Approaching the Final Frontier

Near Space

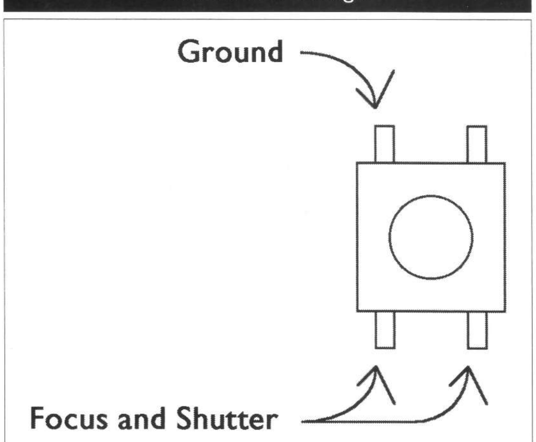
Updates on Modifying Cameras for Digital Control

I've been experimenting with cameras since my last column, and this month, I have some updates on three camera topics: modifying other cameras, adjusting the focus on fixed focused cameras, and IR imaging.

Modifying Some Other Cameras

Be warned that modifying cameras voids their warranty, which is one of my favorite activities. To date, I've used cameras with autofocus on my balloons, and my favorite example is the Canon Elph (an APS film camera). This is the camera that has recorded my most spectacular photographs, and I owe Bill All (N0KKM) a thanks for bringing this camera to my attention. My latest camera is a four megapixel digital camera — the Concord 4060 AF, and I owe Kyle Thorson (KB5TSS) a thanks for bringing that one to my attention.

Figure 1. This is a top view of the shutter button. The front of the camera is located at the bottom of the image.



Cameras like these use a two-position micro-push-button switch for the shutter, and you've probably seen these switches as the reset switches in Parallax's Board of Education or on a VCR PCB (Printed Circuit Board — if you've ever taken one of these apart). The switch measures about 1/4 inch square and has four PCB mount pins. The first depress position on the camera shutter switch focuses the camera and the fully depressed position operates the camera's shutter. (In some cameras, the fully depressed position also focuses the camera.) When you push the shutter button on these cameras, the switch shorts the camera's focus or shutter circuitry to ground.

The plan of attack to modify these cameras is to first open the camera, identify the function of the shutter switch's pins, solder wires to them, and then close up the case.

First, remove the batteries and then open the camera case. Be sure to store the tiny screws where they will not get lost and write down which screws go into which holes if you discover the screws are different lengths. Now that the camera is opened, be especially careful that you don't touch the flash capacitor.

Make a quick drawing of the micro-push-button switch and its pins, as it's always a good idea to document your findings. Set a Digital Multimeter (DMM) to continuity check and locate the pin on the micro-push-button switch that is connected to ground. Connect one DMM lead to the negative spring contact in the battery case and start probing each micro-push-button switch pin until the DMM rings. Check all the pins, as you may find that two micro-push-button switch pins are connected to ground.

After locating the ground pin(s), reassemble the camera case just far enough so you can load batteries back into it. With a short length of thin gauge wire, carefully try shorting the remaining pins to the ground pin and observe the results. When you do this, you want to find the pin that makes the camera take a photograph. Don't point the camera at yourself during your test, unless you like being flashed at close range with a strobe. Again, document your results.

Two Specific Camera Examples

Figure 1 shows the pin locations and functions for the Canon Elph and Concord 4060 AF.

I don't recall having trouble opening the Elph case, but I do know that the hole in the case of the shutter button is too small to work the soldering iron through. You'll need to fully open the case to get to the shutter switch.

I started my experimenting with the Concord by first visiting Kyle Thorson's website — **www.webpages.uidaho.edu/~thor7358/hiball/concord/** I found the camera case a little difficult to open. The buttons over the slide switches are latched together, so you need to pull on the button a bit to separate it from the slide switch. I only opened up the camera far enough to pull the shutter button out of the case. The hole in the case for the shutter button is large enough to get a solder iron through. I suspect it'll be easier to cut out the button instead of trying to open the camera case. From my experiments, I have found that you only need to solder the wires to the Common (ground) pin and the Take pin. I have found no reason to use the switch's Focus pin.

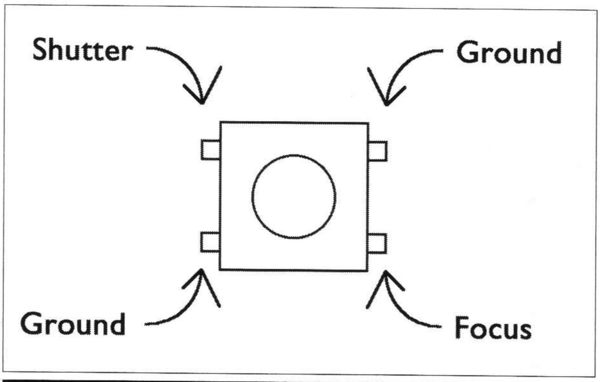


Figure 2. The pins on this switch are very tiny; solder them with care.

Making the Connections

Now that the ground and shutter pins are identified, solder wires to the micro-push-button switch's solder pads, and we'll call the wires the shutter cable. Shut off the camera, remove its batteries, and open the camera case again.

Cut two lengths of thin gauge, stranded wire (I use about a AWG Number 30 wire cut to about nine inches long). I recommend making the wire that's connected to the ground pin green or black in color so you'll know its function once the camera case is closed. Strip about an 1/8 inch of the insulation from one end of each wire. Tin the bare ends, and trim the bare ends back down to 1/8 inch if the heat has melted back the insulation. Tin the solder pads of the micro-push-button switch, and hold the first wire to a switch pad and heat the contact between the tinned wire and the switch pad. The solder on both the wire and the pad should fuse them together. Repeat this with the second switch pin.

Decide at this point if you want to modify the camera solely for digital control or if you want to retain manual control of the camera. If you want only digital control, then you can remove the cover over the shutter button, since you won't be pressing it. If you still want to use the camera manually, then keep the plastic button cover in place and find a location in the camera case where you can drill a small hole to pass the shutter cable through. Find a location in the camera case that is close to the shutter button, drill the hole, then pass the shutter cable through it. You can now close up the camera case for the last time.

I prefer to terminate the shutter cable in a connector, rather than soldering the ends of the wires directly to a transistor switch. I have used Dean's plugs (the micro variety) and headers and receptacles like you find on servo cables. By terminating the shutter cable in a connector, you can position the camera outside of the near spacecraft while leaving the control electronics inside without having to drill a large hole through the wall of the near spacecraft. A terminated shutter cable is also more convenient if you decide to modify the camera for dual use (in which case, you'll own a camera with a pigtail).

To prevent the shutter cable from being pulled off the micro-push-button switch, you need to add strain relief to the shutter cable. I've done this by either hot gluing the shutter cable to the camera case (do not hot glue the wires to the camera's PCB) or, preferably, by zip-tying the shutter cable to the camera case where the camera strap is attached.

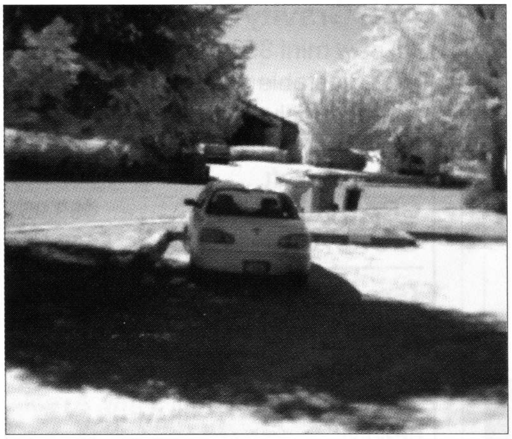


Figure 3. An image with the IR blocking filter removed and the Pencam refocused.

Figure 4. An image with the IR blocking filter in place.

Adding Digital Control

You've now completed the modification of your camera, but you can't operate it until you add digital control, which is a two step process. The first step is to make the transistor switch and the second is to add the control, either a microcontroller or a 555 timer circuit.

Refer to my article in the June 2004 issue of *SERVO Magazine* on adding a digital switch to an R/C transmitter. Specifically look at the diagram on page 23 and note that the LED in my diagram is optional. I would only add it to the circuit as a troubleshooting tool. Be sure to connect the ground wire of the shutter cable to the emitter of the transistor. When you've completed the transistor switch circuit, protect it by covering it and its perf board in a length of heatshrink tubing.

Operating the Camera

On a simple near spacecraft, I use a 555 timer circuit to operate the transistor switch. For advanced missions, I connect the transistor switch to my flight computer. Most cameras today shut down if they are not used within one minute. Keep this limitation in mind when deciding on how often to record images. When operating the camera by a 555 timer circuit, I use a 100 mF capacitor for C1, a 600K resistor for R1, and a 15K resistor for R2.

The resistors have a tighter tolerance than the capacitor does, so I pull resistors out of my junk pile that are anywhere near the calculated values. A 555 timer circuit with these values produces a square wave that is high for 42 seconds and low for one second. The cameras I've used appear to tolerate a user who keeps pushing the shutter button this long.

Fixed Focus Cameras

Now that I have completed my notes on modifying cameras for digital control, let's talk about fixed focus cameras and how they can be properly focused. The example I'll use is the PenCam I experimented with in the last column. The lens in the PenCam is preset to a focus of around 15 feet and not to infinity.

After launch, a camera on a balloon only sees a landscape that is truly infinitely far away. This means that inexpensive cameras with a fixed focus like the PenCam must be adjusted to record properly focused images.

Fortunately, the lens of my PenCam was set into a threaded barrel and I was able to rotate the lens barrel by hand.

To find the proper lens position, I placed one reference mark on the lens barrel and 16 (one every 45 degrees) on the housing that covers the CCD imager. I recorded several images outside my apartment with the lens barrel aligned with each of the reference marks on the CCD housing. After downloading the images, I selected the two best images. I then repeated the above process a second time; however, this time, I rotated the lens barrel one quarter of the way between the reference marks of the best two images before recording an image. After downloading the new images, I selected what appeared to be the best ones; the result was good enough that I really couldn't tell the difference between the two best images.

At that point, I called the focus good enough. The problem with finding the best image is that inexpensive, fixed focused cameras have such low resolution that it's difficult to distinguish between two close images.

While this process worked for my first PenCam, it didn't work for the second one. The lens barrel of the second PenCam was glued into place so strongly that I couldn't twist the barrel without breaking the housing over the CCD imager. Instead of rotating the lens barrel, I tried sanding the bottom of the CCD housing in the hopes of lowering the height of the lens. I discovered that the CCD housing was set on top of the CCD imager cover slip. This meant that I couldn't lower the height of the lens by sanding; all I would do is create a gap between the legs of the CCD housing and the camera's PCB.

The last fixed focused camera I experimented with was the Vivitar ViviCam 3350. I discovered that it uses the same electronics as the PenCam does; it's just packaged in a differently shaped case.

Infrared Images

Along with modifying cameras for digital control, I also found the time to experiment with the PenCams and their IR filters. After removing the filter, I noticed that the new images had a red tint to them.

Foliage, for example, appeared red. I know that chlorophyll reflects some infrared along with green. It's my hope that I can compare visible and IR images taken from near space to detect any plants from near space. Figures 3 and 4 are two examples of images taken with the Pencam.

As you can see, there's some promise in using a digital camera to record IR images for comparison to visible images.

My research budget doesn't permit me to test other cameras at this time. However, I will eventually get around to other cameras. If you get a chance to modify any other cameras, please let me know what you've discovered and I'll share it with others. NV