S&T PHOTO-ILLUSTRATION BY CRAIG MICHAEL UTTER; M57 IMAGE BY STEVE BODIN

Deep-Sky Imaging with Integrating Video Cameras

These electronic marvels provide amazing real-time images of star clusters, galaxies, and nebulae. | **By Adrian R. Ashford**

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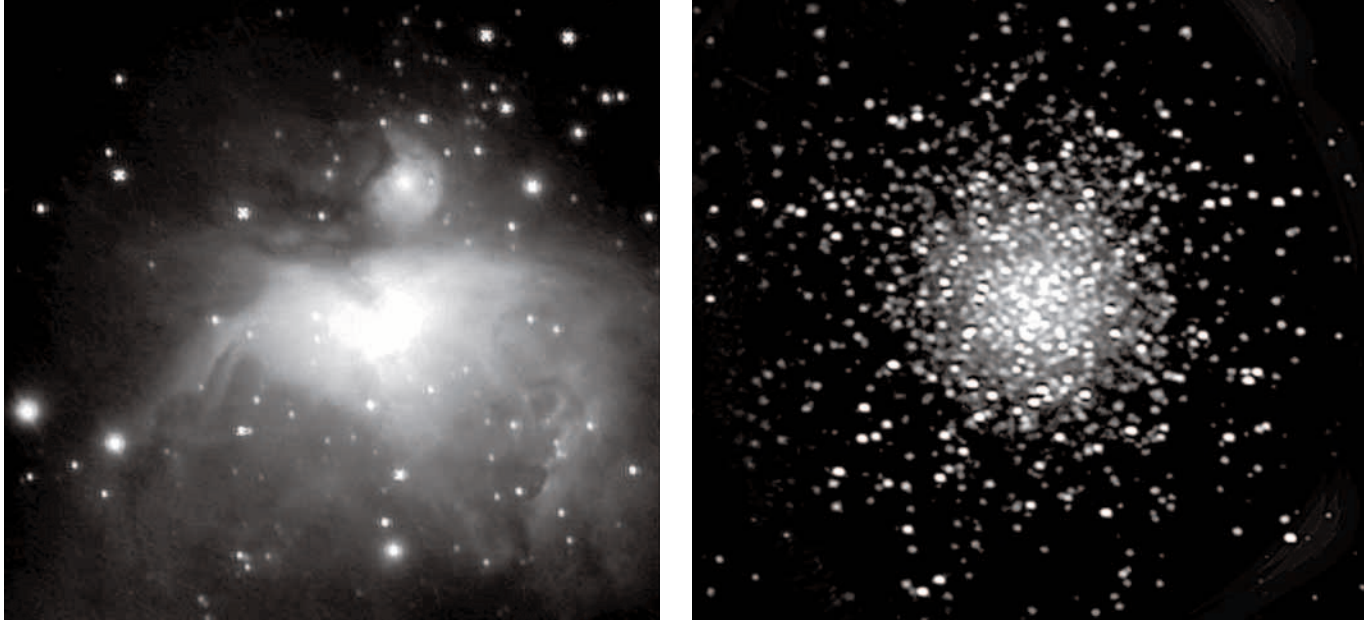
"*. . . The times they are a-changin'.*"

Bob Dylan's lyrics are equally applicable to the field of electronic imaging, in which exciting things are happening. This is especially true of the realm of video astronomy, where a quiet worldwide revolution is taking place. Scattered around the globe, a growing tide of amateur astronomers are forsaking their arsenal of eyepieces in favor of a purely electronic eye's view of the cosmos, particularly when it comes to deep-sky observing.

One of the current hot phrases in the astro-imaging community is "integrating video," and it's quite easy to see why. Imagine slipping a small camera, no larger or more expensive than some premium wide-angle eyepieces, into the focuser of your telescope and observing galaxies millions of light-years away in real time on an adjacent TV monitor or computer screen. Not only that but seeing up to *three magnitudes fainter* than those objects visible through a conventional eyepiece in the same instrument. Suddenly, it's as if your 5-inch scope were delivering views comparable to one with a 20-inch aperture! Too good to be true? On the contrary!

Unlike traditional video cameras, which have inherently low sensitivity and

Video astronomy offers many advantages, including low cost, versatility, convenience, instant gratification, and ease of image manipulation. Some of the best real-time integrating astro-video cameras available today are the Astrovid StellaCam-EX *(right, top),* the ITE DeepSky PRO EX, and the Mintron MTV-12V1-EX *(right, bottom),* shown here attached to the author's 8-inch Celestron Fastar telescope. Their extreme sensitivity produces television views of deep-sky objects much more detailed than those seen through an eyepiece.



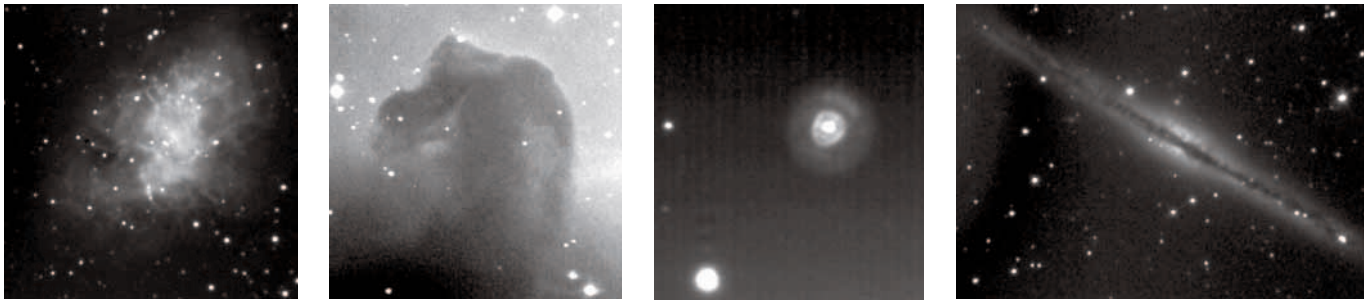
Left: **This portrait of the Orion Nebula was obtained by British astro imager Steve Wainwright with the Mintron MTV-12V1-EX coupled to his 80-mm refractor at f/5. It is the sum of three hundred 2.6-second exposures captured and processed with *AstroVideo* software. North is to the upper right in this ⅔° wide field. *Right:* This close-up of the globular cluster M13 was recorded by California amateur Jim Ferreira using the StellaCam-EX and his 6-inch Intes-Micro M603 Maksutov-Cassegrain telescope working at f/10. The camera's video output was directly captured by a desktop computer. Ferreira selected the best 60 still frames and then digitally stacked and combined them with *Registax* software. Final processing was made with *Adobe Photoshop.* The field measures ¼° across.**

short exposure times, integrating video cameras are equipped with new supersensitive CCD chips that can take exposures (integrate) longer than ⅒ second. This means they are suitable for recording not only bright targets such as the Sun, Moon, and planets, but also much dimmer ones such as star clusters, galaxies, and nebulae.

Santa Barbara Instrument Group got people thinking about deep-sky video astronomy in 1999 with its STV (*S&T:* January 2001, page 67). Whereas the STV is essentially a conventional single-shot, cooled CCD camera that can capture up to several frames per second and add a series of them to synthesize, in effect, a long exposure, contemporary cameras such as the Astrovid StellaCam-EX or the Mintron MTV-12V1-EX utilize an extremely sensitive (0.005 lux, or thereabouts) Sony CCD chip that takes exposures every ⅕₀ second in PAL (European) video format or ⅙₀ second in NTSC (North American) format. (*Lux* is a measure of the camera's sensitivity to dim light; the smaller its value, the more sensitive the camera is.)

Sophisticated electronics inside these cameras automatically stack (combine) up to 128 individual frames, delivering a continuous display to an attached monitor. The result is a detailed celestial view with smoother tonal range and less electronic noise, without the need for a personal computer to acquire and save the images. Under the maximum-sensitivity setting, these cameras approach sensitivities of 0.00005 lux. To put this into some kind of context, when used with an 8-inch telescope under dark skies, they can record faint stars down to about 17th magnitude.

The technique of stacking short, discrete exposures to simulate a much longer single exposure is hardly new, but until very recently you would have needed an attached PC with dedicated software to subtract the electronic noise inherent in the camera, precisely align each exposure, and process the final composite. Aside from the cost and technical savvy required to use such an imaging system effectively, not everyone has the luxury of a backyard observatory to house the computer, camera, telescope, and accessories. Granted, this can be done in the field, but even with a laptop computer you still need a portable power supply, and there are lots of cables involved — not a good idea in the dark, amid possibly



These views *(left to right)* of the Crab Nebula, the Horsehead Nebula, the Eskimo Nebula and the edge-on galaxy NGC 891 were captured by German astro imager Martin Elsässer with the Mintron MTV-12V1-EX. He used a 16-inch Meade Schmidt-Cassegrain telescope working at f/3.5 for the Eskimo and a 24-inch Cassegrain reflector at f/3 for the rest. He selected 83 to 235 of his best frames (each frame is approximately 2.6 seconds long) and stacked and processed them using homegrown software.

unfamiliar surroundings. Of course, CCD imagers have had to contend with this from the outset.

Traditional CCD imaging is enormously popular; however, many observers are discouraged from pursuing it for the reasons given above. This is why video astronomy is appealing, since the average user familiar with a home VCR can grasp the required technical and cabling considerations. Slide the camera into the telescope in place of an eyepiece, plug in the power, connect the video cable to an adjacent monitor, focus the telescope, and voilà — you get an instant picture.

Choosing Your Camera

There are a number of integrating video cameras on the market at the present time; they all share a common Far Eastern manufacturing heritage. The most sensitive of these are purely monochromatic (black and white) and usually have the suffix "EX" added to the model name (see the box on page 134). They are based on Sony's ICX248AL EXview HAD CCD sensor, which features enhanced sensitivity in the near infrared as well as in the visual spectrum. The chip measures approximately 8 by 6.5 millimeters; each of its roughly 380,000 effective pixels measures 8.4 by 9.8 microns.

The cameras listed in the box range in price from about $250 to $820. They feature built-in controls to adjust the sensitivity, gain (amplification), shutter speed, digital zoom, and a host of other features listed in the extensive user documentation that accompanies them, or on the Web. For example, the Astrovid StellaCam-EX (February issue, page 60) and the ITE DeepSky PRO EX are controlled via a supplied external handbox, but the others may be configured with a series of small pushbutton switches on the back of the cameras. When in "configure mode" the cameras' various settings are displayed on the TV monitor as you adjust them — very user friendly.

The lack of color output shouldn't trouble most deep-sky observers since, with very few exceptions, most denizens of deep space appear monochromatic in the eyepiece. And serious astro imagers are well used to making a composite color image by taking three separate images through red, green, and blue filters. But if you wish to take one-shot color images of galaxies and nebulae, there is now an integrating video camera for you — the Polaris DX-8263SL, otherwise known as the

Mintron MTV-63V1. This camera retails for about $250 and requires a C-mount adapter and a 12-volt DC power supply. Note, however, that this camera is less sensitive than the monochrome models by about three magnitudes.

Astro imager Steve Bodin of Silverdale, Washington, has had success shooting emission and planetary nebulae with this camera coupled to his 17.5-inch Dobsonian reflector at f/3 (as demonstrated by the images at right).

Capturing the Deep Sky

Until very recently observers had to resort to costly image-intensifying devices to get the "instant gratification" of real-time, enhanced deep-sky views. Now, at roughly a third of the price, observers can enjoy such views with one of the cameras listed below.

I was very pleased the first time I attached a Mintron MTV-12V1-EX at the f/10 Cassegrain focus of my 9¼-inch Celestron Ultima in order to view the globular cluster M13 on an adjacent 5-inch black-and-white monitor. My first attempt, at ⅕₀-second shutter speed (the slowest) and 128× sensitivity (the maximum), was awe-inspiring; the center of the monitor was ablaze with swarms of stars. Even in a 5-inch Schmidt-Cassegrain, globulars such as M15 exhibit structure that I couldn't possibly see visually through the eyepiece. Galaxies, too, reveal details on the screen with 6- to 8-inch-aperture instruments.

A Selection of Integrating Video Cameras

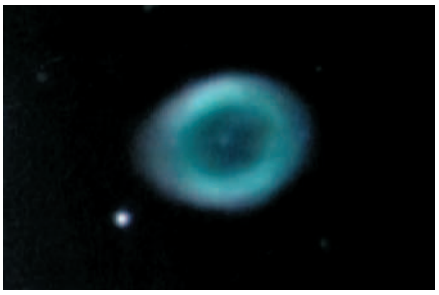
Astrovid StellaCam-EX
Available from Adirondack Video Astronomy
518-812-0025; www.astrovid.com

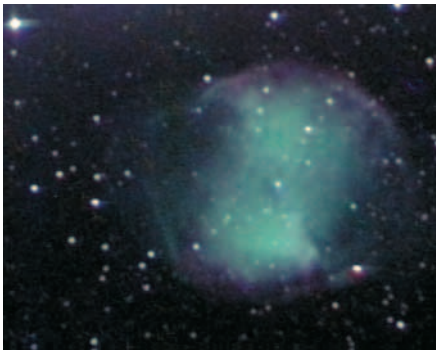
ITE DeepSky PRO EX
Available from ITE Astronomy
561-282-3222; www.iteastronomy.com

Mintron MTV-12V1-EX
Available from various dealers, including Phil Dyer (www.mintron.co.uk) and Günter Lechner (www.lechner-cctv.de)

Polaris DX-8263SL
Available from Polaris Industries
800-308-4204; www.polarisusa.com

Watec WAT-120N
www.mintron.co.uk; www.lechner-cctv.de





Steve Bodin used a Polaris DX-8263SL color video camera on his motor-driven 17.5-inch Coulter Dobsonian reflector to take 2-minute recordings of M57, the Ring Nebula *(above),* M17, the Omega Nebula *(above, right),* and M27, the Dumbbell Nebula on S-VHS tape. He captured the best frames from the tape onto his computer and used *Registax* or *Astrostack* to combine 40 to 50 of them to produce these composites. Final processing was done with *Picture Window.* The distinct reddish and greenish nebula colors are due to emission from ionized hydrogen and oxygen atoms, respectively. Note the 15th-magnitude central star in M57.

Owing to the sensitivity of the Sony CCD chip in the red, views of emission nebulae are significantly enhanced, while those of blue reflection nebulae are improved, but to a lesser degree.

Like webcams, the output of an integrating video camera can be saved to computer disk and the sharpest individual frames stacked to produce a high-resolution image.

A variety of programs, some available as freeware or shareware on the Web, can be used to combine images, including *Registax* (http://aberrator.astronomy.net/), *K3 CCD Tools* (www.pk3.org/Astro), *AstroStack* (www.astrostack.com), and *AstroVideo* (http://www.ip.pt/coaa/software.htm). Further enhancement can be made with image-processing software such as *Adobe Photoshop* or *MaxIm DL.*

Solar-System Objects

What about the Sun, Moon, and planets? Here an observer may not need the great sensitivity of the integrating camera, so shorter shutter speeds (up to ⅟₁₂₀,₀₀₀ second) may be used to good effect.

Imagers such as Jim Ferreira of Livermore, California, have achieved remarkable results with a 6-inch f/6 Maksutov-Cassegrain telescope focused on Jupiter and Saturn, as well as on the Moon. He has also shown that an instrument such as this, with a relatively "fast" focal ratio, delivers stunning results with deep-sky objects, too. Check out his Video Capture Astrophotography Web site at www.lafterhall.com/astro.html.

Comets, Meteors, and Auroras

What if you don't have a telescope? The extreme sensitivity of an integrating video camera, coupled with a short-focal-length C-mount lens and placed on a photo tripod, makes for an awesome wide-angle imaging system. Views of the Milky Way up to 70° across obtained in this fashion are visually stunning, and meteors too faint to be seen by the naked eye will be routinely recorded. Comets and auroras, too, can be very successfully imaged and recorded to tape or disk for subsequent playback. The list of possibilities is limited only by your imagination.

Many resources exist on the Internet to further your enjoyment of integrating video equipment. Please refer to e-mail discussion groups such as VideoAstro (www.fortunecity.com/victorian/canterbury/222/astrovid.htm) and QCUIAG, the QuickCam and Unconventional Imaging Astronomy Group (www.qcuiag.co.uk), for more information.

You can also learn more by reading the comprehensive guidebook *Video Astronomy* by Steve Massey, Thomas Dobbins, and Eric Douglass (available from Sky Publishing for $24.95).

Associate editor Adrian Ashford *wonders how long it will be before "eyeballing" a nebula or galaxy is a thing of the past.*