Electronic Eyes

Curtis Vincent Macchioni

Increase your telescope's reach with an astrovideo camera.

CURTIS MACCHIONI

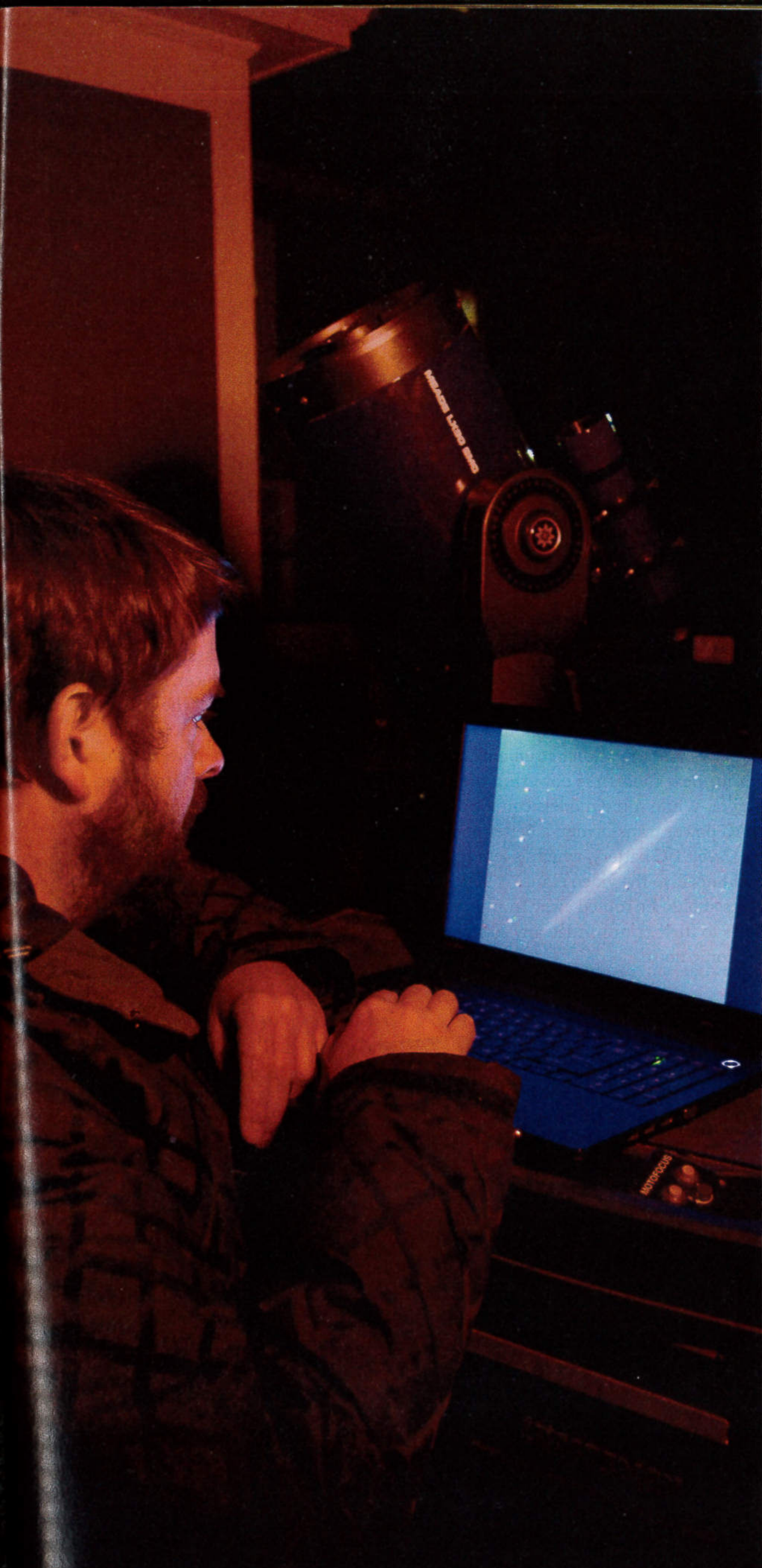
GEARING UP **The author's typical setup includes a Celestron C9.25 Schmidt-Cassegrain telescope, Mallincam Xtreme camera, Phillips LCD monitor, and a DC power supply.**

Video-assisted observing has become increasingly popular among amateur astronomers in recent years. Part of this trend is due to the growing problem of light pollution; video can show you far more from a typical suburban backyard than the same telescope can from a dark site. In fact, enhancing your observing experience with an astrovideo camera reveals objects in the night sky as unambiguous galaxies, nebulae, and star clusters, rather than as the vague smudges they often appear in an eyepiece. But more than this, an astrovideo camera can virtually increase the aperture of your telescope by a factor of three or more at a fraction of the cost of a larger scope.

Amateurs have been mating their telescopes with video cameras since the early 1980s. Video cameras at the time weren't very sensitive and therefore were generally limited to objects like the Sun, Moon, and bright planets, or the occasional occultation of bright stars. It wasn't until the turn of the century that high-sensitivity video cameras began to enter the amateur arena and interest in video astronomy began to grow.

Today, analog video cameras designed for deep-sky observing are available from Mallincam (**mallincam.net**), Astro-Video Systems (**astro-video.com**), and Orion Telescopes & Binoculars (**oriontelescopes.com**), with prices starting around $100. Additionally, surveillance cameras can easily be adapted for video observing.

These cameras have several features in common that allow them to capture bright images of deep-sky objects (DSOs). The most important is their ability to



take longer exposures than a standard video camera. Even the most basic model astrovideo camera (for example, the Astro-Video DSO-1) can record exposures of several seconds, which can reveal thousands of targets in a small scope. Many also include the ability to integrate several exposures together in order to show even fainter targets, while simultaneously reducing noise in the signal.

Most of these astrovideo cameras are built around one of several high-sensitivity Sony CCD detectors in either ⅓- or ½-inch format, with a typical pixel array of 640 × 480 pixels, roughly equivalent to the standard resolution of analog television sets. These are significantly smaller than the CCDs used in conventional astrophotography because they are designed to display an image on a TV screen rather than produce high-resolution images.

All astrovideo cameras allow you to control basic functions like exposure, gain, and gamma. Some come bundled with everything necessary to get you up and running right out of the box, including video and power cables and the C-mount adapter needed to connect the camera to your telescope.

Some camera models include an S-video output in addition to the composite video output. S-Video provides better image quality over short distances, and it can be used to send the signal to a second monitor, which is especially useful when using your system to share the view with an audience. Another helpful option is a remote control that gives access to the camera's control menu; this is much better than having to manipulate the small buttons on the back of the camera, particularly in the dark.

Essential Equipment

Besides the camera and your telescope, you'll need only a few other important accessories to get started. Most models include a standard 1¼-inch nosepiece,

S&T: SEAN WALKER

LIVE VIEWING Video-assisted observing has become a popular way to enjoy the night sky. Detailed views of galaxies, nebulae, and star clusters are within reach of small telescopes when paired with these affordable devices.

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ROD MOLLISE

TINY BUTTONS *Left:* The rear panel of the MallinCam Micro showing the camera control menu buttons. Most astrovideo cameras are far easier to operate with a wireless controller or computer. *Right:* Video camera detectors are small due to the format of analog television displays. But this has the benefit of being too small to reveal any off-axis optical aberrations inherent in many telescope designs.

but if not, you'll need to purchase a C-to-1¼-inch adapter. Next, consider the screen with which you'll be viewing the video feed. Any old (CRT) television and most current LCD TVs accept a composite video input, so you might have a screen all ready to use. If you're concerned about portability, many small LCD screens are available for under $100; look for one with a 4:3 aspect ratio that matches your camera's output format.

A desktop computer or laptop can also be used to display the video feed with the addition of a video capture card and software such as *AmCap* or *SharpCap*. Additionally, using a computer with your astrovideo camera allows you to control many of the camera's functions on screen with the programs *MallinCam Control* or *AstroLive* (**astroprecisioninstruments.com**).

Your next concern is powering the camera. While some models come with an AC power transformer, a better option is a 12-volt DC battery, which is less likely to add noise to the video signal. Video cables should be routed away from power cables to further minimize any sources of electronic noise.

Let's consider the telescope's mount. A tracking mount is essential to the camera's performance — long exposures aren't very beneficial if your target is drifting across the detector during its exposure. While an equatorial mount gives the best results during long integrations, alt-az tracking mounts will work well for short integrations, depending upon the focal length of your telescope and the declination of the object being viewed. A Go To mount makes it much easier and quicker to place your target in the field of view, given the small CCD chips in these cameras.

Now it's time to consider the telescope. Again due to the small detectors in astrovideo cameras, a scope with a wide field of view is preferred to frame most objects. Focal lengths of 1,000 mm or shorter are best, so if you've got a typical 8-inch f/10 Schmidt-Cassegrain, you'll want to use a focal reducer.

One of the benefits of the small chip in every astrovideo camera is that they can utilize much more powerful focal reducers because, unlike large detectors, they only see a small area of the full telescopic field. This means you won't see distorted stars when using an f/3.3 reducer. You can even stack focal reducers together without seriously degrading the on-screen appearance of stars at the corners of the visible field.

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ELECTRIC EYES Some popular camera models are *(left to right)*: MallinCam Xtreme (with optional cooling fan and focal reducer); LNTech 300 (with C-to-1¼-inch adapter); Samsung SCB-2000; and Astro-Video Systems MKIV (with Bluetooth adapter and cooling fan).


CURTIS MACCHIONI (2)

COLORFUL RESULTS Astrovideo observing is primarily geared toward revealing faint targets on your video monitor. These images of M20, the Trifid Nebula *(left)*, and the spiral galaxy M33 are typical of what to expect with a color camera and moderate aperture.

While not essential, a light-pollution filter can make a big difference in what you can see from typical light polluted sites. An infrared "cut filter" will also block unfocused infrared light to produce smaller stellar images.

Helpful Settings

Unless you're operating your camera with a computer, you'll need to access the camera's on-screen display (OSD) to adjust its menu settings. While each camera's OSD menu is slightly different, they all have the same general functions. The most important functions you'll change the most are Exposure, AGC (Automatic Gain Control), and Gamma. If your camera has a color chip, then you'll also have a White Balance setting.

Exposures are typically divided into two or three categories: 1/100-second or shorter exposures are best for solar, lunar, and planetary viewing. Shutter speeds of up to 2 seconds are most useful when focusing or adjusting your Go To pointing alignment, and they can even aid in collimating your telescope. Images of 3 seconds or longer are best for viewing deep-sky objects and the occasional near-Earth asteroid.

The AGC setting is similar to the ISO value on a DSLR camera. It increases the amplifier gain, thereby increasing image detail and reducing the required exposure time. But this comes at the expense of increased noise in your video, as well as noticeable "amp glow," caused when infrared radiation emitted from the read-out amplifier is picked up by the camera's detector. Amp glow appears as a bright background at a corner or top of the video image, and it's more noticeable when using high-gain settings, long exposures, or a combination of both.

Gamma adjustments allow you to stretch the luminosity values in the image, which increases detail (but reduces contrast). A setting of 1 produces an unenhanced image, while lower values enhance fainter nebulosity but lighten the overall background of the video.

In a color camera, White Balance allows you to adjust the color balance in your video. Usually you're offered options for automatic or manual modes. In automatic mode, the camera adjusts the color to what it assumes is optimal; in manual you set the red and blue levels of the video feed until the image appears properly balanced.

Two other important settings are Brightness and Contrast, which are usually adjusted on the monitor itself or within the video-capture software. Brightness raises or lowers all parts of the image from dark to light equally. The Contrast setting changes the slope of the light curve from black to white while keeping the black point fixed, reducing the dynamic range of the image.

Under the Stars

Once you've geared up, here are some tips to start observing. After replacing your telescope's eyepiece with the astrovideo camera, be sure to secure the power and control cables to prevent snags when slewing to targets around the sky.

Start by focusing on a bright star with the Exposure set at about 2 seconds, Gamma at 0.3, and AGC at the midpoint; this should produce a bright image that refreshes quickly. Once focused, slew to a DSO of interest and take a test exposure of 10 seconds or so, depending upon the surface brightness of your target. Adjust

ROD MOLLISE

EXPANDED VIEW One benefit of the small detectors in astrovideo cameras is their ability to utilize strong focal reducers without producing objectionable distortions in stellar images. This allows you, for example, to convert your f/10 SCT into a fast f/3.3 wide-field instrument.

SHARING THE VIEW With the addition of a large TV or monitor, astrovideo cameras let you share the view with groups of observers.

the AGC and Gamma settings to make it easier to see and center your target in the field of view. Next, adjust the Brightness and Contrast to bring out the most detail possible without overexposing the brightest parts of the object. You might need to increase your exposure to find the best settings for your system. If the video image displays elongated stars, try reducing the Exposure and raise the AGC setting to compensate. However, too high an AGC setting may result in objectionable amp glow and noise; too low a Gamma setting might produce a background sky that's too bright.

If you have very dark skies or can utilize long exposures, you'll generally see less noise with a low AGC setting and the Gamma at 1. However, cameras with frame integration should be used with Stacking set for 5 frames and AGC on in order to activate the stacking process. Once again, take successive images with increasing exposure times until you obtain the best possible image. When satisfied, adjust the White Balance settings to obtain a pleasing color.

Getting the best image with a reasonable exposure time is a matter of tradeoffs that will vary with sky conditions, telescope, focal length, and the presence or absence of filters. Once you're happy with the image, you can hop from one DSO to another and use the same settings, varying only the exposure time. If you prefer to keep the Exposure short, use higher AGC and lower Gamma values. On the other hand, longer Exposure provides the most detailed images with the least noisy backgrounds.

While video won't produce the smooth backgrounds and subtle detail seen in dedicated long-exposure astrophotographs, you'll be pleasantly surprised at how fast and easy it is to obtain spectacular views of galaxies, nebulae, and star clusters. With a modest-size scope and a color astrovideo camera, you'll see color in bright nebulae like M8, dust lanes and star-forming regions in nearby galaxies like M33 and M31, and the central star in M57, the Ring Nebula. And as you get more involved in deep-sky observing with astrovideo cameras, chances are your eyepieces may soon begin collecting dust. ✦

Curtis Macchioni enjoys video-enhanced observing from the San Francisco Bay area. Visit his website at **californiaskys.com**.

Pixel Count & Pixel Size

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

CURTIS MACCHIONI (2)

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

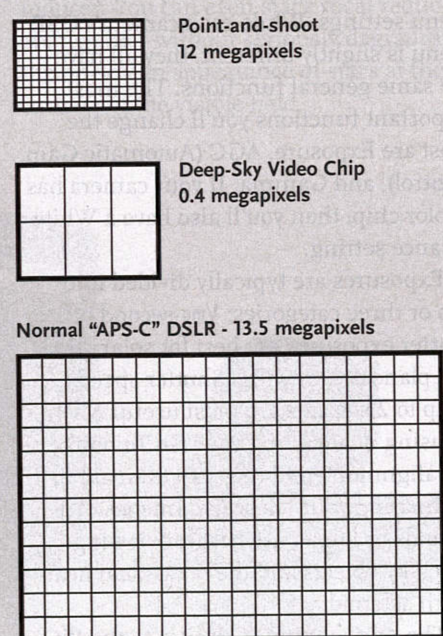
DSLRs have about the same pixel count as point-and-shoots, but their sensors are much bigger. That makes each pixel bigger, giving the camera very good sensitivity when operating in low-light levels.

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

—*Tony Flanders*

VERSATILE CAMERAS Observing with an astrovideo camera like the one shown 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 a 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.

Typical Camera Sensor Chip & Pixel Sizes



Chips are enlarged 250%
Each small square represents 250 x 250 pixels