Overview

Our focus at Harbortronics is on developing camera controllers, but we do get a lot of questions regarding long term site monitoring. Hopefully the notes below will ease your development!

Cameras

The end product for a great number of these projects is a time-lapse video. Note that full screen video resolution is about 640x480 pixels, which is only 1/3 Megapixels. Even HDTV quality video is only about 1 Megapixel. The required picture resolution is really quite low, compared to the resolution available with the latest digital still cameras. It's quite easy to take higher resolution pictures and downconvert them to VGA size for creating a movie. Any of the digital cameras from the last 5 years are able to produce high resolution images, and most customers are satisfied with the quality of the images from the point & shoot class of camera. We have had some customers however that have found that the imagers on these cameras produce noise and artifacts visible on their videos, and prefer the larger imagers found on SLR cameras.

In the past, we generally recommended using Nikon Coolpix cameras, as we have done a lot of work with these cameras, and they are pretty reliable. Commonly used cameras are the Coolpix 5400, 5700, and 8700, for use in long term time-lapse applications with the DigiSnap controllers. We build underwater camera systems for www.AquaPix.net using the Coolpix 5400 camera, and we generally keep a few of these cameras on the shelf for production and replacements. These cameras are used and sometimes refurbished, but as with most electronics, if they work OK for the first month, they will likely work for the next year or more. If a Coolpix 5400 will work for you, we might be able to supply them along with the rest of the electronics.

Nikon as well as most other camera manufacturers have removed remote control capabilities from their lower cost cameras. This now includes all newer Coolpix camera (after the Coolpix 8700). Your choices for a remotely controlled camera are rapidly becoming limited to older model cameras or SLR cameras with a remote shutter release connection.

For most systems left in the field for long periods of time, there is a risk of theft or damage. This is another reason to consider the use of a lower cost camera. Also, given a lower cost camera, you might be able to afford more than one camera, to provide multiple views of your project.

Another difference between the older Coolpix cameras and the new SLRs (with respect to long term time-lapse) is the memory size capacity. A Coolpix camera can only handle up to a 2 GB card, whereas an SLR can use much larger memory cards. Realistically a 2 GB card can hold a couple thousand high resolution images, so perhaps this isn't much of a constraint!

Digital SLR cameras are becoming more reasonably priced, and in fact many models are now lower in price brand new than the Coolpix cameras were when they were new! SLR cameras use a larger area sensor and do offer some potential image quality improvement over the more typical Coolpix camera. An SLR class camera will offer more flexibility in optics, and may yield lower noise in high resolutions. While an SLR camera may seem to offer better reliability, an SLR camera has a moving mirror, which has a finite lifetime, whereas the Coolpix cameras have no such limitation. However, given that SLR cameras can be acquired for a low price, and are brand new, compared to

the potential risk of a used camera, we now exclusively recommend SLR cameras for the greatest reliability.

There are some subtle differences among SLR cameras, when considering a long term time-lapse project. For instance, when externally powered, some SLRs do not shut off the metering within the camera… the camera does not revert to a minimum power state. Also, SLR manufacturers are famous for using proprietary connectors, which increases the price of the cabling. Our latest recommendation for a good quality, low cost, small, highly compatible camera is the Pentax K110D. For this purpose, the K110D is functionally equivalent to the Nikon D50, D70, D80, the Canon Digital Rebel series, etc. There are of course a host of differences in the features in cameras from different vendors, but for a long term time-lapse application, only the most basic features are required. Realistically, most cameras will be used with manual focus, manual white balance, and only the most basic exposure capabilities are required. We try to keep a few of the K110D cameras on our shelves for customers.

Controllers

The DigiSnap 2000 series of controllers are the workhorse of the digital camera time-lapse world. For the vast majority of applications, the standard DigiSnap 2000 is all you need. The DigiSnap 2000 normally uses an internal battery, but we commonly add an external power connection for long term operation.

The other DigiSnap 2000 products have additional input / output capabilities, generally not required. For instance, the DigiSnap 2100 is designed to control SLR cameras. If you want to implement a window wiper arm, an external shutter, lighting control, or other specialized electromechanical gadget, the DigiSnap's may already be able to control it! There are a lot of sophisticated features within the DigiSnap controllers that may not be obvious until you read the manual. Many people use the DigiSnap 2800, as it is designed to work directly from a 12V battery.

Other controllers are available as well, most notably Nikon's own MC-EU1, the Time Machine, and some other trail monitoring camera setups. You can pretty well forget the MC-EU1… it's pretty, but flat-out isn't up to this sort of task. The Time Machine is a nice box, also with lots of capability, but is better geared to high speed scientific photography. Nikon recently started shipping their MC-36 time-lapse remote cable, which is perfectly adequate for controlling Nikon SLR cameras with their proprietary 10 pin connector, for up to a month or so. The DigiSnap has all of the desired qualities of low power, small size, low cost, flexibility, advanced features such as working from a daily clock, and best of all, my personal support.

If you have need for specific cabling requirements, or any other unique electronics support needs, please contact me directly at Mark@Harbortronics.com.

Camera Positioning

For most applications, one or two cameras per site with a fixed position can yield the desired information. If you have a need to periodically sweep a partial or circular panorama, then you might consider the Snap360 product from Harbortronics. This is a time-lapse controller, motorized turntable, and battery pack all integrated into a very compact, low cost package. With the Snap360 you can

perform time-lapse panoramas with ease. Housing a panoramic camera for use in the outdoor environment can be difficult, but we also have access to a very nice glass cylindrical housing for the Snap360, which can fit the Coolpix 5400.

For lower image quality needs, you might also consider a conical mirror device, which allows for a full 360 degree panorama in a single picture. The resulting image is initially highly distorted, but can be 'corrected' by software, albiet with varying amounts of image resolution alterations.

Image Storage

Camera controllers are fairly simple, and just tell the camera to take a picture, so the images are left on the memory cards. Let's say you take JPEG images, limited to a 2 Mpixel size… this yields a typical files size of 500Kbytes. Given a 2 GB memory card, this should allow for as many as 4000 pictures.

Some DSLR cameras have sophisticated remote control programs available from the camera manufacture that can put the images on a laptop hard-drive, but this is outside our expertise. Honestly though, do you really have faith in the long term reliability of a laptop computer running software that controls your camera? Consider the amount of power that your system is going to draw! Use a dedicated controller, and just hike out to the site once in a while to clean the glass and swap memory cards ☺

A great desire for many people is to be able to control a high resolution digital camera remotely, via an internet connection. To the best of our knowledge, this has only been implemented by one group, a TV station with plenty of funding. Good luck! We get requests for this periodically, and are inching our way to a full solution… don't hold your breath though!

Time Lapse Setup

The DigiSnap 2000 controllers have two different time-lapse processes. Simple Time-Lapse has the camera take pictures at a preset interval, all day and all night, as long as you want. Advanced Time-Lapse mode allows you to configure the DigiSnap to start time-lapse sequence at particular times of the day. For instance, you can set up for a group of pictures in the morning, noon, and afternoon, and not at all at night. This can help to reduce the image storage requirements.

Almost everyone asks how often to take pictures. Good question, and there is no perfect answer. My general response it to take more images than you think you'll need, at the highest resolution practical. It's easy to throw images away, or to down-size them!

There a couple of questions to ask yourself… how long of a movie of your project do you want at the end. For instance, say you want to compress your construction project down to a 30 second move, and want say, 24 frames per second. This means you want to start with about 720 pictures. If your project took two years to build, then a single picture per day would be about optimum. If you want a 5 minute movie, (about 7200 images) and your project took only 3 months, then you may want about 80 pictures per day. This simple math gives you a general starting point… there are other considerations however!

As with all photography, lighting is important! As you take pictures during the day, the sun will obviously move across the sky, and the lighting can change dramatically over a day. Depending on

your creative intent, this could be good, or bad! If you want a movie that has somewhat more consistent lighting from day to day, you might gather pictures that were taken at the same time each day. You might take a many pictures during each day, as you never know which time of day will yield the 'best' results. Say you've taken pictures one per hour, from 7AM to 9PM, each day. You could sort the images into 12 sets, where each set has a picture taken every day at the same time. Make 12 different movies, and see which one you like the best. If you don't have a huge number of pictures, you can change the frame rate of the movie you create, to change the 'length' of the movie. For instance, instead of 24 frames per second (motion picture standard), you can use, say, 10 images per second… or even less. The movie may end up somewhat jerkier, so play with it.

Temperature

If you dive into the specifications on digital cameras, SLR and otherwise, you'll find that most all cameras are specified by the manufacturer for a range of 0C to 40C. This is a very limited range of temperature, when considering the range your time-lapse setup may experience 'in the wild'. You may well find that the camera ratings are highly conservative (did anyone mention liability??).

High temperatures are generally not as significant of a problem as you might think. Local shading can deal with direct sunlight heating, and electronics don't generally have much problem with pretty high temperatures. Low temperatures are of more concern than higher temperatures. The camera and controller are going to be idle the majority of the time, so there isn't any real internal heating. When operating at say 10 degrees below freezing, the DigiSnap 2000 should work fine, and I'd guess many cameras will as well. We have a number of customers using DigiSnap controllers in the Arctic, as well as Antarctica. For use at very low temperatures, we recommend the 'low temperature modification', which replaces the on-board oscillator with one that operates better at very low temperatures. This has been used with good success at temperatures as low as –30 C. One researcher found that the Coolpix 5700 handles low temperatures quite well. The Univ of Alaska did some testing of our Time-Lapse Package, which uses the Pentax K110D camera, and the modified DigiSnap controller. It appears that the electronics work all the way down to –60C, but at and below –40C, not all pictures were captured, skipping a picture or two every once in a while, suggesting that the shutter or mirror mechanisms may be getting jammed. We are currently performing high temperature tests, and anticipate similar excellent results.

If you are blessed with AC power, you might include a very small amount of heating to raise very low temperatures to just below freezing. If the water is already frozen, keep it that way.

Enclosures

My frequent recommendation for an enclosure was something pretty simple, such as a good solid stainless steel mailbox! Some applications don't really need a sealed enclosure, and a mailbox or bird-house doesn't advertise that you have some expensive camera equipment! Cut a hole in the end of the box, use RTV to glue in a piece of glass or acrylic, and you are done. Any decent sized mailbox or a custom built birdhouse will hold a camera and all of the other electronics.

In reality, a poorly designed sealed enclosure can cause more problems than one with vents. Sealed enclosures are notorious for sucking in moisture during daily temperature cycling. If you do use a sealed enclosure, you may want to use dry air or nitrogen back-filling each time you open it for service, or make sure you use a dessicant pack.

Power Source

Between pictures, the DigiSnap and the camera are put into a low power state, so that minimum power usage is already guaranteed. The Coolpix 5400 and 8700 have a quirk in their inner operation that will increase the power draw unless the DigiSnap is properly setup. Contact me if you are using these cameras, or just looks for the details in the latest DigiSnap 2000 manual. The Pentax K110D shuts down to a very low power state between pictures.

Battery Power

Most long-term remote installations of any sort use standard sealed lead-acid 12V batteries, such as a motorcycle battery, wheelchair batteries, automotive / marine / industrial or gell-cells. These are relatively cheap and should last for a long time. If you have extremes of temperature, you should do some research to determine the effects on batteries. Low temperatures can strongly degrade battery capacity. There are alternatives to cheap, heavy lead-acid batteries, but they can be very expensive. Tradeoffs to consider include cost, weight, capacity / temperature effects, etc. Lithium Ion Polymer cells are rapidly gaining ground in these applications.

Some cameras can be operated from 12VDC as well, even though the camera manufacturer may not recommend it. We've found that many of the Coolpix cameras work nicely at 12V, including the Coolpix 5400 and 5700, but there have been some failures noted with the Coolpix 990 and 8700 when operated at 12V. Your mileage may vary! We recently developed a high efficiency battery converter, converting a battery voltage (of 10-35V) to 8.5V, which any Coolpix camera can reliably use, as well as to 5V, which can power a DigiSnap controller. This very small device is highly recommended for long term battery powered applications. We also have a 6.5V version which is optimal for use with the Pentax K110D. Just tell us the camera you want to use, and we'll figure out the right voltage.

For applications that will last only a few months, battery power may be all you need. Some people have used automotive batteries and operated for a full year at a time.

For many applications, solar charging of your battery in the field is a great option. Most small (i.e. below 50 watts) solar panels are designed to output a voltage which is compatible with a 12V lead acid battery, and for short uses you may be able to get by with a simple parallel connection. In good sunlight, the solar panels will eventually cook your battery if you don't use a proper 'charger' between the panel and the battery.

We have developed a charger circuit to work between solar panels and 11.1V Li-Ion battery packs. We can adjust the output of this circuit to work with lead acid batteries as well, and you may find lead-acid / solar panel chargers on the open market as well.

One safety consideration is to make sure that you do not charge a lead-acid battery while sealed in an enclosure! All lead acid batteries release hydrogen gas when charging. Even 'sealed' lead acid batteries have safety vents!

AC Power

Consider yourself blessed if you have AC power available, but in a long term application, you should prepare for power outages. I recommend an off the shelf battery backup system, as used for computers.

Given AC power, you can no doubt find an AC adapter for the camera, and we have them available for the DigiSnap controllers as well.

Beyond short power outages, if you are worried about someone disconnecting your AC power on a construction site, you may want to consider operating primarily from a battery, and use AC simply to keep the battery charged, similar to a solar panel. Size the battery to ensure that your system will continue to work until someone periodically arrives to check on the system.

Reliability

Whatever you end up with, set it up and test it for a week or three before leaving something in the field!!!! Too many researchers have spent a great deal of time and money developing a camera system, and then installed it without enough or in many cases, any testing. The more difficult the access to your site, the more time you should spend testing! Many people find they run out of time as the installation date looms near, but please don't get into this trap… test it!!!

The DigiSnap controllers, as well as digital cameras are consumer products, and are not guaranteed to operate with perfectly reliability under all conditions. The communication between a DigiSnap and Coolpix camera is relatively complex, and can indeed fail at random times. Controlling a D-SLR is much simpler, but again the camera is more complex. There are no industrial camera systems that I am aware of intended for long term unattended use. On the other hand, there are a lot of DigiSnap controllers driving Coolpix and D-SLR cameras in long term time-lapse applications all over the planet. If you have an application that absolutely most operate perfectly, then you need to talk with NASA. Hmm, what is their operational success rate? In practice, once your system is installed, and has operated OK for a week, it'll probably work fine for years. If you are really worried about it, install more than one system, operate them independently (different power sources, controllers, cameras, etc.), and your odds go up.

Specific Recommendations

For the vast majority of long term time-lapse applications, we recommend the following equipment, for a do-it-yourself installation.

DigiSnap 2100	$150
Optional DC Power Jack	$25
2100-2.5mm cable	$70
Battery Converter	$100
Converter Cable Set (battery, DigiSnap, camera)	$30
Pentax K110D Camera	$600 (we sell them for MSRP)
(2) 2 GB SD Memory cards	$162.50 (prices drop over time)

Battery ?? Charging ?? Enclosure ?? Mounting ??

Here's an old picture of the recommended equipment, using a Coolpix 5400 camera. There appear to be lot of cables, but each connector is unique so there is no chance of misconnection.

Fully Integrated Solution

Give the number of requests for fully integrated time-lapse systems that we've fielded, we finally did the design work ourselves, and as of the fall of 2006 offer a full solution. The housing in our system is a high strength fiberglass construction, using a glass window, and good quality environmental seals. Developing the details for mounting the camera, internal electronics, solar panel etc. was not trivial! In order to minimize the weight and size of a high capacity battery pack, and allow it to reside inside the housing (less wires for squirrels to chew on), we decided to use Li-Ion Polymer technology. It's more expensive, but for this sort of application, it's worth it! We also offer solar panel charging. It's a full package, and we can even configure the DigiSnap for you. Install it and go! Check our website for more details. http://www.harbortronics.com/timelapsepackage/time-lapse%20package.pdf


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