A Basic Solar Shoot

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Editors Note: Mark and Wendy Estes own and run Digitec Optical. A reseller of astrophotography equipment and telescopes

To a beginner, a Solar shoot may be thought to be an easy, albeit expensive task to undertake. Actually, the opposite is true. A Solar setup can be inexpensive as I will show, but the raw data may pose some interesting challenges to process properly.

Expensive? Not Really!

The Sun is obviously a very bright target so a wide aperture scope with incredible optics really isn't needed. Just about any telescope can be used effectively from a small 60mm refractor to a 12" SCT, if you are lucky enough to own one.
The solar filter itself can present a bit of sticker shock to the wannabe astrophotographer, but there are more inexpensive ways to go.

For this shoot, I used one of our in-house Konus 1793 8" reflectors. The Konus itself is a lost cost scope

but the reason we chose it on this day is because the 1793's dust cover has a small aperture built into it. This being the case, we didn't need to use an expensive 8" solar filter, but instead a small piece of inexpensive Baader solar film held in place across the small aperture using rubber bands. This makes an excellent off axis solar filter for less than $30.00. We wouldn't presume to recommend the rubber band trick for constant use, but on this day I tried it because I was in a hurry and had a lot of solar film laying around. You can construct a permanent filter using multiple pieces of cardboard cut to the correct diameter and sandwiching the film between them. You can make a filter for your finder scope the same way but that is a discussion for another article.

The mount doesn't need to be anything other than an average mount with a RA motor drive. The exposure time for this setup was 1/500th of a second so tracking really isn't an issue. Just roughly polar align it and you're ready to go. Again, inexpensive.

The camera used for this shoot was an air cooled SAC7. Even though the outside temperature was well over 90 degrees the noise levels in the raw pictures was workable through processing as I will demonstrate. Again, inexpensive.

Difficult?

Okay, well not really. But a little extra attention to image processing is in order. Here is what is working against you:

OAT: If the outside temperature is above 75 degrees your raw pictures will be filled with noise. A peltier cooled camera might be a better answer but I was striving for inexpensive here. I chose to use the air cooled SAC7.

Dirty Optics: Even if you have never experienced "dust motes" in any of your night time pictures, you will certainly be beaten over the head with them during any solar shoot. Your optics need to be especially clean to avoid them (our's certainly weren't). Any dust or dirt on the secondary mirror, and especially the CCD itself will produce these nasty dust motes in your pictures. The closer to the CCD they are the more they affect your photographs. On the CCD itself is the worst place to have them. After a few test shots I noticed that my raw pictures were riddled with them. I stopped everything, removed the camera and carefully cleaned the CCD. After another try I could still see some, and I'm guessing they were on the secondary mirror. I decided to forge ahead anyway hoping to remove them in processing.

The Shoot

Equipment Used
Telescope: Konus 1793 8" Reflector
Camera: SAC Imaging SAC7 air cooled camera
Mount: Konus Super Polar Evolution with dual axis drive
Computer: IBM Thinkpad w/USB
Filter: Off axis solar filter quickly constructed using a small piece of Baader solar film.

Conditions
It was hot and muggy outside on this day. I wanted to get this one over with as quickly as possible. Luckily, the sky was pretty clear but a bit hazy, a typical New York summer day.

I started with a 40mm eyepiece to get the scope aligned and was literally blown away by the visual images on this day. There were many beautiful areas of solar activity, so I chose one that had a small group of sun spots and cloud formations. I like to get them near the edge of the sun because the pictures always seem to look better when you can see the edge in the final photograph. I also chose to shoot in monochrome for simplicity.

After centering and focusing I started rattling off as many pictures as I could. After every 10 shots or so, I covered the telescope and shot 3 dark frames. The temperature was rising quickly and there is no temperature regulation in the SAC 7. I mixed these darks into the shoot to make sure that I got the best quality dark frames possible as I knew the pictures would be noisy.

Just as I was getting ready to break down I remembered that I still needed to deal with the dust motes, otherwise my shoot would have been ruined. There is only one way I know of to remove dust motes from pictures and that is to shoot "flat fields" and process them out later. The problem is how to shoot these flats quickly without reconfiguring the scope? The answer came to me quickly. I pointed the scope at an area of the sun near the center that had no solar activity. After finding a spot with an even field of brightness I rattled off 5 flat frames, capped the scope and shot 5 dark frames for them. That was easy and I hoped it would work.

Image Processing

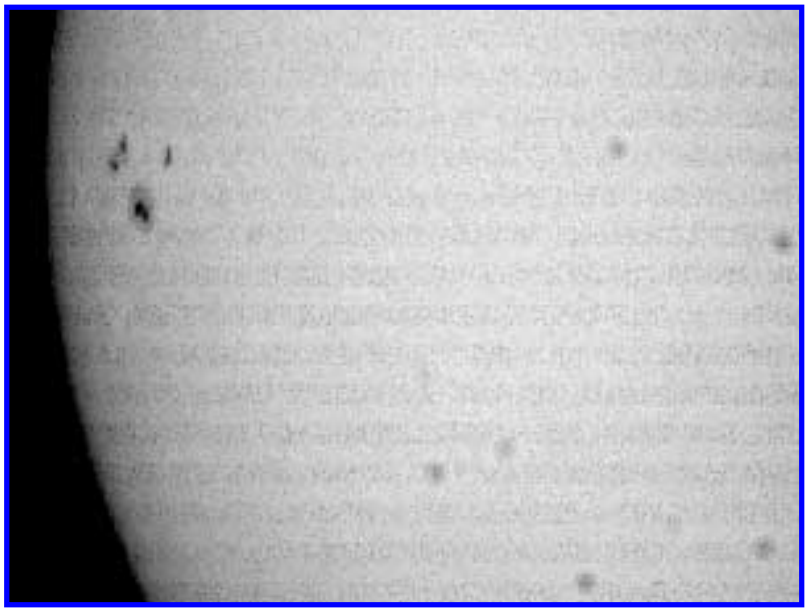
After cleaning up the mess outside I ran into my office to review the raw data. I was horrified at the noise levels, and yes, those #@$%# dust motes had ruined the photos.

I knew noise was going to be a big problem here and I was right. I selected the 10 best of the 100 crummy pictures that I took and loaded them into a temporary directory with all of the necessary darks and flats. The programs I chose to process these were Maxim DL by Cyanogen and Photoshop 6. I chose Maxim DL because it works flawlessly with the 32 bit FIT format outputted by SAC's Astrovid program. Here is how the final image was processed:

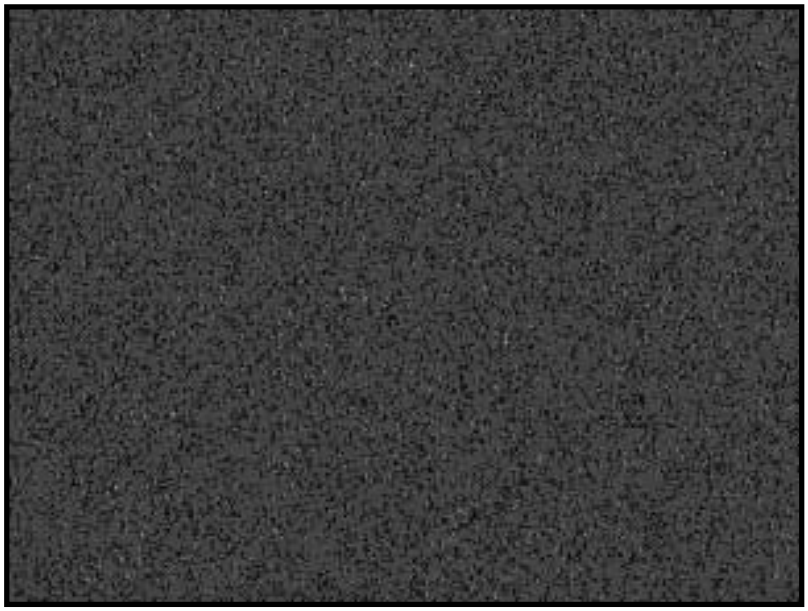
- I averaged the three dark frames in MaximDL to make a master dark.
- I subtracted the master dark from all 10 of the raw images.
- I created a master flat by first averaging the five flat-darks and then subtracted them from five averaged flat frames.
- This master flat was then divided into each of the ten dark corrected images. The calibration of the ten raw images was now complete. I saved them to the temporary directory.
- Next, the ten calibrated images were loaded into MaximDL and aligned to each other. Aligning

solar images is difficult and I probably could have done a better job.

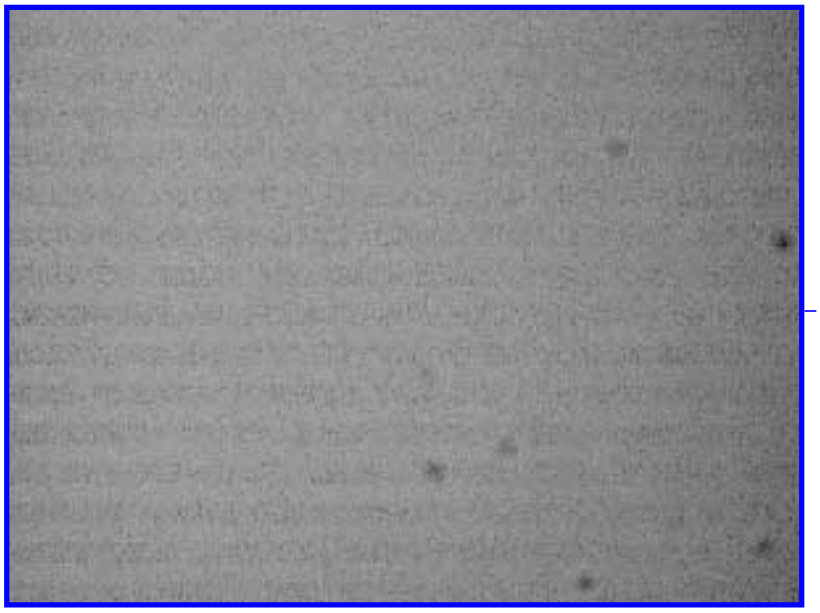
- The ten aligned images were then averaged together using MaximDL. A lot more noise is eliminated through stacking images. I wished I had shot a lot more raw data to stack.
- The image was then loaded into Photoshop 6. Levels were set, the image cropped, and then saved to GIF format for the web.



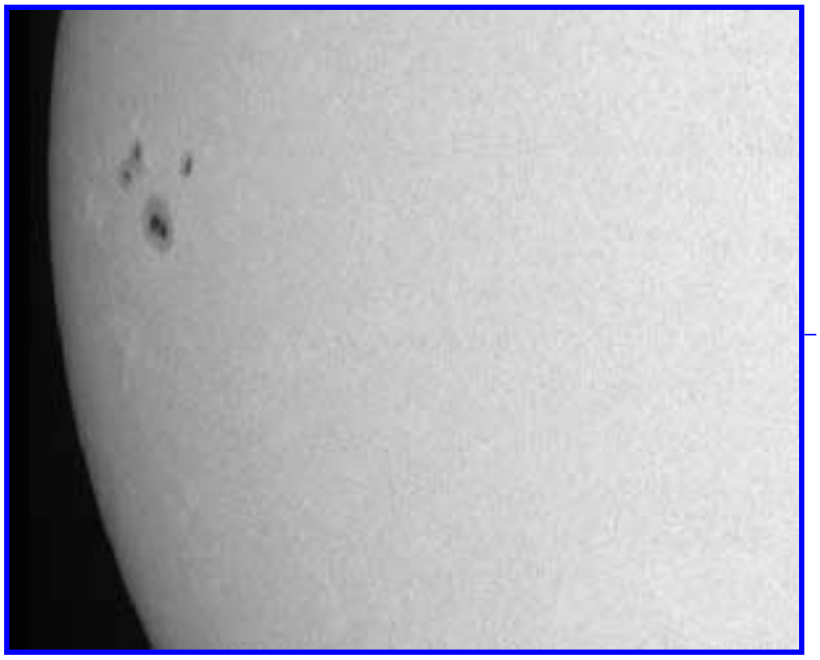
A sample of one of the raw data frames. The noise was livable but the dust motes ruined the photograph.



Here is a sample of one of the main dark frames. With the scope capped, the only thing you see is CCD noise.



This is one of the flat frames that I shot pointing directly at a clear area of the sun. Only the dust motes can be seen.



Here is the final product. A significant amount of noise and all of the dust motes have been removed. It's not a picture worth jumping up and down over, but I'm happy with it.

All in all it was a pleasant shoot but I have gotten better results in the past. It really helps to plan your shoot beforehand instead of rushing the setup and the shoot. On a hot, muggy, sweaty day I can live with a rushed shoot. The one step I left out in the description is that I jumped into the pool right after breaking the equipment down. A cool swimming pool is as good for a photographer as a peltier cooler is for the camera!