

# **Indian Institute of Technology (Indian School of Mines), Dhanbad**

**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**



## **PROJECT REPORT SESSION (2019-20) VIII SEM**

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## *Abstract*

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One of the many sources of income in our country is Agriculture. The growth of the crops is based on various factors like temperature, humidity, rain, etc. All of these are natural factors and are not under the control of the farmer. With the significant rise in global warming on earth, we have witnessed many ill-fated forest fires like those of the Amazon rainforest and Australia due to which millions of hectares of green land were burnt to ashes. In addition, the task of sowing the seeds in a field by a farmer is very laborious and demanding which requires time and human effort as input.

So, the main objective of this project is to design a drone that can be used to spray seeds and increase the greenery of the earth using an efficient afforestation method.

In this report, we discuss in brief the algorithm used to cover the land along with a spraying mechanism by an unmanned drone along with its software specifications. This project will help us vegetate the lands that are prone to soil erosion, landslides or deforestation both naturally or due to human negligence by helping us to plant trees there economically and also help us to reduce the plantation time. This project will reduce the workload on farmers as they can use it to plant their seeds along with this it will also help to reduce calamities like erosion and landslides.

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## Introduction

***"When you want to cover a huge area, manually planting trees is impractical. Certain terrains may not be accessible to people. Drones are helpful in such cases."*** This statement was made by Professor KPJ Reddy from the Department of Aerodynamics in IISc in an interview.

Drones or Unmanned aerial vehicles (UAVs) are the tools that have evolved and developed rapidly over the past decade and widely used in many sectors from archaeology to environment. UAV will soon be an important applicable tool for conservation and revegetation practices. A drone can provide not only efficient and effective methods but also a low-cost and low-impact solution to environmental managers working in a variety of ecosystems. Their agility, image quality and logistic abilities make them become advantageous tools.

Revegetation programs defined the forest rehabilitation approaches and technical intervention methods such as seed planting. In India, there are various tree species being used for revegetation. However, current ongoing revegetation practices are having challenges. Those challenges related to the preparation and operation phase. In preparation stage, revegetation practices require comprehensive assessment of lands that will be revegetated. That assessment should cover vast area and available immediately. The current revegetation practices by commissioning direct seeding through hand sowing are also facing difficulty. This method obviously requires labour. Furthermore, the coverage of labour is limited by access. As a result, sowing cannot reach areas that obstructed by hills and rivers for safety concerns for the workers. Regarding efficiency, it is estimated that a drone can distribute 10 seeds per minute. Due its nature, UAV has capability in the term of visual and transportation matters. Correspondingly, through this project we introduce the use of drone to support the revegetation practices. The project aims to develop a quadcopter drone that is capable of dispersing seeds in revegetation fields with potential for revegetation.

Agriculture in India constitutes more than 60% of occupation. It serves as the backbone of our country's economy. It is very essential to improve the productivity and efficiency of agriculture. The process like spraying of seeds is very important, it takes more than a day to cover the entire land the farmer owns. The spraying of seeds will not only save the time of the farmer but the same drone can also be used to spray pesticides for the farmer, which if done manually is a harmful procedure for the health of farmers. As per WHO report it is recorded that more than 3 million farmers are affected by the pesticides and out of which more than 18000 die. This project aims to not only save time or money for people or just barren lands but to save lives as well.

The drone is using rapidly spinning rotors to push the air downwards, thus creating a thrust keeping the drone aloft. There are two rotors on Traditional helicopters which can be arranged as two coplanar rotors providing upward thrust both spinning in the opposite direction. This opposite direction is to balance the torque exerted on the body of the helicopter.

## Problem Statement


Given a polygonal field of land on which seeds are to be sprayed, the task is to design an algorithm for an automated drone which when fed with the input parameters, cover the entire field and sprays seeds at a regular interval defined by the user.

### Input format-

- Latitude and longitude of each vertex of the polygon field.
- Latitude and longitude of the approximated centre of the field.
- The regular interval at which the seeds are to be sprayed.
- The altitude at which the drone operates.


On receiving the inputs, the algorithm should calculate the positional coordinates at where the seeds are to be sprayed and generates a path that covers all the seed dispersion points optimally.





## **Chapter 1. Installation guide**

Walkthrough to set up the  
PC for successful execution



## 1.1 Update

Install the package updates on your linux system

```
sudo apt-get update
```

## 1.2 Python 2

Install python2 if not already installed.

```
sudo apt install python2
```

## 1.3 DroneKit

DroneKit-Python and the dronekit-sitl simulator can be installed using **pip**.  
First of all you will need to install **pip** and **python-dev**:

```
sudo apt-get install python-pip python-dev  
pip install dronekit
```

## 1.4 DroneKit – SITL

The tool is installed (or updated) on all platforms using the command:

```
pip install dronekit-sitl -UI
```

## 1.5 MAVProxy

```
pip install MAVProxy
```

## 1.6 APMPlanner2

Download the latest deb file for your machine from:

[firmware.ardupilot.org/Tools/APMPlanner](http://firmware.ardupilot.org/Tools/APMPlanner)

Open a terminal window and go to the location where you downloaded the .deb file from step 2 and type the following command:

```
sudo dpkg -i apm_planner*.deb
```

The installation will likely fail because of missing dependencies. These dependencies can be installed with this command:

```
sudo apt-get -f install
```

Then retry the APMPlanner2 installation again:

```
sudo dpkg -i apm_planner*.deb
```

## 1.7 Running the code

Method 1:

Directly running the python scripts:

```
python filename.py
```

Method 2:

Run the APM Planner2 and minimize it.

Open 3 terminals and execute each of the following in each terminal:

a) First run the DroneKit simulator with desired vehicle and its attributes.

```
dronekit-sitl copter --home=10.0,20.0,0,180
```

Above command runs the start the simulation with copter at home location (latitude = 10.0 and longitude = 20.0 in above command) and 0 and 180 are copter parameters like model etc. It starts the SITL connection at: tcp:127.0.0.1:5760

- b) Use MavProxy to replicate the connection to other links like:

```
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
```

APM Planner should automatically connect to one of the out links from above command.

- c) Now run the required python drone script drone\_AUTO.py or drone\_GUIDED.py as follows:


```
python drone_GUIDED.py --connect udp:127.0.0.1:14551
```

or

```
python drone_AUTO.py --connect udp:127.0.0.1:14551
```

Monitor the drone in APM Planner and terminal outputs.

For detailed terminal outputs view the Master.log generated by the code.



## **Chapter 2. Software Description**

This Chapter focuses on the various Software's used in the project and their API's

## 2.1 About DroneKit

DroneKit-Python allows developers to design applications that work on an onboard companion computer and communicate with the ArduPilot flight controller using a low-latency link. The onboard applications can greatly increase the power of the autopilot, which will increase intelligence of vehicle behaviour, and functions that are computationally intensive (e.g. computer vision, path planning, or 3D modelling). DroneKit-Python is used for ground station applications, interacting with vehicles on a higher latency RF-link.

The API interacts with vehicles over MAV Link. It gives automatic access to an associated vehicle's telemetry, state and parameter data, and empowers both strategic and direct authority over vehicle movement and activities.

DroneKit-Python is an open source and community-driven project.

### 2.1.1 API Features

The API provides classes and methods to:

- It can connect to one or more vehicles from script
- It can get and set vehicle state and parameter data.
- Get asynchronous notification about state changes.
- Guide a drone/vehicle to given position (GUIDED mode).
- Send discretionary custom messages to control UAV movement and other equipment (GUIDED mode).
- Create and manage waypoint missions (AUTO mode).
- Override RC channel settings

### 2.1.2 Launching scripts

DroneKit-Python 2.0 apps are executed through a simple Python command prompt.

```
python some_python_script.py
```

## 2.2 Setting up a Simulated Vehicle (SITL)

The [SITL \(Software In The Loop\)](#) simulator allows us to create and test DroneKit-Python applications without a real time vehicle.

SITL can run on Linux , Mac and Windows, or within a virtual machine. It can be installed on the same computer as DroneKit, or on another computer on the same network..

### 2.2.1 DroneKit-SITL

DroneKit-SITL is the simplest as well as fastest way to run SITL on Windows, Linux (x86 architecture only), as well as Mac OS X. It is installed with the help of Python's *pip* tool on all mentioned platforms. It works by downloading and running already built vehicle binaries that are appropriate for the host operating system.

### 2.2.2 Running SITL

```
dronekit-sitl copter
```

## 2.3 MAVProxy

A MAVLink protocol proxy and ground station. MAVProxy is oriented towards command line operation, and is suitable for embedding in small autonomous vehicles or for using on ground control stations. It also features a number of graphical tools such as a slip map for satellite mapping view of the vehicle's location, and status console and several useful vehicle control modules.

### 2.3.1 Features

- MAVProxy is a command line-based application. There are modules remembered for MAVProxy to give a fundamental GUI.
- Can be simulated on a number of different devices.
- It's versatile; it should run on any POSIX OS with python, pyserial, and select() work calls, which implies Linux, OS X, Windows, and others.
- The light weight configuration implies it can run on little notebook easily.
- It underpins loadable modules, and has modules to help console/s, moving maps, joysticks, reception apparatus trackers and so forth.
- Tab-completion of orders.

## 2.4 APM Planner

APM Planner 2.0 represents an open-source ground station application for MAV link-based autopilots which also include APM and PX4/Pixhawk that can be run on Windows, Mac OSX, and Linux.

### 2.4.1 Features

- Arrange and align your ArduPilot or PX4 autopilot for self-governing vehicle control.
- Plan a target to achieve with GPS waypoints and control events.
- Associate a 3DR Radio to see live information and initiate orders in flight



## **Chapter 3.**

### **Documentation of drone\_AUTO.py**

Following chapters explain  
each line of the python  
script

# drone\_Auto.py

## Importing header files:

```
In [ ]: from __future__ import print_function
        from dronekit import connect, VehicleMode, LocationGlobalRelative, Command
        from pymavlink import mavutil
        import os
        import json
        import urllib
        import math
        import time
        import argparse
        import logging , logging.handlers
```

## Logging configuration:

```
In [ ]: logging.basicConfig(filename = "Master.log" , level = logging.DEBUG , format = "%(levelname)s: %(filename)s: %(funcName)s: %(lineno)d: %(message)s")
        logVAR = logging.getLogger(__name__)
        logVAR.setLevel(logging.DEBUG)
        logFileHand = logging.FileHandler("drone_seed_AUTO.log")
        logFileHand.setLevel(logging.DEBUG)
        logFile_streamHandler = logging.StreamHandler()
        logFile_streamHandler.setLevel(logging.ERROR)
        logForVAR = logging.Formatter("%(levelname)s: %(filename)s: %(funcName)s: %(lineno)d: %(message)s")
        logFileHand.setFormatter(logForVAR)
        logFile_streamHandler.setFormatter(logForVAR)
        logVAR.addHandler(logFileHand)
        logVAR.addHandler(logFile_streamHandler)
```

## Functions Used:

### 1. distanceBetweenTwoGeoPoints(locPOINT1, locPOINT2):

This function calculates the ground distance between two points.

This function is a approximation therefore valid for only short distance.

```
In [ ]: def distanceBetweenTwoGeoPoints(locPOINT1, locPOINT2):
        disLatitude = locPOINT2.lat - locPOINT1.lat
        disLongitude = locPOINT2.lon - locPOINT1.lon
        return math.sqrt((disLatitude*disLatitude) + (disLongitude*disLongitude)) * 1.113195e5
```

## 2. calculateDistanceToCurrentPoint():

This function returns the distance to the current waypoint in meters.

If Home Location is given as input the function returns None

```
In [ ]: def calculateDistanceToCurrentPoint():
        nextVehCommandInt = simDRONE.commands.next
        if nextVehCommandInt==0:
            return None
        nextVehCommand=simDRONE.commands[nextVehCommandInt-1] #zero index
        latitude = nextVehCommand.x
        longitude = nextVehCommand.y
        altitude = nextVehCommand.z
        nextPointLoc = LocationGlobalRelative(latitude,longitude,altitude)
        disPoint = distanceBetweenTwoGeoPoints(simDRONE.location.global_frame, nextPointLoc)
        return disPoint
```

## 3. armVehicleThenTakeOFF(flyingALT):

This function takes a altitude as a parameter then arms the simulated drone and then fly to the given altitude.

```
In [ ]: def armVehicleThenTakeOFF(flyingALT):
        while not simDRONE.is_armable:
            logVAR.warning("Waiting for drone to get ready -----")
            time.sleep(1.0)
```

Change the mode of drone to GUIDED :

```
In [ ]: while (simDRONE.mode.name != "GUIDED"):
        simDRONE.mode = VehicleMode("GUIDED")
        time.sleep(0.2)
```

Now we confirm that simulated drone is armed before taking off

```
In [ ]: while not simDRONE.armed:
        simDRONE.armed = True
        logVAR.warning("Wait for simulated drone to get armed")
        time.sleep(0.5)

        print("Simulate Drone is taking off..")
        logVAR.info("Simulate Drone is taking off..")
        simDRONE.simple_takeoff(flyingALT)
```

Now we add a check to see whether drone has reached the safe height:

```
In [ ]: while True:
        height = flyingALT*0.95
        if simDRONE.location.global_relative_frame.alt >= height:
            print("Drone has reached the height of %f" % (flyingALT))
            logVAR.info("Drone has reached the height of %f" % (flyingALT))
            break
        logVAR.info("Height: %f < %f" % (simDRONE.location.global_relative_frame.alt,height))
        time.sleep(1.0)
```

#### 4. print\_simDRONE\_parameters():

This function list all the parameters of the simulated drone and stores it in log file.

```
In [ ]: def print_simDRONE_parameters():
        logVAR.info ("Listing all the current simulated drone parameters (`simDRONE.parameters`):")
        for para, ivalue in simDRONE.parameters.iteritems():
            logVAR.info (" Parameter : %s Current Value : %s" % (para,ivalue))
```

#### Main Body :

```
In [ ]: startingLatitude = 0.0           #latitude variable
        startingLongitude = 0.0         #longitude variable
        startingAltitude = 0.0         #altitude variable
        waypoint_file = ""             #stores the waypoint file name
```

Takes the latitude, longitude and altitude value from USER and check if USER enters the correct values or not.

```
In [ ]: while True:
        try:
            startingLatitude = float(input("Please enter the latitude of starting point:\n"))
            logVAR.debug("USER entered latitude value: %s",str(startingLatitude))
            if(startingLatitude<0 or startingLatitude>90):
                print("Latitude value must be between 0 and 90")
                continue
            startingLongitude = float(input("Please enter the longitude of starting point:\n"))
            logVAR.debug("USER entered longitude value: %s",str(startingLongitude))
            if(startingLongitude<0 or startingLongitude>180):
                print("Longitude value must be between 0 and 180")
                continue
            startingAltitude = float(input("Please enter the altitude for the drone:\n"))
            logVAR.debug("USER entered altitude value: %s",str(startingAltitude))
            if(startingAltitude<0):
                print("Altitude value must be positive")
                continue
            break
        except:
            logVAR.error("Oops! That was no valid lat/lon or altitude. Try again...")
```

Takes the waypoint file name from USER

```
In [ ]: while True:
        waypoint_file = raw_input("Enter the waypoint file name with extension:\n")
        if os.path.exists(waypoint_file):
            break
        else:
            print("Enter file does not exists. Please re enter correct file")
            logVAR.error("Enter file does not exists.")
            continue
```

Now we set up parsing to get the connection string from user

```
In [ ]: parsingVAR = argparse.ArgumentParser(description=' Seed Plantation using drone.')
        parsingVAR.add_argument('--connect', help="simDRONE connection string. SITL is automatically started if connection string not specified.")
        argsVAR = parsingVAR.parse_args()
        userConString = argsVAR.connect
        sitlSIM = None
```

Start the SITL if user do not specify the connection string for the drone

```
In [ ]: if not userConString:
        import dronekit_sitl
        sitlSIM = dronekit_sitl.start_default(lat=startingLatitude,lon=startingLongitude)
        userConString = sitlSIM.connection_string()
```

Now connect to the simulated drone

```
In [ ]: print('Connecting to simulated drone on: %s' % userConString)
logVAR.info('Connecting to simulated drone on: %s' % userConString)
simDRONE = connect(userConString, wait_ready=True)
```

Log drone parameters:

```
In [ ]: print_simDRONE_parameters()
```

Download the simulated drone commands

```
In [ ]: droneCMDS = simDRONE.commands
droneCMDS.wait_ready()
droneCMDS = simDRONE.commands
droneCMDS.clear()
line_count = 0      #Variable that keep track of total commands
```

Add command for starting location:

```
In [ ]: droneCMD = Command( 0, 0, 0, mavutil.mavlink.MAV_FRAME_GLOBAL_RELATIVE_ALT,
mavutil.mavlink.MAV_CMD_NAV_WAYPOINT, 0, 0, 0, 0, 0, 0, startingLatitude,
startingLongitude, startingAltitude)
droneCMDS.add(droneCMD)
```

add command for all waypoints:

```
In [ ]: with open(waypoint_file, "r") as way_p:
        for pt in way_p:
            current_line = pt.split(",")
            line_count += 1
            lat = float(current_line[0])
            lon = float(current_line[1])
            logVAR.debug ("Point: %f %f" % (lat, lon))
            droneCMD = Command( 0, 0, 0, mavutil.mavlink.MAV_FRAME_GLOBAL_RELATIVE_ALT,
mavutil.mavlink.MAV_CMD_NAV_WAYPOINT, 0, 0, 5, 0, 0, 0, lat, lon, startingAltitude)
            droneCMDS.add(droneCMD)
        way_p.close()
```

Add command for returning to base:

```
In [ ]: droneCMD = Command( 0, 0, 0, mavutil.mavlink.MAV_FRAME_GLOBAL_RELATIVE_ALT,
mavutil.mavlink.MAV_CMD_NAV_WAYPOINT, 0, 0, 0, 0, 0, 0, startingLatitude,
startingLongitude, startingAltitude)
droneCMDS.add(droneCMD)
```

Now we upload all the waypoints to our simulated drone.

```
In [ ]: print("Upload points to simulated drone..." )
logVAR.info("Upload points to simulated drone...")
droneCMDS.upload()
print("Drone is arming and taking off:")
logVAR.info("Drone is arming and taking off:")
armVehicleThenTakeOFF(startingAltitude)

print("Starting Seed Plantation mission")
logVAR.info("Starting Seed Plantation mission")
```

Reset command to first point i.e 0

```
In [ ]: simDRONE.commands.next=0
```

To start the mission set the drone MODE to AUTO:

```
In [ ]: while (simDRONE.mode.name != "AUTO"):
    simDRONE.mode = VehicleMode("AUTO")
    time.sleep(0.1)
```

## Monitor mission

It calculates the distance to next waypoint at regular interval (here 1 sec) and if distance is < 1.5m we assume that drone has reached the point where it has to drop the seed and Seed Dropping is going on. (Thats why we see multiple dropping seed print statement in terminal)

When we reach the last point, RTL (Return to launch) command is executed by changing the drone mode to RTL.

```
In [ ]: while True:
    nextVehCommandInt = simDRONE.commands.next
    print('Distance to next seed drop point (%s): %s' % (nextVehComm
andInt, calculateDistanceToCurrentPoint()))
    logVAR.info('Distance to next seed drop point (%s): %s' % (nextV
ehCommandInt, calculateDistanceToCurrentPoint()))
    if calculateDistanceToCurrentPoint()<1.5:
        print("Dropping Seed")
        logVAR.critical("Dropping Seed")
        if nextVehCommandInt==line_count+1:
            print("Drone is heading to start location or launch loca
tion")
            logVAR.info("Drone is heading to start location or launc
h location")
            break;
        time.sleep(1)

    print('Return to base/helipad')
    logVAR.critical("Return to base/helipad")
    while (simDRONE.mode.name != "RTL"):
        simDRONE.mode = VehicleMode("RTL")
        time.sleep(0.1)
```

Close simulated drone object before terminating script

```
In [ ]: print("Close simulated drone object")
logVAR.info("Close simulated drone object")
simDRONE.close()
```

Shut down simulator:

```
In [ ]: if sitlSIM is not None:
        sitlSIM.stop()
        print("Seed Plantation Completed...")
        logVAR.info("Seed Plantation Completed...")
```



## **Chapter 4.**

### **Documentation of drone\_GUIDED.py**

Following chapters explain  
each line of the python  
script

# drone\_Guided.py

## Importing header files:

```
In [ ]: from __future__ import print_function
from pymavlink import mavutil
from dronekit import connect, VehicleMode, LocationGlobalRelative, LocationGlobal, Command
import os
import json
import urllib
import math
import argparse
import time
import logging , logging.handlers
```

## Logging configuration:

```
In [ ]: logging.basicConfig(filename = "Master.log" , level = logging.DEBUG , format = "%(levelname)s: %(filename)s: %(funcName)s: %(lineno)d: %(message)s")
logVAR = logging.getLogger(__name__)
logVAR.setLevel(logging.DEBUG)
logFileHand = logging.FileHandler("drone_seed_GUIDED.log")
logFileHand.setLevel(logging.DEBUG)
logFile_streamHandler = logging.StreamHandler()
logFile_streamHandler.setLevel(logging.ERROR)
logForVAR = logging.Formatter("%(levelname)s: %(filename)s: %(funcName)s: %(lineno)d: %(message)s")
logFileHand.setFormatter(logForVAR)
logFile_streamHandler.setFormatter(logForVAR)
logVAR.addHandler(logFileHand)
logVAR.addHandler(logFile_streamHandler)
```

## Custom Class for taking lat/lon and alt points

LAT\_LON\_ALT class takes three parameters x,y and z save them as lon,lat and alt variables of the class object.

```
In [ ]: class LAT_LON_ALT:
        def __init__(self,x,y,z):
            self.lon = x
            self.lat = y
            self.alt = z
```

## Functions Used:

## 1. distanceBetweenTwoGeoPoints(locPOINT1, locPOINT2):

This function calculates the ground distance between two points.

This function is a approximation therefore valid for only short distance.

```
In [ ]: def distanceBetweenTwoGeoPoints(locPOINT1, locPOINT2):
        disLatitude = locPOINT2.lat - locPOINT1.lat
        disLongitude = locPOINT2.lon - locPOINT1.lon
        return math.sqrt((disLatitude*disLatitude) + (disLongitude*disLongitude)) * 1.113195e5
```

## 2. armVehicleThenTakeOFF(flyingALT):

This function takes a altitude as a parameter then arms the simulated drone and then fly to the given altitude.

```
In [ ]: def armVehicleThenTakeOFF(flyingALT):
        # Wait for autopilot to get ready
        while not simDRONE.is_armable:
            logVAR.warning("Waiting for drone to get ready -----")
            time.sleep(1.0)

        # Change the mode of drone to GUIDED :
        while (simDRONE.mode.name != "GUIDED"):
            simDRONE.mode = VehicleMode("GUIDED")
            time.sleep(0.2)

        # Now we confirm that simulated drone is armed before taking off
        while not simDRONE.armed:
            simDRONE.armed = True
            logVAR.warning("Wait for simulated drone to get armed")
            time.sleep(0.5)

        print("Simulate Drone is taking off..")
        logVAR.info("Simulate Drone is taking off..")
        simDRONE.simple_takeoff(flyingALT)

        # Now we add a check to see whether drone has reached the safe height:

        while True:
            height = flyingALT*0.95
            if simDRONE.location.global_relative_frame.alt >= height:
                print("Drone has reached the height of %f" % (flyingALT))
                logVAR.info("Drone has reached the height of %f" % (flyingALT))
                break
            logVAR.info("Height: %f < %f" % (simDRONE.location.global_relative_frame.alt,height))
            time.sleep(1.0)
```

## 3. goto(targetLocation):

At first we store the target location in Vehicle Global Relative Frame object and calculate the target distance.

Then using the mavlink and vehicle message factory send command to drone to move to next target location.

There is another way to send command to drone by using the inbuilt function `vehicle_simple_goto()`. (But we are using our custom command)

Note: Take care of the coordinate system followed by different msg command (like WGS84 or Lat/lon system etc)

```
In [ ]: def goto(targetLocation):
        # send command to simulated drone
        logVAR.debug("Target location lat: %f , lon: %f , alt: %f" % (targetLocation.lat, targetLocation.lon, targetLocation.alt))
        vc_in_loc = simDRONE.location.global_relative_frame
        simDRONE_initialLocation = LAT_LON_ALT(vc_in_loc.lon, vc_in_loc.lat, vc_in_loc.alt)
        targetDistance = distanceBetweenTwoGeoPoints(simDRONE_initialLocation, targetLocation)
        msg = simDRONE.message_factory.set_position_target_global_int_encode(0, 0, 0, mavutil.mavlink.MAV_FRAME_GLOBAL_RELATIVE_ALT_INT, 0b0000111111111000, targetLocation.lat*1e7, targetLocation.lon*1e7, targetLocation.alt, 0, 0, 0, 0, 0, 0, 0, 0, 0)
        simDRONE.send_mavlink(msg)
        logVAR.debug("Send Command Message to drone")
        # target = LocationGlobal(targetLocation.lat, targetLocation.lon, targetLocation.alt)
        # simDRONE.airspeed=15
        # simDRONE.simple_goto(target)
```

#### CRITICAL :

There may be case that our msg command send above is dropped due to network failure. In that case drone will be stuck at a point.

To handle this we monitor the drone for 5 sec after sending the command. If drone doesnot move (i.e. targetDistance is still greater than 90% of that of at first sec) then we resend the msg command to drone.

Following code even handle the drone Mode change if any.

```

In [ ]: fiveSecondCheck = targetDistance
        fiveCounter = 1
        logVAR.debug("fiveSecondCheck distance: %f " % (fiveSecondCheck))
        logVAR.debug("fiveCounter value: %d " % (fiveCounter))
        while True:
            logVAR.debug("mode: %s" % simDRONE.mode.name)
            while (simDRONE.mode.name != "GUIDED"):
                simDRONE.mode = VehicleMode("GUIDED")
                time.sleep(0.1)

            if fiveCounter == 1:
                vc_loc = simDRONE.location.global_relative_frame
                simDRONE_currentLocation = LAT_LON_ALT(vc_loc.lon,vc_loc.lat,vc_loc.alt)
                fiveSecondCheck = distanceBetweenTwoGeoPoints(simDRONE_currentLocation, targetLocation)
                logVAR.debug("fiveSecondCheck distance: %f " % (fiveSecondCheck))
                logVAR.debug("fiveCounter value: %d " % (fiveCounter))

            if fiveCounter >=5:
                logVAR.debug("fiveSecondCheck distance: %f " % (fiveSecondCheck))
                logVAR.debug("fiveCounter value: %d " % (fiveCounter))
                fiveCounter = 1
                vc_loc = simDRONE.location.global_relative_frame
                simDRONE_currentLocation = LAT_LON_ALT(vc_loc.lon,vc_loc.lat,vc_loc.alt)
                currentDistanceToTarget = distanceBetweenTwoGeoPoints(simDRONE_currentLocation, targetLocation)
                logVAR.debug("fiveSecondCheck currentDistanceToTarget distance: %f " % (currentDistanceToTarget))
                if currentDistanceToTarget >= 0.9* fiveSecondCheck:
                    #resend the msg command to drone
                    simDRONE.send_mavlink(msg)
                    logVAR.critical("Last command message dropped. Resending the command message to drone")
                    logVAR.debug("Resend the command message to drone.")

                vc_loc = simDRONE.location.global_relative_frame
                simDRONE_currentLocation = LAT_LON_ALT(vc_loc.lon,vc_loc.lat,vc_loc.alt)
                remDistance=distanceBetweenTwoGeoPoints(simDRONE_currentLocation, targetLocation)
                logVAR.info("Distance to next seed drop point: %f" % (remDistance))
                print("Distance to next seed drop point: %f" % (remDistance))
                if remDistance <= 1:
                    logVAR.info("Reached drop point")
                    break
                fiveCounter += 1
                time.sleep(1)

```

#### 4. print\_simDRONE\_parameters():

This function list all the parameters of the simulated drone and stores it in log file

```
In [ ]: def print_simDRONE_parameters():
        logVAR.info ("Listing all the current simulated drone parameters
(`simDRONE.parameters`):")
        for para, ivalue in simDRONE.parameters.iteritems():
            logVAR.info (" Parameter : %s Current Value : %s" % (par
a,ivalue))
```

## 5. startMission(startingLocation):

This function controls the planned mission of drone. Collect all the waypoints from the file and use goto() function to give commands to drone.

Once the drone reaches the required location we can drop the seed.

```
In [ ]: def startMission(startingLocation):
        with open(waypoint_file,"r") as waypointFile:
            for pt in waypointFile:
                current_line = pt.split(",")
                nextLocation = LAT_LON_ALT(float(current_line
[1]),float(current_line[0]),startingLocation.alt)
                logVAR.debug("Next location lat: %f , lon: %f ,
alt: %f",nextLocation.lat,nextLocation.lon,nextLocation.alt)
                goto(nextLocation)
                print("Dropping Seed")
                logVAR.info("Dropping Seed")
            waypointFile.close()
```

## Main Body :

```
In [ ]: startingLocation = LAT_LON_ALT(0.0,0.0,0.0) #startingLocation variable
waypoint_file = "" #stores the waypoint file name
```

Takes the lat lon and alt value from USER

```
In [ ]: while True:
        try:
            startingLocation.lat = float(input("Please enter the latitude of starting point:\n"))
            logVAR.debug("USER entered latitude value: %s",str(startingLocation.lat))
            if(startingLocation.lat<0 or startingLocation.lat>90):
                print("Latitude value must be between 0 and 90")
                continue
            startingLocation.lon = float(input("Please enter the longitude of starting point:\n"))
            logVAR.debug("USER entered longitude value: %s",str(startingLocation.lon))
            if(startingLocation.lon<0 or startingLocation.lon>180):
                print("Longitude value must be between 0 and 180")
                continue
            startingLocation.alt = float(input("Please enter the altitude for the drone:\n"))
            logVAR.debug("USER entered altitude value: %s",str(startingLocation.alt))
            if(startingLocation.alt<0):
                print("Altitude value must be positive")
                continue
            break
        except:
            logVAR.error("Oops! That was no valid lat/lon or altitude. Try again...")
```

Takes the waypoint file name from USER

```
In [ ]: while True:
        waypoint_file = raw_input("Enter the waypoint file name with extension:\n")
        if os.path.exists(waypoint_file):
            break
        else:
            print("Enter file does not exists. Please re enter correct file")
            logVAR.error("Enter file does not exists.")
            continue
```

Now we set up parsing to get the connection string from user

```
In [ ]: parsingVAR = argparse.ArgumentParser(description=' Demonstrates Seed Plantation Mission in GUIDED mode.')
parsingVAR.add_argument('--connect', help="simDRONE connection string. SITL is automatically started if connection string not specified.")
argsVAR = parsingVAR.parse_args()
userConString = argsVAR.connect
sitlSIM = None
```

Start the SITL is user do not specify the connection string for the drone

```
In [ ]: if not userConString:
        import dronekit_sitl
        sitlSIM = dronekit_sitl.start_default(lat=startingLocation.lat,lon=startingLocation.lon)
        userConString = sitlSIM.connection_string()
```

Now connect to the simulated drone

```
In [ ]: print('Connecting to simulated drone on: %s' % userConString)
logVAR.info('Connecting to simulated drone on: %s' % userConString)
simDRONE = connect(userConString, wait_ready=True)
```

Log simulated drone parameters:

```
In [ ]: print_simDRONE_parameters()
```

```
In [ ]: print("Drone is arming and taking off:")
logVAR.info("Drone is arming and taking off:")
armVehicleThenTakeOFF(startingLocation.alt)
```

Start the mission by calling the startMission() function

After completion of mission RTL (Return to Launch)

```
In [ ]: print("Starting mission")
logVAR.info("Starting mission")

startMission(startingLocation)

print('Return to base/helipad')
logVAR.critical("Return to base/helipad")
while (simDRONE.mode.name != "RTL"):
    simDRONE.mode = VehicleMode("RTL")
    time.sleep(0.1)
```

Close simulated drone object before terminating script

```
In [ ]: print("Close simulated drone object")
logVAR.info("Close simulated drone object")
simDRONE.close()
```

Shut down simulator.

```
In [ ]: if sitlSIM is not None:
        sitlSIM.stop()
print("Seed Plantation Completed...")
logVAR.info("Seed Plantation Completed...")
```



## **Chapter 5.**

### **Documentation of waypoint\_square.py**

Following chapters explain  
each line of the python  
script

# waypoint\_square.py

In this algorithm we are given a square land that drone has to traverse. We traverse along the sides of the square in a zic-zac manner and add the point in our output file. Finally printing the output file.

## importing headers

```
In [ ]: from __future__ import print_function
import math
```

## Custom Class for taking lat/lon points

POINT class takes two parameters x and y and save them as lon and lat variables of the class object.

```
In [ ]: class POINT:
        def __init__(self,x,y):
            self.lat = x
            self.lon =y
```

## Functions used:

### 1. calNewGeoLocationNE(initialPOINT, yNORTH, xEAST):

This function is used to calculate new GEO Point which is 'y' meters north and 'x' meters east of a Reference point.

Knowing the lat/long of reference point and y and x distance , it returns a POINT class object with new location lat/long value.

This function is an approximation therefore valid over small distances (1m to 1km). It is not valid when calculating points close to the earth poles.

```
In [1]: def calNewGeoLocationNE(initialPOINT, yNORTH, xEAST):

        #Radius of earth
        earthRad=6378137.0

        #New point offset calculated in radian
        templAT = yNORTH/earthRad
        templON = xEAST/(earthRad*math.cos(math.pi*initialPOINT.lat/180))

        #Now calculate the new point in decimal degrees
        finalLAT = initialPOINT.lat + (templAT * 180/math.pi)
        finalLON = initialPOINT.lon + (templON * 180/math.pi)
        finalLOCATION = POINT(finalLAT,finalLON)
        return finalLOCATION
```

## 2. distanceBetweenTwoGeoPoints(locPOINT1, locPOINT2):

This function calculates the ground distance between two points.

This function is a approximation therefore valid for only short distance.

```
In [2]: def get_distance_metres(aLocation1, aLocation2):
        disLatitude = locPOINT2.lat - locPOINT1.lat
        disLongitude = locPOINT2.lon - locPOINT1.lon
        return math.sqrt((disLatitude*disLatitude) + (disLongitude*disLongitude)) * 1.113195e5
```

## 3. def generate\_points(start\_point,edge\_size,seed\_distance,polygon\_hull)

This function calculates the waypoints in a spiral manner for plantation of seeds in a square field.

Input:

aLocation: location of centre of square in lat/lon

aSize: half the side of square

seed\_distance: distance between two waypoints or seed plantation distance

Output:

A txt file named: waypoint\_square.txt, stores the waypoints generated in a sequence.

Opening the output file for writing purpose then calculating the left most bottom corner point of square and adding first point to file.

```
In [4]: def generate_points(aLocation,aSize,seed_distance):
        f = open("waypoint_square.txt","w+")
        temp1 = calNewGeoLocationNE(aLocation, -aSize, -aSize)
        f.write(str(temp1.lat) + "," + str(temp1.lon) + '\n')
```

Here step size which is the number of jumps required to cover one side of the square = aSize/seed\_distance.

Outer for loop moves us in horizontal direction i.e left - right.

Here we move only halfway as we have two inner loops which traverse from bottom-top and top-bottom.

```
In [ ]: for i in range (aSize/seed_distance):
        temp2 = temp1
```

Inner for loop 1. it moves us from bottom-top.

As we move from bottom to top we simultaneously add the points in our output file.

```
In [ ]:         for j in range(2*aSize/seed_distance):
                newpoint = calNewGeoLocationNE(temp2, seed_distance, 0)
                temp2 = newpoint
                f.write(str(temp2.lat) + "," + str(temp2.lon) +
'\n')
```

**Right shift operation is done here.**

Here we make a move to the right and add the point to file.

```
In [ ]:         shift1 = calNewGeoLocationNE(temp2, 0, seed_distance)
                temp2 = shift1
                f.write(str(temp2.lat) + "," + str(temp2.lon) + '\n')
```

**Inner loop 2. here the movement is top-bottom**

As we move from top to bottom we simultaneously add the points in our output file.

```
In [ ]:         for j in range(2*aSize/seed_distance):
                newpoint = calNewGeoLocationNE(temp2, -seed_distance, 0)
                temp2 = newpoint
                f.write(str(temp2.lat) + "," + str(temp2.lon) +
'\n')
```

**Right shift operation is done here.**

Here we make a move to the right and add the point in our output file.

```
In [ ]:         shift2 = calNewGeoLocationNE(temp2, 0, seed_distance)
                temp1 = shift2
                f.write(str(temp1.lat) + "," + str(temp1.lon) + '\n')
```

**This loop computes the last waypoints along the last boundary of the convex structure.**

In the above loops we move up-right-down-right. If we continue to move this way we will miss the last boundary of our square. So this loop does that for us.

```
In [ ]:         for j in range(2*aSize/seed_distance):
                newpoint = calNewGeoLocationNE(temp1, seed_distance, 0)
                temp1 = newpoint
                f.write(str(temp1.lat) + "," + str(temp1.lon) +
'\n')
```

**Main Body:**

### Taking user input for land info:

User enters the latitude and longitude of the center of the land under consideration. We further check if the values entered is valid or not.

```
In [ ]: print("    This code generates the required waypoint for the drone \n")
print("Please enter the geo location of the centre of your field: \n")
in_lat = 0.0
in_lon = 0.0
while True:
    try:
        in_lat = float(input("Please enter the latitude of centre:\n"))
        if(in_lat<0 or in_lat>90):
            print("Latitude value must be between 0 and 90")
            continue
        in_lon = float(input("Please enter the longitude of centre:\n"))
        if(in_lon<0 or in_lon>180):
            print("Longitude value must be between 0 and 180")
            continue
        break
    except:
        print("Oops! That was no valid lat/lon. Try again...")
```

Create out custom POINT object for input:

```
In [ ]: initial_location = POINT(in_lat,in_lon)
```

### Taking user input for size of land:

User enters distance between the center and boundary of square land. We further check if the values entered is valid or not.

```
In [ ]: side_size = 0
while True:
    try:
        side_size = int(input("Please enter the distance between the center and field edge (i.e. side/2):\n"))
        break
    except:
        print("Oops! Please insert positive interger value. Try again...")
```

### Taking the seed distance as an input from the user

This distance plays a significant role while computing the waypoints. We also check if the distance is valid or not and display appropriate messages.

```
In [ ]: distance = 0
while True:
    try:
        distance = int(input("Please enter the distance between
two waypoints:\n"))
        break
    except:
        print("Oops! That was no valid distance. Try again...")
```

**Calling the required function.**

```
In [ ]: generate_points(initial_location,side_size,distance)
print("\n Waypoints are generated and stored in waypoint_square.txt file. \n")
```

## **Chapter 6.**

### **Documentation of waypoint\_convex.py**

Following chapters explain  
each line of the python  
script

## waypoint\_convex.py

In this algorithm we try to fit a larger square on a convex structure and then traverse along the sides of the square in a zic-zac manner and while traversing check if the point lies within the convex structure or not. If it lies within the convex structure we add the point in our output file. Finally printing the output file.

### importing headers

```
In [ ]: from __future__ import print_function
import math
import numpy as np
import os
from shapely.geometry import Point
from shapely.geometry.polygon import Polygon
np.set_printoptions(precision=12)
```

### Custom Class for taking lat/lon points

LAT\_LON class takes two parameters x and y and save them as lon and lat variables of the class object.

```
In [ ]: class LAT_LON:
        def __init__(self,x,y):
            self.lon = x
            self.lat = y
```

### Functions used:

#### 1. calNewGeoLocationNE(initialPOINT, yNORTH, xEAST):

This function is used to calculate new GEO Point which is 'y' meters north and 'x' meters east of a Reference point.

Knowing the lat/long of reference point and y and x distance , it returns a POINT class object with new location lat/long value.

This function is an approximation therefore valid over small distances (1m to 1km). It is not valid when calculating points close to the earth poles.



```
In [1]: def calNewGeoLocationNE(initialPOINT, yNORTH, xEAST):

    #Radius of earth
    earthRad=6378137.0

    #New point offset calculated in radian
    tempLAT = yNORTH/earthRad
    tempLON = xEAST/(earthRad*math.cos(math.pi*initialPOINT.lat/180))

    #Now calculate the new point in decimal degrees
    finalLAT = initialPOINT.lat + (tempLAT * 180/math.pi)
    finalLON = initialPOINT.lon + (tempLON * 180/math.pi)
    finalLOCATION = LAT_LON(finalLON,finalLAT)
    return finalLOCATION
```

## 2. distanceBetweenTwoGeoPoints(locPOINT1, locPOINT2):

This function calculates the ground distance between two points.

This function is a approximation therefore valid for only short distance.

```
In [2]: def distanceBetweenTwoGeoPoints(locPOINT1, locPOINT2):

    disLatitude = locPOINT2.lat - locPOINT1.lat
    disLongitude = locPOINT2.lon - locPOINT1.lon
    return math.sqrt((disLatitude*disLatitude) + (disLongitude*disLongitude)) * 1.113195e5
```

## 3. def generate\_points(start\_point,edge\_size,seed\_distance,polygon\_hull)

This function calculates the waypoints in a spiral manner for plantation of seeds in a convex field.

Input:

start\_point: location of starting point of fitted square in lat/lon  
 edge\_size: side length of square fitted on convex figure  
 seed\_distance: distance between two waypoints or seed plantation distance  
 polygon\_hull: A shapely Polygon object that contains the actual convex figure

Output:

A txt file named: waypoint\_convex.txt, stores the waypoints generated in a sequence.

**Opening the output file for writing purpose and checking if the initial point lies within the convex structure, if so add it to the output file as seed must be thrown on this spot.**

```
In [4]: def generate_points(start_point,edge_size,seed_distance,polygon_hull):

    output_file = open("waypoint_convex.txt","w+")
    func_tempVar1 = start_point
    shapely_tempVar1 = Point(func_tempVar1.lon,func_tempVar1.lat)
    if (polygon_hull.contains(shapely_tempVar1) or shapely_tempVar1.
within(polygon_hull) or polygon_hull.touches(shapely_tempVar1) ):
        output_file.write(str(func_tempVar1.lat) + "," + str(func_tempVar1.lon) + '\n')
```

**Adjusting the step size which is the number of jumps required to cover one side of the square.**

```
In [ ]: step_size = edge_size/seed_distance
```

**Outer for loop moves us in horizontal direction i.e left - right.**

Here we move only halfway the stepsize as we have two inner loops which traverse from bottom-top and top-bottom.

```
In [ ]: for i in range (step_size/2):
        func_tempVar2 = func_tempVar1
```

**Inner for loop 1. it moves us from bottom-top.**

As we move from bottom to top we simultaneously check if the points lie within the convex structure if so we add them in our output file.

```
In [ ]: for j in range(step_size):
        func_newpoint = calNewGeoLocationNE(func_tempVar
        2, seed_distance, 0)
        func_tempVar2 = func_newpoint
        shapely_tempVar1 = Point(func_tempVar2.lon,func_
        tempVar2.lat)
        if (polygon_hull.contains(shapely_tempVar1) or s
        hapely_tempVar1.within(polygon_hull) or polygon_hull.touches(shapely_tem
        pVar1) ):
            output_file.write(str(func_tempVar2.lat)
            + "," + str(func_tempVar2.lon) + '\n')
```

**Right shift operation is done here.**

Here we make a move to the right and check if the point lies inside or not.

```
In [ ]: func_shift1 = calNewGeoLocationNE(func_tempVar2, 0, seed
        _distance)
        func_tempVar2 = func_shift1
        shapely_tempVar1 = Point(func_tempVar2.lon,func_tempVar
        2.lat)
        if (polygon_hull.contains(shapely_tempVar1) or shapely_t
        empVar1.within(polygon_hull) or polygon_hull.touches(shapely_tempVar1)
        ):
            output_file.write(str(func_tempVar2.lat) + "," +
            str(func_tempVar2.lon) + '\n')
```

**Inner loop 2. here the movement is top-bottom**

As we move from top to bottom we simultaneously check if the points lie within the convex structure if so we add them in our output file.

```
In [ ]:         for j in range(step_size):
                func_newpoint = calNewGeoLocationNE(func_tempVar
2, -seed_distance, 0)
                func_tempVar2 = func_newpoint
                shapely_tempVar1 = Point(func_tempVar2.lon,func_
tempVar2.lat)
                if (polygon_hull.contains(shapely_tempVar1) or s
hapely_tempVar1.within(polygon_hull) or polygon_hull.touches(shapely_tem
pVar1) ):
                    output_file.write(str(func_tempVar2.lat)
+ "," + str(func_tempVar2.lon) + '\n')
```

**Right shift operation is done here.**

Here we make a move to the right and check if the point lies inside or not.

```
In [ ]:         func_shift2 = calNewGeoLocationNE(func_tempVar2, 0, seed
_distance)
                func_tempVar1 = func_shift2
                shapely_tempVar1 = Point(func_tempVar1.lon,func_tempVar
1.lat)
                if (polygon_hull.contains(shapely_tempVar1) or shapely_t
empVar1.within(polygon_hull) or polygon_hull.touches(shapely_tempVar1)
):
                    output_file.write(str(func_tempVar1.lat) + "," +
str(func_tempVar1.lon) + '\n')
```

**This loop computes the last waypoints along the last boundary of the convex structure.**

In the above loops we move up-right-down-right. If we continue to move this way we will miss the last boundary of our square fitting our convex structure. So this loop does that for us.

```
In [ ]:         for j in range(step_size):
                func_newpoint = calNewGeoLocationNE(func_tempVar1, seed_
distance, 0)
                func_tempVar1 = func_newpoint
                shapely_tempVar1 = Point(func_tempVar1.lon,func_tempVar
1.lat)
                if (polygon_hull.contains(shapely_tempVar1) or shapely_t
empVar1.within(polygon_hull) or polygon_hull.touches(shapely_tempVar1)
):
                    output_file.write(str(func_tempVar1.lat) + "," +
str(func_tempVar1.lon) + '\n')
```

## Main Body:

### Taking user input for the file\_name

This file contains the latitude and longitude of the land under consideration. We further check if the file name entered is valid or not.

```
In [ ]: input_file = ""
while True:
    input_file = raw_input("Enter the file name with extension containing lat long of corners of polygon:\n")
    if os.path.exists(input_file):
        break
    else:
        print("Enter file does not exists. Please re enter correct file")
        continue
```

### Taking the seed distance as an input from the user

This distance plays a significant role while computing the waypoints. We also check if the distance is valid or not and display appropriate messages.

```
In [ ]: while True:
        try:
            seed_distance = int(input("Please enter the distance between two waypoints:\n"))
            break
        except:
            print("Oops! That was no valid distance. Try again...")
```

### Creating a latitude longitude list

Here we read from the input file the latitude and longitude of the land under the consideration and add them to the latlon\_list.

```
In [ ]: latlon_list = []
with open(input_file,"r") as input_f:
    for line in input_f:
        current_line = line.split(",")
        latlon_list.append([float(current_line[1]),float(current_line[0])])
```

### Converting the latlon\_list to a numpy array and constructing the convex hull using the function Polygon.

```
In [ ]: latlon_num = np.array(latlon_list )#,dtype = np.float64)
polygon_hull = Polygon(latlon_num)
```

### Finding the minimum and maximum co-ordinates.

This helps us in find the square that is capable of containing the entire convex structure into it.

```
In [ ]: min_col = np.amin(latlon_num,axis = 0)
max_col = np.amax(latlon_num,axis = 0)
```

### Finding the 3 points using the min\_col and max\_col

This helps us to get the side length of the largest square that can fit our convex structure.

```
In [ ]: t1 = LAT_LON(min_col[0],min_col[1])
        t2 = LAT_LON(min_col[0],max_col[1])
        t3 = LAT_LON(max_col[0],min_col[1])
```

#### Calling the `get_distance_meters` function.

`cal_d` contains the maximum distance of the of the three points we computed, which ultimately helps us to get the side of the square. The above way point function works on an assumption that the length of the side of the square should be even. So we have placed a check for that.

```
In [ ]: cal_d = max(distanceBetweenTwoGeoPoints(t1,t2),distanceBetweenTwoGeoPoints(t1,t3))
        total_step = math.ceil(cal_d/seed_distance)
        if total_step%2 == 0:
            cal_d = seed_distance*(total_step)
        else:
            cal_d = seed_distance*(total_step+1)
```

#### Initialising the starting point for waypoint calculation and calling the required function.

```
In [ ]: start_point = t1
        generate_points(start_point,int(cal_d),seed_distance,polygon_hull)
        print("\n    Waypoints are generated and stored in waypoint_square.txt file. \n")
```

## **Chapter 7.**

### **Documentation of input\_generator.py**

Following chapters explain  
each line of the python  
script

# input\_generator.py

This is a python script used to get the latitude and longitude of the corner points of the field when user knows the distance of each point with respect to one reference point. (Ref Point lat/long must be known)

## importing headers

```
In [1]: from __future__ import print_function
import math
```

## Custom Class for taking lat/lon points

POINT class takes two parameters x and y and save then as lon and lat variables of the class object.

```
In [2]: class POINT:
        def __init__(self,x,y):
            self.lat = x
            self.lon = y
```

## Functions used:

### 1. calNewGeoLocationNE(initialPOINT, yNORTH, xEAST):

This function is used to calculate new GEO Point which is 'y' meters north and 'x' meters east of a Reference point.

Knowing the lat/long of reference point and y and x distance , it returns a POINT class object with new location lat/long value.

This function is an approximation therefore valid over small distances (1m to 1km). It is not valid when calculating points close to the earth poles.

```
In [3]: def calNewGeoLocationNE(initialPOINT, yNORTH, xEAST):

        #Radius of earth
        earthRad=6378137.0

        #New point offset calculated in radian
        templAT = yNORTH/earthRad
        templON = xEAST/(earthRad*math.cos(math.pi*initialPOINT.lat/180))

        #Now calculate the new point in decimal degrees
        finalLAT = initialPOINT.lat + (templAT * 180/math.pi)
        finalLON = initialPOINT.lon + (templON * 180/math.pi)
        finalLOCATION = POINT(finalLAT,finalLON)
        return finalLOCATION
```

## Main Body:

### Taking user input for land info:

User enters the latitude and longitude of the reference point of the land under consideration. We further check if the values entered is valid or not.

```
In [5]: print("    This code generates the input lat long values \n")
print("Please enter the geo location of the reference point of your field: \n")
in_lat = 0.0
in_lon = 0.0
while True:
    try:
        in_lat = float(input("Please enter the latitude of point:\n"))
        if(in_lat<0 or in_lat>90):
            print("Latitude value must be between 0 and 90")
            continue
        in_lon = float(input("Please enter the longitude of point:\n"))
        if(in_lon<0 or in_lon>180):
            print("Longitude value must be between 0 and 180")
            continue
        break
    except:
        print("Oops! That was no valid lat/lon. Try again...")
```

This code generates the input lat long values

Please enter the geo location of the reference point of your field:

Please enter the latitude of point:

10.0

Please enter the longitude of point:

10.0

Create out custom POINT object for input:

```
In [6]: first_point = POINT(in_lat,in_lon)
```

Create a input.txt file to store all the calculated points.

Store the first point taken from user in file.

```
In [7]: input_file = open("input.txt","w+")
input_file.write(str(first_point.lat) + "," + str(first_point.lon) + '\n')
```

### Taking user input for number of points to be generated:

```
In [8]: number_of_points = int(input("Please enter the more number of point to generate:\n"))
```

Please enter the more number of point to generate:

5



### User inputs the distance of each point from reference point

User inputs the each corner point distance in form of (NORTH,EAST) i.e. if next point is 10 m north and 20 m east of initial reference , user enters 10 20 when asked.

```
In [9]: for i in range(number_of_points):
        print("Enter the next point distance in meter (north,east) from
        reference point:\n")
        move_north = int(input("North distance to point: "))
        move_east = int(input("East distance to point: "))
        new_point = calNewGeoLocationNE(first_point,move_north,move_eas
t)
        input_file.write(str(new_point.lat) + "," + str(new_point.lon) +
'\n')
        print("All generated points are stored in input.txt.\n")
```

Enter the next point distance in meter (north,east) from refrence point:

North distance to point: -50

East distance to point: 50

Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 0

East distance to point: 100

Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 50

East distance to point: 100

Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 100

East distance to point: 50

Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 50

East distance to point: 0

All generated points are stored in input.txt.

## **Chapter 8.**

### **Snapshots of Input and Output**

This chapter includes all the inputs to the various file along with their outputs.

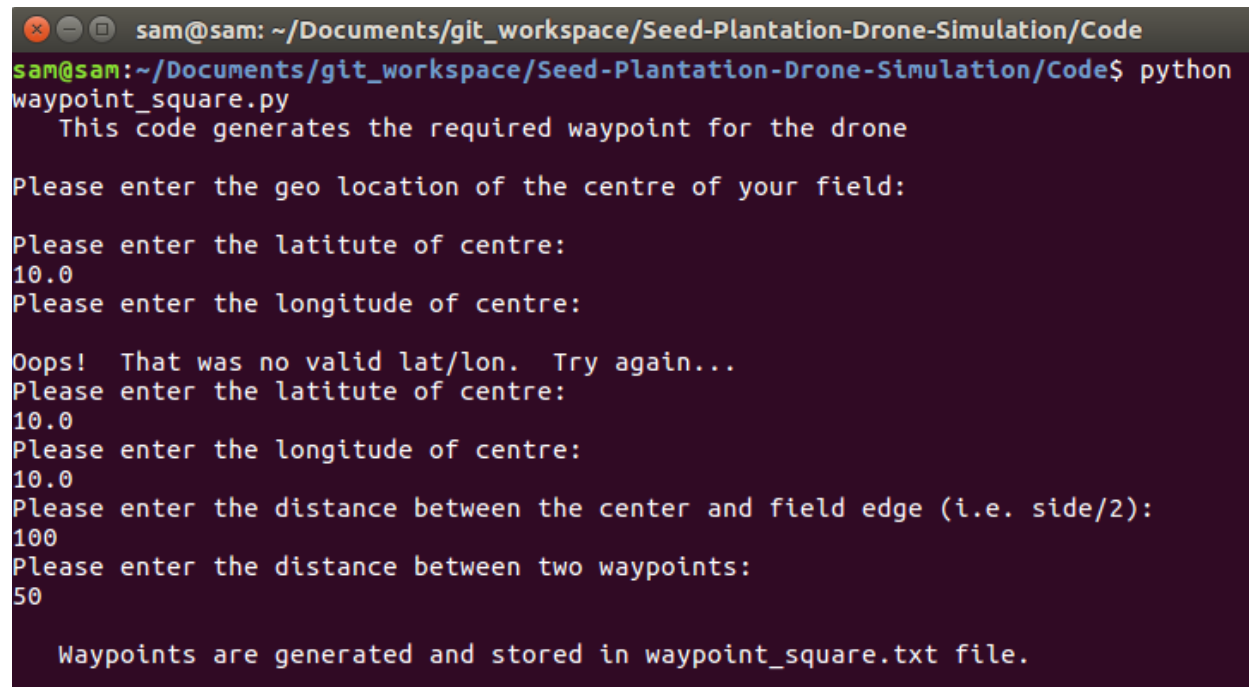
Helps in better understanding of how the code works with different types of inputs.

## 8.1 Square Field (AUTO mode) inputs and outputs

GitHub link:

<https://github.com/sambhaves/Seed-Plantation-Drone-Simulation/tree/master/Sample%20Input%20Output/Square%20AUTO>

### 8.1.1 Square waypoint generator terminal



```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
waypoint_square.py
    This code generates the required waypoint for the drone

Please enter the geo location of the centre of your field:

Please enter the latitude of centre:
10.0
Please enter the longitude of centre:

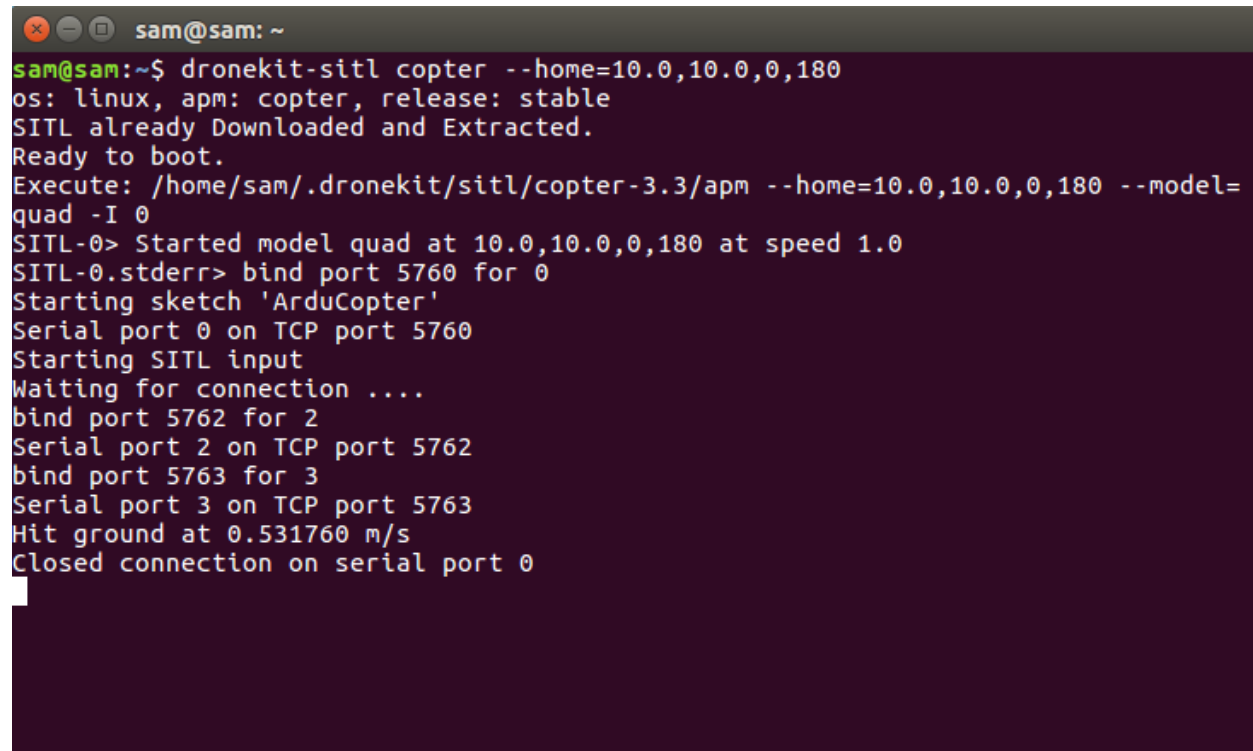
Oops! That was no valid lat/lon. Try again...
Please enter the latitude of centre:
10.0
Please enter the longitude of centre:
10.0
Please enter the distance between the center and field edge (i.e. side/2):
100
Please enter the distance between two waypoints:
50

Waypoints are generated and stored in waypoint_square.txt file.
```

### 8.1.2 Waypoint square text file

```
1 9.99910168472,9.99908782675
2 9.99955084236,9.99908782675
3 10.0,9.99908782675
4 10.0004491576,9.99908782675
5 10.0008983153,9.99908782675
6 10.0008983153,9.99954391464
7 10.0004491576,9.99954391464
8 10.0,9.99954391464
9 9.99955084236,9.99954391464
10 9.99910168472,9.99954391464
11 9.99910168472,10.0
12 9.99955084236,10.0
13 10.0,10.0
14 10.0004491576,10.0
15 10.0008983153,10.0
16 10.0008983153,10.0004560879
17 10.0004491576,10.0004560879
18 10.0,10.0004560879
19 9.99955084236,10.0004560879
20 9.99910168472,10.0004560879
21 9.99910168472,10.0009121732
22 9.99955084236,10.0009121732
23 10.0,10.0009121732
24 10.0004491576,10.0009121732
25 10.0008983153,10.0009121732
```

### 8.1.3 Terminal outputs



```
sam@sam: ~  
sam@sam:~$ dronekit-sitl copter --home=10.0,10.0,0,180  
os: linux, apm: copter, release: stable  
SITL already Downloaded and Extracted.  
Ready to boot.  
Execute: /home/sam/.dronekit/sitl/copter-3.3/apm --home=10.0,10.0,0,180 --model=  
quad -I 0  
SITL-0> Started model quad at 10.0,10.0,0,180 at speed 1.0  
SITL-0.stderr> bind port 5760 for 0  
Starting sketch 'ArduCopter'  
Serial port 0 on TCP port 5760  
Starting SITL input  
Waiting for connection ....  
bind port 5762 for 2  
Serial port 2 on TCP port 5762  
bind port 5763 for 3  
Serial port 3 on TCP port 5763  
Hit ground at 0.531760 m/s  
Closed connection on serial port 0
```

```

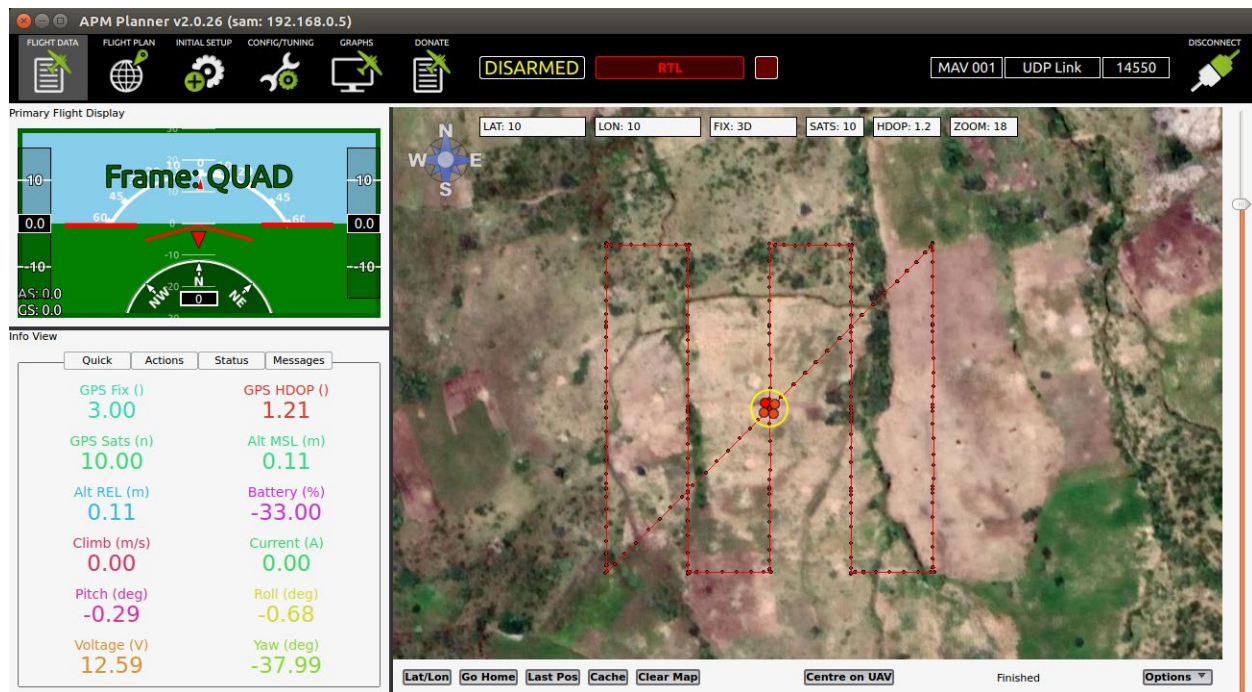
sam@sam: ~
sam@sam:~$ mavproxy.py --master tcp:127.0.0.1:5760 --sitl 127.0.0.1:5501 --out 1
27.0.0.1:14550 --out 127.0.0.1:14551
Connect tcp:127.0.0.1:5760 source_system=255
Log Directory:
Telemetry log: mav.tlog
Waiting for heartbeat from tcp:127.0.0.1:5760
MAV> online system 1
STABILIZE> Mode STABILIZE
APM: Calibrating barometer
APM: Initialising APM...
APM: barometer calibration complete
APM: GROUND START
Init Gyro**
INS
-----
G_off: 0.00, 0.00, 0.00
A_off: 0.00, 0.00, 0.00
A_scale: 1.00, 1.00, 1.00

Ready to FLY fence breach
ublox APM: APM:Copter V3.3 (d6053245)
APM: Frame: QUAD
Got MAVLink msg: COMMAND_ACK {command : 520, result : 0}
Flight battery 100 percent
Received 526 parameters
Saved 526 parameters to mav.parm
Got MAVLink msg: MISSION_ACK {target_system : 255, target_component : 0, type :
0, mission_type : 0}
Got MAVLink msg: MISSION_ACK {target_system : 255, target_component : 0, type :
0, mission_type : 0}
APM: flight plan received
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}

```

```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
drone_AUTO.py --connect udp:127.0.0.1:14551
Please enter the latitude of starting point:
10.0
Please enter the longitude of starting point:
10.0
Please enter the altitude for the drone:
30.0
Enter the waypoint file name with extension:
waypoint_square.txt
Connecting to vehicle on: udp:127.0.0.1:14551
Uploading waypoints to vehicle...
Arm and Takeoff
Taking off!
Reached target altitude of 30.000000
Starting mission
Distance to waypoint (1): 142.484415766
Distance to waypoint (1): 141.85460084
Distance to waypoint (1): 140.524763008
Distance to waypoint (1): 137.652196586
Distance to waypoint (1): 134.747918828
Distance to waypoint (1): 131.442299175
Distance to waypoint (1): 127.750801489
Distance to waypoint (1): 123.736376646
Distance to waypoint (1): 119.462133362
Distance to waypoint (1): 114.991038479
Distance to waypoint (1): 110.433285817
Distance to waypoint (1): 105.788874506
Distance to waypoint (1): 101.081648334
Distance to waypoint (1): 96.3348353281
Distance to waypoint (1): 89.9587828433
Distance to waypoint (1): 85.1728495817
```

### 8.1.4 Square APM Planner2 output





## 8.1.5 Square log file

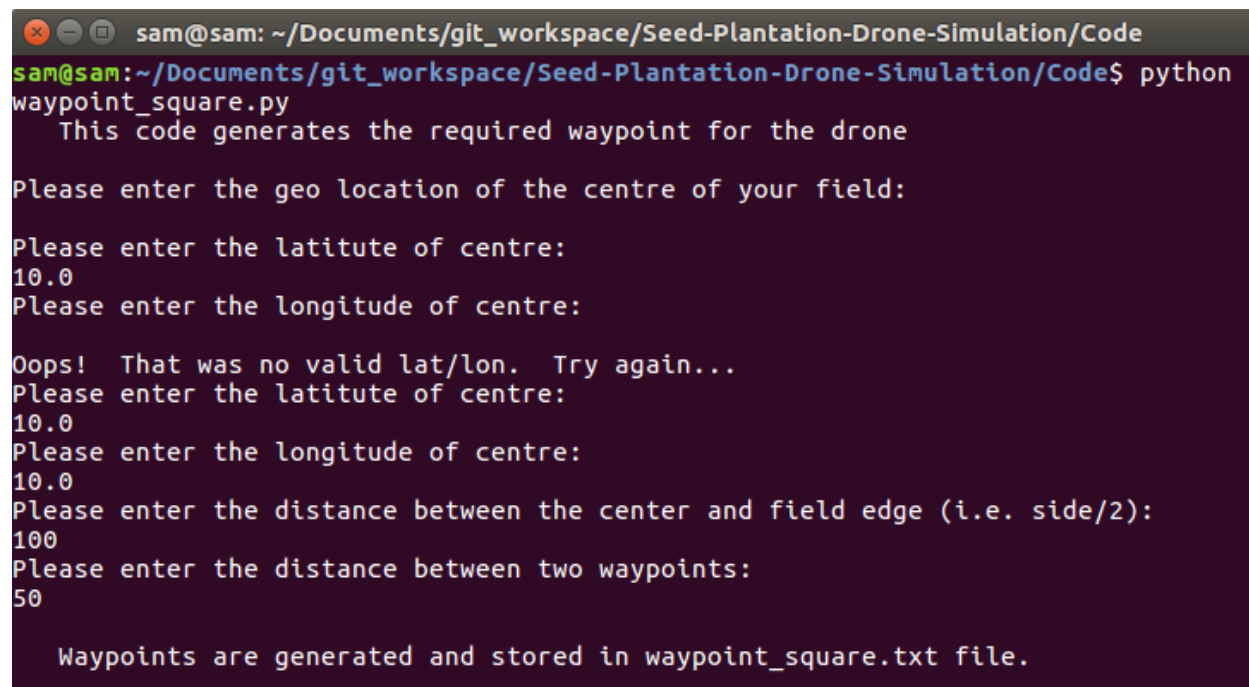
```
1  DEBUG: drone_AUTO.py: <module>: 141:          USER entered latitude value: 10.0
2  DEBUG: drone_AUTO.py: <module>: 146:          USER entered longitude value: 10.0
3  DEBUG: drone_AUTO.py: <module>: 151:          USER entered altitude value: 30.0
4  INFO: drone_AUTO.py: <module>: 187:          Connecting to vehicle on: udp:127.0.0.1:14551
5  CRITICAL: __init__.py: statustext_listener: 1065:          APM:Copter V3.3 (d6053245)
6  CRITICAL: __init__.py: statustext_listener: 1065:          Frame: QUAD
7  DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
8  DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
9  DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
10 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
11 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
12 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
13 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
14 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
15 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
16 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
17 INFO: drone_AUTO.py: print_vehicle_attributes: 98:          Autopilot Firmware version: APM:Copter-3.3.0
18 INFO: drone_AUTO.py: print_vehicle_attributes: 99:          Autopilot capabilities (supports ftp): False
19 INFO: drone_AUTO.py: print_vehicle_attributes: 100:          Global Location: LocationGlobal:lat=10.0,lon=10.0,alt=None
20 INFO: drone_AUTO.py: print_vehicle_attributes: 101:          Global Location (relative altitude): LocationGlobalRelative:lat=10.
21 INFO: drone_AUTO.py: print_vehicle_attributes: 102:          Local Location: LocationLocal:north=None,east=None,down=None
22 INFO: drone_AUTO.py: print_vehicle_attributes: 103:          Attitude: Attitude:pitch=0.00139206054155,yaw=-3.13637590408,roll=0
23 INFO: drone_AUTO.py: print_vehicle_attributes: 104:          Velocity: [0.02, -0.03, 0.0]
24 INFO: drone_AUTO.py: print_vehicle_attributes: 105:          GPS: GPSInfo:fix=3,num_sat=10
25 INFO: drone_AUTO.py: print_vehicle_attributes: 106:          Groundspeed: 0.0
26 INFO: drone_AUTO.py: print_vehicle_attributes: 107:          Airspeed: 0.0
27 INFO: drone_AUTO.py: print_vehicle_attributes: 108:          Gimbal status: Gimbal: pitch=None, roll=None, yaw=None
28 INFO: drone_AUTO.py: print_vehicle_attributes: 109:          Battery: Battery:voltage=12.587,current=0.0,level=100
29 INFO: drone_AUTO.py: print_vehicle_attributes: 110:          EKF OK?: True
30 INFO: drone_AUTO.py: print_vehicle_attributes: 111:          Last Heartbeat: 0.605894084
```

## 8.2 Square Field (GUIDED mode) inputs and outputs

GitHub link:

<https://github.com/sambhaves/Seed-Plantation-Drone-Simulation/tree/master/Sample%20Input%20Output/Square%20GUIDED>

### 8.2.1 Square waypoint generator terminal



```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
waypoint_square.py
    This code generates the required waypoint for the drone

Please enter the geo location of the centre of your field:

Please enter the latitude of centre:
10.0
Please enter the longitude of centre:

Oops! That was no valid lat/lon. Try again...
Please enter the latitude of centre:
10.0
Please enter the longitude of centre:
10.0
Please enter the distance between the center and field edge (i.e. side/2):
100
Please enter the distance between two waypoints:
50

Waypoints are generated and stored in waypoint_square.txt file.
```

## 8.2.2 Waypoint square text file

```
1 9.99910168472,9.99908782675
2 9.99955084236,9.99908782675
3 10.0,9.99908782675
4 10.0004491576,9.99908782675
5 10.0008983153,9.99908782675
6 10.0008983153,9.99954391464
7 10.0004491576,9.99954391464
8 10.0,9.99954391464
9 9.99955084236,9.99954391464
10 9.99910168472,9.99954391464
11 9.99910168472,10.0
12 9.99955084236,10.0
13 10.0,10.0
14 10.0004491576,10.0
15 10.0008983153,10.0
16 10.0008983153,10.0004560879
17 10.0004491576,10.0004560879
18 10.0,10.0004560879
19 9.99955084236,10.0004560879
20 9.99910168472,10.0004560879
21 9.99910168472,10.0009121732
22 9.99955084236,10.0009121732
23 10.0,10.0009121732
24 10.0004491576,10.0009121732
25 10.0008983153,10.0009121732
```

---

### 8.2.3 Terminal outputs

```
sam@sam: ~  
sam@sam:~$ dronekit-sitl copter --home=10.0,10.0,0,180  
os: linux, apm: copter, release: stable  
SITL already Downloaded and Extracted.  
Ready to boot.  
Execute: /home/sam/.dronekit/sitl/copter-3.3/apm --home=10.0,10.0,0,180 --model=  
quad -I 0  
SITL-0> Started model quad at 10.0,10.0,0,180 at speed 1.0  
SITL-0.stderr> bind port 5760 for 0  
Starting sketch 'ArduCopter'  
Serial port 0 on TCP port 5760  
Starting SITL input  
Waiting for connection ....  
bind port 5762 for 2  
Serial port 2 on TCP port 5762  
bind port 5763 for 3  
Serial port 3 on TCP port 5763  
Hit ground at 0.524962 m/s  
Closed connection on serial port 0  
^Csam@sam:~$
```

```

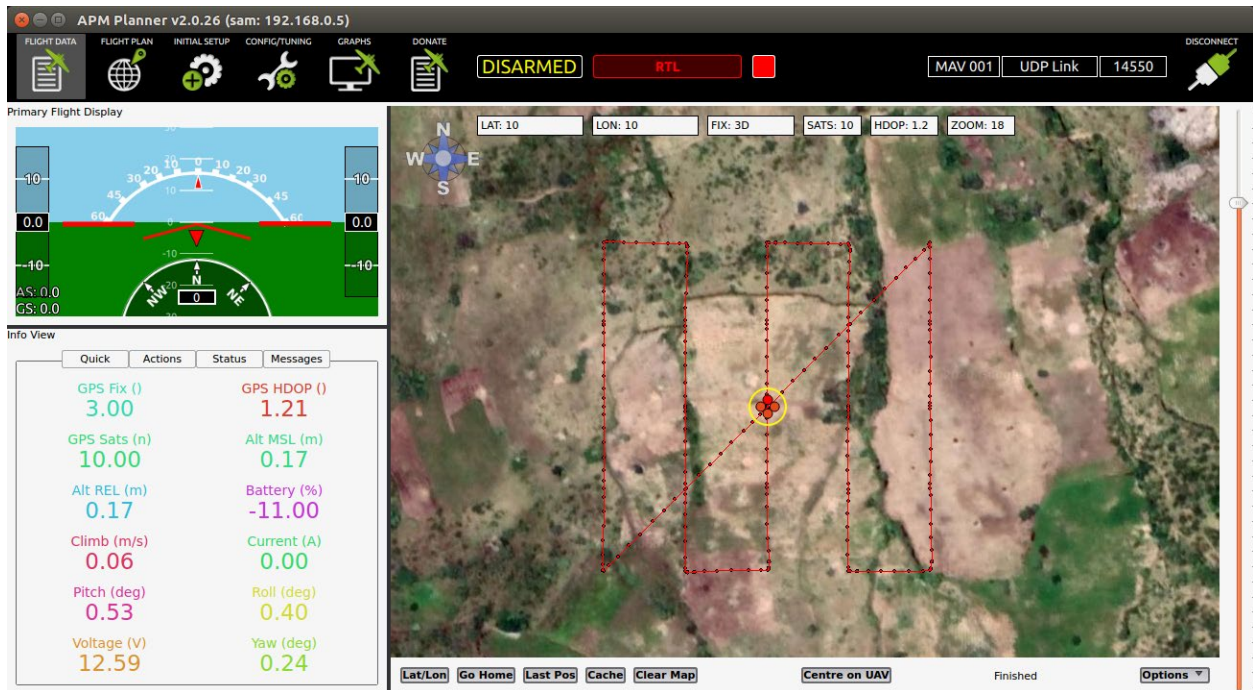
sam@sam: ~
sam@sam:~$ mavproxy.py --master tcp:127.0.0.1:5760 --sctl 127.0.0.1:5501 --out 1
27.0.0.1:14550 --out 127.0.0.1:14551
Connect tcp:127.0.0.1:5760 source_system=255
Log Directory:
Telemetry log: mav.tlog
Waiting for heartbeat from tcp:127.0.0.1:5760
MAV> online system 1
STABILIZE> Mode STABILIZE
APM: APM:Copter V3.3 (d6053245)
APM: Frame: QUAD
APM: Calibrating barometer
APM: Initialising APM...
APM: barometer calibration complete
APM: GROUND START
Init Gyro**
INS
-----
G_off: 0.00, 0.00, 0.00
A_off: 0.00, 0.00, 0.00
A_scale: 1.00, 1.00, 1.00

Ready to FLY ublox Received 526 parameters
Saved 526 parameters to mav.parm
fence breach
APM: APM:Copter V3.3 (d6053245)
APM: Frame: QUAD
Got MAVLink msg: COMMAND_ACK {command : 520, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
GUIDED> Mode GUIDED
APM: ARMING MOTORS
APM: GROUND START
Init Gyro**
INS
-----
G_off: 0.00, 0.00, 0.00
A_off: 0.00, 0.00, 0.00
A_scale: 1.00, 1.00, 1.00

```

```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
drone_GUIDED.py --connect udp:127.0.0.1:14551
Please enter the latitude of starting point:
10.0
Please enter the longitude of starting point:
10.0
Please enter the altitude for the drone:
30.0
Enter the waypoint file name with extension:
waypoint_square.txt
Connecting to vehicle on: udp:127.0.0.1:14551
Arm and Takeoff
Taking off!
Reached target altitude of 30.000000
Starting mission
Distance to target: 142.515788
Distance to target: 141.673505
Distance to target: 138.092858
Distance to target: 132.040368
Distance to target: 124.476116
Distance to target: 114.376642
Distance to target: 105.206413
Distance to target: 95.799447
Distance to target: 84.645096
Distance to target: 74.993903
Distance to target: 65.279898
Distance to target: 55.558684
Distance to target: 45.916598
Distance to target: 34.683586
Distance to target: 25.040951
Distance to target: 15.389972
Distance to target: 5.338184
Distance to target: 0.217261
Dropping Seed
Distance to target: 49.909638
Distance to target: 50.258104
Distance to target: 48.021348
```

## 8.2.4 Square APM Planner2 output



## 8.2.5 Square log file

```
1  DEBUG: drone_GUIDED.py: drone_GUIDED: <module>: 216:
2  DEBUG: drone_GUIDED.py: drone_GUIDED: <module>: 221:
3  DEBUG: drone_GUIDED.py: drone_GUIDED: <module>: 226:
4  INFO: drone_GUIDED.py: drone_GUIDED: <module>: 262:
5  CRITICAL: __init__.py: __init__: statustext_listener: 1065:
6  CRITICAL: __init__.py: __init__: statustext_listener: 1065:
7  DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
8  DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
9  DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
10 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
11 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
12 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
13 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
14 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
15 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
16 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
17 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 160:
18 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 161:
19 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 162:
20 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 163:
21 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 164:
22 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 165:
23 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 166:
24 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 167:
25 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 168:
26 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 169:
27 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 170:
28 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 171:
29 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 172:
30 INFO: drone_GUIDED.py: drone_GUIDED: print_vechicle_attributes: 173:

USER entered latitude value: 10.0
USER entered longitude value: 10.0
USER entered altitude value: 30.0
Connecting to vehicle on: udp:127.0.0.1:14551
APM:Copter V3.3 (d6053245)
Frame: QUAD
    Still waiting for data from vehicle: parameters
    Still waiting for data from vehicle: parameters
    Still waiting for data from vehicle: parameters
    Still waiting for data from vehicle: parameters
    Still waiting for data from vehicle: parameters
    Still waiting for data from vehicle: parameters
    Still waiting for data from vehicle: parameters
    Still waiting for data from vehicle: parameters
    Still waiting for data from vehicle: parameters
    Still waiting for data from vehicle: parameters
    Still waiting for data from vehicle: parameters
    Autopilot Firmware version: APM:Copter-3.3.0
    Autopilot capabilities (supports ftp): False
    Global Location:LocationGlobal:lat=10.0,lon=10.0,al
    Global Location (relative altitude): LocationGlobal
    Local Location: LocationLocal:north=None,east=None,
    Attitude: Attitude:pitch=0.000782963936217,yaw=-3.1
    Velocity: [0.01, -0.01, 0.0]
    GPS: GPSInfo:fix=3,num_sat=10
    Groundspeed: 0.0
    Airspeed: 0.0
    Gimbal status: Gimbal: pitch=None, roll=None, yaw=N
    Battery: Battery:voltage=12.587,current=0.0,level=1
    EKF OK?: True
    Last Heartbeat: 0.657818574
```



## 8.3 Hexagon Field (AUTO mode) inputs and outputs

GitHub link:

<https://github.com/sambhaves/Seed-Plantation-Drone-Simulation/tree/master/Sample%20Input%20Output/Hexagon%20AUTO>

### 8.3.1 Input Generator file

```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
input_generator.py
    This code generates the input lat long values

Please enter the geo location of the reference point of your field:

Please enter the latitude of point:
asd
Oops! That was no valid lat/lon. Try again...
Please enter the latitude of point:
10.0
Please enter the longitude of point:
10.0
Please enter the more number of point to generate:
5
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: -50
East distance to point: 50
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 0
East distance to point: 100
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 50
East distance to point: 100
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 100
East distance to point: 50
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 50
East distance to point: 0
All generated points are stored in input.txt.

sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$
```

### 8.3.2 Input Text file

```
1 10.0,10.0
2 9.99955084236,10.0004560866
3 10.0,10.0009121732
4 10.0004491576,10.0009121732
5 10.0008983153,10.0004560866
6 10.0004491576,10.0
```

### 8.3.3 Hexagon Google Maps



### 8.3.4 Hexagon waypoint generator terminal

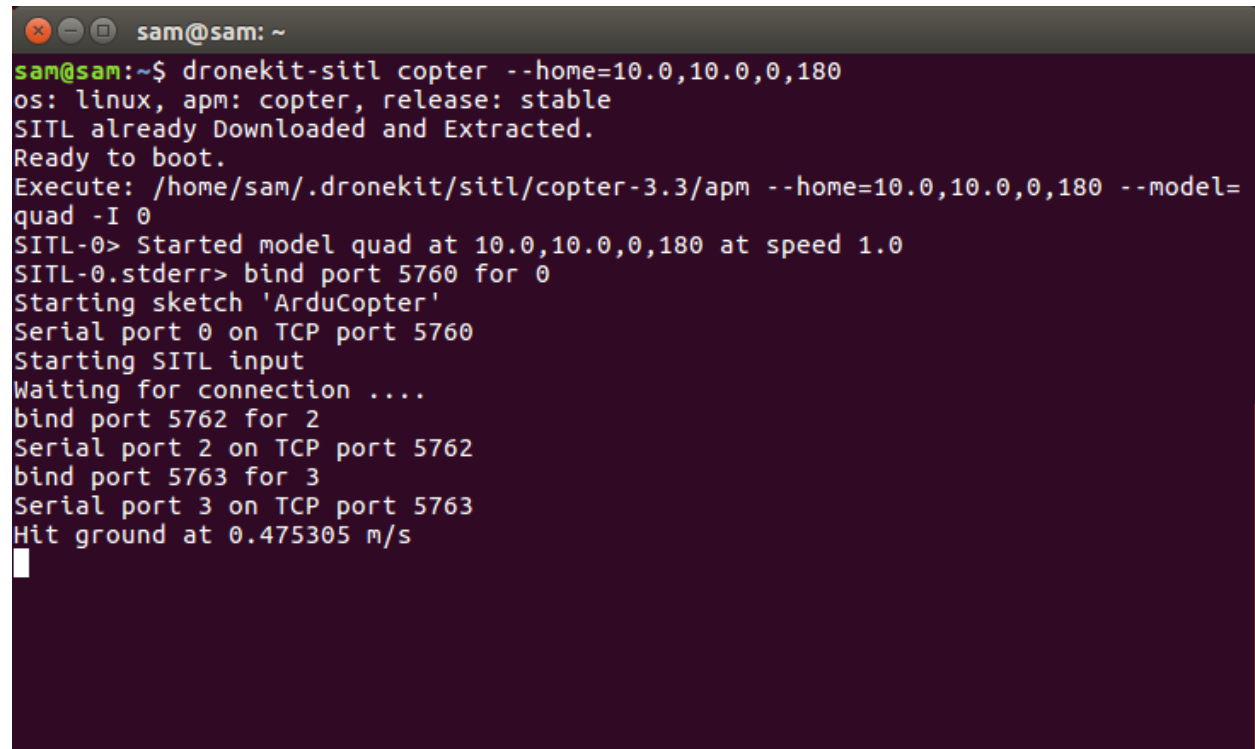
```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
waypoint_convex.py
Enter the file name with extension containing lat long of corners of polygon:
input.txt
Please enter the distance between two waypoints:
10

Waypoints are generated and stored in waypoint_square.txt file.
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$
```

### 8.3.5 Waypoint hexagon text file

99 lines (99 sloc)	2.57 KB
1	10.0,10.0
2	10.0000898315,10.0
3	10.0001796631,10.0
4	10.0002694946,10.0
5	10.0003593261,10.0
6	10.0005389892,10.0000912176
7	10.0004491576,10.0000912176
8	10.0003593261,10.0000912176
9	10.0002694946,10.0000912176
10	10.0001796631,10.0000912176
11	10.0000898315,10.0000912176
12	10.0,10.0000912176
13	9.99991016847,10.0000912176
14	9.99982033695,10.0001824348
15	9.99991016847,10.0001824348
16	10.0,10.0001824348
17	10.0000898315,10.0001824348
18	10.0001796631,10.0001824348
19	10.0002694946,10.0001824348
20	10.0003593261,10.0001824348

### 8.3.6 Terminal outputs

A terminal window titled 'sam@sam: ~' with a dark background. The prompt is 'sam@sam:~\$'. The command entered is 'dronekit-sitl copter --home=10.0,10.0,0,180'. The output shows system information, confirmation that SITL is downloaded, and a list of TCP ports for serial connections. The simulation ends with 'Hit ground at 0.475305 m/s'.

```
sam@sam:~$ dronekit-sitl copter --home=10.0,10.0,0,180
os: linux, apm: copter, release: stable
SITL already Downloaded and Extracted.
Ready to boot.
Execute: /home/sam/.dronekit/sitl/copter-3.3/apm --home=10.0,10.0,0,180 --model=
quad -I 0
SITL-0> Started model quad at 10.0,10.0,0,180 at speed 1.0
SITL-0.stderr> bind port 5760 for 0
Starting sketch 'ArduCopter'
Serial port 0 on TCP port 5760
Starting SITL input
Waiting for connection ....
bind port 5762 for 2
Serial port 2 on TCP port 5762
bind port 5763 for 3
Serial port 3 on TCP port 5763
Hit ground at 0.475305 m/s
```

```

sam@sam: ~
sam@sam:~$ mavproxy.py --master tcp:127.0.0.1:5760 --sitr 127.0.0.1:5501 --out 1
27.0.0.1:14550 --out 127.0.0.1:14551
Connect tcp:127.0.0.1:5760 source_system=255
Log Directory:
Telemetry log: mav.tlog
Waiting for heartbeat from tcp:127.0.0.1:5760
MAV> online system 1
STABILIZE> Mode STABILIZE
APM: Calibrating barometer
APM: Initialising APM...
APM: barometer calibration complete
APM: GROUND START
Init Gyro**
INS
-----
G_off: 0.00, 0.00, 0.00
A_off: 0.00, 0.00, 0.00
A_scale: 1.00, 1.00, 1.00

Ready to FLY fence breach
ublox APM: APM:Copter V3.3 (d6053245)
APM: Frame: QUAD
Got MAVLink msg: COMMAND_ACK {command : 520, result : 0}
Flight battery 100 percent
Received 526 parameters
Saved 526 parameters to mav.parm
Got MAVLink msg: MISSION_ACK {target_system : 255, target_component : 0, type :
0, mission_type : 0}
Got MAVLink msg: MISSION_ACK {target_system : 255, target_component : 0, type :
0, mission_type : 0}
APM: flight plan received
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
GUIDED> Mode GUIDED
APM: ARMING MOTORS

```

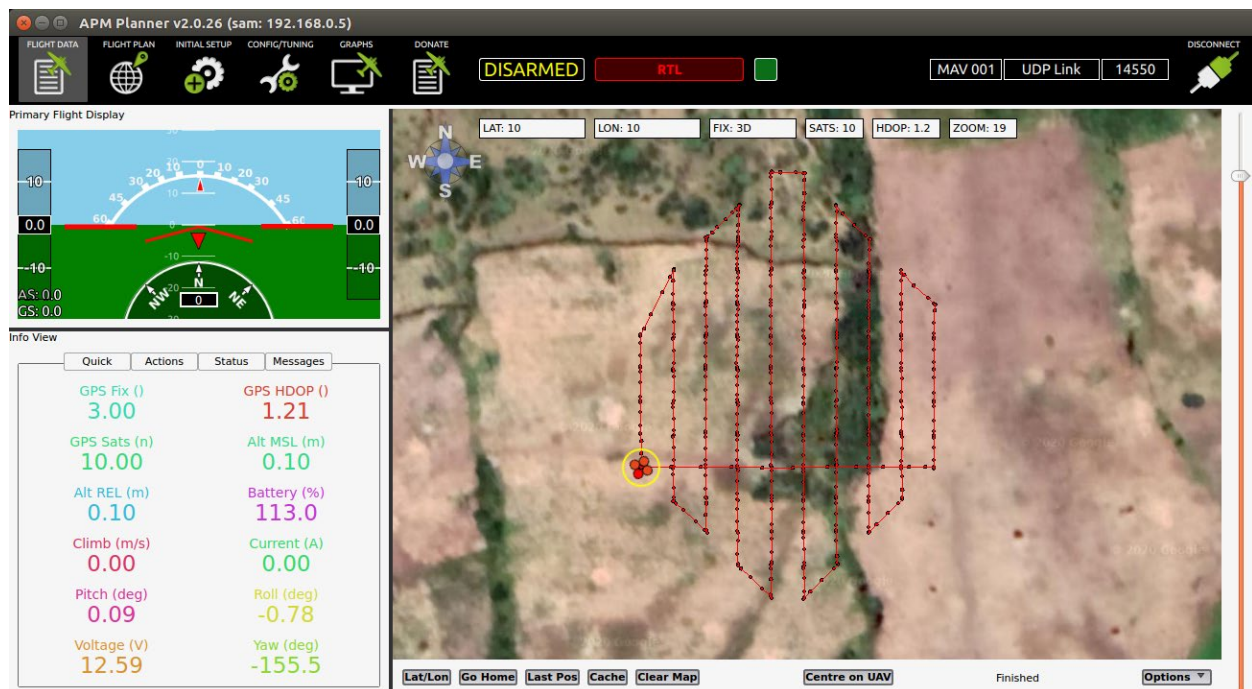
```

sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ clear

sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python drone_AUTO.py --connect udp:127.0.0.1:14551
Please enter the latitude of starting point:
10.0
Please enter the longitude of starting point:
10.0
Please enter the altitude for the drone:
15.0
Enter the waypoint file name with extension:
waypoint_convex.txt
Connecting to vehicle on: udp:127.0.0.1:14551
Uploading waypoints to vehicle...
Arm and Takeoff
Taking off!
Reached target altitude of 15.000000
Starting mission
Distance to waypoint (1): 0.0556597500572
Dropping Seed
CRITICAL: drone_AUTO.py: <module>: 253:                               Dropping Seed
Distance to waypoint (1): 0.0333958499948
Dropping Seed
CRITICAL: drone_AUTO.py: <module>: 253:                               Dropping Seed
Distance to waypoint (1): 0.022263900624
Dropping Seed
CRITICAL: drone_AUTO.py: <module>: 253:                               Dropping Seed
Distance to waypoint (1): 0.0333958499948
Dropping Seed
CRITICAL: drone_AUTO.py: <module>: 253:                               Dropping Seed
Distance to waypoint (1): 0.01574295457
Dropping Seed
CRITICAL: drone_AUTO.py: <module>: 253:                               Dropping Seed
Distance to waypoint (1): 0.0248917969477
Dropping Seed
CRITICAL: drone_AUTO.py: <module>: 253:                               Dropping Seed
Distance to waypoint (2): 9.96662668138
Distance to waypoint (2): 9.24356802784
Distance to waypoint (2): 7.86521606743
Distance to waypoint (2): 5.84226137491
Distance to waypoint (2): 3.06176628747
Distance to waypoint (2): 1.49522930351
Dropping Seed

```

### 8.3.7 Hexagon APM Planner2 output





### 8.3.8 Hexagon log file

```
1  DEBUG: drone_AUTO.py: <module>: 141:          USER entered latitude value: 10.0
2  DEBUG: drone_AUTO.py: <module>: 146:          USER entered longitude value: 10.0
3  DEBUG: drone_AUTO.py: <module>: 151:          USER entered altitude value: 15.0
4  INFO: drone_AUTO.py: <module>: 187:          Connecting to vehicle on: udp:127.0.0.1:14551
5  CRITICAL: __init__.py: statustext_listener: 1065:          APM:Copter V3.3 (d6053245)
6  CRITICAL: __init__.py: statustext_listener: 1065:          Frame: QUAD
7  DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
8  DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
9  DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
10 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
11 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
12 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
13 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
14 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
15 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
16 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
17 INFO: drone_AUTO.py: print_vehicle_attributes: 98:          Autopilot Firmware version: APM:Copter-3.3.0
18 INFO: drone_AUTO.py: print_vehicle_attributes: 99:          Autopilot capabilities (supports ftp): False
19 INFO: drone_AUTO.py: print_vehicle_attributes: 100:          Global Location: LocationGlobal:lat=10.0,lon=10.0,alt=None
20 INFO: drone_AUTO.py: print_vehicle_attributes: 101:          Global Location (relative altitude): LocationGlobalRelative:lat=10.
21 INFO: drone_AUTO.py: print_vehicle_attributes: 102:          Local Location: LocationLocal:north=None,east=None,down=None
22 INFO: drone_AUTO.py: print_vehicle_attributes: 103:          Attitude: Attitude:pitch=0.00131169112865,yaw=-3.13779854774,roll=0
23 INFO: drone_AUTO.py: print_vehicle_attributes: 104:          Velocity: [0.01, -0.02, 0.0]
24 INFO: drone_AUTO.py: print_vehicle_attributes: 105:          GPS: GPSInfo:fix=3,num_sat=10
25 INFO: drone_AUTO.py: print_vehicle_attributes: 106:          Groundspeed: 0.0
26 INFO: drone_AUTO.py: print_vehicle_attributes: 107:          Airspeed: 0.0
27 INFO: drone_AUTO.py: print_vehicle_attributes: 108:          Gimbal status: Gimbal: pitch=None, roll=None, yaw=None
28 INFO: drone_AUTO.py: print_vehicle_attributes: 109:          Battery: Battery:voltage=12.587,current=0.0,level=100
29 INFO: drone_AUTO.py: print_vehicle_attributes: 110:          EKF OK?: True
30 INFO: drone_AUTO.py: print_vehicle_attributes: 111:          Last Heartbeat: 0.658461211
```

## 8.4 Hexagon Field (GUIDED mode) inputs and outputs

GitHub link:

<https://github.com/sambhaves/Seed-Plantation-Drone-Simulation/tree/master/Sample%20Input%20Output/Hexagon%20GUIDED>

### 8.4.1 Input Generator file

```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
input_generator.py
    This code generates the input lat long values

Please enter the geo location of the reference point of your field:

Please enter the latitude of point:
asd
Oops! That was no valid lat/lon. Try again...
Please enter the latitude of point:
10.0
Please enter the longitude of point:
10.0
Please enter the more number of point to generate:
5
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: -50
East distance to point: 50
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 0
East distance to point: 100
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 50
East distance to point: 100
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 100
East distance to point: 50
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 50
East distance to point: 0
All generated points are stored in input.txt.

sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$
```



#### 8.4.2 Input Text file

```
1 10.0,10.0
2 9.99955084236,10.0004560866
3 10.0,10.0009121732
4 10.0004491576,10.0009121732
5 10.0008983153,10.0004560866
6 10.0004491576,10.0
```

#### 8.4.3 Hexagon Google Maps



#### 8.4.4 Hexagon waypoint generator terminal

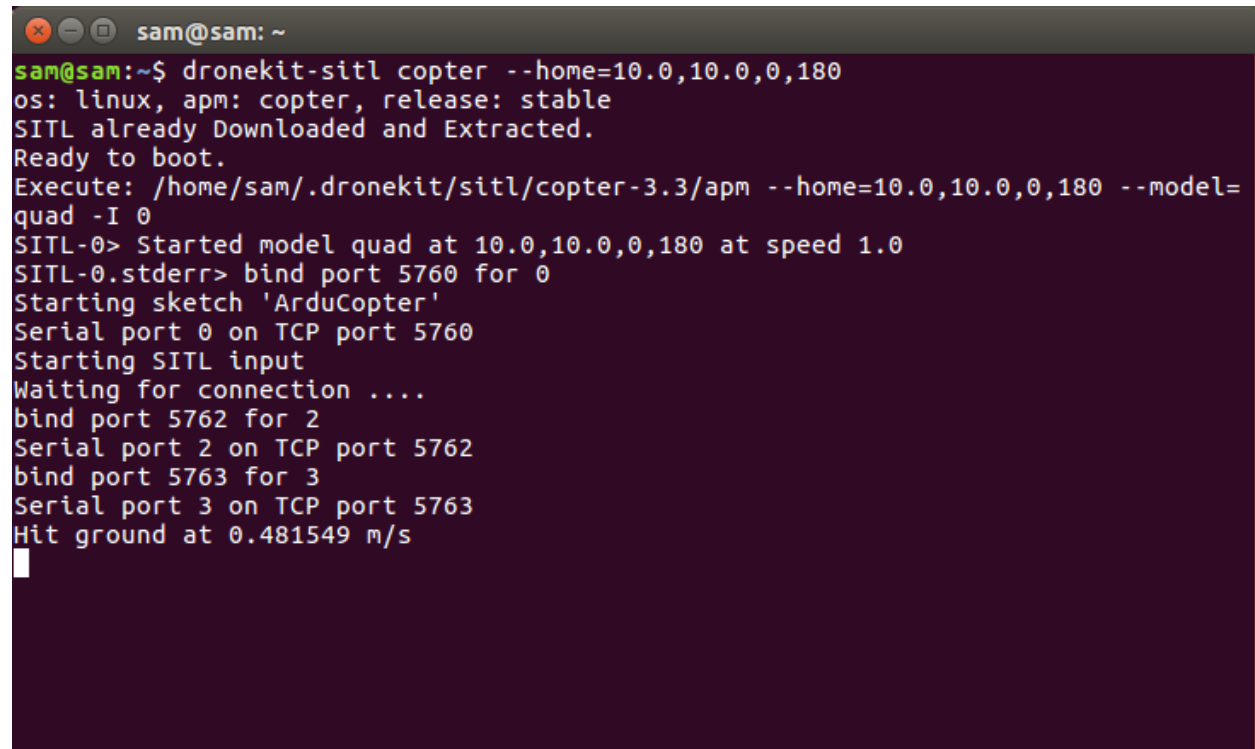
```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
waypoint_convex.py
Enter the file name with extension containing lat long of corners of polygon:
input.txt
Please enter the distance between two waypoints:
10

Waypoints are generated and stored in waypoint_square.txt file.
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$
```

#### 8.4.5 Waypoint hexagon text file

99 lines (99 sloc)	2.57 KB
1	10.0,10.0
2	10.0000898315,10.0
3	10.0001796631,10.0
4	10.0002694946,10.0
5	10.0003593261,10.0
6	10.0005389892,10.0000912176
7	10.0004491576,10.0000912176
8	10.0003593261,10.0000912176
9	10.0002694946,10.0000912176
10	10.0001796631,10.0000912176
11	10.0000898315,10.0000912176
12	10.0,10.0000912176
13	9.99991016847,10.0000912176
14	9.99982033695,10.0001824348
15	9.99991016847,10.0001824348
16	10.0,10.0001824348
17	10.0000898315,10.0001824348
18	10.0001796631,10.0001824348
19	10.0002694946,10.0001824348
20	10.0003593261,10.0001824348

#### 8.4.6 Terminal outputs



```
sam@sam: ~  
sam@sam:~$ dronekit-sitl copter --home=10.0,10.0,0,180  
os: linux, apm: copter, release: stable  
SITL already Downloaded and Extracted.  
Ready to boot.  
Execute: /home/sam/.dronekit/sitl/copter-3.3/apm --home=10.0,10.0,0,180 --model=  
quad -I 0  
SITL-0> Started model quad at 10.0,10.0,0,180 at speed 1.0  
SITL-0.stderr> bind port 5760 for 0  
Starting sketch 'ArduCopter'  
Serial port 0 on TCP port 5760  
Starting SITL input  
Waiting for connection ....  
bind port 5762 for 2  
Serial port 2 on TCP port 5762  
bind port 5763 for 3  
Serial port 3 on TCP port 5763  
Hit ground at 0.481549 m/s  
█
```

```

sam@sam: ~
sam@sam:~$ mavproxy.py --master tcp:127.0.0.1:5760 --sctl 127.0.0.1:5501 --out 1
27.0.0.1:14550 --out 127.0.0.1:14551
Connect tcp:127.0.0.1:5760 source_system=255
Log Directory:
Telemetry log: mav.tlog
Waiting for heartbeat from tcp:127.0.0.1:5760
MAV> online system 1
STABILIZE> Mode STABILIZE
APM: Calibrating barometer
APM: Initialising APM...
APM: barometer calibration complete
APM: GROUND START
Init Gyro**
INS
-----
G_off: 0.00, 0.00, 0.00
A_off: 0.00, 0.00, 0.00
A_scale: 1.00, 1.00, 1.00

Ready to FLY fence breach
ublox APM: APM:Copter V3.3 (d6053245)
APM: Frame: QUAD
Got MAVLink msg: COMMAND_ACK {command : 520, result : 0}
Flight battery 100 percent
Received 526 parameters
Saved 526 parameters to mav.parm
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
GUIDED> Mode GUIDED
APM: ARMING MOTORS
APM: GROUND START
Init Gyro**
INS
-----
G_off: 0.00, 0.00, 0.00
A_off: 0.00, 0.00, 0.00
A_scale: 1.00, 1.00, 1.00

```

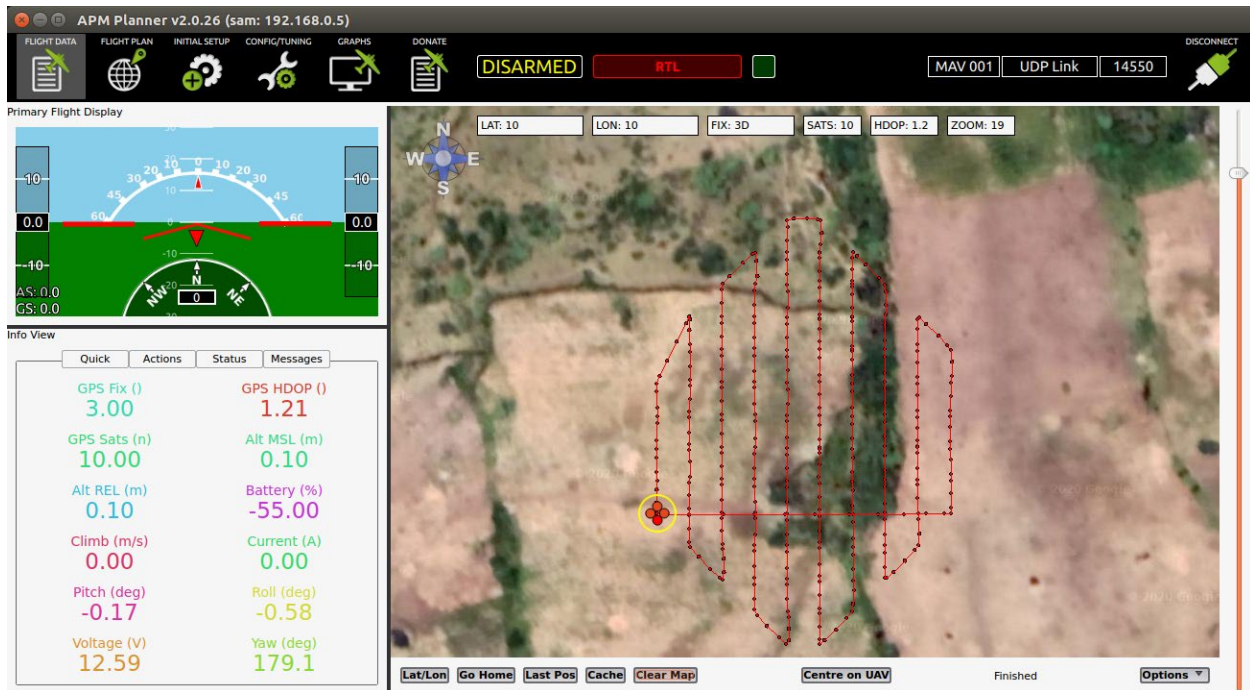
```

sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
drone_GUIDED.py --connect udp:127.0.0.1:14551
Please enter the latitude of starting point:
10.0
Please enter the longitude of starting point:
10.0
Please enter the altitude for the drone:
30.0
Enter the waypoint file name with extension:
waypoint_convex.txt
Connecting to vehicle on: udp:127.0.0.1:14551
Arm and Takeoff
Taking off!
Reached target altitude of 30.000000
Starting mission
Distance to target: 0.022264
Dropping Seed
Distance to target: 10.000022
Distance to target: 9.933212
Distance to target: 9.298745
Distance to target: 7.385005
Distance to target: 5.282691
Distance to target: 3.858776
Distance to target: 1.573151
Distance to target: 0.545163
Dropping Seed
Distance to target: 10.538225
Distance to target: 10.037411
Distance to target: 9.759127
Distance to target: 9.669967
CRITICAL: drone_GUIDED.py: drone_GUIDED: goto: 169:
mand message dropped. Resending the command message to drone
Distance to target: 9.692134
Distance to target: 9.703470
Distance to target: 8.879530
Distance to target: 7.466261
Distance to target: 5.430213
Distance to target: 3.316372
Distance to target: 1.627603
Distance to target: 0.530896
Dropping Seed
Distance to target: 10.519681

```

Last com

## 8.4.7 Hexagon APM Planner2 output



## 8.4.8 Hexagon log file

```
1  DEBUG: drone_GUIDED.py: drone_GUIDED: <module>: 245:
2  DEBUG: drone_GUIDED.py: drone_GUIDED: <module>: 250:
3  DEBUG: drone_GUIDED.py: drone_GUIDED: <module>: 255:
4  INFO: drone_GUIDED.py: drone_GUIDED: <module>: 291:
5  CRITICAL: __init__.py: __init__: statustext_listener: 1065:
6  CRITICAL: __init__.py: __init__: statustext_listener: 1065:
7  DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
8  DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
9  DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
10 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
11 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
12 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
13 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
14 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
15 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
16 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
17 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 189:
18 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 190:
19 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 191:
20 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 192:
21 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 193:
22 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 194:
23 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 195:
24 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 196:
25 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 197:
26 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 198:
27 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 199:
28 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 200:
29 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 201:
30 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 202:

USER entered latitude value: 10.0
USER entered longitude value: 10.0
USER entered altitude value: 30.0
Connecting to vehicle on: udp:127.0.0.1:14551
    APM:Copter V3.3 (d6053245)
    Frame: QUAD
        Still waiting for data from vehicle: parameters
        Still waiting for data from vehicle: parameters
        Still waiting for data from vehicle: parameters
        Still waiting for data from vehicle: parameters
        Still waiting for data from vehicle: parameters
        Still waiting for data from vehicle: parameters
        Still waiting for data from vehicle: parameters
        Still waiting for data from vehicle: parameters
        Still waiting for data from vehicle: parameters
        Still waiting for data from vehicle: parameters
        Still waiting for data from vehicle: parameters
        Autopilot Firmware version: APM:Copter-3.3.0
        Autopilot capabilities (supports ftp): False
        Global Location:LocationGlobal:lat=10.0,lon=10.0,al
        Global Location (relative altitude): LocationGlobal
        Local Location: LocationLocal:north=None,east=None,
        Attitude: Attitude:pitch=0.00102841900662,yaw=-3.13
        Velocity: [0.01, -0.01, 0.0]
        GPS: GPSInfo:fix=3,num_sat=10
        Groundspeed: 0.0
        Airspeed: 0.0
        Gimbal status: Gimbal: pitch=None, roll=None, yaw=N
        Battery: Battery:voltage=12.587,current=0.0,level=1
        EKF OK?: True
        Last Heartbeat: 0.669647895
```



## 8.5 Random Convex Polygonal Field (AUTO mode) inputs and outputs

GitHub link:

<https://github.com/sambhaves/Seed-Plantation-Drone-Simulation/tree/master/Sample%20Input%20Output/Random%20Convex%20Polygon%20AUTO>

### 8.5.1 Input Generator file

```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
input_generator.py
    This code generates the input lat long values

Please enter the geo location of the reference point of your field:

Please enter the latitude of point:
10.0
Please enter the longitude of point:
10.0
Please enter the more number of point to generate:
5
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 40
East distance to point: -40
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 80
East distance to point: -40
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 120
East distance to point: 0
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 120
East distance to point: 40
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 80
East distance to point: 110
All generated points are stored in input.txt.

sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$
```

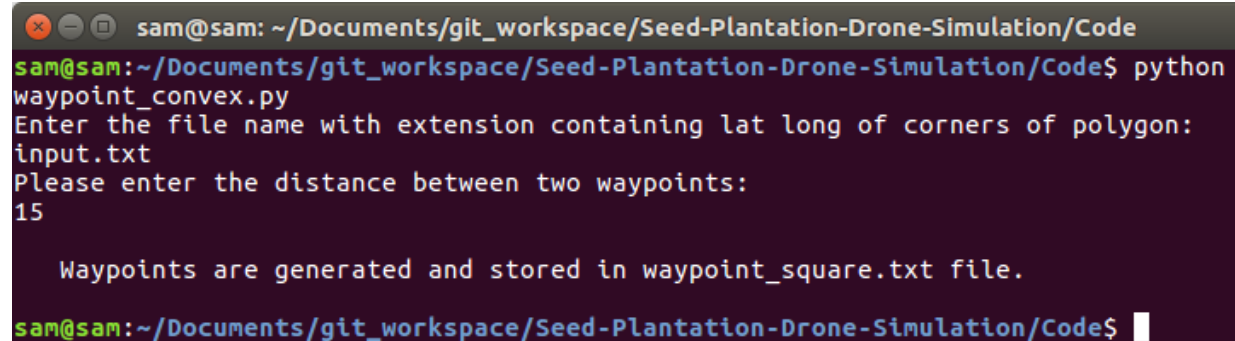


### 8.5.2 Input Text file

```
1 10.0,10.0
2 10.0003593261,9.9996351307
3 10.0007186522,9.9996351307
4 10.0010779783,10.0
5 10.0010779783,10.0003648693
6 10.0007186522,10.0010033906
```

---

### 8.5.3 Convex Polygon waypoint generator terminal



```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
waypoint_convex.py
Enter the file name with extension containing lat long of corners of polygon:
input.txt
Please enter the distance between two waypoints:
15

Waypoints are generated and stored in waypoint_square.txt file.
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$
```

#### 8.5.4 Waypoint convex text file

48 lines (48 sloc)   1.28 KB	
1	10.0004042419,9.9996351307
2	10.0005389892,9.9996351307
3	10.0006737365,9.9996351307
4	10.0008084838,9.99977195737
5	10.0006737365,9.99977195737
6	10.0005389892,9.99977195737
7	10.0004042419,9.99977195737
8	10.0002694946,9.99977195737
9	10.0001347473,9.99990878335
10	10.0002694946,9.99990878335
11	10.0004042419,9.99990878335
12	10.0005389892,9.99990878335
13	10.0006737365,9.99990878335
14	10.0008084838,9.99990878335
15	10.000943231,9.99990878335
16	10.000943231,10.00004561
17	10.0008084838,10.00004561
18	10.0006737365,10.00004561
19	10.0005389892,10.00004561
20	10.0004042419,10.00004561

### 8.5.5 Terminal outputs

```
sam@sam: ~  
sam@sam:~$ dronekit-sitl copter --home=10.0,10.0,0,180  
os: linux, apm: copter, release: stable  
SITL already Downloaded and Extracted.  
Ready to boot.  
Execute: /home/sam/.dronekit/sitl/copter-3.3/apm --home=10.0,10.0,0,180 --model=  
quad -I 0  
SITL-0> Started model quad at 10.0,10.0,0,180 at speed 1.0  
SITL-0.stderr> bind port 5760 for 0  
Starting sketch 'ArduCopter'  
Serial port 0 on TCP port 5760  
Starting SITL input  
Waiting for connection ....  
bind port 5762 for 2  
Serial port 2 on TCP port 5762  
bind port 5763 for 3  
Serial port 3 on TCP port 5763  
Hit ground at 0.450966 m/s  
Closed connection on serial port 0  
^Csam@sam:~$
```

```

sam@sam: ~
sam@sam:~$ mavproxy.py --master tcp:127.0.0.1:5760 --sitl 127.0.0.1:5501 --out 1
27.0.0.1:14550 --out 127.0.0.1:14551
Connect tcp:127.0.0.1:5760 source_system=255
Log Directory:
Telemetry log: mav.tlog
Waiting for heartbeat from tcp:127.0.0.1:5760
MAV> online system 1
STABILIZE> Mode STABILIZE
APM: Calibrating barometer
APM: Initialising APM...
APM: barometer calibration complete
APM: GROUND START
Init Gyro**
INS
-----
G_off: 0.00, 0.00, 0.00
A_off: 0.00, 0.00, 0.00
A_scale: 1.00, 1.00, 1.00

Ready to FLY fence breach
ublox APM: APM:Copter V3.3 (d6053245)
APM: Frame: QUAD
Got MAVLink msg: COMMAND_ACK {command : 520, result : 0}
Flight battery 100 percent
Received 526 parameters
Saved 526 parameters to mav.parm
Got MAVLink msg: MISSION_ACK {target_system : 255, target_component : 0, type :
0, mission_type : 0}
Got MAVLink msg: MISSION_ACK {target_system : 255, target_component : 0, type :
0, mission_type : 0}
APM: flight plan received
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
GUIDED> Mode GUIDED
APM: ARMING MOTORS
APM: GROUND START

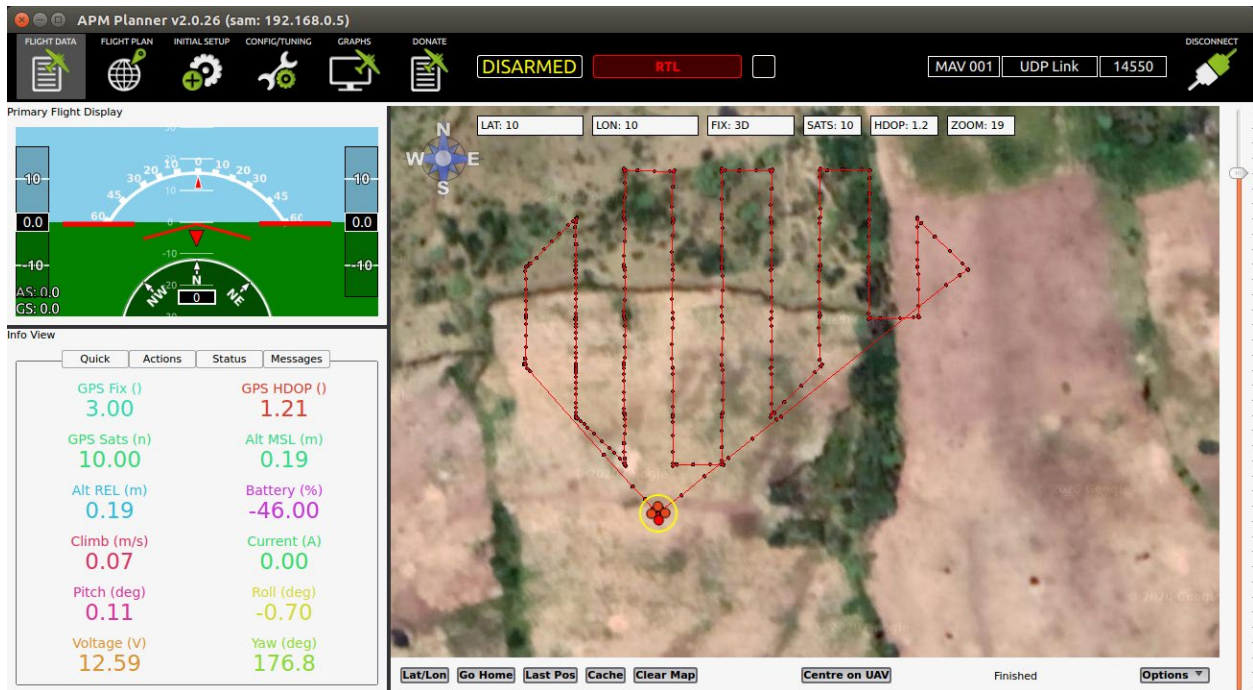
```

```

sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
drone_AUTO.py --connect udp:127.0.0.1:14551
Please enter the latitude of starting point:
10.0
Please enter the longitude of starting point:
10.0
Please enter the altitude for the drone:
15.0
Enter the waypoint file name with extension:
waypoint_convex.txt
Connecting to vehicle on: udp:127.0.0.1:14551
Uploading waypoints to vehicle...
Arm and Takeoff
Taking off!
Reached target altitude of 15.000000
Starting mission
Distance to waypoint (1): 60.5906791426
Distance to waypoint (1): 60.4400986505
Distance to waypoint (1): 59.5127255724
Distance to waypoint (1): 57.9632702337
Distance to waypoint (1): 56.526278191
Distance to waypoint (1): 53.8170637397
Distance to waypoint (1): 51.7587806357
Distance to waypoint (1): 48.3099464455
Distance to waypoint (1): 45.8135714932
Distance to waypoint (1): 28.6114484554
Distance to waypoint (1): 2.00262994066
Distance to waypoint (1): 2.00262994066
Distance to waypoint (1): 2.00262994066
Distance to waypoint (1): 2.00262994066
Distance to waypoint (1): 2.00262994066
Distance to waypoint (1): 2.00262994066
Distance to waypoint (1): 2.00262994066
Distance to waypoint (1): 2.00262994066
Distance to waypoint (1): 2.00262994066
Distance to waypoint (1): 2.00262994066
Distance to waypoint (1): 0.585553671131
Dropping Seed
CRITICAL: drone_AUTO.py: <module>: 253:                               Dropping Seed
Distance to waypoint (1): 0.262771515437
Dropping Seed

```

## 8.5.6 Convex Polygon APM Planner2 output



## 8.5.7 Convex Polygon log file

```
1  DEBUG: drone_AUTO.py: <module>: 141:          USER entered latitude value: 10.0
2  DEBUG: drone_AUTO.py: <module>: 146:          USER entered longitude value: 10.0
3  DEBUG: drone_AUTO.py: <module>: 151:          USER entered altitude value: 15.0
4  INFO: drone_AUTO.py: <module>: 187:          Connecting to vehicle on: udp:127.0.0.1:14551
5  CRITICAL: __init__.py: statustext_listener: 1065:          APM:Copter V3.3 (d6053245)
6  CRITICAL: __init__.py: statustext_listener: 1065:          Frame: QUAD
7  DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
8  DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
9  DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
10 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
11 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
12 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
13 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
14 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
15 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
16 DEBUG: __init__.py: default_still_waiting_callback: 3082:          Still waiting for data from vehicle: parameters
17 INFO: drone_AUTO.py: print_vehicle_attributes: 98:          Autopilot Firmware version: APM:Copter-3.3.0
18 INFO: drone_AUTO.py: print_vehicle_attributes: 99:          Autopilot capabilities (supports ftp): False
19 INFO: drone_AUTO.py: print_vehicle_attributes: 100:          Global Location: LocationGlobal:lat=10.0,lon=10.0,alt=None
20 INFO: drone_AUTO.py: print_vehicle_attributes: 101:          Global Location (relative altitude): LocationGlobalRelative:lat=10.
21 INFO: drone_AUTO.py: print_vehicle_attributes: 102:          Local Location: LocationLocal:north=None,east=None,down=None
22 INFO: drone_AUTO.py: print_vehicle_attributes: 103:          Attitude: Attitude:pitch=0.00110931112431,yaw=-3.13855171204,roll=0
23 INFO: drone_AUTO.py: print_vehicle_attributes: 104:          Velocity: [0.01, -0.02, 0.0]
24 INFO: drone_AUTO.py: print_vehicle_attributes: 105:          GPS: GPSInfo:fix=3,num_sat=10
25 INFO: drone_AUTO.py: print_vehicle_attributes: 106:          Groundspeed: 0.0
26 INFO: drone_AUTO.py: print_vehicle_attributes: 107:          Airspeed: 0.0
27 INFO: drone_AUTO.py: print_vehicle_attributes: 108:          Gimbal status: Gimbal: pitch=None, roll=None, yaw=None
28 INFO: drone_AUTO.py: print_vehicle_attributes: 109:          Battery: Battery:voltage=12.587,current=0.0,level=100
29 INFO: drone_AUTO.py: print_vehicle_attributes: 110:          EKF OK?: True
30 INFO: drone_AUTO.py: print_vehicle_attributes: 111:          Last Heartbeat: 0.608151212999
```

## 8.6 Random Convex Polygonal Field (GUIDED mode) inputs and outputs

GitHub link:

<https://github.com/sambhaves/Seed-Plantation-Drone-Simulation/tree/master/Sample%20Input%20Output/Random%20Convex%20Polygon%20GUIDED>

### 8.6.1 Input Generator file

```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
input_generator.py
    This code generates the input lat long values

Please enter the geo location of the reference point of your field:

Please enter the latitude of point:
10.0
Please enter the longitude of point:
10.0
Please enter the more number of point to generate:
5
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 40
East distance to point: -40
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 80
East distance to point: -40
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 120
East distance to point: 0
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 120
East distance to point: 40
Enter the next point distance in meter (north,east) from refrence point:

North distance to point: 80
East distance to point: 110
All generated points are stored in input.txt.

sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$
```

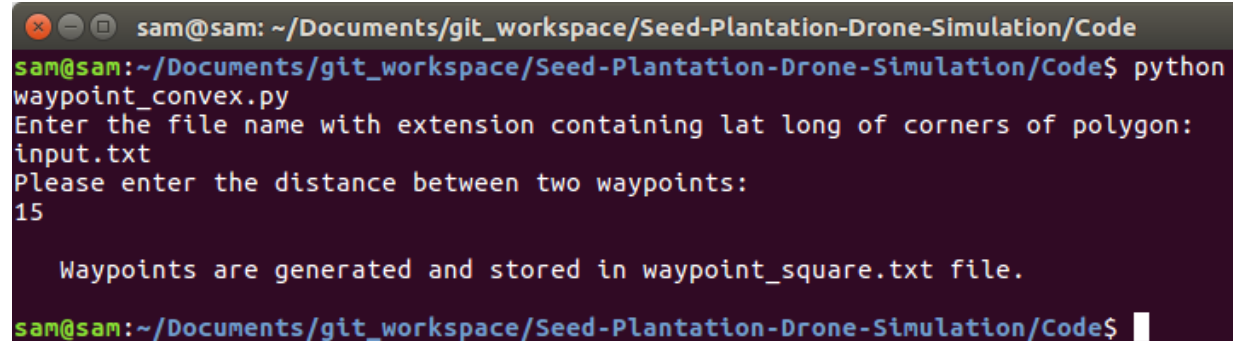


### 8.6.2 Input Text file

```
1 10.0,10.0
2 10.0003593261,9.9996351307
3 10.0007186522,9.9996351307
4 10.0010779783,10.0
5 10.0010779783,10.0003648693
6 10.0007186522,10.0010033906
```

---

### 8.6.3 Convex Polygon waypoint generator terminal



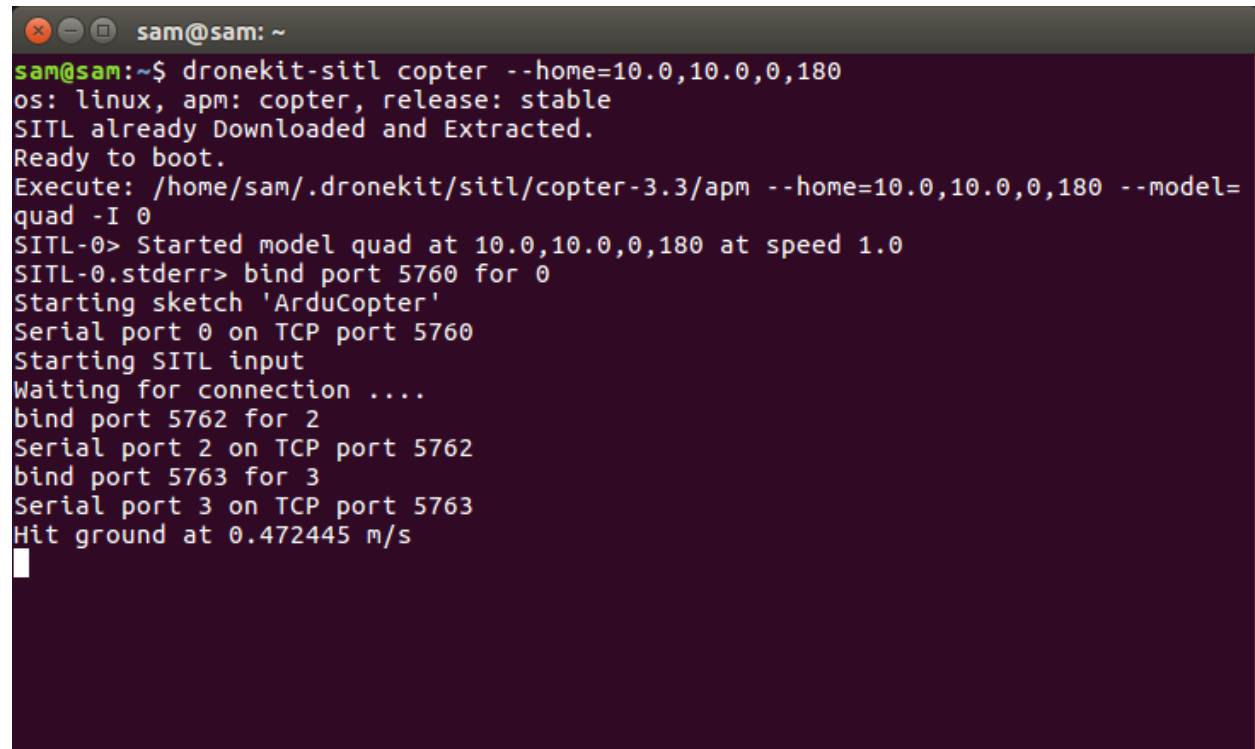
```
sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python
waypoint_convex.py
Enter the file name with extension containing lat long of corners of polygon:
input.txt
Please enter the distance between two waypoints:
15

Waypoints are generated and stored in waypoint_square.txt file.
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$
```

#### 8.6.4 Waypoint convex text file

48 lines (48 sloc)   1.28 KB	
1	10.0004042419,9.9996351307
2	10.0005389892,9.9996351307
3	10.0006737365,9.9996351307
4	10.0008084838,9.99977195737
5	10.0006737365,9.99977195737
6	10.0005389892,9.99977195737
7	10.0004042419,9.99977195737
8	10.0002694946,9.99977195737
9	10.0001347473,9.99990878335
10	10.0002694946,9.99990878335
11	10.0004042419,9.99990878335
12	10.0005389892,9.99990878335
13	10.0006737365,9.99990878335
14	10.0008084838,9.99990878335
15	10.000943231,9.99990878335
16	10.000943231,10.00004561
17	10.0008084838,10.00004561
18	10.0006737365,10.00004561
19	10.0005389892,10.00004561
20	10.0004042419,10.00004561

### 8.6.5 Terminal outputs



```
sam@sam: ~  
sam@sam:~$ dronekit-sitl copter --home=10.0,10.0,0,180  
os: linux, apm: copter, release: stable  
SITL already Downloaded and Extracted.  
Ready to boot.  
Execute: /home/sam/.dronekit/sitl/copter-3.3/apm --home=10.0,10.0,0,180 --model=  
quad -I 0  
SITL-0> Started model quad at 10.0,10.0,0,180 at speed 1.0  
SITL-0.stderr> bind port 5760 for 0  
Starting sketch 'ArduCopter'  
Serial port 0 on TCP port 5760  
Starting SITL input  
Waiting for connection ....  
bind port 5762 for 2  
Serial port 2 on TCP port 5762  
bind port 5763 for 3  
Serial port 3 on TCP port 5763  
Hit ground at 0.472445 m/s  
█
```

```

sam@sam: ~
sam@sam:~$ mavproxy.py --master tcp:127.0.0.1:5760 --sitr 127.0.0.1:5501 --out 1
27.0.0.1:14550 --out 127.0.0.1:14551
Connect tcp:127.0.0.1:5760 source_system=255
Log Directory:
Telemetry log: mav.tlog
Waiting for heartbeat from tcp:127.0.0.1:5760
MAV> online system 1
STABILIZE> Mode STABILIZE
APM: Calibrating barometer
APM: Initialising APM...
APM: barometer calibration complete
APM: GROUND START
Init Gyro**
INS
-----
G_off: 0.00, 0.00, 0.00
A_off: 0.00, 0.00, 0.00
A_scale: 1.00, 1.00, 1.00

Ready to FLY fence breach
ublox APM: APM:Copter V3.3 (d6053245)
APM: Frame: QUAD
Got MAVLink msg: COMMAND_ACK {command : 520, result : 0}
Flight battery 100 percent
Received 526 parameters
Saved 526 parameters to mav.parm
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
Got MAVLink msg: COMMAND_ACK {command : 11, result : 0}
GUIDED> Mode GUIDED
APM: ARMING MOTORS
APM: GROUND START
Init Gyro**
INS
-----
G_off: 0.00, 0.00, 0.00
A_off: 0.00, 0.00, 0.00
A_scale: 1.00, 1.00, 1.00

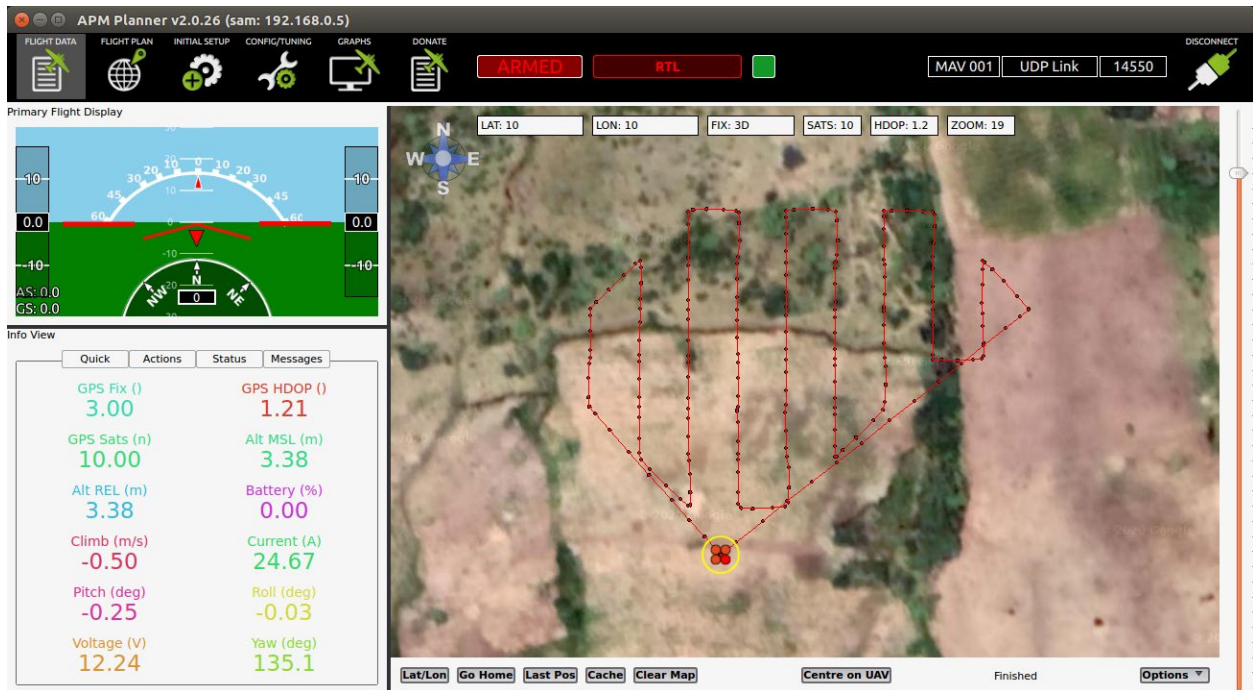
```

```

sam@sam: ~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code
sam@sam:~/Documents/git_workspace/Seed-Plantation-Drone-Simulation/Code$ python drone_GUIDED.py --connect udp:127.0.0.1:14551
Please enter the latitude of starting point:
10.0
Please enter the longitude of starting point:
10.0
Please enter the altitude for the drone:
15.0
Enter the waypoint file name with extension:
waypoint_convex.txt
Connecting to vehicle on: udp:127.0.0.1:14551
Arm and Takeoff
Taking off!
Reached target altitude of 15.000000
Starting mission
Distance to target: 60.620497
Distance to target: 60.573330
Distance to target: 59.607066
Distance to target: 58.105553
CRITICAL: drone_GUIDED.py: drone_GUIDED: goto: 169: Last command message dropped. Resending the command message to drone
Distance to target: 55.863582
Distance to target: 51.979696
Distance to target: 48.579674
Distance to target: 44.815739
Distance to target: 40.751532
Distance to target: 36.433273
Distance to target: 30.451948
Distance to target: 25.872177
Distance to target: 22.782657
Distance to target: 16.517834
Distance to target: 11.868247
Distance to target: 7.573123
Distance to target: 3.992236
Distance to target: 1.304131
Distance to target: 0.216394
Dropping Seed
Distance to target: 14.883322
Distance to target: 14.346831
Distance to target: 13.081683
Distance to target: 10.288174
Distance to target: 7.646634
Distance to target: 5.034828

```


## 8.6.6 Convex Polygon APM Planner2 output




## 8.6.7 Convex Polygon log file

```
1  DEBUG: drone_GUIDED.py: drone_GUIDED: <module>: 245:
2  DEBUG: drone_GUIDED.py: drone_GUIDED: <module>: 250:
3  DEBUG: drone_GUIDED.py: drone_GUIDED: <module>: 255:
4  INFO: drone_GUIDED.py: drone_GUIDED: <module>: 291:
5  CRITICAL: __init__.py: __init__: statustext_listener: 1065:
6  CRITICAL: __init__.py: __init__: statustext_listener: 1065:
7  DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
8  DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
9  DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
10 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
11 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
12 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
13 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
14 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
15 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
16 DEBUG: __init__.py: __init__: default_still_waiting_callback: 3082:
17 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 189:
18 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 190:
19 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 191:
20 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 192:
21 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 193:
22 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 194:
23 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 195:
24 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 196:
25 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 197:
26 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 198:
27 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 199:
28 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 200:
29 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 201:
30 INFO: drone_GUIDED.py: drone_GUIDED: print_vehicle_attributes: 202:

USER entered latitude value: 10.0
USER entered longitude value: 10.0
USER entered altitude value: 15.0
Connecting to vehicle on: udp:127.0.0.1:14551
      APM:Copter V3.3 (d6053245)
      Frame: QUAD
      Still waiting for data from vehicle: parameters
      Still waiting for data from vehicle: parameters
      Still waiting for data from vehicle: parameters
      Still waiting for data from vehicle: parameters
      Still waiting for data from vehicle: parameters
      Still waiting for data from vehicle: parameters
      Still waiting for data from vehicle: parameters
      Still waiting for data from vehicle: parameters
      Still waiting for data from vehicle: parameters
      Autopilot Firmware version: APM:Copter-3.3.0
      Autopilot capabilities (supports ftp): False
      Global Location:LocationGlobal:lat=10.0,lon=10.0,al
      Global Location (relative altitude): LocationGlobal
      Local Location: LocationLocal:north=None,east=None,
      Attitude: Attitude:pitch=0.000933106115554,yaw=-3.1
      Velocity: [0.0, -0.01, 0.0]
      GPS: GPSInfo:fix=3,num_sat=10
      Groundspeed: 0.0
      Airspeed: 0.0
      Gimbal status: Gimbal: pitch=None, roll=None, yaw=N
      Battery: Battery:voltage=12.587,current=0.0,level=1
      EKF OK?: True
      Last Heartbeat: 0.6662882
```



## **Chapter 9. Conclusion and Future Scope**





In this project work, we designed the algorithm to spray seeds at regular intervals in fields whose parameters are provided by the user.

The time complexity of the proposed algorithm is  $O((l/d)^2)$  where  $l$  is the side of the fitted square and  $d$  is the distance between seeds dropped. So basically, the proposed algorithm works in  $O(n^2)$ .

Though this algorithm is best to spray seeds in fields whose parameters are known.

There is certain research/work which needs to be done for better application of drone for reforestation or afforestation. Some of them include: -

## Software Advancement

We as a human cannot reach many barren lands due to bad terrain or unavailability of paths, new research work can be put where we send drone beforehand to analyze the land piece and collect data about the quality of land and its dimension and weather conditions. In this research, a lot of IoT and AI Edge knowledge is required along with computer vision.

## Hardware Advancement

A deep study needs to be done on how to carry seeds through drone to minimize the payload as well as maintain effective plantation rate also. As well as the firing speed needs to be controlled so as to maintain such a speed that the seed enters the soil otherwise an artificial pod needs to be made to contain the seed so as wherever it falls the tree is planted without being covered by soil.

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## *References*

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- 1) <https://dronekit-python.readthedocs.io/en/latest/>
- 2) <http://gis.stackexchange.com/questions/2951/algorithm-for-offsetting-a-latitude-longitude-by-some-amount-of-meters>
- 3) <https://github.com/diydrones/ardupilot/blob/master/Tools/autotest/common.py>
- 4) <https://ardupilot.org/copter/index.html>