Skyhook/Skyshot Helikite Standard Operating Protocol

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Introduction

A Helikite is an inflatable, tethered hybrid flier that consists of a disk-shaped helium balloon, a kite, and an aerial photo bracket. The balloon provides buoyance to loft into the air, the kite provides orientation and stability against the wind, and the bracket allows you to connect a suitable digital camera for continuous collection of photos.

See http://www.allsopp.co.uk for details, options, and pricing. The unit comes from the UL and the cost is roughly $1,500 for a basic 1.6 m^3 Skyshot that can loft an appropriate 10-15 MP digital camera.

Purpose

This technology enables the user to collect aerial photos in the 0-500' altitude range. It is then possible to mosaic the images together using appropriate software, such as Agisoft Photoscan.

If one desires to "georectify" the mosaic so that it may be used to overlay on other imagery or data, then it is necessary to lay out and survey ground-based aerial targets. These can be used in ArcGIS to create match points between data points and targets in photos. The more targets used and the more distributed throughout the area of interest the better. Any photo areas outside the region bounded by the targets will not georectify and will look badly warped.

Ground-Based Aerial Targets

It is recommended to purchase or create aerial targets that you can place on the ground to establish known points with known geographic coordinates. Thin plywood sheets 2'x2' square are ideal. They should be painted black with very large white letters on them. The important thing is to have high contrast with the ground. For shallow underwater locations, you can take a 5-gallon bucket and place into it cobbles painted with bright fluorescent colors. These markers won't be numbered, but you can see them clearly in aerial photos and they can hold up against low to moderate velocities.

There also exist commercial aerial targets that you can buy at stores that serve surveyors, such as California Surveying and Drafting in Sacramento, CA.

Buying Helium

1. You need a vendor to get helium. There is a long-term national shortage in helium, so it can be challenging to get it, so plan ahead.
2. A primary vendor for helium in our region is Airgas, which is located Woodland, Sacramento, Yuba City, and elsewhere.

3. Check with your institution to see if you have an account and what that number is. Then call Airgas, give them your account number. Call ahead to make sure they have it on hand.
4. The first time you go, they will give you a full tank. We usually get one 80 cubic foot (cf) tank or two 40 cf tanks.
5. If you have one or more empty tanks, then take those and exchange them at the store for a new one.

Blimp Transport

6. Before leaving campus, be sure that you have all supplies needed by using the blimp field checklist. Check that you have all items on the list and you are ready to go.
7. Items loaded in the truck bed are the helium tanks, blimp, car battery, wooden tiles, and linoleum tiles.
8. First load in the helium tanks and secure them to the truck with the clamp straps. Use one strap around the bottom of the two tanks to secure them together. Use a second strap to secure the two tanks to the truck, using the hook on the truck rack at the truck cab to help hold the strap in place during transport. Use a third strap to secure the tanks to the truck at the neck of the tank safety caps.
9. Place the 12 volt battery between the wheel well and the inside helium tank, against the side of the truck bed.
10. Now load the blimp and tarp diagonally across the truck bed. Place the wood tiles equally across the tarp then spread the linoleum tiles evenly across the tops of the wood tiles to hold everything in place. The driver should watch for tarp blowing up from the truck bed – and stop to rearrange the tiles as soon as this occurs. With all tiles evenly spread, this should not happen, but you should check the arrangement from time to time.
11. All other equipment goes into the truck cab.

Tile and Blimp set-up

12. Once at the site, set up tiles and GPS their coordinates before doing anything with the blimp. This is the most time consuming part of the whole effort. The more tiles you lay out, the more tiles you will get in a photo closer to the ground and the better the ability to accurately stitch together the photos. Make a crude map of tile numbers and locations so that you can match up pictures and tiles for analysis.
13. Prepare the helium tank using plumbers tape on the connector and tightening the pressure regulator onto the helium tank. Open the tank valve and check for leaks. I found that there was a small leak even with plumbers tape, but not too bad (could be the individual tank).
14. Attach the clear plastic hose to the helium tank hose barb. When putting away equipment, be sure this item is on top of the pressure regulator rather than underneath it, to prevent damage to the hose.
15. Move the tarp and blimp to the top of the truck cab. Determine the blimp's direction – the input valve has to be adjacent to the tank so that the plastic hose remains attached to the blimp during the fill procedure. Be sure the two release valves on the opposite side of the blimp are closed before starting to fill the blimp.

16. At this point, attach the blimp to the truck with a green clamp strap. Use the white blimp loop located near the junction of the stays for this attachment. It is very important that the blimp is attached to you or to a solid object at all times!
17. Now attach the black-taped end of the hose to the blimp, and turn the smallest knob on the pressure regulator to begin filling. If the helium is noisy at the input valve, simply open the small knob some more. The large knob can also be manipulated. I believe it regulates how fast the helium from the tank can flow through the pressure regulator.
18. It does not take long to fill the blimp, about 5-10 minutes. There is a string that is attached at the top and bottom of the blimp that assists in navigation. While filling, position this string so that as the blimp tightens, the string on the fill side is positioned close to the input valve and the string on the far side is positioned between the two release valves.
19. Toward the end of the fill, it is possible that the pressure inside the blimp will pop the plastic hose off of the input valve, so you may want to hold the valve/hose connection at this point. Note: the whole valve pulled out of the blimp during one deployment as I was pulling the plastic hose off of the valve. The valve is now inserted further into its opening and seems to be doing fine. The position of the valve no longer permits the valve cover to attach to it. This does not seem to be a problem either in flight or in storage.
20. The amount of helium used to fill the blimp is ~ 900-1000 psi. An entire helium 40 cf tank holds ~1800 psi, so you can get 2 fills per tank.
21. The blimp is full when the strings are tight and the multiple creases at the seam are smallish. Remember that the goal is not how much helium can we get in the blimp; all we want is enough loft so that the blimp is capable of lifting the camera.
22. During the fill time, you should be straightening out the blimp's stays, positioning the blimp strings, tying the ribbons to the stays (do not make knots!), and generally making sure that the blimp's mechanics look functional.
23. Once the blimp is full, tie the kite string to the blimp feeder string. We've attached the string to the blimp with knots, then have duck-taped the entire connection for safety.
24. Before moving the blimp, be sure to attach it to your body in some way! The blue clamp strap works well cinched onto the kite winder handle then knotted onto a belt loop.
25. Now get the camera ready.

Digital Camera Information

In order to collect aerial imagery, you need a digital camera that has either a "continuous shooting" mode or time lapse capability. This changes over the years, but the Canon Powershot has long had this capability, so this is the camera referred to in this protocol. Three of the Canon Powershot models we have used are the SD900, SD990, and S110, of which the SD990 was the best.

26. The settings for the Canon Powershot should be flash on, manual, continuous, and ISO400. Be sure the battery is fully charged and that the memory card is empty. Make sure that the maximum resolution is being used. For a 16 GB card, that should yield ~2400 potential pictures. If the camera says there are 9999 pictures remaining, it tells you the resolution is too low.
27. Attach the camera to the blimp once the settings are confirmed.
28. The last thing before launching the blimp is to set up the open shutter on the camera. Saving this for the final step will save you a bunch of pictures.
29. Use the device sent with the blimp for holding down the shutter. Use two rubber bands to secure it to the camera. Make sure the camera is clicking away as you loft the blimp.
30. To empty blimp, open the two release valves and gently assist pushing helium out of the blimp. Blimp needs to be completely empty before wrapping it into the tarp. Detach the short stay as before from its ribbons and fold it along the other stay for ease of transport.

Blimp Flight Guidelines

1. FAA regulations only permit a maximum flight height of 500', but the blimp often goes at an angle, so the spool has up to 1000' of string. The string is colored so that every 50' has a different color, which allows you to track how much you have let out.
2. How high up you go depends on how wide the channel is and what resolution you are aiming for. ~250' seems like an ideal balance, but if the channel is too wide, then you might have to go up to the full 500', but the closer to the ground the clearer the pictures. As cameras increase in resolution, then this is less of a problem.
3. The best approach to using the blimp is to go right up to the maximum height of 500' and do a run along the river at that height. Then drop down to the preferred height and do another run at that height to get the maximum resolution with reasonable coverage.
4. Depending upon wind conditions, it may take lots of blimp manipulation (more or less height via the kite string), walking, or boat maneuvering to get the shots needed. Wind plays a big role in how much effort it takes to reel in the blimp.
5. If the blimp simply will not go up, then that tells you there is an air inversion taking place. This usually happens when hotter air gets trapped under cooler air, which we have seen several times in canyons. The cooler air prevents the blimp from rising. There is no solution other than to hold off until the next morning or when conditions change.

Notes on blimp/camera

1. You will be able to see the flash flashing, so you should be able to tell if the camera is still taking pictures. I've tried the 'no flash' setting and it uses up the memory card space in less than five minutes – not good.
2. Typically I have the blimp lofted for 30-60 minutes per deployment. Just keep looking for the flashes and as long as that is going, then you know you are good.

3. The camera takes pictures every 5-20 s, slowing down over time. It helps to count out so you know to steady up when a photo is about to be taken.
4. The most tedious part of the deployment is reeling in the blimp. It is also the hardest part if it's windy.
5. Did I mention to always have the blimp tied down? We don't want to lose it!
6. If it is windy, you may want to weigh down the tiles with a rock so they don't blow off of their GPS location.
7. It's easy to re-deploy the camera again and again once the tiles are in place.
8. Recharge the camera battery between deployments!! The one battery will run out of power more quickly than our desire to get more pictures. Plug the battery and recharge unit into the inverter as soon as you have downloaded the pictures and erased them from the memory card.
9. Use the time in between deployments to have a good look at the latest pictures. Use knowledge from previous deployments to figure out where you might need to walk/boat to get pictures of other needed areas.

Blimp deployment
Field Check List

laptop computer, fully charged
computer power cord
waterproof computer case

camera
camera battery, fully charged
camera manual
USB cord from camera to computer
camera battery recharger
shutter hold-down used for deployment

tarp
kite-blimp wrapped inside tarp
numeric tiles, wooden
linoleum tiles, all

Items in white bucket:
blue clamp strap
two green clamp straps
two rubber tie-downs
duct tape
thread tape for pressure regulator
wrench to tighten pressure regulator
kite string and winder
rubber bands
zip-ties
repair kit for blimp
tape measure
two pairs of gloves
extra ziplock bags
first aid safety manuals
boating rules
extra rope at bottom of bucket
sponge

GPS case
GPS data logger
GPS antenna
GPS antenna pole (two pieces taken apart will fit into bottom of case)
GPS batteries(4), fully charged

12v battery, fully charged
power inverter
pressure regulator
air hose from tank to blimp (inside pressure regulator box)
two helium tanks, with safety tops

hedge clippers
caliper
swiss army knife

First Aid kit
life jackets
towel to shade computer, if needed

clipboard
data sheets
pencils/pens/sharpie

	Length of Spool out (ft)											
Angle (•)	**50**	**100**	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**	**550**	**600**
20	17	34	51	68	86	103	120	137	154	171	188	205
25	21	42	63	85	106	127	148	169	190	211	232	254
30	25	50	75	100	125	150	175	200	225	250	275	300
35	29	57	86	115	143	172	201	229	258	287	315	344
40	32	64	96	129	161	193	225	257	289	321	354	386
45	35	71	106	141	177	212	247	283	318	354	389	424
50	38	77	115	153	192	230	268	306	345	383	421	460
55	41	82	123	164	205	246	287	328	369	410	451	491
60	43	87	130	173	217	260	303	346	390	433	476	520
65	45	91	136	181	227	272	317	363	408	453	498	544
70	47	94	141	188	235	282	329	376	423	470	517	564
75	48	97	145	193	241	290	338	386	435	483	531	580
80	49	98	148	197	246	295	345	394	443	492	542	591
85	50	100	149	199	249	299	349	398	448	498	548	598
90	50	100	150	200	250	300	350	400	450	500	550	600

Angle (•)	**650**	**700**	**750**	**800**	**850**	**900**	**950**
20	222	239	257	274	291	308	325
25	275	296	317	338	359	380	401
30	325	350	375	400	425	450	475
35	373	402	430	459	488	516	545
40	418	450	482	514	546	579	611
45	460	495	530	566	601	636	672
50	498	536	575	613	651	689	728
55	532	573	614	655	696	737	778
60	563	606	650	693	736	779	823
65	589	634	680	725	770	816	861
70	611	658	705	752	799	846	893
75	628	676	724	773	821	869	918
80	640	689	739	788	837	886	936
85	648	697	747	797	847	897	946
90	650	700	750	800	850	900	950

Use this table to determine the height at which the blimp is flying. The table assumes that there is no slack in the line. Remember to add the height from the ground to the position of the clinometer.