Preface

In a span of less than five years, webcam astrophotography has exploded onto the astronomy scene. It has evolved from short exposure six-bit black-and-white imagery into long-exposure full-color 16-bit per channel imagery of such quality that it rivals "conventional" means of astrophotography. Indeed, webcams have become the method of choice for planetary imaging. This is the equivalent of compressing the entire 150-year history of film astrophotography, from the daguerreotype to hypered Technical Pan film, into a span of five years. Such incredible progress will surely continue as new developments in webcam-derived astrophotography appear constantly. The learning process is never-ending and it is amazing what can be done with such an affordable device.

My objective here is to provide a comprehensive introduction to the subject and not a step-by-step manual that will instantly become out of date. While I make frequent reference to specific cameras and software products I do so within the framework of how they work. I firmly believe that anybody who reads this book today or five years from now will smoothly move into the technology of that instant no matter how it has evolved—which it most certainly will. The tools for imaging have changed, but not the principles. I say this with the conviction of a "geezer" who has been at astronomical imaging for over 45 years and has seen and participated in the evolution of film to digital imaging. This concept was the same over three quarters of a century ago when master photographer Ansel Adams produced his classic photographs. Not once did he mark and publish the location of his tripod holes. Rather, he dealt with principles, techniques, and the need for preparation. His advice had nothing to do with equipment, thus 75 years later his words still guide us.

The message of this book is that you too can participate in the revolution without spending very much money. You do not need to invest $10,000 in a CCD camera, telescope and software. A basic webcam costs about the same as a "so-so" eyepiece. Software that will get you going is free. If you have the telescope (practically any telescope that will track) and a computer you are ready. This book is therefore a portal to show the newcomer what has been accomplished so far and to guide them toward sources of recent information and techniques which appear so quickly that

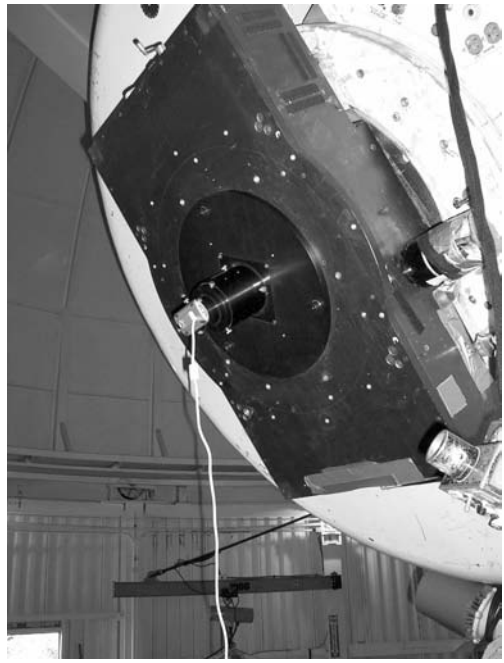
nobody can capture the latest within the pages of a book.

There have been hundreds of different brands and styles of webcams on the market over the past half-decade. A majority of them use a complementary metal oxide semiconductor (CMOS) imaging sensor, a device that has proven inferior for webcam astrophotography; but others use charge-coupled device (CCD) sensors that have proven their worth in this application. One of these is the Philips brand of CCD-based webcams. My experience is limited to this brand and I discuss its models at length in this text, but good results are also achieved with Logitech CCD-based webcams.

The use of webcams for lunar and planetary imaging actually precedes the recent explosion in the use of "conventional" digital cameras for celestial photography. Thought of as insensitive, low-resolution imaging devices by most people, webcams have become a surprisingly powerful tool in astrophotography. Creative modifications to the electronics of inexpensive webcams and the development of camera control and image processing software that utilizes the streaming video output of these cameras have made them a force to be reckoned with. Indeed, today's webcams produce lunar and planetary images that are rivaled only by the magnificent images returned by NASA space probes.

While webcams have proven to be capable performers for bright solar system objects, they traditionally lacked the long-exposure capability needed for deep-sky imaging. This changed in 1999 when Dave Allman discovered that by clipping a single wire in the Connectrix (now Logitech) black-and-white webcam, it could be used for long exposures beyond the limits of its normal software. Steve Chambers followed the innovation path in 2001 by developing modifications to the low-cost CMOS Trust SpaceC@m and Philips CCD-based Vesta webcams. From these humble beginnings fostered by the tinkering of amateur astronomers, an industry has sprung up that has produced the capable SAC, Atik, and Artemis cameras as well as the Celestron, Meade, and Orion webcam-style planetary and deep-sky imaging devices. Legions of do-it-yourself electronics buffs—in the tradition of the *Cookbook Camera* of the early 1990s—have modified their own Philips Vesta, ToUcam, and SPC900NC cameras as well as the Logitech 4000 series of cameras. The introduction of Luminera high-performance low-noise USB 2.0 cameras has opened even more opportunities for the celestial photographer. In the blink of an eye the field of webcam imaging has blossomed from non-existence to the latest hot item in celestial imaging.

The success of adapting low-cost webcams to various forms of astrophotography has opened celestial imaging to many who otherwise could



Inspired by the webcam planetary work performed by amateurs, successful experiments in planetary imaging using a ToUcam on the Lunar and Planetary Laboratory's 61-inch telescope have led to the application of webcam-style cameras for planetary research. Photo by Rick Hill.

not afford it or had telescopic equipment not suited for use with heavier conventional film or digital cameras. Just within the past several years there has been a complete paradigm shift in the nature of how high-resolution lunar and planetary images are achieved. Traditional approaches using film cameras to capture the Moon and planets were rendered obsolete. The essentially free method of electronic image capture (after initial equipment purchase) has liberated the photographer from the cost and time burdens of photographic film and developing. This allows more extensive and frequent imaging leading to a noticeable amateur upsurge in high-quality lunar and planetary observing.

Paralleling the developments in webcam long-exposure capabilities are software packages that allow control of modified cameras and processing of their output into amazingly detailed images. Programs like K3CCDTools authored by Peter Katreniak allow easier and more precise astronomical control of the webcam than possible with the programs bundled by the manufacturer. Astrovideo by COAA and Vega by Colin Bowness allow integration of large numbers of short exposures into high-depth 32-bit Fits files simulating long exposures. RegiStax, created by Cor Ber-

revoets, and Astro-Stack, authored by Robert J. Stekelenburg, allow the stacking of hundreds of lunar and planetary video frames into a single high-resolution image that out-resolves any single film or digital camera exposure. Camera control programs like K3CCDTools and commercial packages available with the SAC, Atik, Artemis, Meade, Celestron, and Orion cameras also allow modified cameras to take unlimited-length exposures.

Performing real astronomical science is now a possibility using both standard and long-exposure modified webcams. The technicalities of such activity are beyond the scope of this book, but anybody who wishes to apply their camera to such activity should know that modified webcams are very capable of such observations. The procedures for testing a CCD to calibrate it for science acquisition and the techniques of performing spectroscopy (analyzing the spectrum of a celestial object), astrometery (measuring the exact position of an astronomical object), and photometery (measuring the brightness of an object) are well documented in *The Handbook of Astronomical Image Processing with AIP4Win Software*, an excellent book and software package by Richard Berry and James Burnell. Readers interested these subjects will find Chapters 6 through 11 in the second edition (2005) of HAIP to be of interest. A plus is the included *AIP4Win* software that does both scientific and "pretty picture" image processing without compromise.

Although modified webcam deep-sky imaging is not as sensitive as dedicated CCD astrocameras, the low cost and simple operation of the webcam is drawing enthusiastic legions to this new form of astrophotography. For minimal investment, you can image the heavens with a webcam and share your results over the Internet with thousands of like-minded astronomers.

Regardless of how you apply a webcam to astrophotography, you will derive a number of benefits. Working with them has been accurately described as interesting, challenging, and fulfilling. They are capable of producing beautiful astrophotos that create a lasting record of your astronomical experience. Webcam astrophotography is an area where any enthusiast can, with relatively little investment, join an ever-increasing army of highly capable imagers in exploring an exciting new means of capturing the beauties of the sky and preserving them for all to enjoy. The pages that follow will guide the reader into this fascinating topic and allow them to become a participant in this latest wave of astrophotography progress.