AT31901: Bramor Training 2

Mission Planning Fundamentals

Today we will cover some of the main aspects related to proper mission planning, followed by a demonstration of the C3P Bramor Mission Planner Software. Your lab this week will involve you using the C3P software and creating several types of missions within the C3P platform.

Objectives:

- Objective #1: Gain a basic understanding of mission planning essentials
- Objective #2: Understand how mission planning and pre-flight checks are integrated
- Objective #3: Demonstrate proficiency in creating different types of missions with the C3P mission planning software.

Part 1: Discussion of Mission Planning Essentials – SITUATIONAL AWARENESS.

This material was discussed in the lecture/demo portion of the lab. Please keep it as a reference for questions in the lab you are asked to address

- In the Office (Before you depart)
    - Know your study site
        - Cell Signal (may need to cache data)
        - Will there be crowds (ILLEGAL)
    - Know the vegetation
    - Know the Terrain
    - Look at map for possible human made obstacles and features
    - Draw out several possible mission plans
        - Use geospatial data available
    - Check weather
    - Equipment:
        - Batteries Charged for all electronics
- Departure:
    - Equipment Checklist
    - Weather Check

- In the field
    - Field Weather (Wind Speed, Wind Direction, Temp, Dew Point)
    - Assess Vegetation
    - Assess Terrain
    - Assess if EMI issues will be present
        - Power lines
        - Underground Metal or cables
        - Power stations
    - Get Elevation of launch site
    - Establish Units team will be working in and maintain consistency
        - Metric is best
    - Reevaluate Missions saved missions
    - Confirm cellular network connectivity
    - Integrate Field observations into pre-flight check and flight logs

Part 2: Review of Software Demonstration

This information was covered in the lecture/lab demo. It is in this lab as a reference

- Overview of the Symbols
    - Home
    - T – Takeoff
    - R – Rally
    - L – Land
- Map Icon
    - Toggle Between Maps
    - Best to have imagery and something with elevation
    - Can Change in Settings
- Mission Settings
    - Altitude (Can be relative or Absolute)
    - Speed (Watch for Stalling speeds)
    - Sidelap and Overlap – tied to sensor
    - GSD (relates to sensor)
    - Overshoot – Important for Fixed wing. Adjust for wind and overlap
- Draw:
    - Measure (a handy feature)
    - Street Points (great for Corridors)
    - Area (typical mission)

Part 3: Create Missions using the C3P mission planning software

Provide answers in purple beneath where questions are asked. All screen shots and images should be labeled as a figure with a figure caption.

- Draw an area over Purdue Wildlife Area that approximates the area in Figure 1.
    - Place your home, take off, rally/landing area in the open field area in SE corner.
    - Make sure you initialize your sensors. (this relates to altitude settings)
    - Set altitude to Relative to Terrain (bottom right corner)
    - Set your Altitude to 125 meters
    - Set to 80% frontal overlap and 75% sidelap (lateral)
    - Set the Camera to the RX1R II 35mm
- Set the overshoot to 150m

- Take a screen shot of your mission and place it in the space below

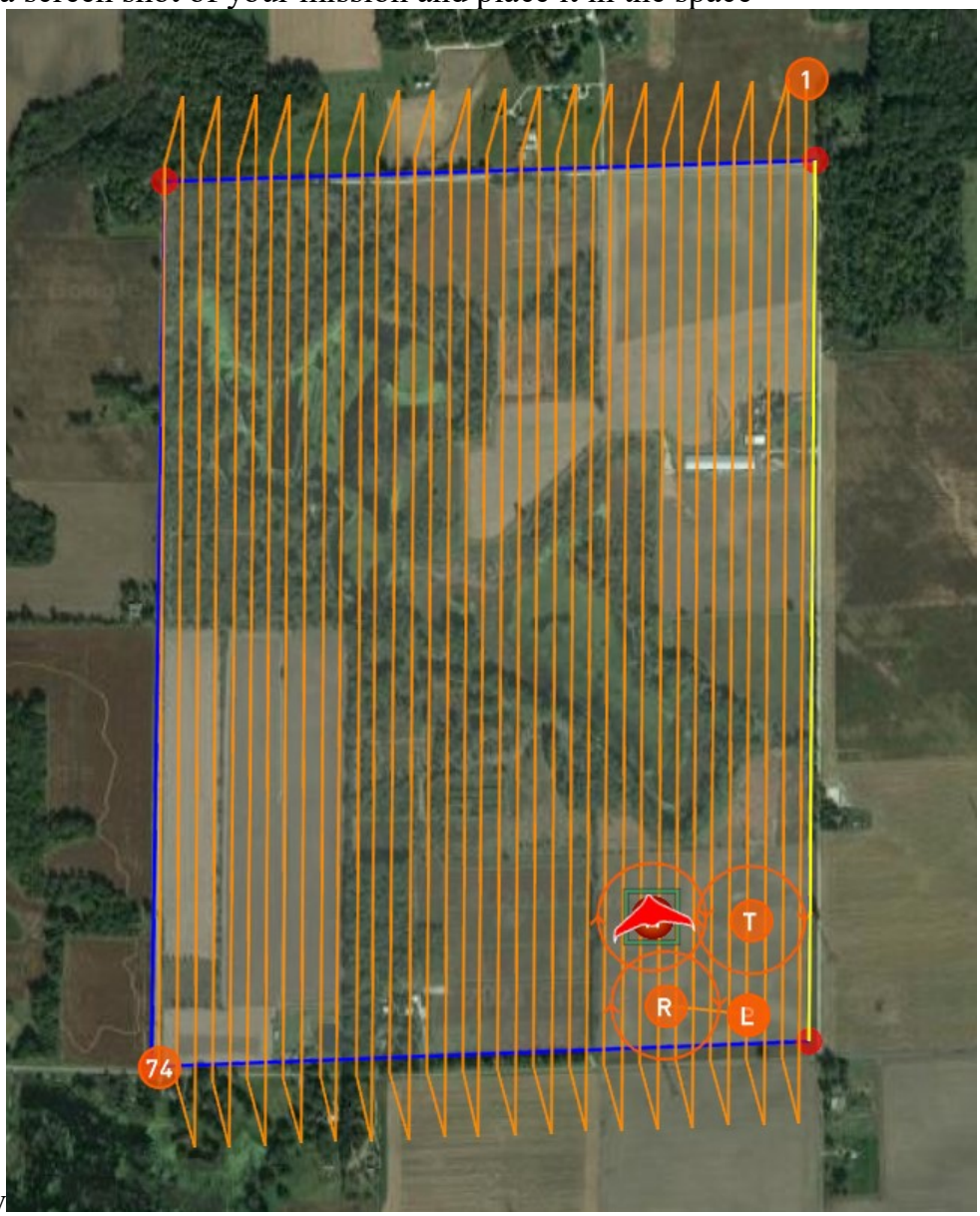


Figure 1: The flight path with altitude of 125 meters and overshoot of 150 meters

- Now clear the existing mission with ‘Clear All’ and draw another mission covering the same area as Figure 1 with the following parameters:

- Set altitude to Relative to Terrain (bottom right corner)
- Set your GSD to 2.5 cm/pixel
- Set to 80% frontal overlap and 75% sidelap (lateral)
- Set the Camera to the RX1R II 35mm
- Set the overshoot to 120m

- Place screen shot of your mission in the space below

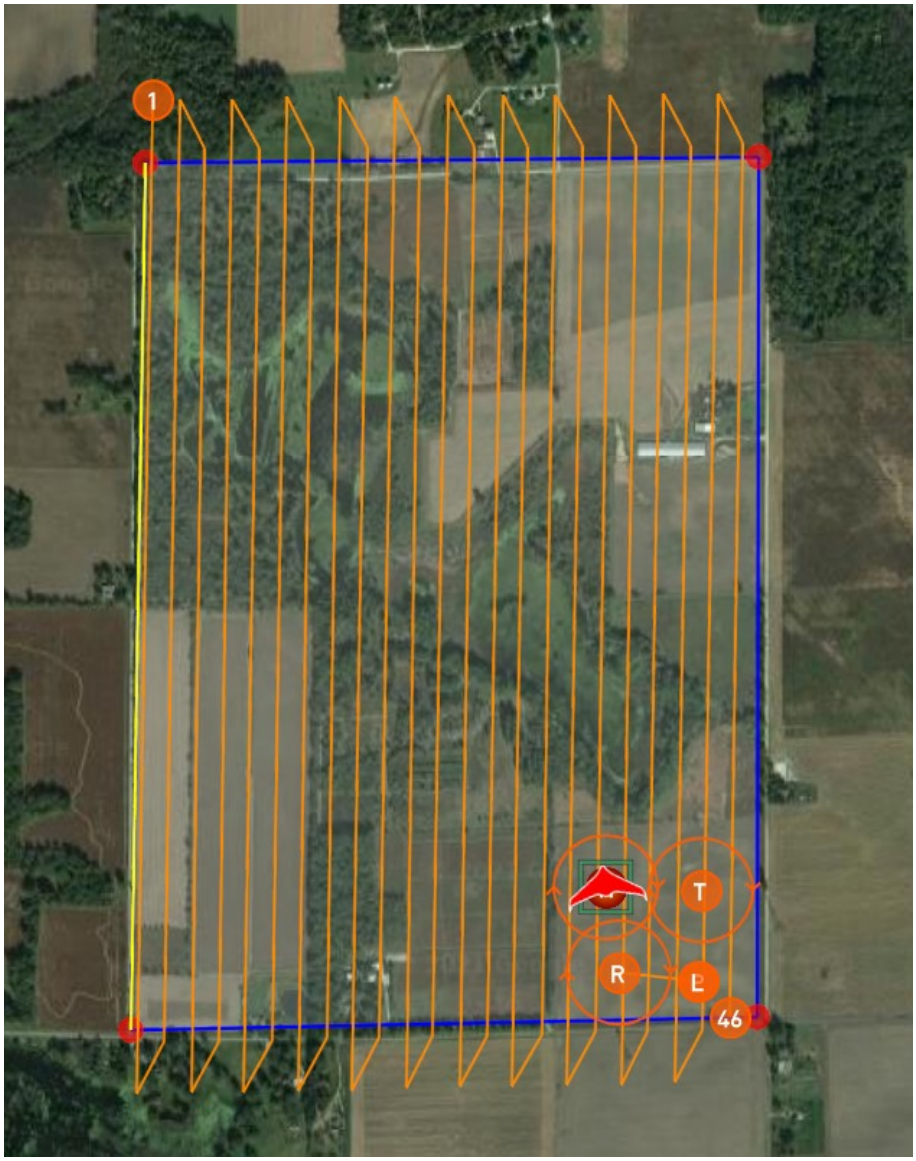


Figure 2: The GSD is set to 2.5cm/pixel. Compare to figure 1, the spacing is slightly larger.

- Compare the two missions you created and then answer the questions below.
    - *How does changing the GSD relate to changes in Altitude?*
- The altitude will increase if the value of GSD increases.
    -
    - *What is a 2.5cm GSD resolution in inches?*
- 2.5 cm * 1 in / 2.54 cm = 0.98425 inches. Thus, each pixel represents 0.98425 inches on the ground.
    -
    - *As you move up in Altitude, what happens to the flight line spacing?*
    - The spacing becomes larger.
    - *How does increasing/decreasing the overshoot relate to the size/area of the mission flown?*
- The size of the mission area expands on the direction of the overshoot.
    -

Considering you are flying this mission with a fixed-wing aircraft, why does overshoot matter? Why might you change this according to flight path spacing?

A fixed-wing aircraft is keep going forward. It can't just stop and make a sharp turn. It needs a space to turn so the aircraft is aiming at the correct direction when it re-enter the mission area. Also, the overshoot can make sure every area can be scanned completely.

The overshoot might change according to the flight path spacing because the fixed-wing has the turning radius. If the spacing is less than the radius, the aircraft need more space to turn 180 degrees.

    -
    - *This is obviously a simulated run, but what legal issues are presented with the size of the mission area and the altitude when set to 2.5cm GSD*
    - When the GSD is 2.5 cm, the altitude is set to 196 meters AGL, which is also 643.045 feet AGL. According to the regulation, the maximum allowed altitude is 400 feet AGL, and this setting exceed the 400 feet, so that's the issue.

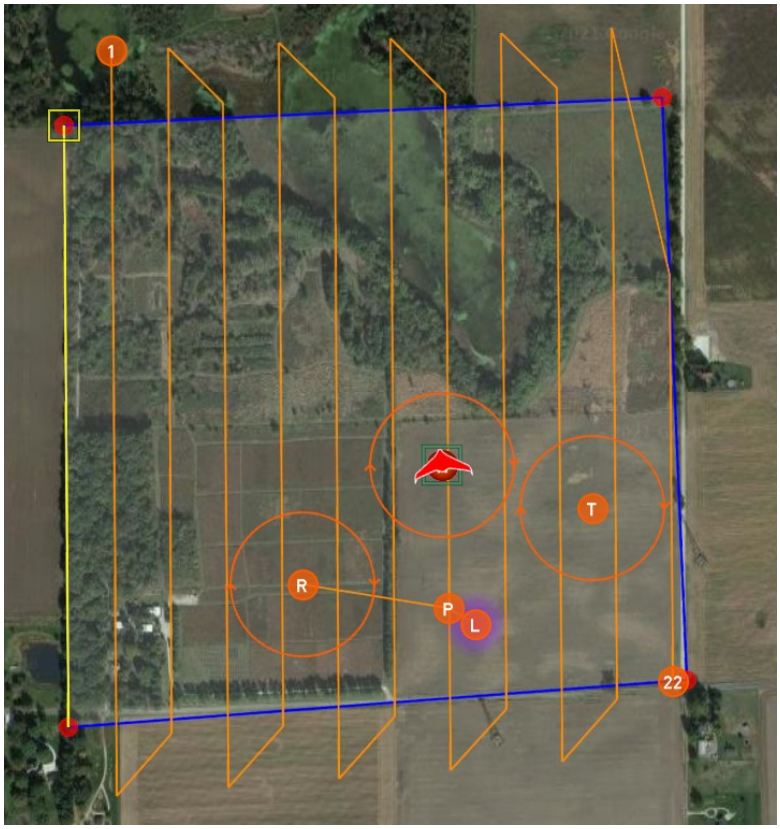
- *In the demo we covered some other draw functions. What are those other functions. Provide a short description of each and an example of when they would be used.*
- The "Measure" function can measure the distance from a waypoint to another. It can measure the distance of several segment at once. For example, if I want

to measure the length of the flight path between way point 23 to way point 26, I can just click where the way point 23 is, and then click 24, 25, and finally 26. The total distance will be shown.

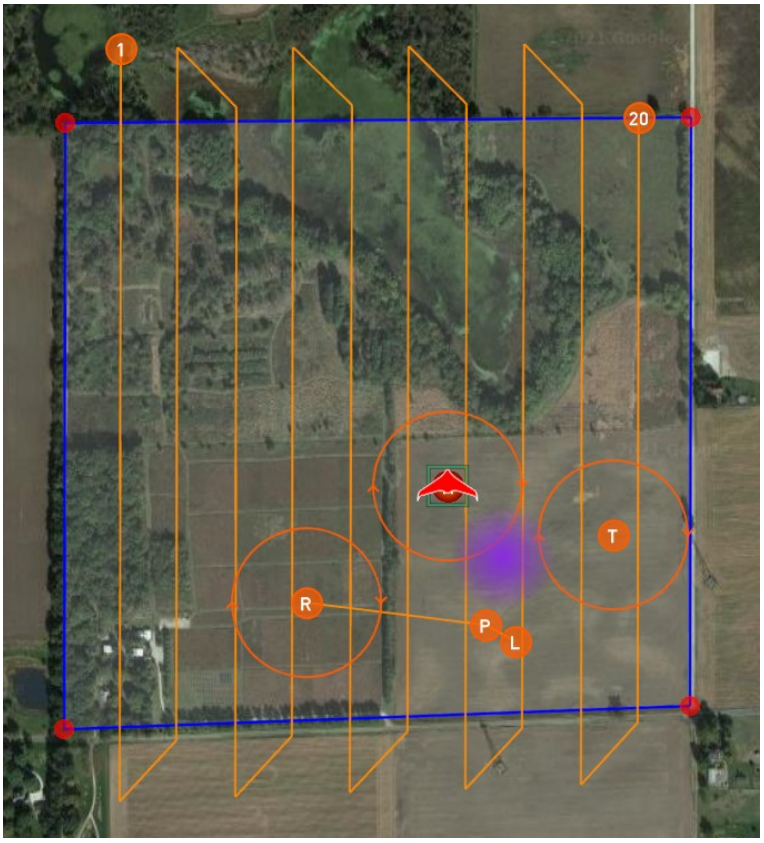
- Street Points function lets you set the way points in the shape of a street which has the length, width, and turns. The width is the same, and use the width to sweep along a path which has a length and may have changing in direction, like a ring moving along a path to form a pipe in 3D. This function can be used when the area is not a square, and also making sure the whole area is covered with less overlapping flight path.
- The "Way Points" function allows you to draw a single flight path, not many paths back and forth in an area. Its flight path is formed by several segments. It can be used when you want the UAV to get to some specific points.

- Now let's move more into some more mission planning fundamentals to where you are going to focus more on an actual simulated mission. The last mission you created was pretty big, so we want something that is smaller to run our simulation. Set your mission to the approximate size and location seen in Figure 2 over PWA, with the settings provided below.
    - Altitude 300m / Relative Altitude Mode.
    - Overlap 80%, Sidelap 75%
    - Overshoot 100m
    - Selected Camera RX1R
- Set your Home, Takeoff, Rally, and Landing areas approximate to Figure 2. Locate the County Amphitheatre Park in West Lafayette

- Start by Doing a Sensor Initialize.
- Right now you should have a Wind speed and direction at 0.0m/s. As you know, this is highly unlikely and you will often have some wind.
    - In the upper right click on the wind icon and change the value to 5 m/s (about 11 mph/10 knots).
    - Then change the heading to 300 degrees (N/NW wind).
        - Note wind direction is ALWAYs the direction the wind is coming from.
    - *What do you see appear next to the landing icon? Please a screen shot and describe.*



- Figure 3: A fuzzy purple circle appears under the landing position, the parachute icon appears to the direction where the wind comes from (right).
- Now change the heading to 194 and the speed to 10 m/s.
- *Place a screen shot and describe the pattern change.*



- Figure 4: The purple fuzzy circle moved to the north of the landing mark.
- Keep the heading at 194, but lower the wind speed to 6 m/s

- The home location is where the plane is located and launched from.
  - *With a wind direction of 194, what direction should you face your catapult for launch? (Consult your demo notes)*
  - The catapult should face to 194 degree where the wind comes from.
- Now set the takeoff area to a safe location with an altitude of 80m and a radius of 120m
  - *What is the Takeoff area circle? How does it differ from Home? Describe its function*
  - The Bramor will fly into the takeoff area after it is launched. That's the area where Bramor will gain and reach the designated altitude. Home is the position where we launch the Bramor on the ground, but Takeoff area is in the air.
  - *Why should you know your study area for creating these settings?*
  - So the aircraft won't fly into the obstacles or elevations during takeoff..
- Set the rally area to 60m and with a radius of 110m.
  - *What is the Rally area circle? How does it differ from the takeoff circle.*
  - Before the Bramor land, it will fly here and approach in the rally area. In the rally area, the Bramor descends, but in the takeoff area, Bramor ascends.

    - *Why is it important to not have the rally point set at too high an altitude?*
    - The rally point has the same altitude with the parachute deployment. If the rally point is too high, i.e. the parachute deploys at a very high altitude, it may drift further with the wind.
    - *What about too low?*
    - It may hit the obstacle.
- Reinitialize the sensor and upload the waypoints.
- Enable takeoff to start the simulation. Watch the aircraft for about a minute
    - *Where does the aircraft head to?*
    - The aircraft was heading to north when launching, then flying in the takeoff area clockwise.
    - *Why is this an important part of the mission safetywise?*
    - This process will make sure that the aircraft doesn't fly into the obstacles on the way to the first waypoint.
- Enable the mission
    - *What icon do you hit to do this?*
    - "Navigate", it is on the left hand side of the screen.
- Engage the loiter icon
    - *What does the aircraft do?*
    - The aircraft is flying in a circle where the center is at when I hit "Loiter"
    - *Why might you do this in a mission?*
    - If we observe a large group of bird is flying by, we may pause the mission and wait for the birds to leave.
- Reengage the mission.
    - *What does the aircraft then do?*
    - It flies back to the waypoint one and start the mission from there.
    - *What altitude does it climb to?*
    - It climbs to 300 meters AGL.
- Let the aircraft fly its mission and then take a screenshot and place it in the blank below. Then answer the associated questions.

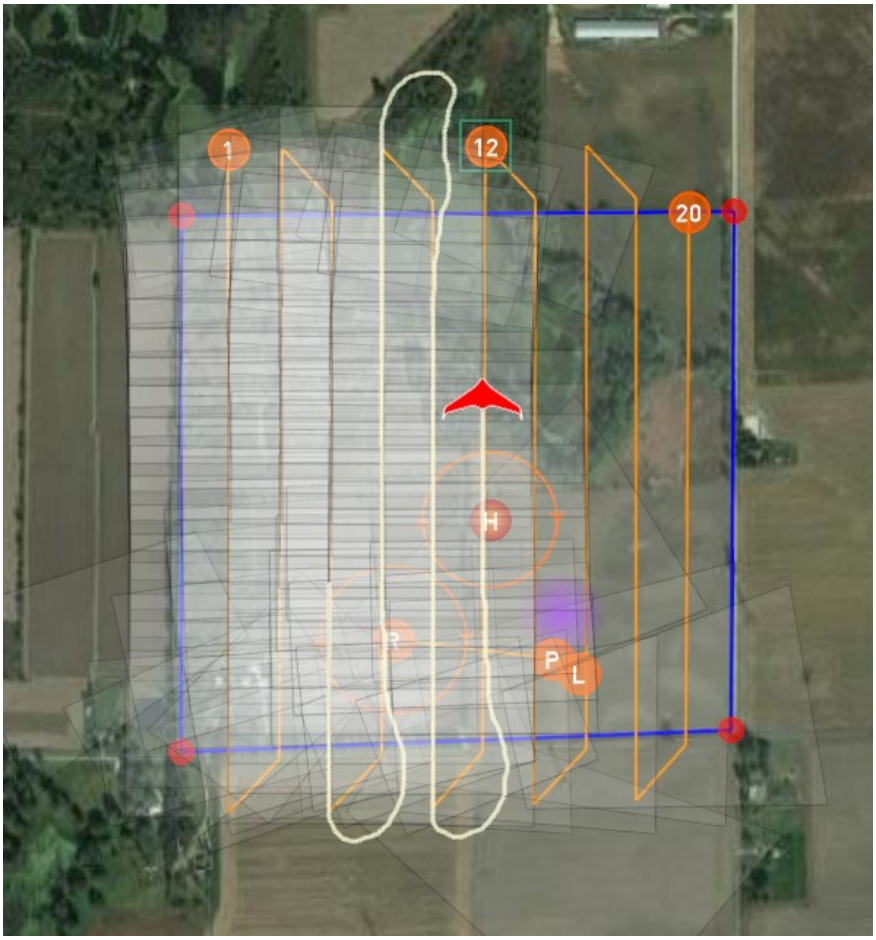
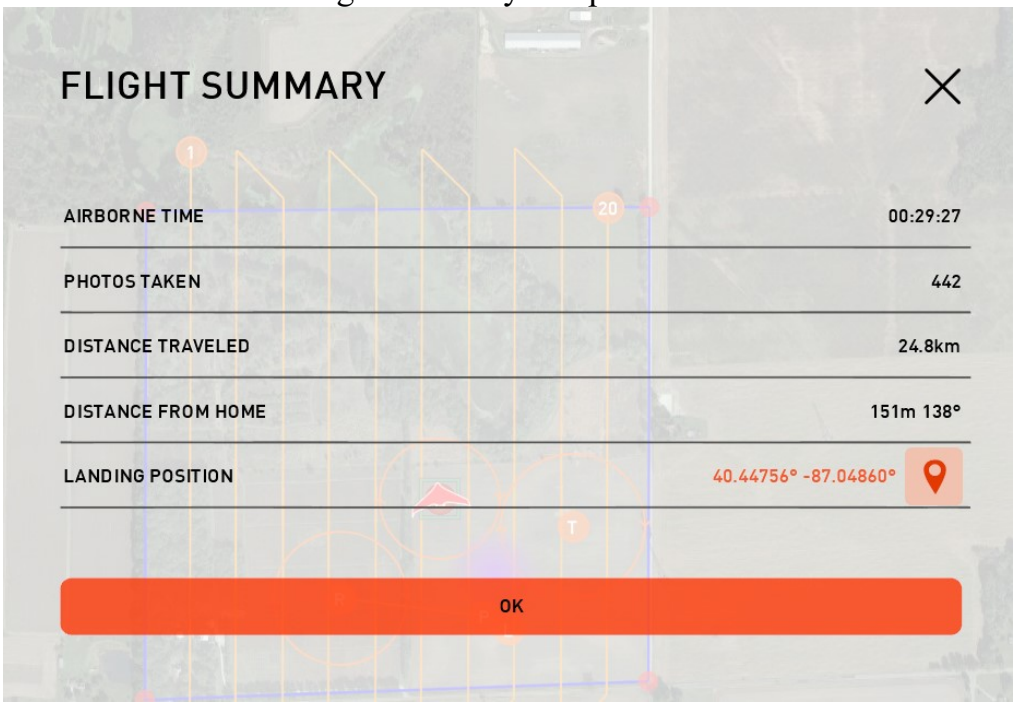
- 

Figure 5: Simulated flight over PWA.

    - *When does the camera start triggering?*
- It starts after the aircraft passes the first waypoint.
    - *Does it trigger outside the mission box?*
- Yes, it does, but it is not triggered when the aircraft is turning outside the mission box.
    - *What do you suppose the greyed rectangles represent? Why is this important to potentially simulate in mission planning?*
- The greyed rectangles represent what portion of the ground is taken in the picture. It is important to simulate because from this we can know how much time the flight takes, whether the whole area will be scanned completely, and know what should happen so we can compare it during the actual flight.
    - *Where does the aircraft head after flying all of the mission?*
    - The aircraft head to the home after passed the last waypoint.
- Now finish the entire landing sequence and answer the following questions
    - *Which icon do you press to move toward the landing sequence?*

- "Rally"
- *Describe the rally circle/action. What needs to happen to move into landing sequence?*
- The aircraft needs to fly into the rally area from home.
- *What happens to the altitude in rally when the landing sequence is engaged?*
- The altitude starts decreasing.
- *At what altitude did the parachute finally engage?*
- The parachute deploys at the height of 57 meters

- Take a screen shot of the flight summary and place it in the area below:



- Figure 6: Simulated flight summary above PWA

Part 4: Critical Though Questions. Provide a detailed response to each of the questions below: (This material was also covered in the demo)

- *Summarize what we covered regarding Mission Planning Essentials. Integrate how mission planning relates to pre-flight check lists.*

- The mission planning tells the aircraft where to fly. Without the navigation it can't fly. We have to make sure the home, takeoff, waypoints, rally, parachute, and landing area are set correctly. For the parameters of takeoff, rally, and landing, we must make sure the parameters are correct so the aircraft won't fly into the obstacles. The mission is correct on the computer is not enough, we also need to let the aircraft know what the plan is, so uploading the mission is also needed.
- *Think through the simulated mission the settings you created before the mission. Discuss what manual overrides can be done during a mission.*
- There are speed override and altitude override. They can be done during the flight. Override will be on automatically at the moment when the dialog of override is opened. The changes will be uploaded to the aircraft automatically. Speed override overrides the speed, and the altitude override overrides the altitude. To cancel the overrides, click "Cancel" in the override dialog.
- *Building upon the above, provide examples of when the pilot would want to interrupt the mission and go into loiter mode, return the aircraft to home, or head to the rally point.*
- We want to interrupt the mission when there is an unexpected incident or emergency. If we see a group of birds is flying by, we can let the aircraft go into loiter mode. Or even we are operating in a controlled airspace with permission, and there is a manned aircraft coming by, we have to wait the manned aircraft leave.
- *Now speculate upon and provide examples of when and if one might need to manually pop the parachute.*
- If there are any emergency happens on the aircraft, we might deploy the parachute manually. The emergencies could be fire which is caused by Li-Po battery, low battery voltage, broken propeller, unstable GPS signal, air speed not showing, broken wings, camera not working, flying away, collision with birds, etc.