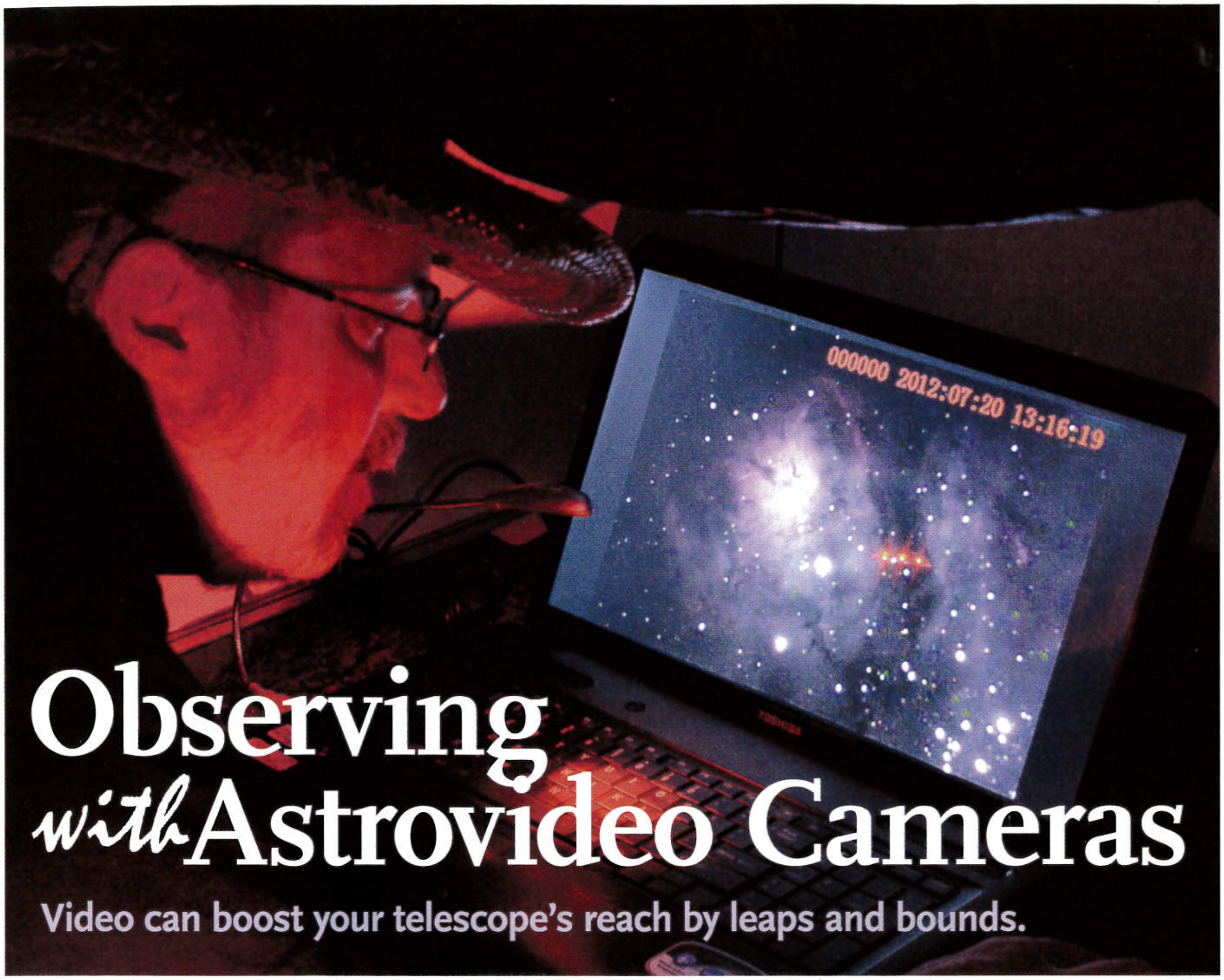


Observing *with* Astrovideo Cameras

Video can boost your telescope's reach by leaps and bounds.

By Rod Mollise

A few years ago the approach of another birthday got me feeling philosophical. Not just about life in general, but about amateur astronomy. How far had I seen? What is really out there in deep space? I had observed many amazing objects, but I felt like I'd only scratched the surface.

ALL IMAGES BY THE AUTHOR

I didn't just want another look at the same old clusters, nebulae, and galaxies; I wanted to dig deep and see what lies beyond the bright showpieces.

How would I do that? I could do it visually with a large telescope. It's not unusual anymore to see amateurs using 20-, 30-, or even 40-inch Dobsonian light buckets. The problem with that idea was I'd have to haul one around whenever I had the hankering to observe. Innovative designs have made large amateur telescopes lighter than ever (see page 63), but you can only make a 25-inch Newtonian so small. A long time ago I decided I would not let my choice of telescope dictate my choice of vehicle.

What about astrophotography? I've been down the imaging road a time or two with film cameras, CCD cameras, and DSLRs. I love taking pictures of the sky, but that

Astrovideo observing has become a popular way to enjoy astronomy. Detailed views of targets such as the Lagoon Nebula (above and left) are within reach using modest equipment from less-than-ideal locations.

Astrovideo observing is not geared toward producing stunning astrophotos. Its primary goal is simply to reveal faint targets on a video monitor or laptop screen. These images of M27 *(left)* and M51 were recorded in only 15 and 28 seconds, respectively, through an 8-inch Celestron C8 Schmidt-Cassegrain telescope.

was not quite what I had in mind. Doing a good job with a conventional camera means concentrating on one or two objects an evening. Given my weather in the South, that meant I might "see" eight or ten new objects over the course of a year. And I wanted to go way beyond that in my explorations.

Then I remembered video. I had done a little experimenting, shooting the Moon and planets with my camcorder. I liked the results but hadn't been able to image dimmer objects. A standard video camera's exposures don't allow enough time for the light of a distant galaxy to build up. I wondered, though, what would happen if I could take longer exposures with a video camera?

I didn't have to wonder long. Several of my friends had embraced "astrovideo," as they were calling it, and were routinely capturing the dimmest objects with video cameras. They viewed them in near real-time with no computer required, just a camera and a monitor. It was even more appealing that they were doing it from light-polluted suburban sites! My buddies were using special cameras from Mallincam (**mallincam.com**), CosmoLogic Systems (formerly StellaCam, **cosmologicsystems.com**), and Orion Telescopes & Binoculars (**oriontelescopes.com**). These cameras had several things in common that

Augmenting your observing gear with an astrovideo camera is almost like tripling the aperture of your telescope. This 22-inch Starstructure Dobsonian, combined with a MallinCam Xtreme, routinely reveals galaxies fainter than those plotted in popular star atlases.

Above: Astrovideo cameras are very compact, often smaller than a wide-field eyepiece. Popular models shown above or those available from Orion Telescopes & Binoculars come with a 1¼-inch nosepiece to fit directly in your telescope's focuser.

Left: Besides the camera, you'll need a video monitor to display your exposures as they come off of the camera. When in remote locations, the author uses a small, portable DVD player that includes a video input. The player's internal battery is adequate for displaying images throughout an entire evening.

Video camera detectors are by their very nature small due to the format of analog television. Although this makes placing your target on the detector difficult, the tiny field of view is too narrow to reveal any off-axis distortion inherent in most telescope optical designs.

allowed them to capture deep-sky objects.

The most important difference between astrovideo cameras and camcorders is the astronomy cameras' ability to take longer exposures. The less-expensive astrovideo cameras can expose for 5 to 10 seconds. That may not sound like much, but it's enough to reveal amazingly faint objects. My first astronomy video camera was limited to 10-second exposures, but had no difficulty revealing 15th-magnitude galaxies with an 8-inch telescope.

I found I liked the astrovideo experience: it was more like visual observing than sweating over a CCD camera and computer. Video cameras begin a new exposure as soon as the previous one is completed. With a new frame flashing onto the screen automatically every 10 seconds, I felt like I was seeing objects in real time. An additional bonus was the camera's good performance from my less-than-perfect site, thanks to the wide dynamic range of its CCD detector.

What really fired me up, though, was astrovideo's ability to reveal the dim and distant. How deep can one go? I've heard it said that an astrovideo camera can multiply a telescope's aperture three times, but this may be a conservative estimate. I have visually observed faint objects such as the Horsehead Nebula in Orion with large scopes, but even a 42-inch has never delivered at the eyepiece the level of detail visible with my video camera and 11-inch Schmidt-Cassegrain telescope (SCT).

I loved my first camera, the discontinued StellaCam 2. Although it was able to image objects such as the Horsehead Nebula with fair ease, to do that I had to crank up the gain (sensitivity) on its wired hand control to levels that made the image on the video screen noisy, with ugly, uneven backgrounds. The answer to this minor annoyance is to consider moving up to a more sensitive camera. More advanced models such as the StellaCam 3 or the MallinCam Xtreme are capable of exposing for hours (not that you'd ever want to do that).

When it was time to replace my StellaCam 2, I turned to the MallinCams, since they feature color sensors. I settled on the MallinCam Xtreme, which was a big step up from my earlier camera.

Even with the gain set at low levels, images from astrovideo cameras, like those of still CCD cameras, show considerable thermal noise. Internal heat causes electrons to be liberated from the imaging chip, and these electrons show up in pictures as "false stars." The MallinCam Xtreme includes electronic cooling to reduce thermal noise, just like a dedicated CCD camera.

The results I quickly achieved with the Xtreme were nothing short of amazing. Going from 10-second to 1-minute exposures made a huge difference. Not only was I able to keep the gain setting low, resulting in smoother-looking images on the monitor, I could see more detail than with short exposures no matter how high the gain was set on the StellaCam.

On first-light night for the Xtreme, Orion was hanging in the sky, so I naturally slewed the 11-inch SCT to the Horsehead, set the exposure to 56 seconds, and let fly. What was displayed when the first image came in made my jaw drop! IC434, the "background," was bright red. The reflection nebula to the northeast, NGC 2023, was icy blue. But what most impressed me was the dark nebula itself.

One benefit of the small detectors in astrovideo cameras is they can utilize strong focal reducers without producing objectionably distorted star images, allowing you to convert your f/10 SCT into an f/3.3 wide-field instrument.

Details were visible that I had only seen in long still-camera exposures, and I was seeing them without a computer and hours of image processing.

In addition to letting me see faint objects, I found that astrovideo cameras fulfilled my other requirement: seeing plenty of good stuff each and every night. The simplicity of my setup allowed me to cover lots of ground in a single evening. When I was doing The Herschel Project (*S&T*: August 2012, page 60), my quest to see all 2,500 of William and Caroline Herschel's deep-sky objects, I often logged 100 or more faint fuzzies a night.

So is astrovideo for you? It might be if your goals are similar to mine. If you are more interested in pretty pictures, however, it might not be your cup of tea. Stills made from video will never look as attractive as images from astronomical CCD cameras, though some video users have come close using frame grabbers to transfer cameras' analog video into a computer for processing.

Astrovideo may also not be for you if you don't like a fair amount of somewhat expensive technology coming between you and the sky. You'll need a camera, a monitor, a power supply, and cables for a minimal setup. If you want to record your videos for later viewing, you'll also need a video recorder. How much money is involved? The best cameras are relatively inexpensive compared to astronomical CCD still cameras (about $500 to $2,000 depending on the make and model), but you'll still need to factor in the cost of the additional items.

Most cameras come with a small AC power supply, but often that won't do much good at a dark site out in the sticks. I power my camera with a DC power cord supplied by the manufacturer and a 12-volt automotive battery. Furthermore, I've found that running the camera off a battery results in less-noisy video than if I power it from the typical "wall-wart" AC power supply.

The sort of monitor you'll want depends on your

Pixel Count *and* Pixel Size

How can deep-sky video cameras produce recognizable pictures of galaxies in 10 seconds when a DSLR would need a minute or more? It's all a matter of pixel size. The bigger the pixels on the light sensor, the more light falls on each pixel in a given period, and the better the low-light sensitivity.

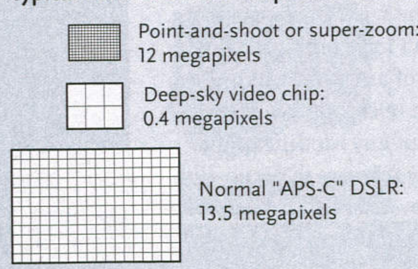
Point-and-shoot and super-zoom cameras are poor choices for deep-sky photography because they have tiny sensors (to keep their long zoom lenses compact) divided into huge numbers of pixels — which is largely a marketing gimmick. A full-page photo in this magazine needs just 6 to 8 megapixels.

DSLRs have about the same pixel count as point-and-shoots, but their sensors are much bigger. That makes each pixel bigger, giving the camera very good sensitivity when operating in low light levels.

The sensors in deep-sky video cameras are small, but they have very low pixel counts. That results in huge pixels, making them extremely sensitive to faint light, but at the cost of resolution.

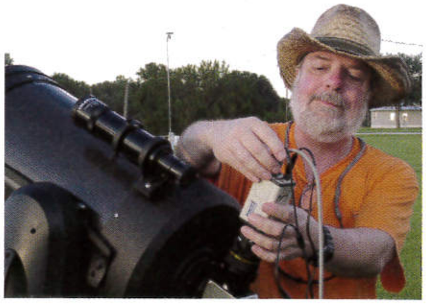
— Tony Flanders

Typical Camera Sensor Chip and Pixel Sizes



Chips are shown at true size.
Each small square represents 250 x 250 pixels.

Observing with an astrovideo camera like the one here doesn't require much additional equipment to tow into the field. Besides the camera, you'll need a DC power source and a video monitor or laptop computer to display your exposures. You can also use a variety of Barlows and focal reducers to tailor your field of view to each target, just like switching eyepieces when visually observing.



Left: Setting up an astrovideo camera couldn't be easier — simply replace your eyepiece with your astrovideo camera. Your telescope then becomes the camera's lens.

observing site. If you are working from home with AC power available, you can use any TV/monitor with a standard composite video input. At a remote location, you'll usually need one that runs on DC. I use one of the ubiquitous portable DVD players, one with an input jack for external video that allows me to use it as a monitor. The screen is small, but it looks good and runs a long time on the internal battery.

I preserve the video that comes out of my camera with a solid-state video recorder that saves my shots to an SD memory card. It will run a whole evening on its battery, and it's small and convenient. I have used a home DVD recorder, and that worked fine, but I had to power it with an inverter and a large marine battery that was heavy and was quickly discharged by the inverter.

Silly me. I forgot to mention the No. 1 accessory you need: a telescope. What kind of scope? To go beyond the Moon and planets (most current astrovideo cameras are competent planetary imagers, too), you need a telescope that fulfills three requirements: it needs wide-field optics, it must be able to reach focus with a camera, and it must have a motor drive — preferably one with Go To pointing.

Some Newtonian reflectors don't have enough focus travel to allow the use of a camera of any kind when the camera is inserted directly into the telescope's focuser. Refractors will usually work without any modifications. Telescopes that move their primary mirrors to focus, like Schmidt-Cassegrains and Maksutov-Cassegrains, rarely have focus problems with cameras thanks to their wide focus range.

The imaging chips on astrovideo cameras are small, so a scope with a wide field of view is needed to satisfactorily frame most objects. The perfect focal length for a video telescope is around 500 to 1,000 mm. Is yours longer than that? If so, it's easy to fix with a focal-reducing lens. I use an f/3.3 reducer to change my way-too-long 2,000-mm SCT to a video-friendly 660 mm.

I'm often asked if you can start out in video with a simple Dobsonian telescope that doesn't have a drive to track the stars. Unfortunately, the answer is no. The tiny sensor chips of astrovideo cameras make tracking objects (even planets) by hand an exercise in frustration. The good news is that inexpensive Dobsonian reflectors can be purchased with alt-az drives or after-market tracking platforms. The small video chips also make it difficult to find and track objects, so a Go To telescope that locates objects automatically is much more efficient and less aggravating for video use.

So now you've got a telescope and a video camera. How do they work together? That's easy. The camera goes right into the focuser. No eyepiece is required, and astrovideo cameras don't come with lenses — your telescope becomes the lens. Most cameras come with a 1¼-inch nosepiece that allow them to be inserted directly into the focuser.

There's still the question of the choice of camera model. I won't say that a beginner isn't well-served by a top-of-the-line MallinCam Xtreme or StellaCam 3, but it's possible to start out simply and inexpensively. Both the Orion StarShoot Deep Space Video Camera and the MallinCam Jr are easy to use and give excellent results right out of the gate. They are limited to exposures of 4 seconds, but I was able to image hundreds of objects with similar exposures with my StellaCam 2.

I've seen plenty using astrovideo cameras from places like my humble backyard and our light-polluted club site. Although I still like looking through an eyepiece, I see much more with video. My cameras have more than fulfilled my wish to see what's out there, helping me look beyond the Messier and NGC catalogs to the hordes of dim galaxies that form the backdrop of the universe. ✦

*Contributing editor **Rod Mollise** observes faint fuzzies from Chaos Manor South, most often using catadioptric telescopes.*