

# Image Collecting by UAV

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Kyle Windland (Chief Test Engineer)

Kavya Venugopal (Test Engineer)

Seth Higginbotham (Test Engineer)

Hayden Metzger (Test Engineer)

Eric Sun (Test Engineer)

# Agenda

- Background & Purpose of Test
- Recap of Flight Test Plan
- Test plan modification
- Flight Test
- Image collection
- Conclusion

# Background

- Competition presented by the Association of Unmanned Vehicle Systems International Student Unmanned Aerial Systems (AUVSI SUAS)
  - Designed to reflect the current state of UAS
  - Foster interest in UAS
  - Challenge students with the design, integration, and reporting of a complex UAS
  - Capabilities must include autonomous flight/navigation, remote sensing via onboard payload sensors, and ability to execute specific set of tasks

# Purpose of Test

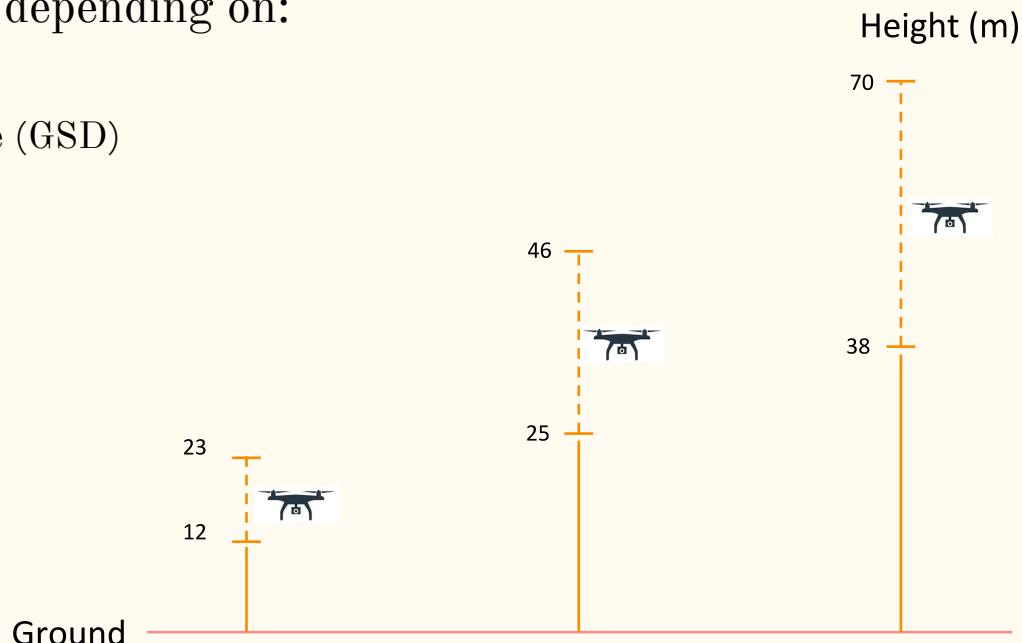
- Fly at different altitudes collecting images of ground targets in order to validate the neural network algorithm
  - Shapes
  - Shape Color
  - Alpha-Numeric
  - Alpha-Numeric Color



# Test Strategy

- 3 flights at different altitudes depending on:
  - Chosen camera
  - Desired ground sampling distance (GSD)

<b><u>Image Calculator for GSD</u></b>	
Parameter/Variables	Input Value
Sensor Width of Camera (mm) Sw	6.17
Real Focal Length of Camera (mm) Fr	3.92
Image Width (pixels) imW	4000
Image Height (pixels) imH	3000
Desired Ground Sampling Distance (GSD) (cm/px)	1.0
Mission Specifics	
Height of flight (Y) (m)	25.4



# Primary UAV

- The test plan called for one of these two drones to be used
- DJI Matrice 100 was utilized for flight test

**DJI Matrice 100**



- Specifications:
  - Development Platform
  - Flight Time of 20 – 35 minutes
- Use Cases:
  - Aerial Mapping
  - Traffic Monitoring

**DJI Matrice 210 RTK**



- Specifications:
  - Dual Camera System
  - Top Mounted Gimbal
  - Uses RTK (Real-Time Kinematic) GPS
  - Flight Time of 25 – 38 minutes
- Use Cases:
  - Bridge and Facilities Inspection
  - Aerial Mapping

# Primary Camera Systems

- Main Camera: Z3 – 3x (4K) Optical Zoom Camera (Mapping and Facilities Inspection)
- Backup Camera: X5/X5S – High Resolution Camera with interchangeable lenses (Mapping and Traffic Monitoring)



Z3 Optical Zoom  
Camera - Used for the  
Flight Test



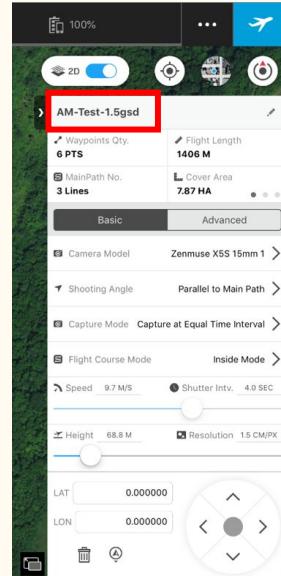
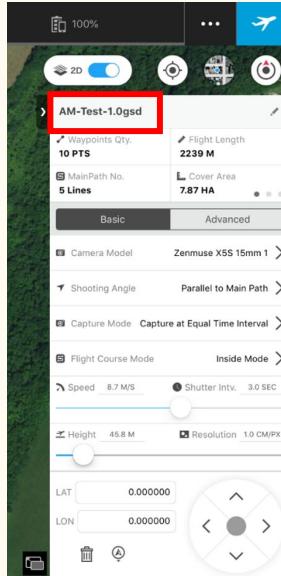
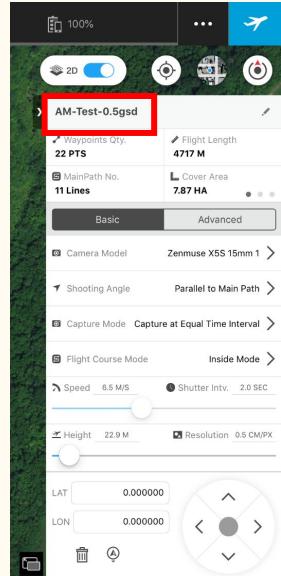
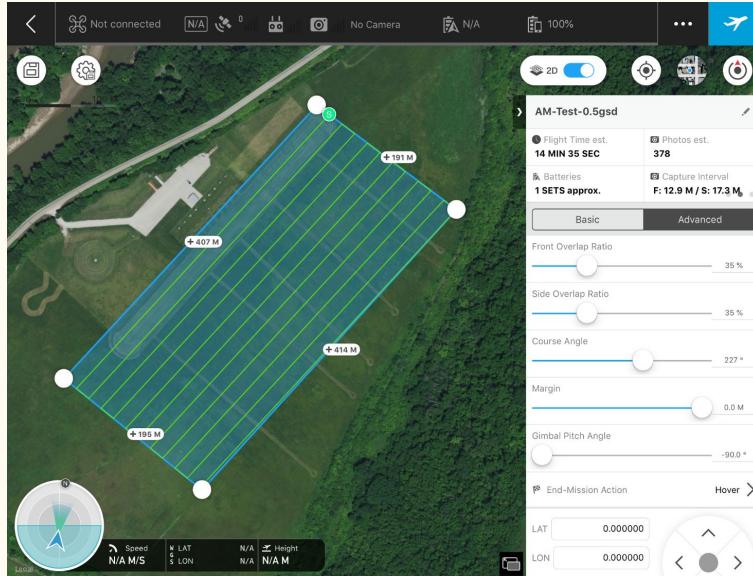
X5S with 15mm lens



X5 with 15mm lens

# Mission Planning

- Flight planned in the app



# Image Collecting

- Images collected via onboard SD card
- Images transferred from onboard SD card to PC
- Images verified in the field for accuracy and precision

# Risk Management Matrix

	Marginal	Critical	Catastrophic
Probable	4	8	12
Infrequent	3	6	9
Remote	2	4	6
Improbable	1	2	3



# Operational Risk Management

Problem #	Problem Description	Severity /Impact	Likelihood	Risk Value	Mitigation
1	Battery die during flight	Catastrophic	Remote	6	Operational Awareness
2	Ground station lose connection to the UAV	Critical	Probable	8	Maintain Unobstructed View of UAV
3	Electric fire	Catastrophic	Improbable	3	Check Electrical Hardware Prior to Launch & Have Fire Extinguisher On-Hand
4	Engine failure	Catastrophic	Improbable	3	Engine Maintenance Pre-Check
6	No GPS signal	Critical	Probable	8	Redundancy Checks Mid-Flight & Fly with Favorable Weather (In Accordance with Manual)

# Environmental Risk Management

Problem #	Problem Description	Severity/Impact	Likelihood	Risk Value	Mitigation
1	Sudden gust of wind	Marginal	Probable	4	Fly in Favorable Conditions (Pre-Flight Check)
2	Bird strike (Moving object strike)	Catastrophic	Improbable	3	Operational Awareness
3	Trespass to launch & recovery area	Marginal	Remote	2	Pre-Flight Checklist/Operational Awareness

# Location & Weather

- Location:  
AirMasters RC Flying Club,  
Miami Township, OH  
(39.155N, 84.789W)

- Weather:  
Forecast type: FROM:  
standard forecast or significant change  
Visibility: > 3 miles  
Ceiling: > 500 AGL



# Modification of Test plan

- Add Aerial Imaging Test Specific Risk Management

Problem #	Problem Description	Severity/Impact	Likelihood	Risk Value	Mitigation
1	Improper camera settings	Marginal	Probable	4	Pre-Flight Check of camera settings (frame rate, still images, video)
2	Loosened camera components	Critical	Remote	4	Ensure camera mounting system is securely attached
3	SD card memory space	Marginal	Probable	4	Clear the memory and insert into the camera

# Test Day

- Date: March 12th, 2019
- Time: 10:00 am ~ 11:00 am
- Location: AirMasters RC Flying Club, Miami Township, OH (39.155N, 84.789W)
- Weather:
  - Temp: 48 F
  - Wind: 0 mph
  - Condition: Cloudy

# Test Day (cont.)

- Test crew: team led by Bryan Brown
- Equipment: M100 + Z3
- Test process:
  - Go through the pre-flight checklist
  - Perform the flight test
    - 3 flight tests with each at specific altitude
      - low: 14.079 m
      - medium: 26.779 m
      - high: 39.752 m
    - Collect images
  - Go through the post-flight checklist



# Test Day - Targets

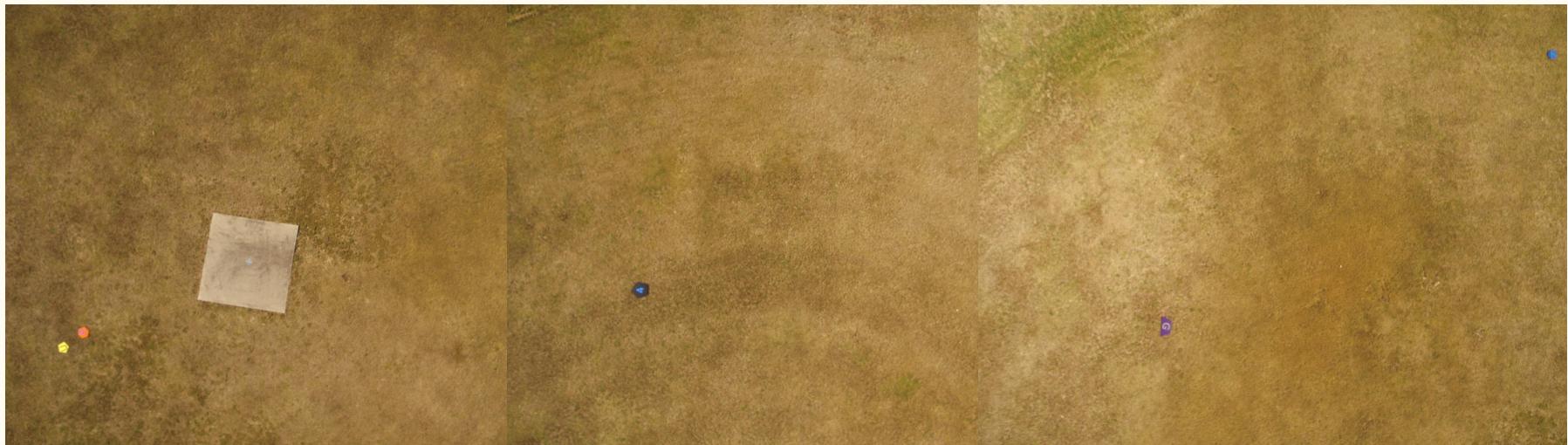
7 Targets

	Latitude	Longitude	Altitude	Orientation
Target 1	39.15447742	84.79018853	156.125	102.81
Target 2	39.15449358	84.79036481	155.957	46.32
Target 3	39.15439145	84.79049368	155.84	81.5
Target 4	39.15429732	84.79059338	155.786	90.48
Target 5	39.15425689	84.79042438	155.97	23.76
Target 6	39.15434006	84.79029442	155.971	N/A
Target 7	39.15433865	84.79028419	156.009	24.38



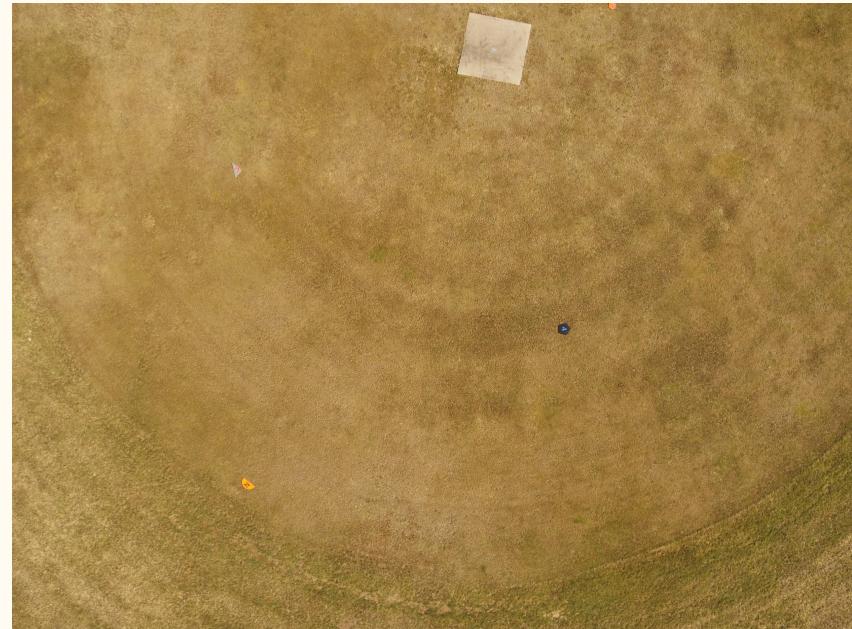
# Image Collection - Low Altitude

188 images collected



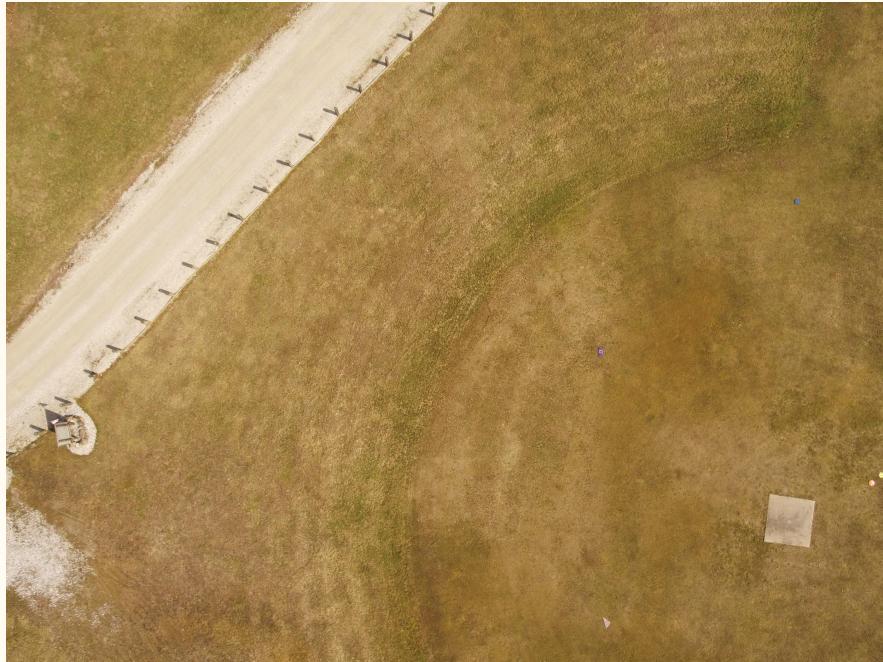
# Image Collection - Medium Altitude

44 images collected



# Image Collection - High Altitude

19 images collected



# Conclusion

- Flight Test Plan was followed and executed according to plan.
- A comprehensive flight test plan helped a lot in the flight test.

# Q&A

# References

- [https://www.faa.gov/news/fact\\_sheets/news\\_story.cfm?newsId=20516](https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=20516)

# Pre-Flight Checklist

- Verify FAA certificate number
- Check weather condition (record in flight log)
- Launch and recovery area free and clear of obstacles and people
- Brief roles and responsibility, weather conditions, emergency procedures and etc.
- Visually inspect the condition of the UAV components
- Inspect propellers, airframe structure, servo motors, avionics...
- Verify all systems have adequate energy supply
- Verify communications with UAV has acquired GPS location
- Verify all controller operations for heading and altitude

# Mid-Flight Checklist

- May not exceed a groundspeed of 87 kts (100 mph)
- Cannot fly higher than 400 AGL
- Cannot operate the UAV in a careless or reckless manner
- Cannot operate the UAV from a moving aircraft or from a moving vehicle
- Cannot operate the UAV during night
- Cannot carry hazardous material
- Cannot operate in a prohibited or restricted area without permission from the controlling agency
- Follow the data management plan

# Post-Flight Checklist

- Conduct debriefing with crew
- Complete UAV maintenance logbook
- Complete UAV flight log
- Complete pilots logbook
- Complete data manage plan

# Calculating Ground Sampling Distance (Z3)

## Image Calculator for GSD

Parameter/Variables	Input Value
Sensor Width of Camera (mm) Sw	6.17
Real Focal Length of Camera (mm) Fr	3.92
Image Width (pixels) imW	4000
Image Height (pixels) imH	3000
Desired Ground Sampling Distance (GSD) (cm/px)	0.5
Mission Specifics	
Height of flight (Y) (m)	12.7

## Image Calculator for GSD

Parameter/Variables	Input Value
Sensor Width of Camera (mm) Sw	6.17
Real Focal Length of Camera (mm) Fr	3.92
Image Width (pixels) imW	4000
Image Height (pixels) imH	3000
Desired Ground Sampling Distance (GSD) (cm/px)	1.0
Mission Specifics	
Height of flight (Y) (m)	25.4

## Image Calculator for GSD

Parameter/Variables	Input Value
Sensor Width of Camera (mm) Sw	6.17
Real Focal Length of Camera (mm) Fr	3.92
Image Width (pixels) imW	4000
Image Height (pixels) imH	3000
Desired Ground Sampling Distance (GSD) (cm/px)	1.5
Mission Specifics	
Height of flight (Y) (m)	38.1