A Practical Guide to Elevated Imaging

This article is for the photography enthusiast who would like to take their camera to new heights. We will explore some cost-effective ways to easily capture elevated aerial views. Elevated imaging has some practical applications for documenting survey and engineering works.

Many of my fondest field survey memories are from days spent flying from mountain top to valley survey sites performing survey control for large and medium scale mapping in many locations within the province. We had the luxury of using a Twin Otter and a Beaver fixed wing aircraft to transport equipment and set up jet fuel caches for the helicopter. I always enjoyed the aerial views. It was a great way to explore our beautiful province.

The fixed wing and helicopters played another important role. We fabricated camera mounts to house 70 mm format Hulcher and Hasselblad cameras to take low level identification photographs of mapping survey control monuments and selected cadastral ties. The monuments were ground targeted with appropriately sized strips of signal cotton. The low-level photography was used to transfer the control locations to the mapping photography.

It seems like an era long gone for me. I spend almost all my work time indoors at a desk now. In order to rekindle my interest in aerial imaging, I developed a helium balloon imaging rig. The biggest obstacle was to develop a lightweight camera platform. My solution was to use a lightweight nylon strapping that fit around a 53" latex balloon filled with helium. When the balloon was completely filled it would cinch tight to a plexiglass camera mount at the bottom of the balloon. The camera platform had a simple locking tilt plate that could be set to a vertical or oblique viewing angle. The platform could also rotate horizontally 360°. I chose a lightweight (8 oz.) APS format camera.

In order to trip the camera shutter, I used an inexpensive (S100) 2 channel digital proportional radio transmitter and receiver. The receiver was linked to a custom built relay that was connected to trigger the camera's infrared remote control. The tiny infrared remote transmitter was mounted directly in front of the camera's infrared receiver. I simply had to toggle the radio transmitter from the ground location to electronically trip the camera shutter. The balloon imaging system was tethered using Tuff-line on a fishing reel that was mounted on a one-gallon plastic gasoline container filled with water. The container acted as a counterweight for hands-free operation of the transmitter.

My inaugural flight ended in disaster as I used 40 lb. test nylon fishing line which promptly snapped. I watched my red balloon drift out of sight - it kept going and going. I luckily did not have my camera on the rig. The kids that had gathered thought this was the greatest show and they kept asking me when I was going to do it again.

Tuff-line really does work and I went on to acquire some very good vertical and oblique images up to 500 feet above ground level. However, the system had some stability problems and it was not really practical to be reliably used as a production aerial imaging system.

A little research on the Internet will show that many others have tried this before me. There are quite a few commercial balloon/dirigible aerial imaging systems available. They are very expensive and require a large enclosed trailer to transport. These rigs also have many features such as a multi-channel transmitter to control tilt, pan, swing and also a live micro video camera view.

Kite photography is another method of acquiring aerial images. You will find many web sites devoted to this art and they show some very good results. Another option is radio controlled aircraft or helicopters. However, all these systems have too many limitations for practical production work in my point of view.

My next project was to explore the use of pole photography to capture elevated aerial views. This is a long way from high level airborne images, however, it has many practical applications. My goal was to develop a fast, portable and cost effective elevated pole imaging system.

I used a 24-foot aluminium window washing pole for my first experiment. The telescoping pole came in 3 twist locking sections. I designed a plexiglass camera mount with a tilt plate which was simply attached by a bolt mount to the top of the pole.

The shutter consisted of a stock 20-foot air release cable mounted along the length of the pole.

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I had to make a custom mount for the shutter release depressor that would firmly sit directly above the camera shutter button. This manual shutter release system was easy to use, inexpensive and reliable.

I attached a rod level bubble to the pole for levelling and a hinged compass mount for direction. I wrapped a coil of 1/4 diameter lead line to the bottom of the pole for a counterweight.

The system was fast and simple to operate. The camera was mounted to the tilt plate and turned on with proper exposure controls set. The pole was then extended, locked to the desired length and then raised to the vertical position. Photographs were taken by squeezing the air release shutter bulb. The compass was used to determine direction for taking overlapping images. The system enabled one to capture single oblique elevated views or a full elevated 360° panoramic image.

The only problem with this system was that it was a little difficult to raise and lower. I found that it was most practical to partially extend the pole to 18 feet. The sturdiness of the pole was marginal, especially at the 24-foot height, as the pole tended to sway somewhat depending on the weight of the camera.

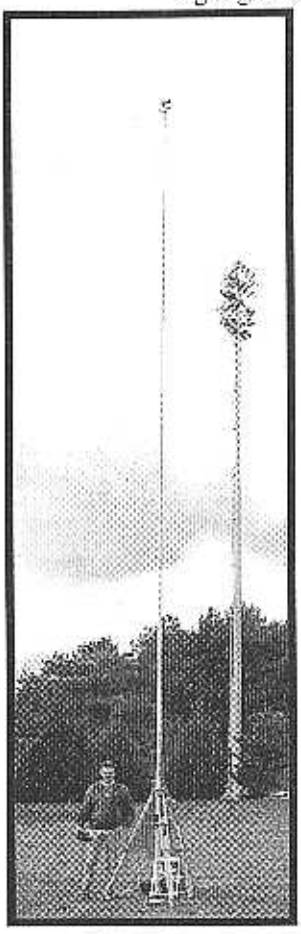

Photo 1 - Monopod fully extended to 40 feet above ground level.

Fibreglass painting poles are a better choice as they are much sturdier. They range from 12 to 18 feet in length. Some of the poles have interlocking buttons at one-foot intervals. This makes it easy to vertically raise the camera rather than extending the pole to full length along the ground and then raise it like a fulcrum to the vertical position.

Although 12 to 18 feet above the ground will capture some great elevated perspectives, I wanted to go higher. I went on to fabricate a pole imaging system that goes up to 40 feet above ground level (see photo 1). The system meets my design criteria - it is fast, portable, inexpensive and has a universal mount for both digital and film-based cameras.

Cameras - Digital vs. Film

Like many technologies today, both digital and film cameras are evolving at such a fast pace it is difficult to keep up with the latest improvements. Film is about the only option for high resolution medium format applications. Film cameras also have an advantage of being able to use many types of high quality film for various applications. Another advantage of film cameras is the ability to capture a high dynamic range (proper exposure over a wide range of highlights and shadows - excellent tone coverage).

Some of the latest generation of pro digital cameras are very attractive. The resolution is almost equivalent to 35 mm film format, the new chip sets capture very clean images, the dynamic range has improved dramatically and they perform well in low light situations. If you already have a large investment in a film camera (with lots of lens accessories) you may want to consider purchasing one of these new generation digital camera bodies (approx. $3500) that operates with your existing lenses - the Fuji S2 Pro is remarkable.

Another option that is more in line with my budget, is the prosumer model digital camera (approx. $1500). These cameras suit my needs, as they are lightweight, come with optional lens accessories and have a multitude of functions including full manual exposure settings. Image resolution is adequate for many applications and is quickly approaching a 35 mm film equivalent. The dynamic range is limited to about the equivalent of slide film. The current chip technology produces a noisier image (grainy in low light, chromatic aberration-bluefringing, etc.) however many of these deficiencies can be enhanced with image processing techniques.

Another option is the consumer level digital camera. Many of these cameras take very respectable images, however, they do not accommodate accessory lenses and offer limited operational functions.

The Internet provides a wealth of information and reviews of digital cameras which will help you make the right purchase decision for your application.

Image Capture and Processing

Once you have chosen your camera, there are many ways of obtaining useful images beyond the normal snapshot. For instance, many cameras include panorama stitching software which allow you to create up to a 360° horizontal field of view compiled image.

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Ideally, to enable easy image stitching, the photographs should be taken with the camera level and rotated about its nodal point with about 30% overlap between photographs. The stitching software automatically aligns, blends and creates a seamless image. Using care, the photographs for an outdoor scene can often be taken and stitched successfully without the use of a tripod.

If your digital camera did not come with stitching software, there are many freeware and inexpensive commercial packages available. Two notable freeware packages are:

Panorama Tools by professor Dersch at Website: http://www.path.unimelb.edu.au/~dersch/

PT Assembler by Max Lyons at Website: http://www.tawbaware.com/maxlyons/

These freeware programs are outstanding and are considered industry standards for panorama enthusiasts. If you would like to purchase a commercial package, I recommend that you look at the Panoguide review page. Website: http://www.panoguide.com/

Another noteworthy application is creating high resolution rectilinear images of survey/engineering or architectural works by stitching together a mosaic of images taken with a lower resolution digital camera. There are some excellent examples at Max Lyons website.

Photo 2 - Full 360 degree horizontal field of view by 180 degree vertical field of view spherical panorama taken at 30 feet above ground level.

Many powerful image processing and presentation software applications have been developed and are now readily available. The traditional static image presentation has evolved to become a truly immersive viewing experience.

My personal favourite use is to capture a series of overlapping photographs with my photopod at 30 or 40 feet above ground level that covers a full 360° HFOV by 180° field of view. I then stitch the photographs, with the aforementioned software into an equirectangal projection (see photo 2) of the image sphere. The resulting image can easily be presented in an interactive viewer over the Internet using a simple Java applet program. The viewer re-maps the image on the fly and displays it in a user re-sizeable viewing window. The user can zoom and pan in any direction to examine the image in detail from an aerial perspective. The viewing experience can easily be enhanced with sound and hotspot links to other images and even automated node to node fly-throughs. Another useful feature of the image processing software is the ability to extract rectilinear views anywhere within the image sphere. Extracting a nadir view from an elevated image sphere enables you to create a vertical aerial view (see photo 3). See photo 4 and 5 to see samples of elevated views taken from 30 feet above ground level.

Applications

I am sure some readers are saying to themselves that this all sounds like a fun hobby, but how does it apply to surveying/engineering? I think visual documentation of survey work is an important part of many projects. We traditionally document our work with hardcopy photographs. I encourage our members to look beyond the conventional photograph and look for opportunities to better document various works using some of the elevated imaging and panoramic techniques described earlier in this article. You may not have a fixed wing aircraft or helicopter mounted with a high end 70 mm camera, but I think we all have the means to fabricate an inexpensive pole imaging system or at least make use of tripod height partial or full 360° panoramas when applicable. Here are some practical projects where these techniques could be applied.

1. Accident Survey - Complement your traditional site plan with immersive elevated 360° panoramas, normal tripod height panoramas and elevated oblique still views for court presentation purposes.

2. Accretion and Natural Boundary Adjustment and Land Use/Zoning Applications - Elevated and panorama views would often help visually clarify field conditions.

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3. **As-Built Documentation** - Use elevated views to document various stages of as-built works.

4. **Mapping and GIS** - Create interactive maps, site plans, orthophotos and floor plans with links to elevated panoramas, etc.

5. **Resource Surveys** - Document hazardous waste sites, sensitive habitat, riparian zones, etc.

I am sure you will think of many more applications. In order to share experiences, I would be very interested in hearing from any members that use elevated and panorama imaging in their practice. If you would like to see some of my samples of immersive elevated 360 degree panorama's, you can visit my website at http://www.members.shaw.ca/hvi3/elevate.html The 40 foot photopod can be viewed at http://www.members.shaw.ca/hvi2/hvi-40/hvi-40.html

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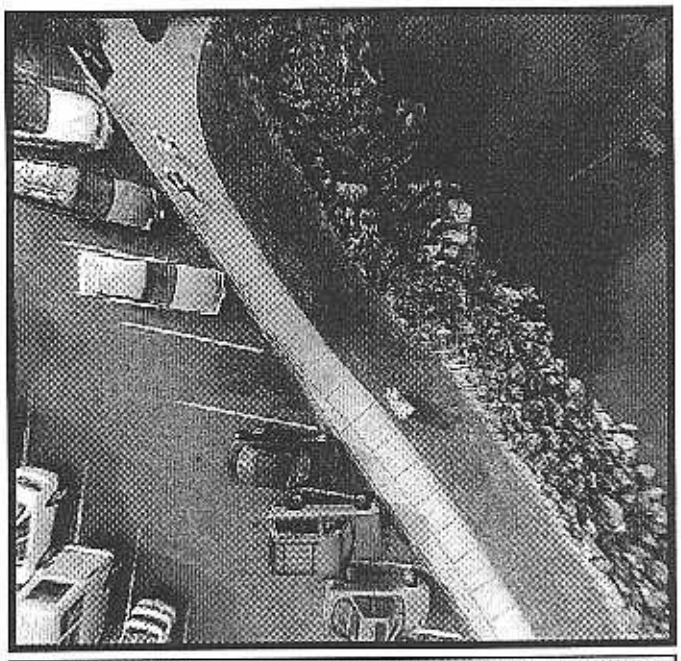

Photo 3 - Nadir view (looking straight down) extracted from panorama Photo 2 and having a resulting field of view of 120 degrees by 120 degrees.

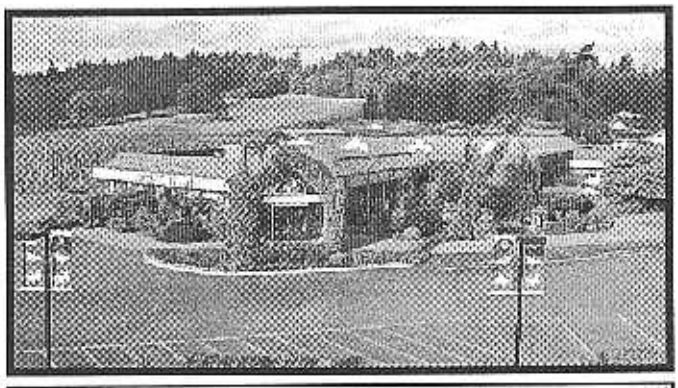

Photo 4 - Aerial view of commercial property taken at 30 feet above ground level ... a single wide angle image using a 19 mm lens.

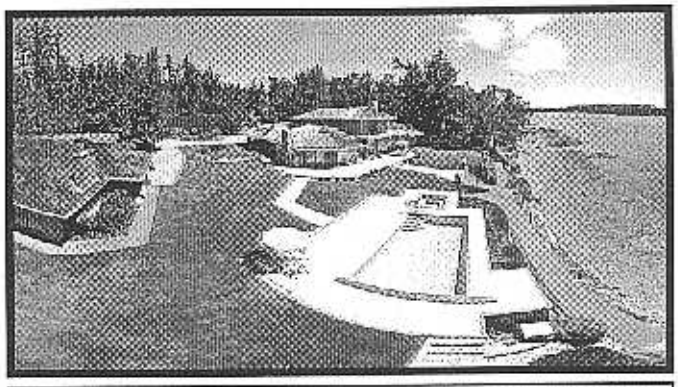

Photo 5 - Aerial view of residential property taken at 30 feet above ground level ... a super wide angle view cropped from an equirectangular format panorama.

Halloween Survey

This being the Halloween season, the season of skeletons in part, perhaps it would be best to get a Halloween survey skeleton out of the way.

Several years ago, shortly after I had become the owner of a survey business (which was in itself a scary enough proposition), I had some work to do in Haida Gwaii and happened to go there with my helper on Halloween. We worked through the day near Queen Charlotte City, then went to our accommodation which was part of a motel but looked like a residential home from the street.

Being completely concerned with the job at hand, it hadn't even occurred to me that it was Halloween, let alone that our accommodation looked like any other house on the street. So, we didn't expect any knocks on the door and didn't have any Halloween handouts.

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