



Evaluation of three technical modifications that will significantly improve the application of small UAS technologies



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Mission Concept Review

Summary:

The APH-22 is an already proven platform for photogrammetric research and aerial surveys. With the addition of 3 new pieces of equipment, the SWFSC UAS lab seeks to improve the capabilities and usefulness of the platform. These are: Gimbal, Laser altimeter, modified APH-22 breath sampler.



Mission Objective: Laser Altimeter

- Accurate altimetry reading is important for photogrammetric accuracy.
- Distance from surface of water is difficult to estimate due to tidal range. UAS reads altimetry in distance above Mean Sea Level (MSL) and distance above the take off point.
- Laser altimetry is necessary to determine the exact distance above animals at the water's surface.





Mission Goal: Laser Altimeter

- LightWare SF11/C
- Incorporate laser altimeter data into on-board flight control system/data recorder
- Demonstrate laser altimeter accuracy over ground using known target size
- Demonstrate laser altimeter accuracy over water by ground-truthing with floating calibration targets



Risk Assessment: Laser Altimeter



Technical: 2,3

Cost: 1,1

Schedule: 2, 3

(Updated per GPR 7120.4D guidance)

LIKELIHOOD	Very High	High	Moderate	Low	Very Low						
	> 50%	25% - 50%	15% - 25%	2% - 15%	0.1% - 2%						
	> 75%	50% - 75%	25% - 50%	10% - 25%	2% ≤ 10%						
	5	4	3	2	1						
						Tech	1	2	3	4	5
						Technical	No KPP impact / no tech required	Minor impact to KPP / mod to existing tech required	Moderate impact to KPP/ some new tech required	Significant impact to KPP/ mod new tech required	KPP cannot be met / major new tech required
						Cost	≤ 1% increase	≥ 1% but ≤ 2% increase	≥ 2% but ≤ 5% increase	≥ 5% but ≤ 8% increase	> 8% increase
						Schedule	No slip	Non-critical slip 1-2 mo	Non-critical slip 2-3 mo	Non-critical slip 3-4 mo	Slip on critical path, launch date
CONSEQUENCES											

Criticality	L x C Trend	Approach
High	↑ Increasing (Worsening)	M – Mitigate
Med	↔ Unchanged	W – Watch
Low	↓ Decreasing (Improving)	A – Accept
		R – Research
		* - New



Mission Objective: Gimbal mount

- Pitch and roll angle of the hexacopter causes exaggerated images since the camera is not constant.
- Images that are skewed in this manner are less useful to for photogrammetry since they cannot be measured as accurately.
- A motorized gimbal mount for the Olympus EPM-2 will smooth video feeds and keep the camera angle relative with the water's surface constant.



Mission Goal: Gimbal mount

- Brushed motor gimbal built by Aerial Imaging Solutions incorporated seamlessly with existing APH-22 software.
- Demonstrate efficacy of motorized gimbal on ground targets of known size while flying at steep approach angles.
- Determine gimbal's improvement of video feed during maneuvers vs a solidly mounted camera.

Risk Assessment: Gimbal



Technical: 2,2

Cost: 2,1

Schedule: 2, 3

(Updated per GPR 7120.4D guidance)

LIKELIHOOD	Very High	High	Moderate	Low	Very Low		1	2	3	4	5
	> 50%	25% - 50%	15% - 25%	2% - 15%	0.1% - 2%	Tech	1	2	3	4	5
	> 75%	50% - 75%	25% - 50%	10% - 25%	2% ≤ 10%	Cost/Schd	1	2	3	4	5
	5	4	3	2	1						
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Low	↓ Decreasing (Improving)	A – Accept
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		* - New



Mission Objective: Breath Sampler

- Cetacean breath sampling can be done more effectively from a drone than traditionally from a boat.
- Drone breath sampling is both easier for the scientists and safer/less stressful for the animals.
- The APH-22 has been used to collect breath samples, but a more water resistant hexacopter will be required for continued use.



Mission Objective: Breath Sampler

- “Anita” class APH-22 variant being designed by Aerial Imaging Solutions
- Standard APH-22 hexacopter with a water resistant composite body shell
- Demonstrate acquisition of useable amount of breath sample using hexacopter and quadcopter
- Determine if significant difference of breath sample collection exists between the hexacopter vs quadcopter



Proposed Schedule / Flights

—Breath Sampler

- Preliminary laboratory smoke tests May 24 and 25
- Field tests TBD

—Gimbal

- Ground tests over targets of known size at Descanso Ranch
- June-July 2016

—Laser Altimeter

- Ground tests and calibration at Descanso Ranch (Fall 2016)
- In field testing in Antarctic (Fall – Winter 2016-2017)
- In field testing during gray whale survey (Spring 2017)



GENERAL CONOPS

Trained flight team consisting of one pilot and one ground station operator (GSO).

After calibration, hexacopter takes off while being held by GSO. This allows for a more stable take off platform while aboard vessels and moves the hexacopter away from the ground/deck.

GSO monitors real-time video feed and telemetry data from hexacopter, including: GPS status, battery voltage, magnetic heading, altitude, and distance over ground.



GENERAL CONOPS (cont'd)

Pilot responsible for controlling aircraft, performing operations, and maintaining safe flight attitude. Must maintain visual contact with aircraft at all times.

Flights are ended when battery voltage reaches 14.5v to allow ample time for landings.

Landings are done manually with the GSO used to “catch” the aircraft, rather than landing on the ground/deck.



Performance Metrics

APH-22 Modification	Current TRL	Performance Metric	Anticipated TRL if Metric Achieved
Laser Altimeter	6	Obtain accurate altitude consistent with ground truth	7
	6	Successfully integrate into flight system	7
Gimbal	6	Demonstrate ability to stabilize camera feed	7
	6	Successfully integrate into flight system	7
Breath Sampler	6	Successful flight test in Jamul testing grounds	7
	6	Successful collection of cetacean breath sample	7