:~/cse3102$ python drones5.py
Connected!
Waiting for vehicle to arm...
```
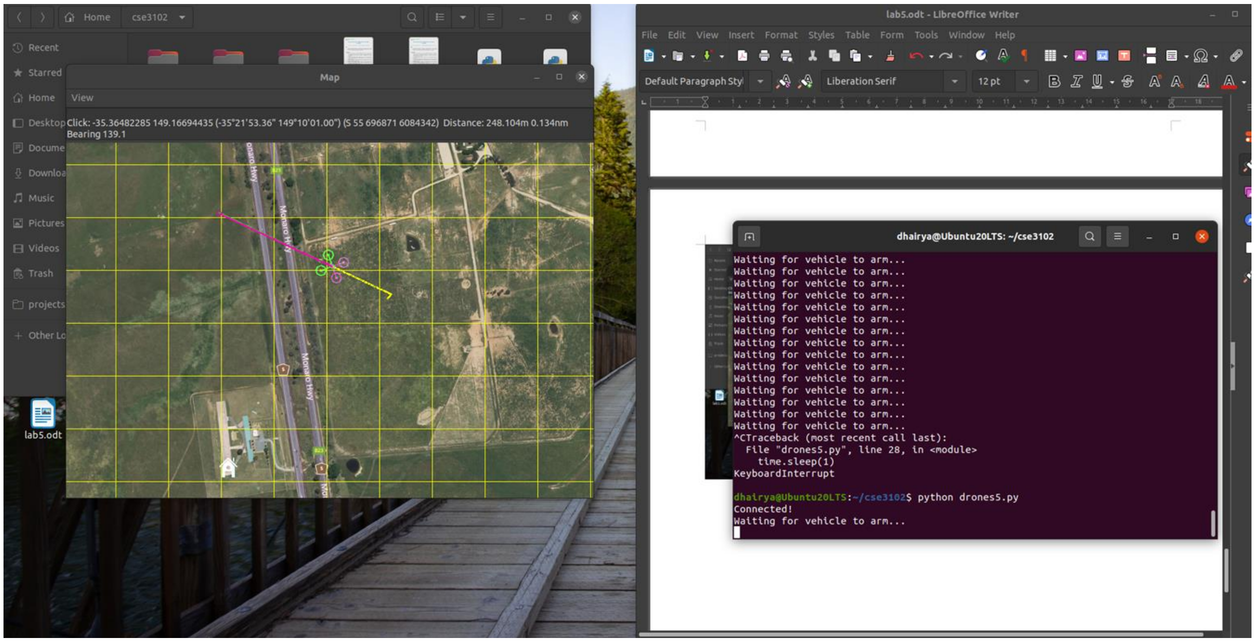

```
Loaded module console
Loaded module map
Log Directory:
Telemetry log: mav.tlog
Waiting for heartbeat from tcp:127.0.0.1:5760
MAV> Detected vehicle 1:1 on link 0
STABILIZE> Received 1339 parameters (ftp)
Saved 1339 parameters to mav.parm
```



Click: -35.36482285 149.16694435 (-35°21'53.36" 149°10'01.00") (S 55 696871 6084342) Distance: 248.104m 0.134nm
Bearing 139.1

```
Waiting for vehicle to arm...
Waiting for vehicle to arm...
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Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
^CTraceback (most recent call last):
  File "drones5.py", line 28, in <module>
    time.sleep(1)
KeyboardInterrupt

dhairya@Ubuntu20LTS:~/cse3102$ python drones5.py
Connected!
Waiting for vehicle to arm...
```

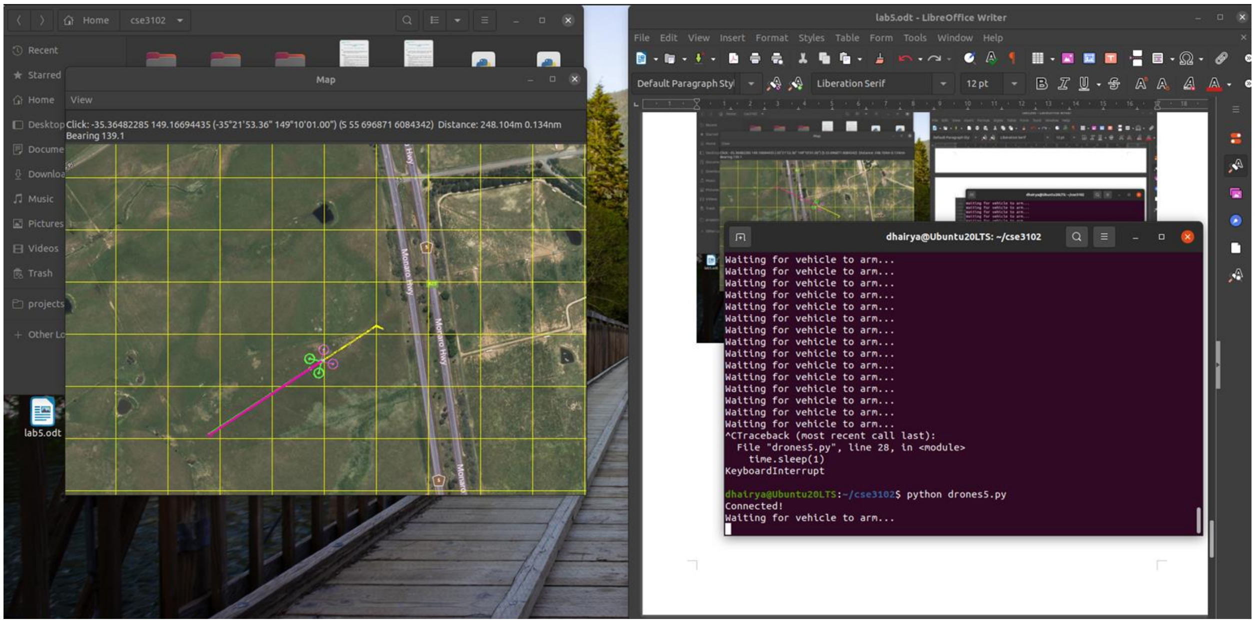

Click: -35.36482285 149.16694435 (-35°21'53.36" 149°10'01.00") (S 55 696871 6084342) Distance: 248.104m 0.134nm Bearing 139.1

```
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
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Waiting for vehicle to arm...
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Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
^CTraceback (most recent call last):
  File "drones5.py", line 28, in <module>
    time.sleep(1)
KeyboardInterrupt

dhairya@Ubuntu20LTS:~/cse3102$ python drones5.py
Connected!
Waiting for vehicle to arm...
```
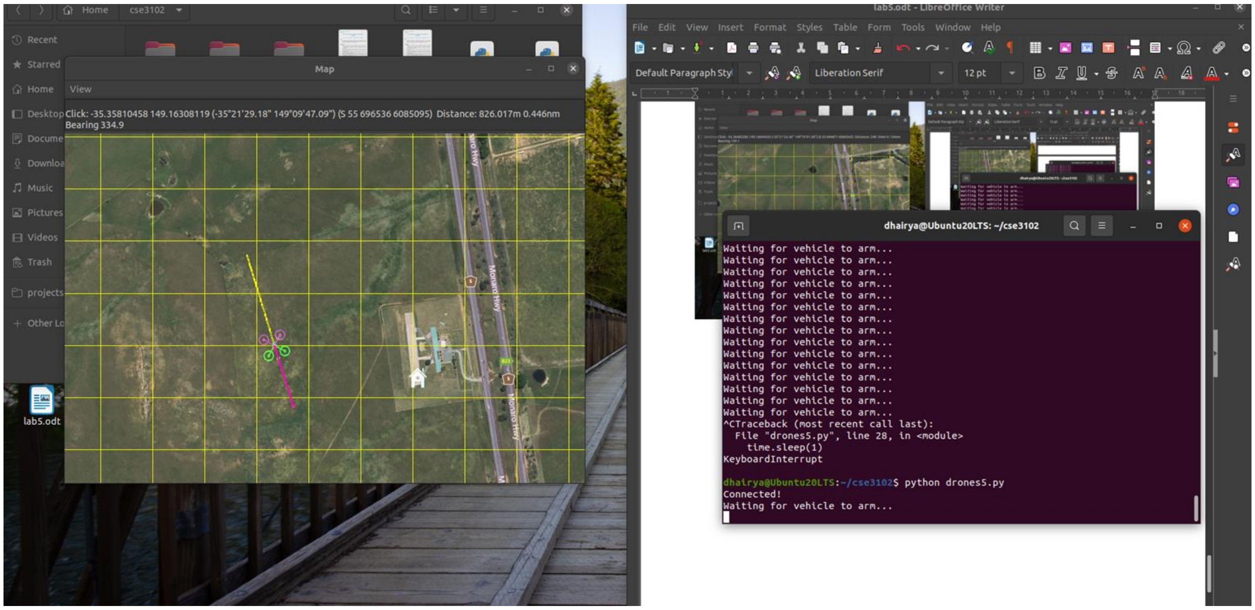
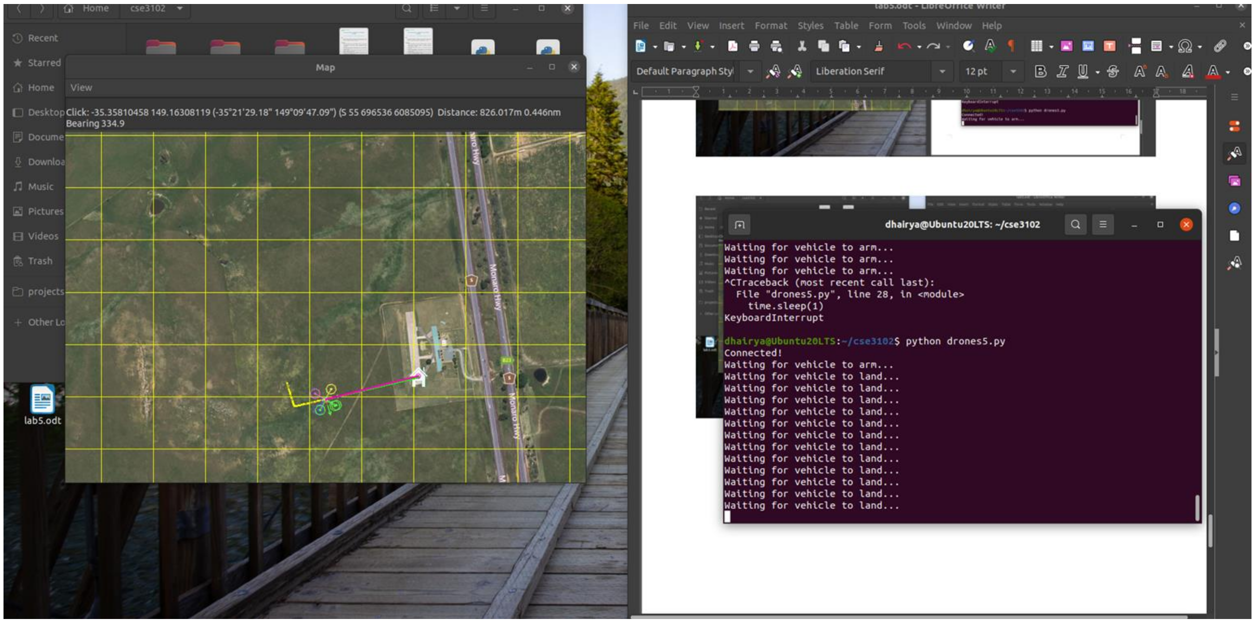



Click: -35.35810458 149.16308119 (-35°21'29.18" 149°09'47.09") (S 55 696536 6085095) Distance: 826.017m 0.446nm Bearing 334.9

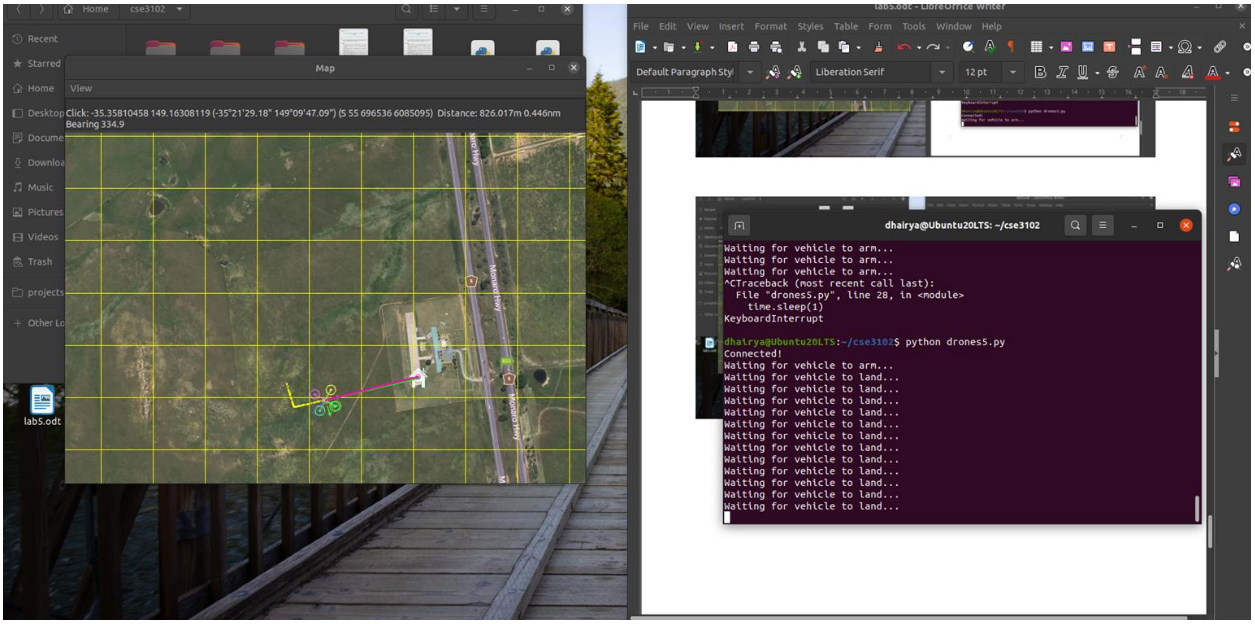
```
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
^CTraceback (most recent call last):
  File "drones5.py", line 28, in <module>
    time.sleep(1)
KeyboardInterrupt

dhairya@Ubuntu20LTS:~/cse3102$ python drones5.py
Connected!
Waiting for vehicle to arm...
```



Click: -35.35810458 149.16308119 (-35°21'29.18" 149°09'47.09") (S 55 696536 6085095) Distance: 826.017m 0.446nm
Bearing 334.9

dhairya@Ubuntu20LTS: ~/cse3102

```
Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
^CTraceback (most recent call last):
  File "drones5.py", line 28, in <module>
    time.sleep(1)
KeyboardInterrupt

dhairya@Ubuntu20LTS:~/cse3102$ python drones5.py
Connected!
Waiting for vehicle to arm...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
```


Click: -35.35810458 149.16308119 (-35°21'29.18" 149°09'47.09") (S 55 696536 6085095) Distance: 826.017m 0.446nm
Bearing 334.9

dhairya@Ubuntu20LTS: ~/cse3102

Waiting for vehicle to arm...
Waiting for vehicle to arm...
Waiting for vehicle to arm...
^CTraceback (most recent call last):
  File "drones5.py", line 28, in <module>
    time.sleep(1)
KeyboardInterrupt

dhairya@Ubuntu20LTS:~/cse3102$ python drones5.py
Connected!
Waiting for vehicle to arm...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
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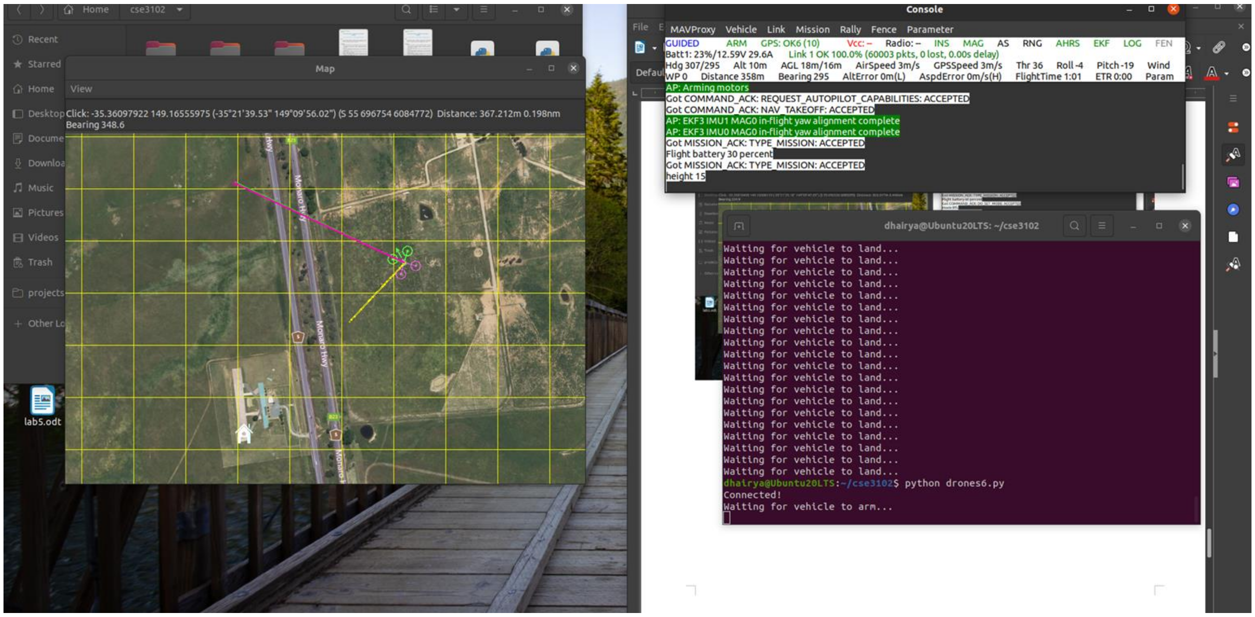
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...

DRONE6.py



Click: -35.36097922 149.16555975 (-35°21'39.53" 149°09'56.02") (S 55 696754 6084772) Distance: 367.212m 0.198nm
Bearing 348.6

Console

```
MAVProxy  Vehicle  Link  Mission  Rally  Fence  Parameter
GUIDED   ARM   GPS: OK6 (10)   Vcc: --   Radio: --   INS   MAG   AS   RNG   AHRS   EKF   LOG   FEN
Batt1: 23%/12.59V 29.6A    Link 1 OK 100.0% (60003 pkts, 0 lost, 0.00s delay)
Hdg 307/295   Alt 10m   AGL 18m/16m   AirSpeed 3m/s   GPSSpeed 3m/s   Thr 36   Roll -4   Pitch -19   Wind
WP 0   Distance 358m   Bearing 295   AltError 0m(L)   AspdError 0m/s(H)   FlightTime 1:01   ETR 0:00   Param
AP: Arming motors
Got COMMAND_ACK: REQUEST_AUTOPILOT_CAPABILITIES: ACCEPTED
Got COMMAND_ACK: NAV_TAKEOFF: 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
Flight battery 30 percent
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
```

dhairya@Ubuntu20LTS: ~/cse3102

```
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
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Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
dhairya@Ubuntu20LTS:~/cse3102$ python drones6.py
Connected!
Waiting for vehicle to arm...
```

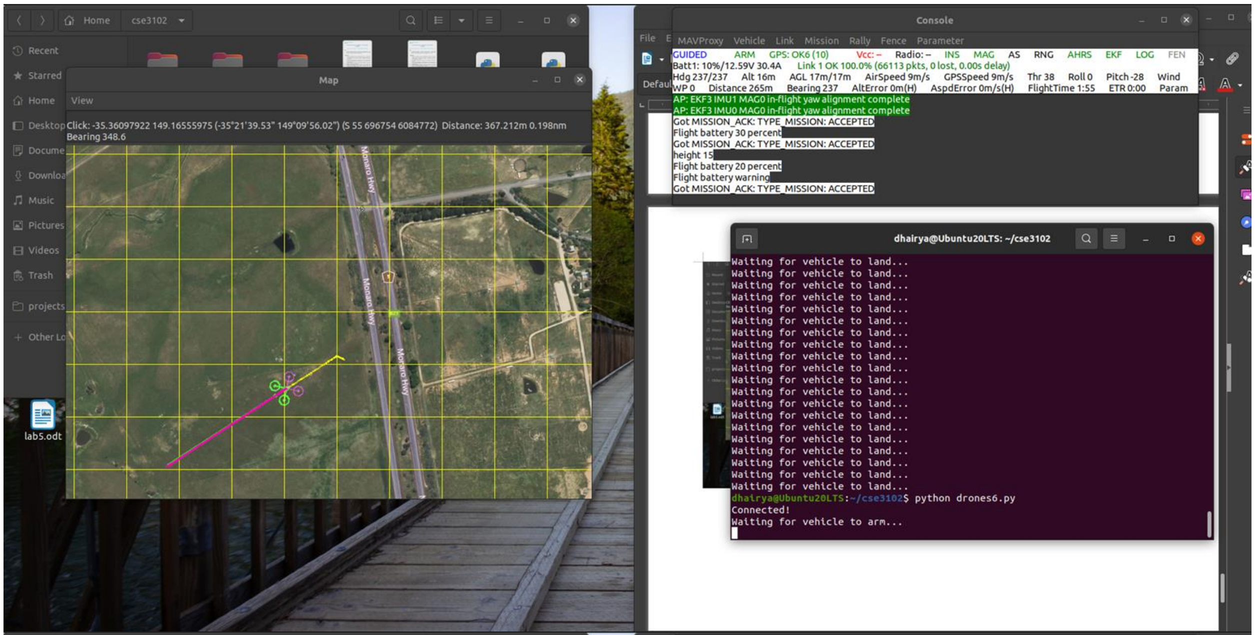

Click: -35.36097922 149.16555975 (-35°21'39.53" 149°09'56.02") (S 55 696754 6084772) Distance: 367.212m 0.198nm
Bearing 348.6

Console

```
MAVProxy  Vehicle  Link  Mission  Rally  Fence  Parameter
GUIDED   ARM   GPS: OK6 (10)   Vcc: --   Radio: --   INS   MAG   AS   RNG   AHRS   EKF   LOG   FEN
Batt1: 10%/12.59V 30.4A    Link 1 OK 100.0% (66113 pkts, 0 lost, 0.00s delay)
Hdg 237/237   Alt 16m   AGL 17m/17m   AirSpeed 9m/s   GPSSpeed 9m/s   Thr 38   Roll 0   Pitch -28   Wind
WP 0   Distance 265m   Bearing 237   AltError 0m(H)   AspdError 0m/s(H)   FlightTime 1:55   ETR 0:00   Param
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
AP: EKF3 IMU0 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Flight battery 30 percent
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
Flight battery 20 percent
Flight battery warning
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
```

dhairya@Ubuntu20LTS: ~/cse3102

```
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
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Waiting for vehicle to land...
Waiting for vehicle to land...
dhairya@Ubuntu20LTS:~/cse3102$ python drones6.py
Connected!
Waiting for vehicle to arm...
```

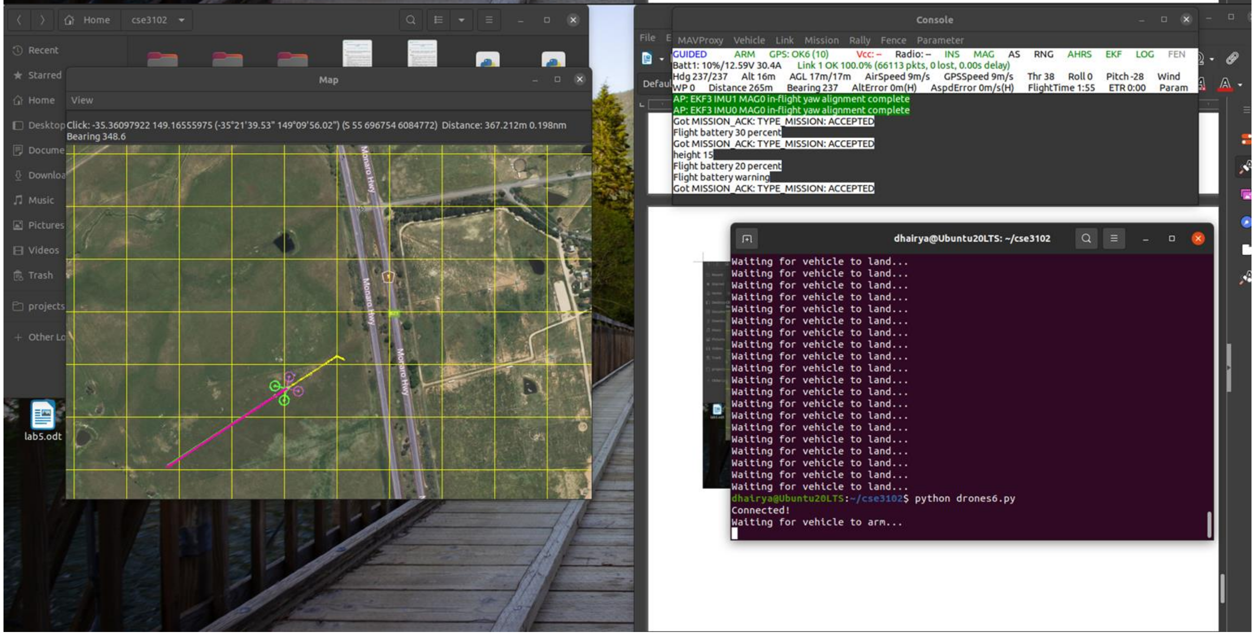
Click: -35.36097922 149.16555975 (-35°21'39.53" 149°09'56.02") (S 55 696754 6084772) Distance: 367.212m 0.198nm
Bearing 348.6

Console

MAVProxy Vehicle Link Mission Rally Fence Parameter
GUIDED   ARM   GPS: OK6 (10)   Vcc: --   Radio: --   INS   MAG   AS   RNG   AHRS   EKF   LOG   FEN
Batt1: 10%/12.59V 30.4A   Link 1 OK 100.0% (66113 pkts, 0 lost, 0.00s delay)
Hdg 237/237   Alt 16m   AGL 17m/17m   AirSpeed 9m/s   GPSSpeed 9m/s   Thr 38   Roll 0   Pitch -28   Wind
WP 0   Distance 265m   Bearing 237   AltError 0m(H)   AspdError 0m/s(H)   FlightTime 1:55   ETR 0:00   Param
AP: EKF3 IMU1 MAG0 in-flight yaw alignment complete
AP: EKF3 IMU0 MAG0 in-flight yaw alignment complete
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
Flight battery 30 percent
Got MISSION_ACK: TYPE_MISSION: ACCEPTED
height 15
Flight battery 20 percent
Flight battery warning
Got MISSION_ACK: TYPE_MISSION: ACCEPTED

dhairya@Ubuntu20LTS: ~/cse3102

Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
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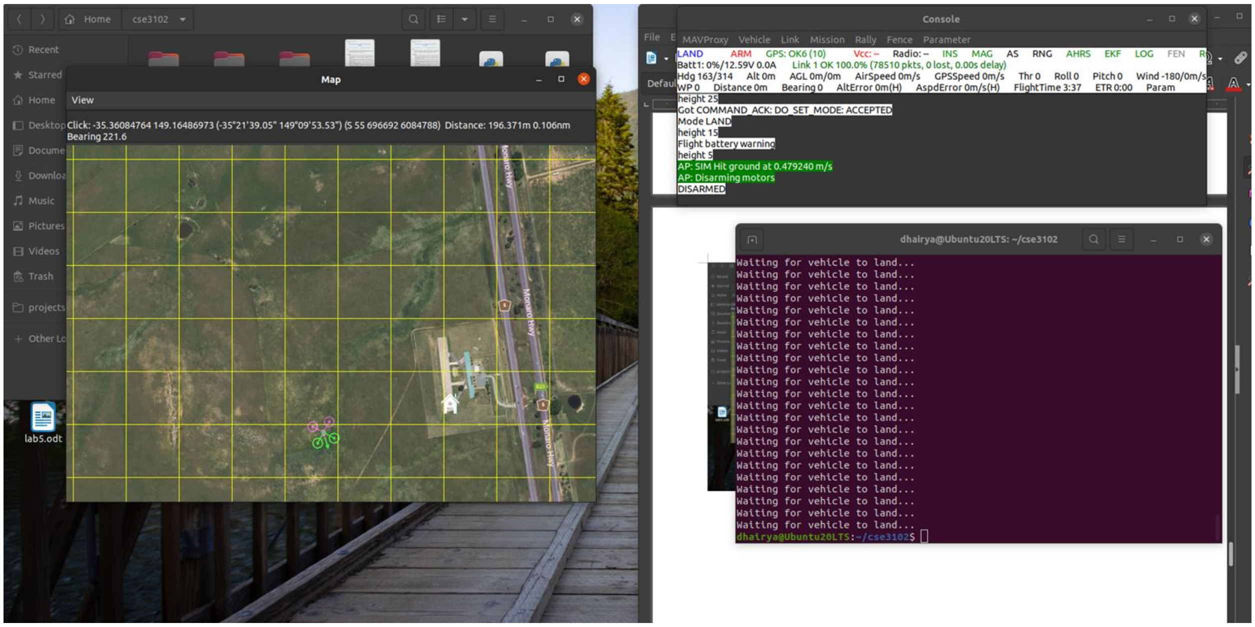
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
Waiting for vehicle to land...
dhairya@Ubuntu20LTS:~/cse3102$ python drones6.py
Connected!
Waiting for vehicle to arm...



```
Click: -35.36084764 149.16486973 (-35°21'39.05" 149°09'53.53") (S 55 696692 6084788)  Distance: 196.371m 0.106nm
Bearing 221.6
```

```
LAND    ARM   GPS: OK6 (10)    Vcc: --   Radio: --   INS   MAG   AS   RNG   AHRS   EKF   LOG   FEN   R
Batt1: 0%/12.59V 0.0A    Link 1 OK 100.0% (78510 pkts, 0 lost, 0.00s delay)
Hdg 163/314   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(H)   AspdError 0m/s(H)   FlightTime 3:37   ETR 0:00   Param
height 25
Got COMMAND_ACK: DO_SET_MODE: ACCEPTED
Mode LAND
height 15
Flight battery warning
height 5
AP: SIM Hit ground at 0.479240 m/s
AP: Disarming motors
DISARMED
```

dhairya@Ubuntu20LTS: ~/cse3102

```
Waiting for vehicle to land...
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Waiting for vehicle to land...
Waiting for vehicle to land...
dhairya@Ubuntu20LTS:~/cse3102$
```
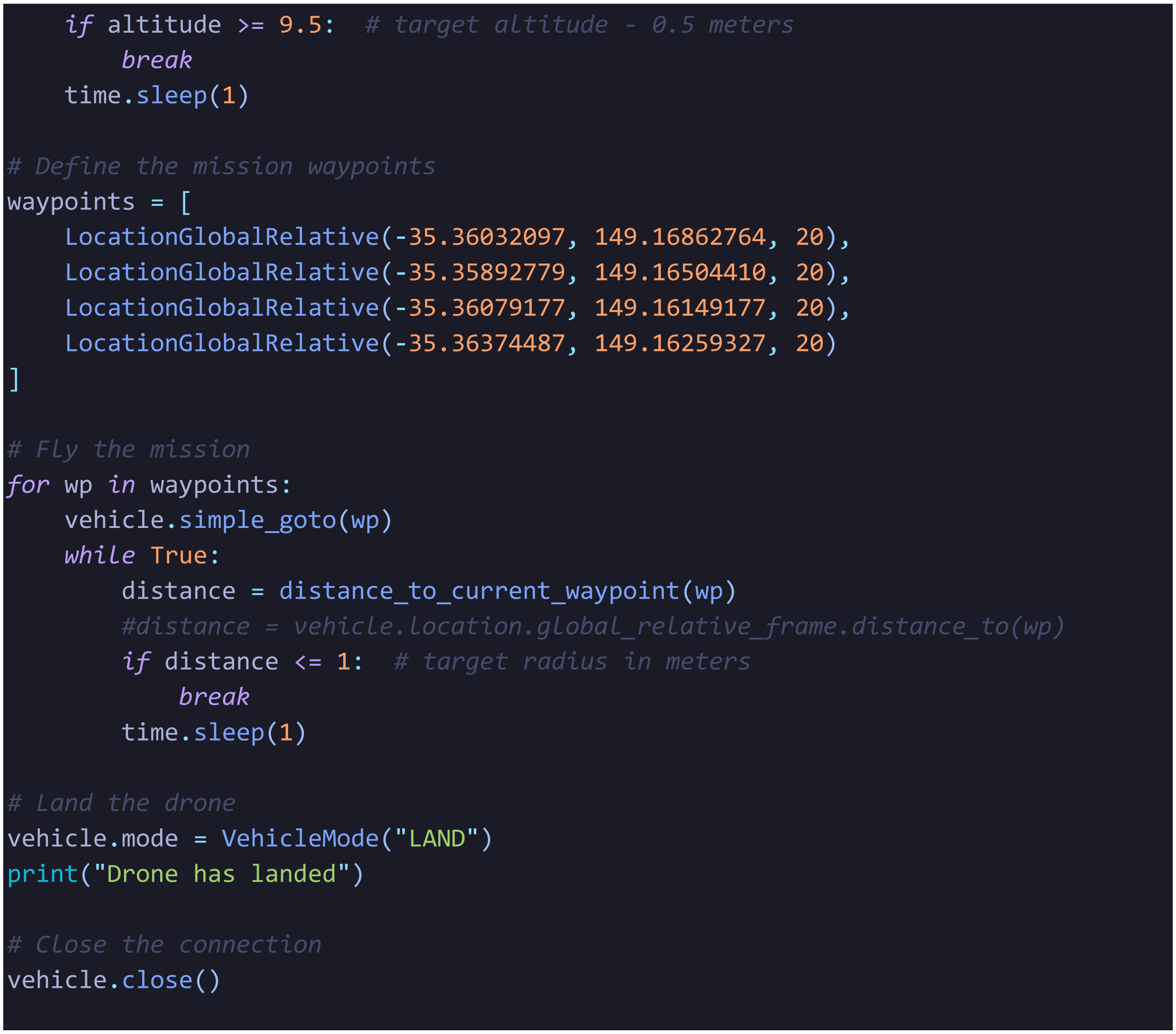

CODES

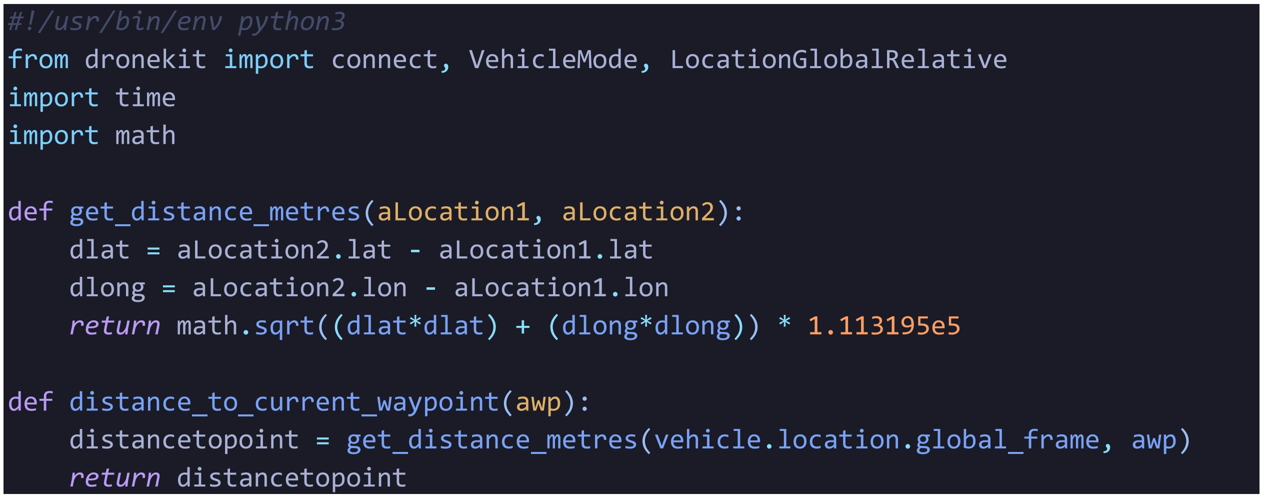
Dorne2.py

```
#!/usr/bin/env python3
from dronekit import connect, VehicleMode, LocationGlobalRelative
import time
import math

def get_distance_metres(aLocation1, aLocation2):
    dlat = aLocation2.lat - aLocation1.lat
    dlong = aLocation2.lon - aLocation1.lon
    return math.sqrt((dlat*dlat) + (dlong*dlong)) * 1.113195e5

def distance_to_current_waypoint(awp):
    distancetopoint = get_distance_metres(vehicle.location.global_frame, awp)
    return distancetopoint

# 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
```

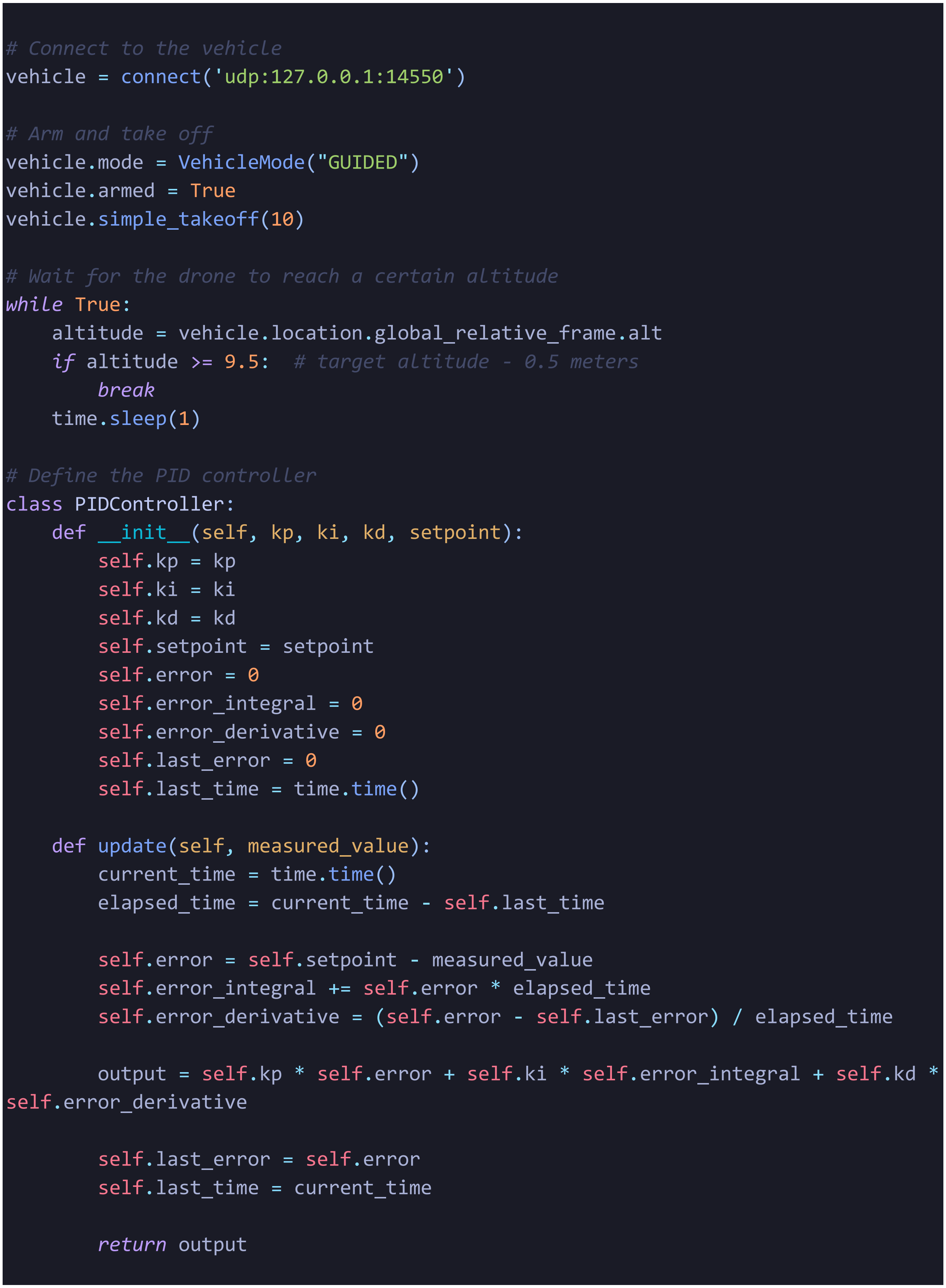


```
    if altitude >= 9.5:  # target altitude - 0.5 meters
        break
    time.sleep(1)

# Define the mission waypoints
waypoints = [
    LocationGlobalRelative(-35.36032097, 149.16862764, 20),
    LocationGlobalRelative(-35.35892779, 149.16504410, 20),
    LocationGlobalRelative(-35.36079177, 149.16149177, 20),
    LocationGlobalRelative(-35.36374487, 149.16259327, 20)
]

# Fly the mission
for wp in waypoints:
    vehicle.simple_goto(wp)
    while True:
        distance = distance_to_current_waypoint(wp)
        #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")
print("Drone has landed")

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

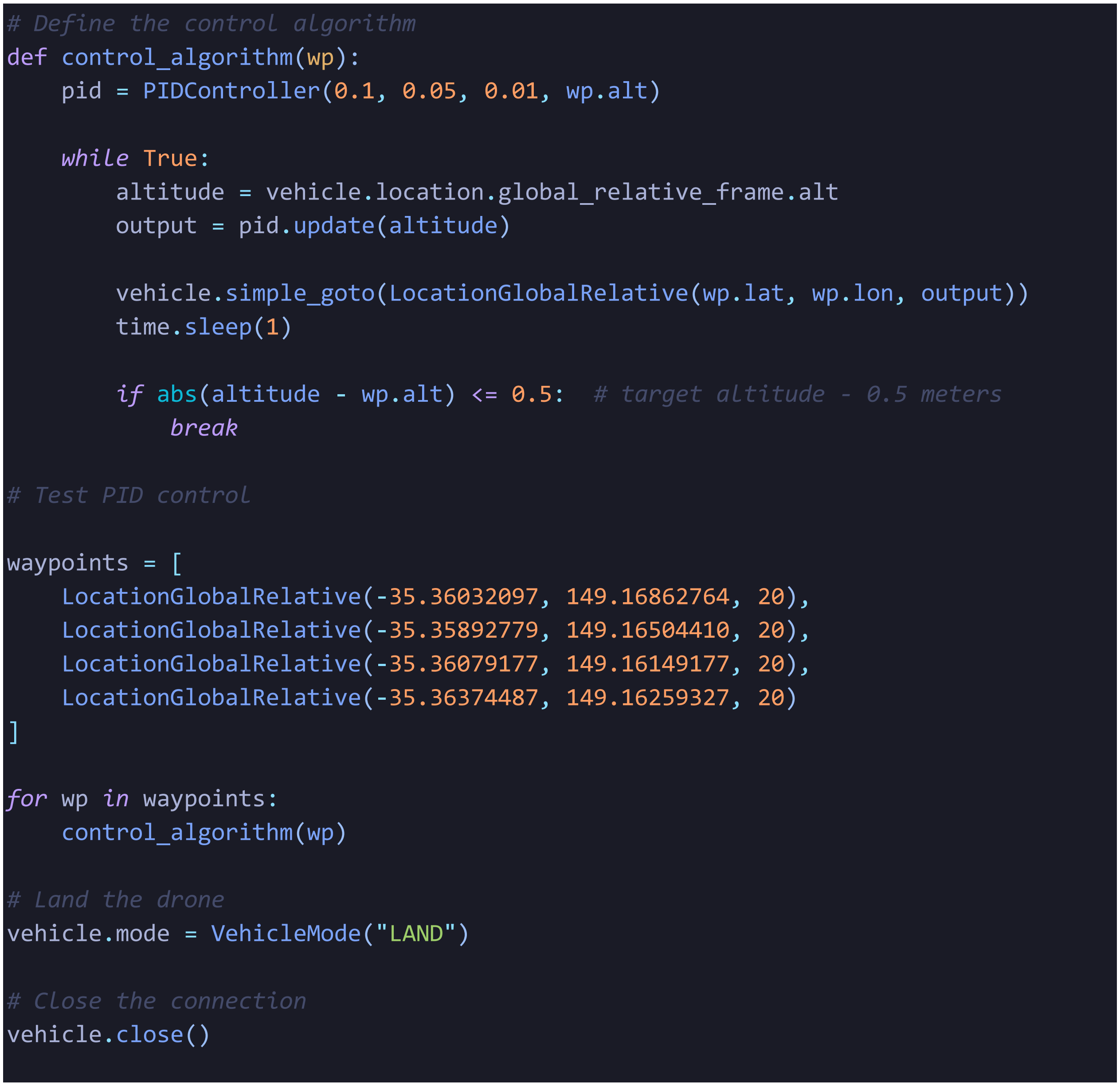
Done3.py



```
#!/usr/bin/env python3
from dronekit import connect, VehicleMode, LocationGlobalRelative
import time
import math

def get_distance_metres(aLocation1, aLocation2):
    dlat = aLocation2.lat - aLocation1.lat
    dlong = aLocation2.lon - aLocation1.lon
    return math.sqrt((dlat*dlat) + (dlong*dlong)) * 1.113195e5

def distance_to_current_waypoint(awp):
    distancetopoint = get_distance_metres(vehicle.location.global_frame, awp)
    return distancetopoint
```

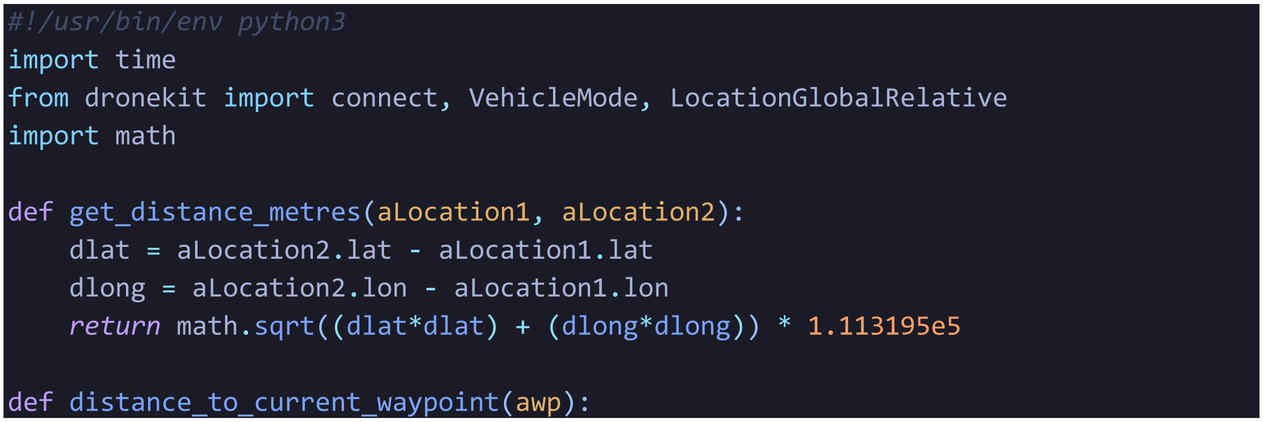


```python
# Connect to the vehicle
vehicle = connect('udp:127.0.0.1:14550')

# 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 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
```

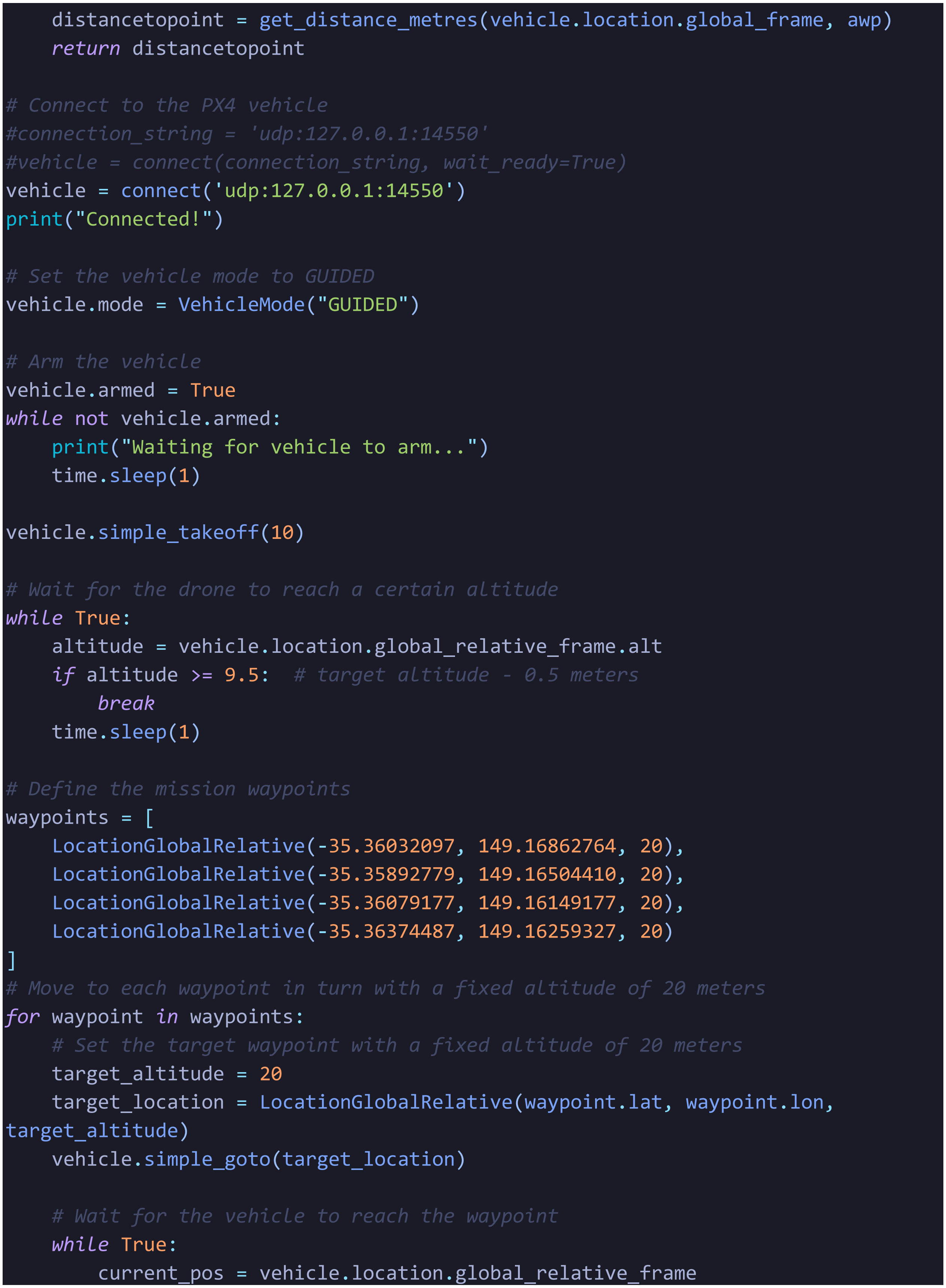


```python
# Define the control algorithm
def control_algorithm(wp):
    pid = PIDController(0.1, 0.05, 0.01, wp.alt)

    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(-35.36032097, 149.16862764, 20),
    LocationGlobalRelative(-35.35892779, 149.16504410, 20),
    LocationGlobalRelative(-35.36079177, 149.16149177, 20),
    LocationGlobalRelative(-35.36374487, 149.16259327, 20)
]

for wp in waypoints:
    control_algorithm(wp)

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

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

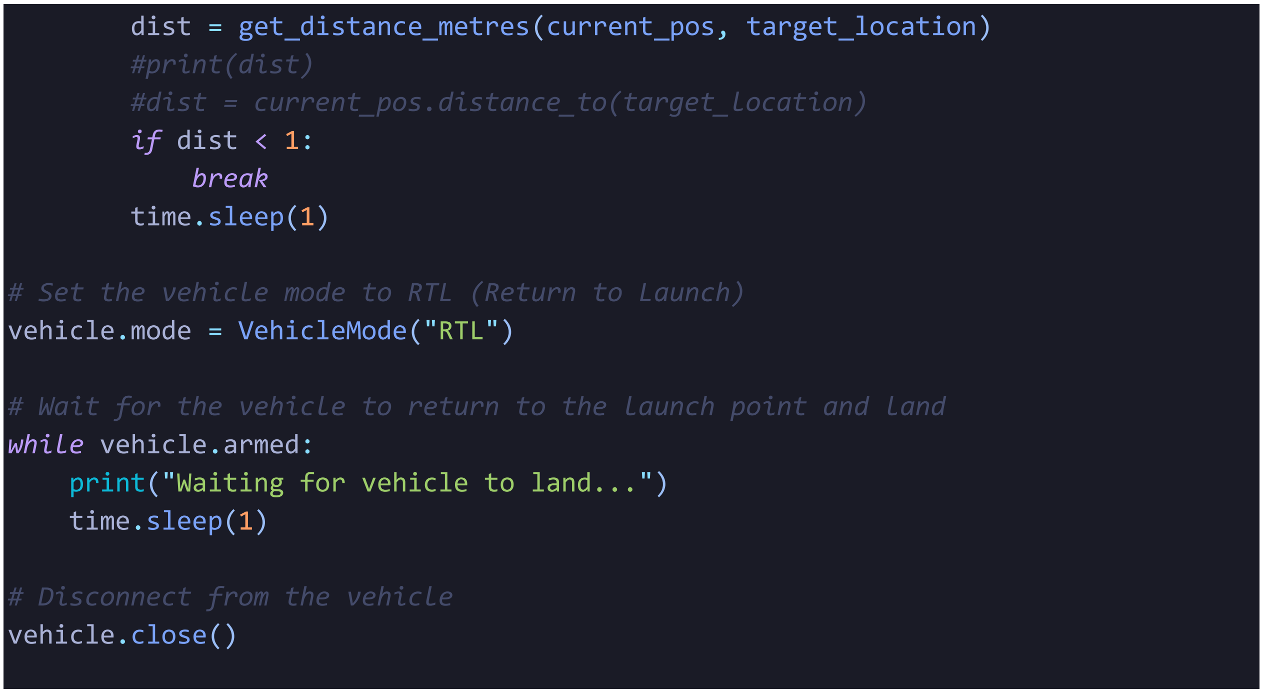
Drone5.py



```python
#!/usr/bin/env python3
import time
from dronekit import connect, VehicleMode, LocationGlobalRelative
import math

def get_distance_metres(aLocation1, aLocation2):
    dlat = aLocation2.lat - aLocation1.lat
    dlong = aLocation2.lon - aLocation1.lon
    return math.sqrt((dlat*dlat) + (dlong*dlong)) * 1.113195e5

def distance_to_current_waypoint(awp):
```

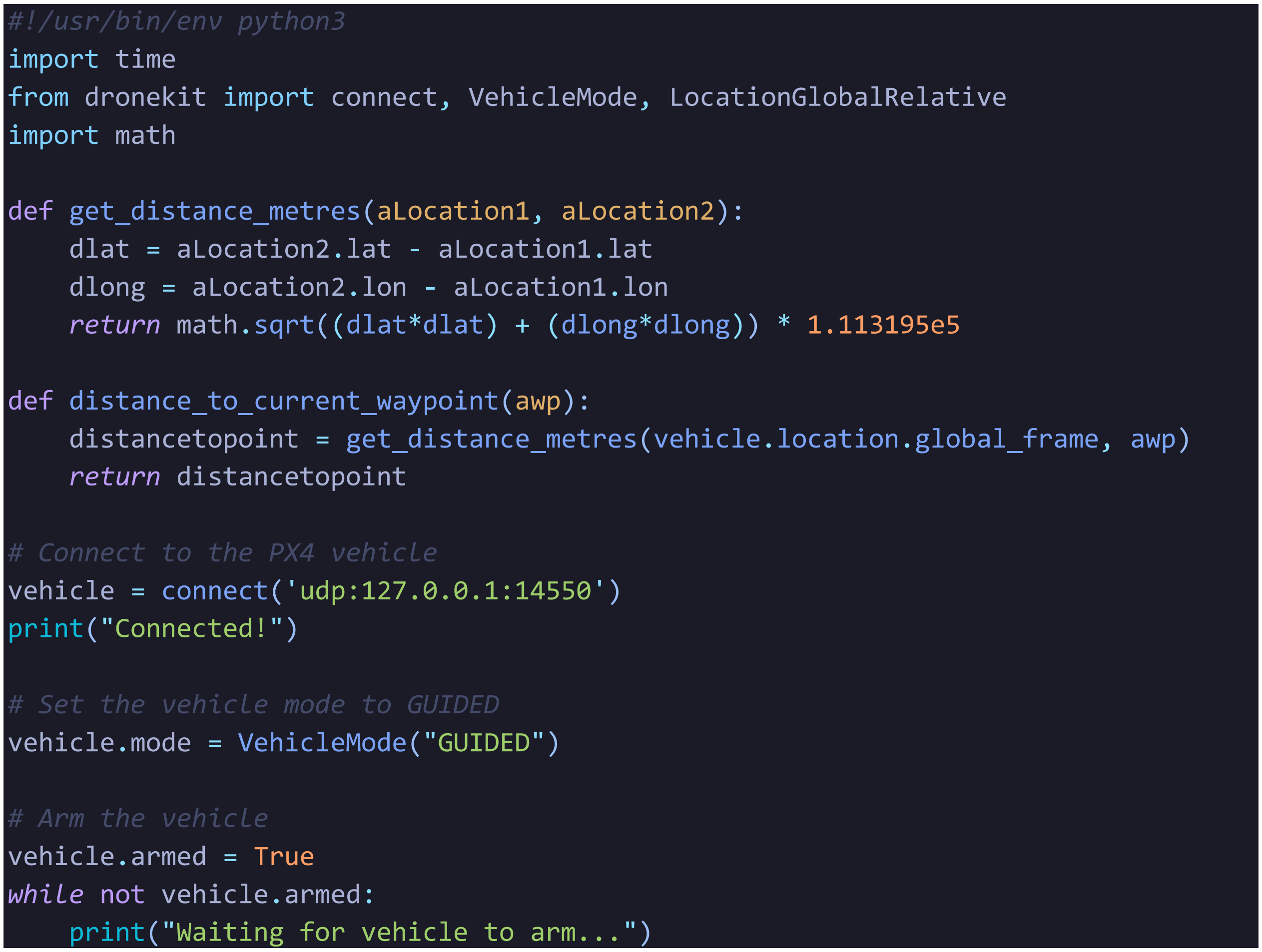


```
    distancetopoint = get_distance_metres(vehicle.location.global_frame, awp)
    return distancetopoint

# Connect to the PX4 vehicle
#connection_string = 'udp:127.0.0.1:14550'
#vehicle = connect(connection_string, wait_ready=True)
vehicle = connect('udp:127.0.0.1:14550')
print("Connected!")

# Set the vehicle mode to GUIDED
vehicle.mode = VehicleMode("GUIDED")

# Arm the vehicle
vehicle.armed = True
while not vehicle.armed:
    print("Waiting for vehicle to arm...")
    time.sleep(1)

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(-35.36032097, 149.16862764, 20),
    LocationGlobalRelative(-35.35892779, 149.16504410, 20),
    LocationGlobalRelative(-35.36079177, 149.16149177, 20),
    LocationGlobalRelative(-35.36374487, 149.16259327, 20)
]
# Move to each waypoint in turn with a fixed altitude of 20 meters
for waypoint in waypoints:
    # Set the target waypoint with a fixed altitude of 20 meters
    target_altitude = 20
    target_location = LocationGlobalRelative(waypoint.lat, waypoint.lon,
target_altitude)
    vehicle.simple_goto(target_location)

    # Wait for the vehicle to reach the waypoint
    while True:
        current_pos = vehicle.location.global_relative_frame
```

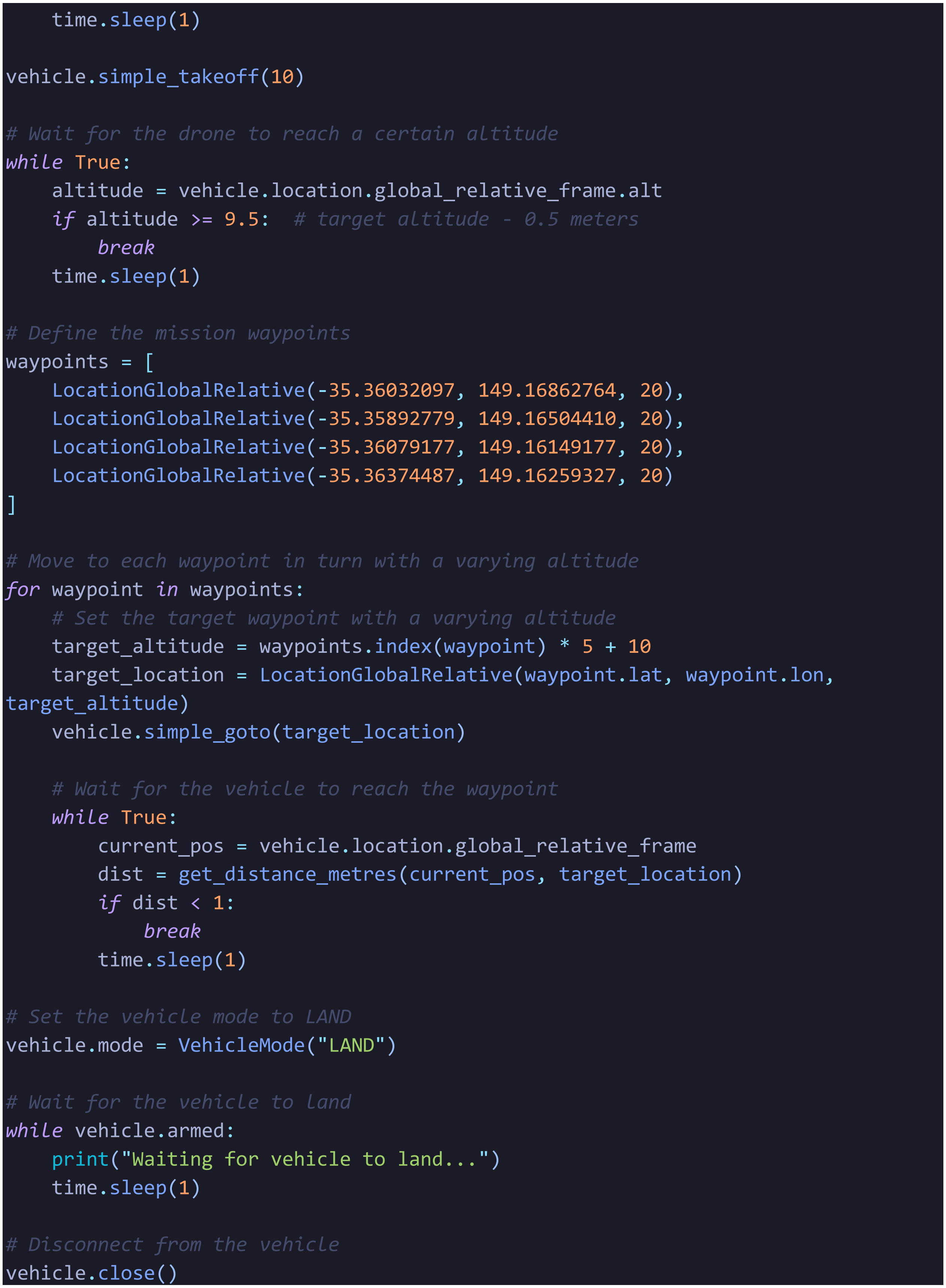


```
        dist = get_distance_metres(current_pos, target_location)
        #print(dist)
        #dist = current_pos.distance_to(target_location)
        if dist < 1:
            break
        time.sleep(1)

# Set the vehicle mode to RTL (Return to Launch)
vehicle.mode = VehicleMode("RTL")

# Wait for the vehicle to return to the launch point and land
while vehicle.armed:
    print("Waiting for vehicle to land...")
    time.sleep(1)

# Disconnect from the vehicle
vehicle.close()
```

Drone6.py



```
#!/usr/bin/env python3
import time
from dronekit import connect, VehicleMode, LocationGlobalRelative
import math

def get_distance_metres(aLocation1, aLocation2):
    dlat = aLocation2.lat - aLocation1.lat
    dlong = aLocation2.lon - aLocation1.lon
    return math.sqrt((dlat*dlat) + (dlong*dlong)) * 1.113195e5

def distance_to_current_waypoint(awp):
    distancetopoint = get_distance_metres(vehicle.location.global_frame, awp)
    return distancetopoint

# Connect to the PX4 vehicle
vehicle = connect('udp:127.0.0.1:14550')
print("Connected!")

# Set the vehicle mode to GUIDED
vehicle.mode = VehicleMode("GUIDED")

# Arm the vehicle
vehicle.armed = True
while not vehicle.armed:
    print("Waiting for vehicle to arm...")
```



```
    time.sleep(1)

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(-35.36032097, 149.16862764, 20),
    LocationGlobalRelative(-35.35892779, 149.16504410, 20),
    LocationGlobalRelative(-35.36079177, 149.16149177, 20),
    LocationGlobalRelative(-35.36374487, 149.16259327, 20)
]

# Move to each waypoint in turn with a varying altitude
for waypoint in waypoints:
    # Set the target waypoint with a varying altitude
    target_altitude = waypoints.index(waypoint) * 5 + 10
    target_location = LocationGlobalRelative(waypoint.lat, waypoint.lon,
target_altitude)
    vehicle.simple_goto(target_location)

    # Wait for the vehicle to reach the waypoint
    while True:
        current_pos = vehicle.location.global_relative_frame
        dist = get_distance_metres(current_pos, target_location)
        if dist < 1:
            break
        time.sleep(1)

# Set the vehicle mode to LAND
vehicle.mode = VehicleMode("LAND")

# Wait for the vehicle to land
while vehicle.armed:
    print("Waiting for vehicle to land...")
    time.sleep(1)

# Disconnect from the vehicle
vehicle.close()
```

CONCLUSION

We are able to write and execute python programs to take off the drone and land in new location, simulate a mission using series of waypoints and test the control algorithm using PID algorithm.