Our Experiences with UAVs in Coastal Monitoring at Gator Lake

Capt. Joe Morrow
MRD Associates, Inc. – Destin, Florida
Disclaimer:
MRD Associates, Inc. does not provide commercial drone services and was not paid for these services under the Gator Lake Breakwaters Monitoring contract. All work presented was for research and development only.
OVERVIEW

• Purpose
• Equipment
• Use Cases
• Acquisition and Data
• Limitations
• Value Added for Your Client
PURPOSE & GOALS

• What Can Using a Consumer Level Off-The-Shelf Drone Add to Coastal Monitoring Applications?
  – Qualitative Assessment of Project Performance?
  – Volume Changes?
  – Shoreline Response?
  – Construction Observations?
  – Georeferenced Aerials?
PHANTOM 3 PROFESSIONAL
SPECIFICATIONS

- **Cost:** $1,200 (2015/2016)
  - $750 (2018)
- **Flight Time:** ~15-17 Minutes
- **Camera:** 12.0MP 4K UHD Sensor
- **GPS+GLONASS Positioning Sensor**
- **Barometer**
- **Ultrasonic Height Sensor**
- **Accelerometers/Gyroscopes/etc...**
ACQUISITION AND PROCESSING

- **Pix4dmapper ($$$$$)**
  - Free App + Paid Subscription ($350/m)
- **DroneDeploy ($$$)**
  - Free APP + Paid Subscription ($99/m) -> ($350/m with GCPs)
- **MapsMadeEasy ($)**
  - $5 - $30 APP + Pay as You Go/Per Job ($350 -> ~21,000 Pts.)
  - Enough to cover ~11,000 Acres
- **DJI Go (Free)**
  - Manual Capture
- **OpenDroneMap (Free)**

*Costs taken from company websites on January 29, 2018*
OUR PROCESS

• Pre-flight Planning
  – DroneDeploy Mobile or Desktop APP
  – Research TFR’s, Weather, No Fly Zone’s
  – Equipment and Surrounding Check Prior To Take off

• Acquisition
  – DJI Go & DroneDeploy Mobile APPs

• Post Processing
  – Uploaded Images to MapsMadeEasy for Georeferenced Stitched Aerial
  – Utilized AutoCAD for Final Georeferencing of Aerial
MISSION PLANNING (DRONEDEPLOY)

- 389’ AGL
- 1.4” per pixel
- ~120 Acres
- 60% sidelap
- 70% frontlap
- 34 mph (max)

*Note: Flight Path did not encroach into any known restricted airspace.*
ACQUISITION WITH GCP’S
FLIGHT LOG

• Aerial Cartographics of America, Inc. (ACA)
  – March 15, 2017

• MRD Associates, Inc. (MRD)
  – February 2, 2017
  – May 16, 2017
  – August 2, 2017
  – September 18, 2017
  – November 20, 2017
  – Ongoing....
USE CASES

• Marketing Images and Video
• Construction Observation
• Site Conditions
• Shoreline Changes
• DEM, DTM, DSM...
• Volumes ??? (mehhh)
MARKETING IMAGES
SHORELINE CHANGES

November 2017

February 2017
DEM’S

May 2017

September 2017

November 2017
VOLUME CHANGE ANALYSIS

• Options Exist...
  – MapsMadeEasy Online tool
  – ACAD Civil 3D
  – DEM & LAS Data Sets
  – Pick your favorite surface generating program...

• Would I trust the results?
  – mehhhh
POST-PROCESSING OPTIONS

• Pix4Dmapper
• Maps Made Easy Online Editing
• AutoCAD
• Hypack
• DroneDeploy (not evaluated)
• Others...
PIX4D PROCESSING
PIX4D AND MAPS MADE EASY OUTPUTS

- **2D Outputs:**
  - Orthomosaics in GeoTIFF Format
  - Google KML Format
  - Others...

- **2.5D Output:**
  - DSM and DTM’s in GeoTIFF Format

- **3D Output:**
  - Point Cloud in .las, .xyz and .ply formats
  - Contour Lines in .shp, .dxf, and .pdf formats
  - Others...
PROCESSING RESULTS

• How accurate is accurate?
  – 30 feet
  – 5 foot
  – 1 foot
  – 1 inch

• What are your goal(s)?

• What is an acceptable RMS Error?
  – Typical DEP Upland Survey Criteria requires RMS no greater than 0.1’ for Horizontal and Vertical Control
LOCATION ACCURACY

- MapsMadeEasy (with and without GCP’s)
  - Horizontal RMS Error (ft): >25’
  - Z RMS Error (ft): Varied Greatly >10’
  - No Method to Tweak Results
LOCATION ACCURACY

• Pix4D Processing (w/o GCP’s)
  – X RMS Error (ft): 9.8*
  – Y RMS Error (ft): 6.8*
  – Z RMS Error (ft): 3.6*

• Pix4D Processing (with 11 GCP’s)
  – X RMS Error (ft): 3.79
  – Y RMS Error (ft): 3.03
  – Z RMS Error (ft): 1.55

• ACA Aerial (03/2017) Horizontal RMS Error (with 4 GCP’s): 0.07’
VOLUME CHANGE ANALYSIS

Elevation (feet, NAVD 88)

Drone (Post Processed with Pix4D)

Survey
IMPROVING ACCURACY

• Survey Markers & GCP’S
  – More may or may not be better
  – Location of the GCP’s
• Add more overlap (forward and side)
• Lower Altitudes
• RTK GPS
• Another UAV
LIMITATIONS

• Flight Time
  – %30 Rule
• Camera Sensor
• Flight Restrictions (TFR’s, Military Bases, Airports, etc...)
• Pure Water Shots
• Software Options
  – Garbage In...Garbage Out
LIMITATIONS (POST-PROCESSING)
LIMITATIONS (POST-PROCESSING)
CONCLUSIONS

• Qualitative Assessment of Gator Lake Breakwater Performance?
  – YES!

• Shoreline Response?
  – YES!

• Georeferenced Aerials
  – YES! (with some work)

• Volume Change Analysis
  – Possible, but significant planning and post-processing efforts required
CONCLUSIONS

• Will This Equipment Replace Your Surveyor?
  – Absolutely Not

• Could The Phantom 3 Professional be used as a substitute to LIDAR?
  – Absolutely Not

• Is it Great for a Qualitative Assessment of the Project Performance and its Surroundings?
  – Absolutely 😊
CONCLUSIONS

• The Good
  – Shoreline Changes and Project Performance
  – Construction Observation

• The Bad
  – Utilized ACA Aerial for Ultimate Geo-referencing of Aerials
  – Volume Calculations not realistic

• Value added to your Products
  – Marketing Images and Video
  – Project Promotion Material
  – Another Perspective for your Client to see the Final Project as well as Interim and Post Project Updates
THANK YOU!