Step by Step Procedure for Webcam Planetary Photography

1. Set up telescope and turn on drive.
2. Turn on your computer and make sure the date and time are set correctly.
3. Locate object in finder and insert amplifier and parfocalized eyepiece into the focuser.
4. Center and focus object.
5. Replace eyepiece with webcam
6. Plug USB cable from webcam into computer.
7. Launch VRecord. If you have centered the object properly, you will see something on the screen. It may even be in focus. If not, focus it.
8. In the options menu, make sure that the "Set Preview" box is checked and select "Set Video Format" and verify that it is set for the default 320x240 pixel mode or whatever mode you wish to use.
9. In file menu select "Set Capture File" and name the file appropriately for the object you are observing. I like to use the name of the object followed by the date and a serial number, such as: Mars 10 27 05 3. You don't need to put the time information in (or even the date) since that will be timestamped on the file when it is saved after taking the video.
10. In the capture window, select "Set Time Limit". In the dialog box be sure to check the "Use Time Limit" box. Type in the video file length in seconds you wish to use and say ok. I use 120 or 180 seconds for planetary work and 30 seconds for lunar work where I plan to take a whole lot of pictures to make a terminator strip.
11. In the options menu select "Video Parameters", and under the Image Controls tab, turn off the full auto mode and select 15 frames per second and then click on the tab named "Camera Controls". Put the exposure slider to 1/50th of a second and the gain at about 50% of full scale. If the image is too bright, select a shorter exposure, if it is too faint select a longer one or slide the gain control to a higher value.
12. You also have controls for white level which may be difficult to use if nothing in the object is supposed to be white. Auto should be off. Make small adjustments in blue and red level until the color of the object is correct. Note: you can make these adjustments during the daytime using a distant tree top as a subject. The automatic controls will work in this case (if you turn them on) and you can let it do its thing, then turn them off and save the settings for use at night. All you will have to change at night will be the exposure or gain controls.
13. In the capture window, select start capture. This will give you another dialog box which you have to click on again to actually start the capture. At the end of the scheduled time, the file capture will stop automatically. You don't need to save the file since it is written to while you are taking the video.
14. Don't forget to create a new capture file for your next video. If you don't, the next video will overwrite the last one and you will be very upset.
15. When you drop the file menu and select "set capture file" again. It will come up with the name of the last file as a default. You can either type in a new name, or if you use the serial number procedure I do, just change the last number.

16. If your computer has enough resouces (RAM, processor speed) you will able to run Registax on your .avi files as you accumulate them. If not, wait until you are done observing before trying to run Registax. I have had a number of computer crashes requiring restart because I had too many things going on at once (I was running Windows ME at the time, it may not be a problem for the later versions of Windows).
17. Launch Registax. Press Select button in upper left corner of startup screen. This will give you a file browser box which will allow you to point to the one of your .avi files you wish to process. When you click on the file name (even before you click the Open button) you will see the first frame of the video in the right side of the file browser box as well as in the Registax screen behind it. If this is the correct file, press Open.
18. When the file opens, if you move the cursor over the image you will see a square with a plus sign in the middle of it. If this square is too small (the 32 pixel one for example) processing will be fast, but the program might get lost. I like to pick the 128 pixel box when I am in the default video format of 320x240.
19. Move the slider at the bottom of the screen to step through the video file. When you find a good frame (one that is sharper, more symmetrical, shows detail) move the cursor over the image and center the square on the object and do one left click on the mouse.
20. At this point you will see a graph with a power spectrum of the selected frame. This is a red curve starting on the left near the top with high intensity of low spatial frequency components and dropping off rapidly to the right. You can also select a Quality Estimate method to use at this point. I really like the Gradient method. Select it if it is not already selected. You can also select the appropriate % lowest quality parameter. I would pick 80% for a start.
21. You will also see a multicolored plot of the two dimensional Fourier transform of the image. You should see a reasonably symmetric plot with a red region in the center. If you do, you can leave it alone and press the button marked Align just below the blue tab also marked Align (if the red region is too broad, use the arrows by the FFT filter box to raise the number you see there).
22. When you press the Align button, you will see the image area start jiggling about madly with the alignment box moving with it. This is a first pass at roughly aligning all the frames, but most importantly, it is the time when the program measures the quality of each frame by the method you selected in a previous step. When the quality estimation phase is finished, you will see a graph with a red curve and a blue curve. The red one is a plot of the quality of each frame as determined by the method you chose. Registax rearrange the frame order putting the best frames to the left, the worst ones to the right. The blue curve gives you the registration difference between each frame and the reference frame you picked at the beginning.
23. Now you get to pick how many of the best frames to keep for further processing and eventual stacking. Grab the slider at the bottom of the screen and move it to the left. The vertical green line will move to the left also. As you move it the frame number and the stack size number below slider will change. Notice that the frame numbers appear to be random now. When you have picked the stack size

you wish to keep (the better the seeing, the more you get to keep) press the Limit button just below the Align button.

24. At this point you can go on and select Optimize and Stack (or just Optimize) and the program will go through the smaller set of frames and do a better job of aligning them up with the reference frame. A better choice at this point, however, is to press the Create button. This takes the fifty best frames (or whatever number you see in the box to the right of the button) and creates a much better reference frame from them to use to do the whole set of good frames you selected.
25. Let's say you press the Create button. When you do, the program will rapidly optimize this small set of the best frames, stack them and give you the chance to do some processing. When it is finished you will get a redundant dialog box telling you to enhance image and press continue and you have to say OK. When you do, you can play with the wavelet sliders to perk up the image. Don't mess around too much at this stage, otherwise the program might not recognize the unprocessed frames as being the same object as the tuned up reference frame. I would just move the slider under the checked 3:2 wavelet spot to about 50% and uncheck the first two boxes. At this point you probably are already pleased. Just wait.
26. Press the continue button, and the redundant OK button, and then press optimize and stack. The program now goes through the rest of the good frames and optimizes their alignment very precisely against the created reference frame. When it has finished this process, it digitally adds all the frames together, pixel by pixel to give the stacked image.
27. You can press the preview button by each wavelet to see the contribution it will make in the final image. Some look noisy or empty. Uncheck them. When you do, the noise in that particular wavelet component of the image will be eliminated from the final image. Sort of a smart low pass filter. Some look like they have interesting detail in them. Move their sliders to higher values to see how they can help the image. A good place to start is with the first wavelet unchecked, the second one at 25%, the third and fourth at 50%, the fifth at 25% and the sixth just left alone. Play with the wavelets until you are satisfied and then you can check the box to hold the wavelet setting for processing the next video.
28. Look closely at the image. You may see a red fringe on one side and a blue one on the other. This is atmospheric dispersion and you can tune it out. Select the RGB shift tab to the right of the screen and you will see up/down/left/right buttons for shifting both the red and the blue components of the RGB image around relative to the green one. To help you do this, you can turn off any or all of the components as well. It usually only takes a few pixel shift of the red component in one direction and a few more of the blue component in the opposite direction to make a significant improvement. The fringes should go away, and small scale details may sharpen up considerably.
29. Now press the Final tab near the top and center of the screen. This stage of the process will allow you to rotate and or flip the image to correct for odd numbers of reflections (left and right reversed, like with a star diagonal) and make North or South up as you prefer.
30. You now save the final image as either a bitmap or a jpeg 8 bit file, or three 16 bit

formats: FITS, TIFF or PNG. The FIT option is the most accurate way to save the files as separate 16bit R, G and B components. TIFF is like jpeg and can be compressed, however it is a 16 bit file, and I have no idea what a PNG file is.

31. Now press Select to load another file and start all over again.

Computer Stuff:

- The Computer
  - If you are setting up outside each time, the computer probably has to be a laptop. If you have a permanent observatory, a desktop is better.
  - You need a reasonably fast windows PC (no Macs, sorry), preferrably running 2000NT or XP. You can get by with ME, but it can be a painful experience.
  - Buy as much RAM and hard drive space as you can possibly afford, 200 gigabyte hard drive space is not too much! Get a DVD writer to use for video file backup if you can.
  - You need a free USB port to plug the webcam into.
- Webcam software: All you need is the driver and it is probably already in your system. Look for a program called Vrecord using the find function in your computer. Run it after plugging your webcam into the USB port. You don't need the stuff on the CDROM that came with your webcam.
- Download Registax: It's free! http://registax.astronomy.net/
- Registax tutorials: http://www.threebuttes.com/RegistaxTutorial.htm

Helpful Hints:

- Use a 2x Barlow for your early experiments. It gets the focus outside the drawtube and into the webcam focal plane. You might not be able to focus without it and you need some amplification no matter how lousy the seeing is.
- Parfocalize an eyepiece with your webcam. Life is much easier if you can prefocus before getting into the computer stuff. A motorized finder is very helpful. It is amazing how much image motion you get when you barely touch a manual focuser while you're working at f/60.
- You must have a good finder. I doubt that GO-TO scopes are accurate enough when you are using f/60 or higher. The 7-10x finder that came with your scope is probably not powerful enough. A second finder working at 25x or higher is a really good idea. I'm putting a 3" f/10 Newtonian on the side of my scope with an illuminated eyepiece.
- Work with the moon first. It is bright and easy to find.

Clif Ashcraft, October 13, 2005