ATR992M User Manual

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Contents

1 Description and Features

The ATR992M is a professional short-wave infrared imaging device specifically developed for astronomical research and observation. This sensor offers the advantages of a broad band range of 400nm to 1700nm and ultra-high sensitivity. Its outstanding performance and wide-ranging applications contribute to better outcomes in scientific research experiments.

The features of ATR992M are listed below:

- IMX992 Mono CMOS Sensor
- Resolution: 2560 x 2048
- 3.45μm Square Pixel
- 1/1.4-inch Optical Format
- 12-bit ADC
- 512 Mbyte Memory
- Precise Temperature Regulation
- Zero Amp-Glow
- Noise: 68.34 to 80.16e-
- Support High Frame Rate Mode (36 FPS at all Pixel Readout 12 bit)
- SNR Max: 44.9 dB
- Dynamic Range: 8.5 dB
- -30°C below ambient under short exposure

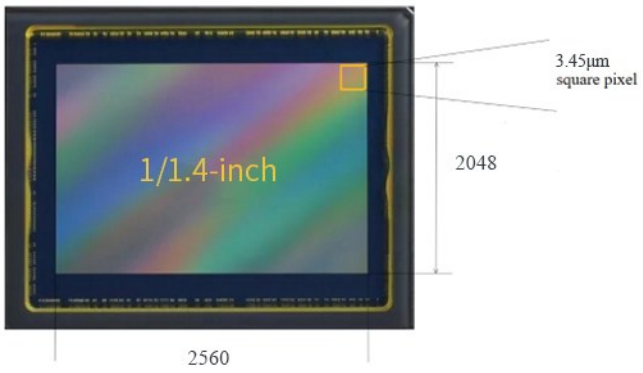

Figure 1 IMX992 Sensor and Its Pixel Structure

2 ATR992M Specifications and Performance

2.1 Camera Specifications

Table 1 ATR992M Technique Specifications.

Sensor	Sony IMX992 front illuminated sensor	
Diagonal	11.4 mm	
Image Resolution	5 mega pixels (2560*2048)	
Pixel Size	3.45μm × 3.45μm	
Image Area	9.2mm × 7.6mm	
Max FPS at Resolution (USB 3.0)	12bit	8bit
	36 FPS @ 2560*2048 139 FPS @ 1280*1024	64FPS @ 2560*2048 139FPS @ 1280*1024
Max FPS at Resolution (USB 2.0)	12bit	8bit
	4.2 FPS @ 2560*2048 15.4FPS @ 1280*1024	7.4 FPS @ 2560*2048 15.4 FPS @ 1280*1024
Shutter Type	Global shutter	
Exposure Time	0.015ms – 60s	
Gain	1x – 150x	
SNR	44.9 dB	
Dynamic Range	8.5 dB	
Read Noise (Low Noise Mode)	68.34 – 80.16 e^-	
QE Peak	>90%	
Full Well	70.3ke-	
ADC	12bit	
DDR3 Buffer	512MB (4Gb)	
Connection Port	USB3.0/USB2.0	
Camera Adaptor	M42 × 0.75mm	
Protect Windows	Longpass Filter	
Spectral Range	400-1700nm	
Capture/Control SDK	Windows/Linux/macOS/Android Multiple Platform SDK (Native C/C++, C#/VB.NET, Python, Java, DirectShow, Twain, etc.);	
Recording System	Still picture and movie	
Camera Dimensions	Diameter 80mm * height 107.1mm	
Camera Weight	0.59kg	
Back Focus Distance	17.5mm	
Cooling:	Two stage TEC	
Effective Cooling Temp:	-30°C below ambient under short exposure	
Supported OS	Microsoft® Windows® XP / Vista / 7 / 8 /10 (32 & 64 bit) OS x (Mac OS X) Linux	

2.2 Sony IMX992 Sensitivity

Its spectral sensitivity is shown in Figure 2.

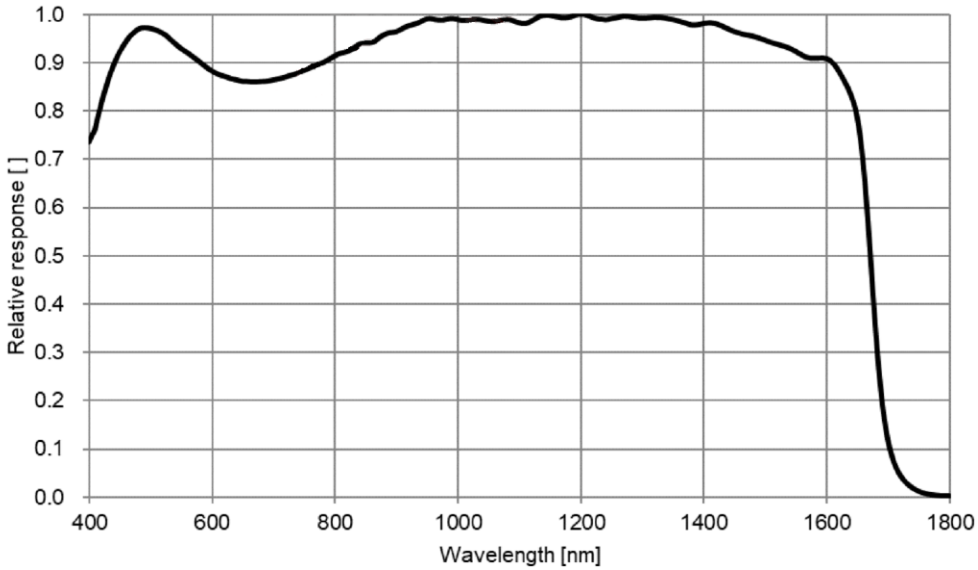

Figure 2 IMX992 Spectral Sensitivity Characteristic

2.3 12bit ADC and ROI

ATR992M has built in 12bit ADC. It also has 12bit output mode for hardware binning and smaller resolution. The camera also supports hardware ROI, and the smaller the ROI size is, the higher the frame rate is.

Table 2 shows the frame rate of ATR992M in 12/8 bit mode, USB3.0 / USB2.0 data transfer interface at different resolutions:

Table 2 ATR992M Frame Rate at Different Resolution/Data Bit/Data Transfer (USB3.0/ USB2.0)

Bit & Interface / FPS / Resolution	12bit ADC		8bit ADC	
	USB3.0	USB2.0	USB 3.0	USB 2.0
2560 * 2048	36	4.2	36	7.4
1280*1024	139	15.4	139	15.4

2.4 DDR3 Buffer

The ATR992M camera has a 512MB (4Gb) DDR3 buffer, which helps maintain the stability of data transmission, and effectively reduce the amp-glow caused, because image data can be temporarily buffered without being sent hastily to the receiver.

2.5 Binning

ATR992M supports digital binning from 1×1 to 8×8 in either stacking or averaging method, and hardware binning from 1×1 to 2×2 in averaging method. Hardware pixel binning is much faster than software binning.

2.6 Conversion Gain Switch

ATR992M support HCG and LCG mode switch.

2.7 Power and Cooling System for Precise Temperature Regulation

Please remember, the Camera can be powered only by DC12V 3A power source.

The cooling system of ATR992M is two-stage Thermoelectric Cooling (TEC) with controllable electric fan assisting heat dissipation.

The TEC system is controlled by PID algorithm, which allows the TEC to be precisely regulated towards the target temperature with 0.1°C deviation.

The working temperature can be regulated to specific number, and effective temperature drop can be 30°C from ambient temperature. Such efficient cooling system guarantees the stability of ultra-low noise mode and quality of the camera image.

2.8 Camera Performance Analysis

Camera performance can be evaluated with e-/ADU, Read Noise, Full Well and Dynamic Range.

e-/ADU: The sensors found in cameras used for vision applications have pixels that convert incoming photons into electrons. Gain on a CCD /CMOS camera represents the conversion factor from electrons (e-) into digital counts, or Analog-Digital Units (ADUs). Gain is expressed as the number of electrons that get converted into a digital number, or electrons per ADU (e-/ADU).

Read Noise: Read Noise is created within the camera electronics during the readout process as the electrons are subjected to the analog to digital conversion, amplification and processing steps that enable an image to be produced.

Full Well: The electrons are held in each pixel and are converted into electrical charge which can be measured to show the amount of light that has fallen on each pixel. The maximum electrical charge possible is termed "full well capacity". Under the same conditions such as noise and A/D converter quality, the greater full well capacity a sensor has, the wider dynamic range the sensor has. As there is a limit to the depth to which pixels can be made, the full well capacity is often proportional to the frontal area of the light gathering element of the pixel.

Dynamic Range: Dynamic Range is the ratio between the maximum output signal level and the noise floor at minimum signal amplification (noise floor which is the RMS (root mean square) noise level in a black image). The noise floor of the camera contains sensor readout noise, camera processing noise and the dark current shot noise. Dynamic range represents the camera's ability to display/reproduce the brightest and darkest portions of the image and how many variations in between. This is technically intra-scene dynamic range. Within one image there may be a portion that is in complete black and a portion that is completely saturated.

For the ATR series camera, the Gain Value is in xxx% mode. Here xxx is used as the x axis (Gain Value) for the description of the camera performance

$$Rel\ Gain(dB) = 20 * log_{10}[xxx(Gain\ Value)/100]$$

$$xxx(Gain\ Value) = 100 \times 10^{(Rel\ Gain(dB)/20}$$

Camera setting used for HCG performance analysis is shown below:

- Full resolution
- RAW 12-bit mode
- Ambient Temperature: 28°C

Figure 3 shows the curves of the camera analysis data in Table 3

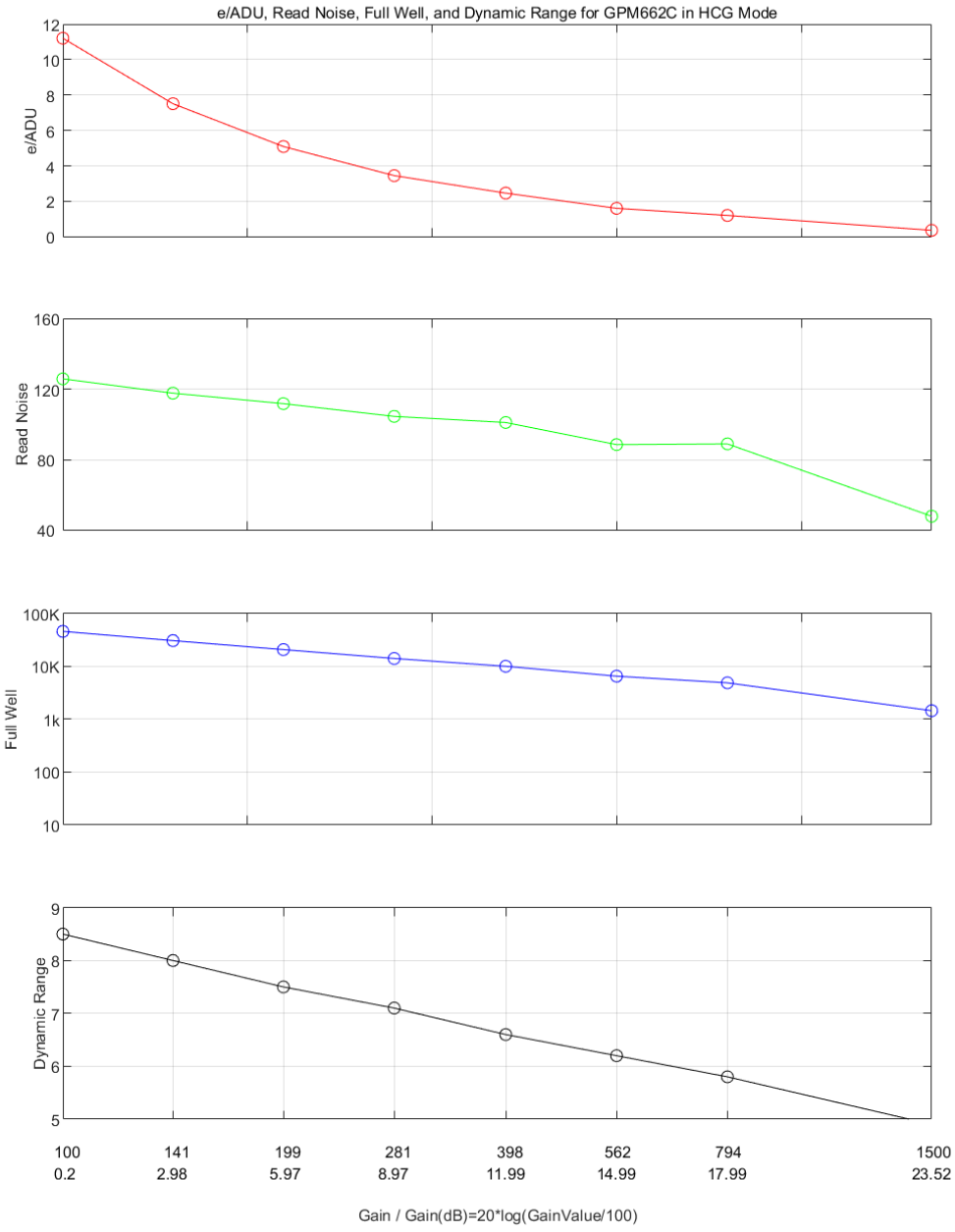

Figure 3 e/ADU, Read Noise, Full Well and Dynamic Range for ATR992M

The camera analysis data is shown in Table 3:

Table 3 Camera Analysis Data

Sensor Analysis Data								
Gain Value	100	141	199	281	398	562	794	1500
Rel Gain (dB)	1	1.36	1.93	2.71	3.92	5.51	7.69	14.44
e-/ADU	11.21	7.51	5.09	3.45	2.46	1.6	1.2	0.36
Read Noise (e-)	125.87	117.75	111.81	104.57	101.11	88.54	88.94	47.89
Full Well (ke-)	45.19	30.27	20.48	13.9	9.89	6.43	4.81	1.43
Dynamic Range (stop)	8.5	8	7.5	7.1	6.6	6.2	5.8	4.9

Camera setting used for LCG performance analysis is shown below:

- Full resolution
- RAW 12-bit mode
- Ambient Temperature: 28°C

Figure 4 shows the curves of the camera analysis data in Table 4

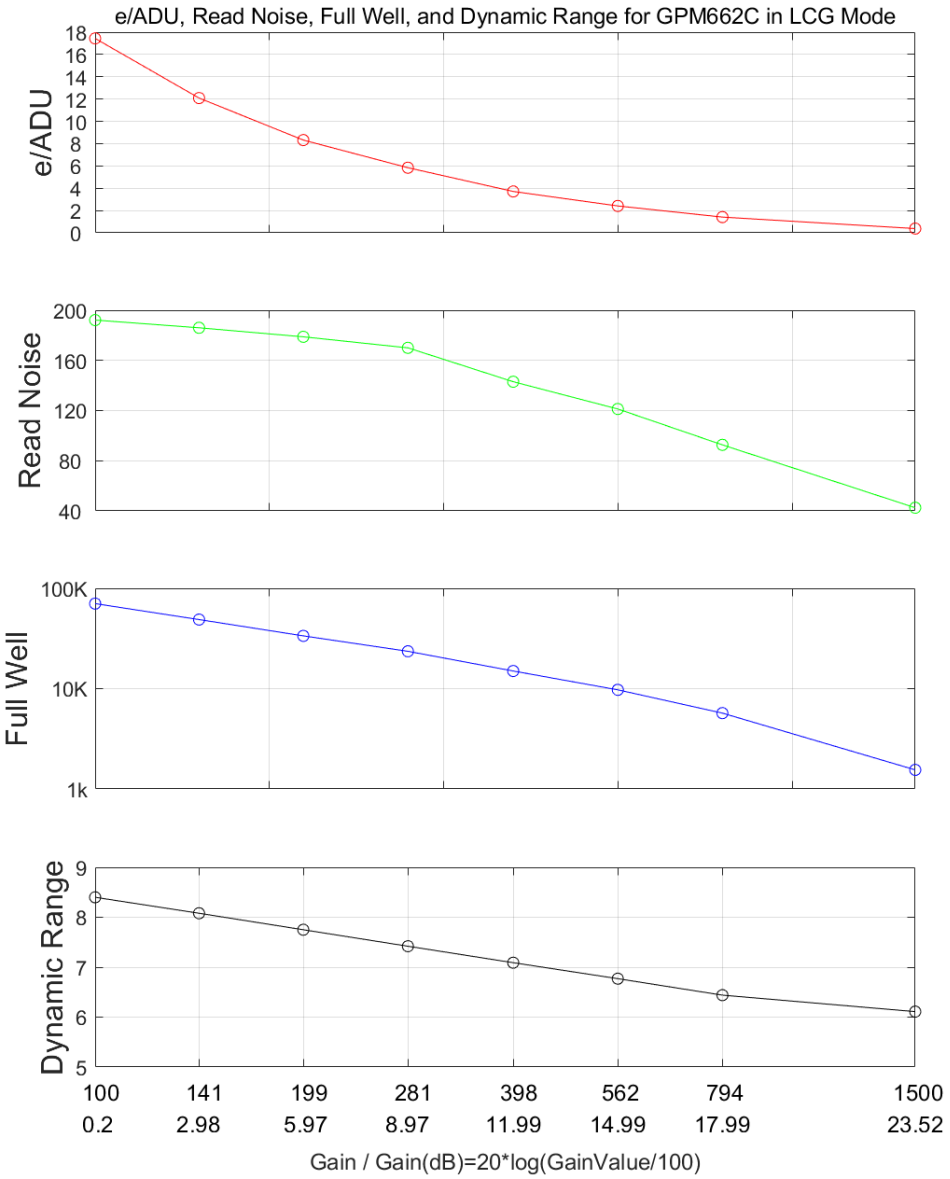

Figure 4 e/ADU, Read Noise, Full Well and Dynamic Range for ATR992M

The camera analysis data is shown in Table 4:

Table 4 Camera Analysis Data

Sensor Analysis Data								
Gain Value	100	141	199	281	398	562	794	1500
Rel Gain (dB)	1	1.4	1.97	2.74	3.91	5.5	7.72	14.68
e-/ADU	17.44	12.09	8.32	5.84	3.71	2.41	1.41	0.38
Read Noise (e-)	192.17	186.02	178.82	170.03	143.01	121.26	92.65	42.51
Full Well (ke-)	70.39	48.82	33.58	23.57	14.99	9.73	5.7	1.55
Dynamic Range (stop)	8.4	8.08	7.75	7.42	7.09	6.77	6.44	6.11

3 GPS Specifications

The ATR series are high-performance CMOS cameras with integrated cooling systems, now equipped with GPS modules for precision timestamping. Hardware timestamps capture exposure start and end times directly in the image data with microsecond-level accuracy, ensuring that temporal information is both precise and globally synchronized.

3.1 ZHONGKE Mirco-ATGM332D-5N-71

The ATGM332D-5N-71 GPS module supports multi-constellation GNSS (GPS, BDS, GLONASS) with high sensitivity and low power consumption. It embeds precise UTC-synchronized timestamps and geolocation data (longitude, latitude, altitude, satellite count) directly into each frame's metadata.

Key features include:

- Support **GPS, BDS (BeiDou), and GLONASS** multi-constellation positioning with simultaneous signal reception for combined PNT (positioning, navigation, and timing).
- Outputs UTC-synchronized **PPS (Pulse Per Second)** signal with <30 ns timing accuracy (1σ).
- Outputs NMEA 0183 data via **UART** interface..
- Provides UTC timestamps, longitude, latitude, altitude, positioning quality indicator, and satellite tracking count.

Application: Occultation timing, variable star photometry, meteor tracking, exoplanet transits, and multi-site coordinated observations requiring sub-microsecond time synchronization.

Table 5 GPS status windows explanation

Label	Content
Status	Locked (GPS ready), Unlock (GPS not ready).
Sequence #	Sequence number of current image.
Latitude	Latitude of current location.
Longitude	Longitude of current location.
Altitude	Elevation of current location. Supports up to 8848.86m (above sea level).
Start	yyyy-mm-ddThh:mm:ss.ssssssz (UTC).
End	yyyy-mm-ddThh:mm:ss.ssssssz (UTC).
Exp. (us)	Exposure time measured by GPS.
Line Time (ns)	Time difference for each line starting exposure.
Sys Clock	nnnnn.nnn sec ahead of GPS.
# Sats	Number of satellites signals being received by module.

3.1.1 Fundamental Principles

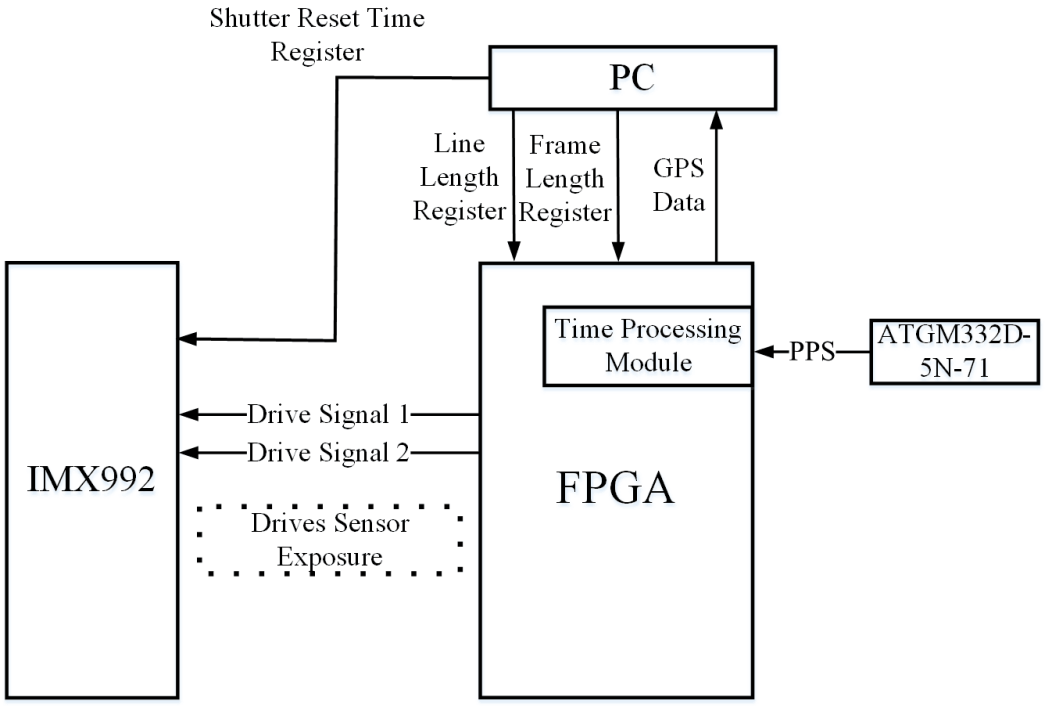

Figure 7 Block Diagram of GPS Timing Princip

The PC configures exposure parameters via line length and frame length registers. The FPGA generates drive signals to trigger sensor exposure and captures hardware timestamps at exposure start and end events. The Time Processing Module synchronizes these timestamps to UTC using the PPS signal from the ATGM332D GPS module. Shutter reset time feeds back to regulate subsequent exposure timing.

- Factors influencing the line length and frame length registers used to set the exposure time: Changes in the frame rate setting and switches in bit depth.
- The FPGA utilizes a 100 MHz (10 ns period) counter to achieve a microsecond-level local clock.
- Time correction within the FPGA is performed based on the PPS signal from the ATGM332D-5N-71 module, achieving synchronization once per second.
- A steady 1 Hz PPS indicator confirms GPS lock. Valid data includes longitude, latitude, altitude, UTC timestamps (exposure start/end), satellite count, and positioning quality.

3.2 Use GPS camera with SharpCap

Preparation

SharpCap 4.1 or later supports ATR992M GPS functionality. Update to the latest version if GPS features are unavailable.

Software Usage

- Open SharpCap.
- Click on "Camera" in the menu bar Cameras and click the corresponding camera name ATR992M (Take ATR992M for example). The camera will be opened.
- In the "Camera Controls" panel on the right, set the image "Output Format" to FITS File and the "Color Space" to RAW16/MONO16.
- Click "Start Capture" to begin exposures. To view GPS data, right-click any captured FITS file and check "FITS Header" data.
- GPS information is displayed in several locations:

■ Software main screen:

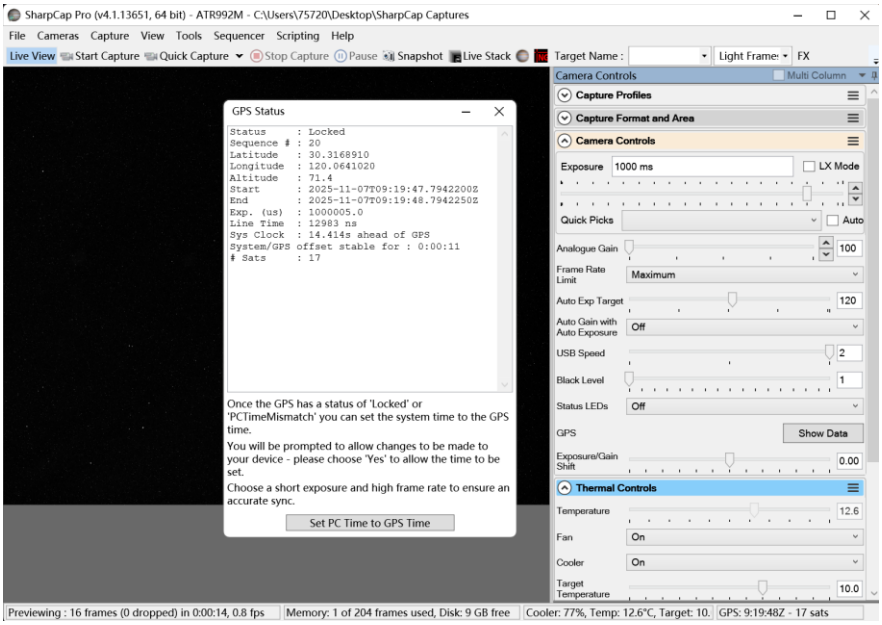

Figure 5 SharpCap Pro main screen with GPS camera in use.

- A window containing GPS data automatically pops up after the camera is connected and opened. User can also click Show Data button in the "Camera Controls" panel on the right.

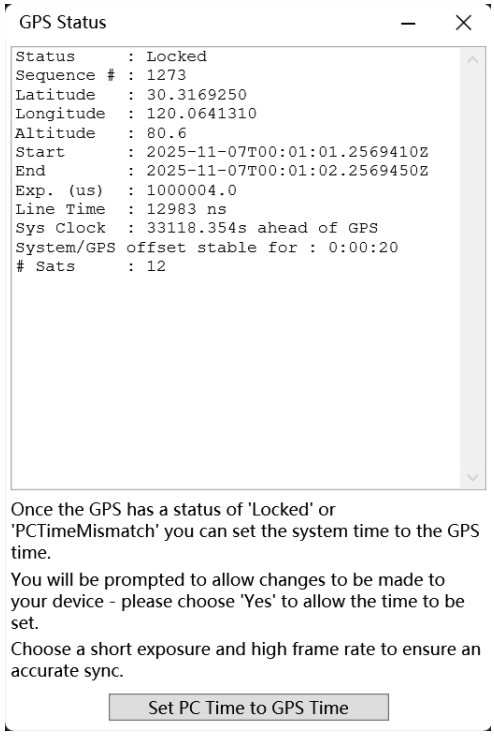

Figure 6 GPS information pop-up window

- The status bar at the bottom of the window shows GPS status.

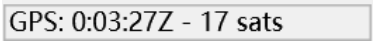

Figure 7 GPS status bar with satellites number locked

- When saving image as FITS format, all the necessary GPS information will also be saved. FITS file header contains the most comprehensive GPS information listed below.

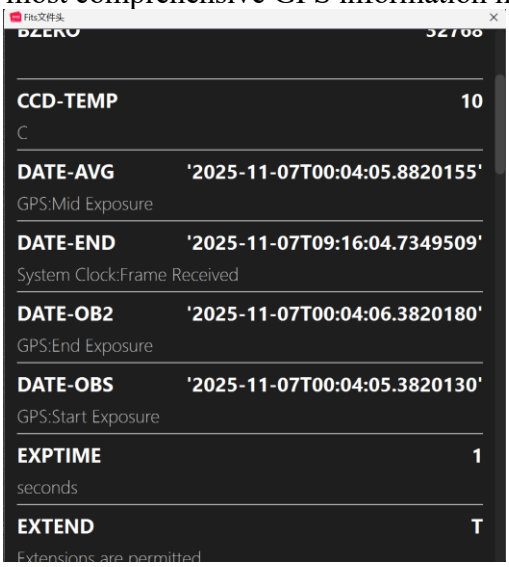

Figure 8 GPS information in FITS header

4 Product Package and Connections

4.1 Packing List

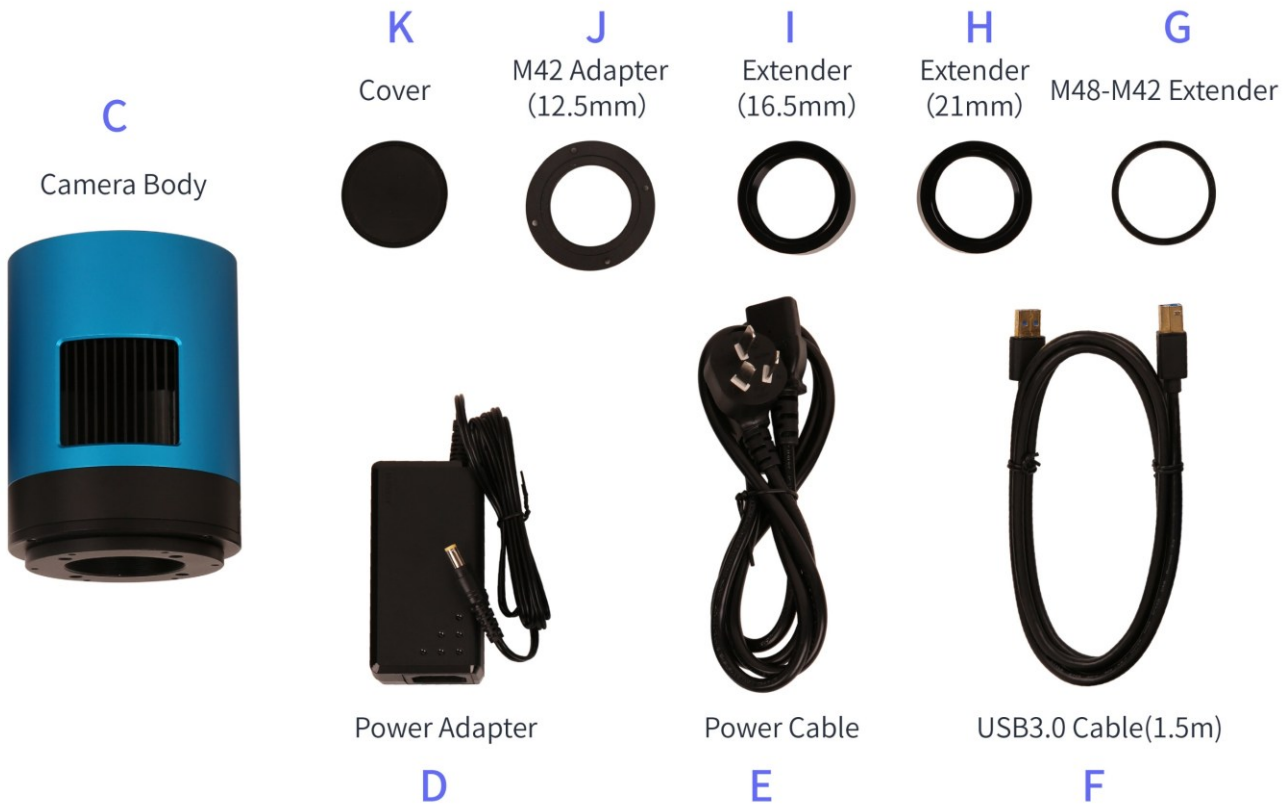

Figure 8 Packing Information of ATR992M

Table 6 ATR992M Packing List

Standard Package	
A	Carton L:50cm W:30cm H:30cm (20pcs, 12~17Kg/ carton, 0.045m3), not shown in the photo
B	3-A safety equipment case: L:28cm W:23cm H:15cm (1pcs, 3.9Kg/ box); carton size: L:28.2cm W:16.7cm H:25.5cm (TBD), not shown in the photo
C	ATR series camera (M42x0.75 Mount+2" adapter)
D	Power adapter: input: AC 100~240V 50Hz/60Hz, output: DC 12V 3.3A
E	Power cable
F	High-Speed USB3.0 A male to B male gold-plated connectors cable /1.5m
G	M48-M42 extender 0mm
H	M42M-M42F extender 21mm (TBD)
I	M48F - M42M extender 16.5mm (TBD)
J	M42M adapter 12.5mm
K	Cover

4.2 Camera Dimension and Its Mount

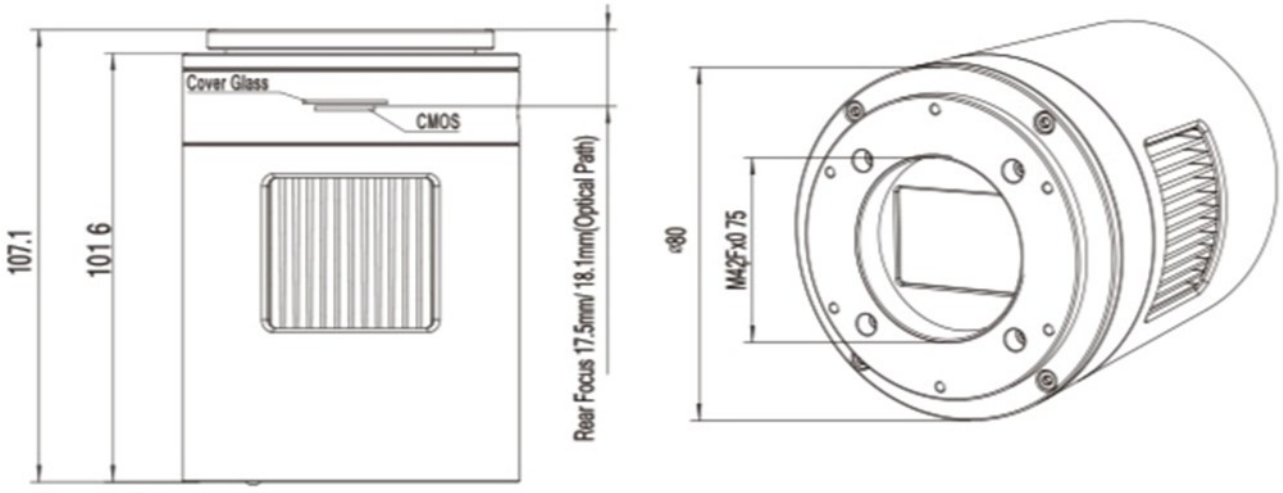

Figure 9 Dimension and Mount of ATR992M

Table 7 Dimension and Mount of ATR992M

Item	Specification
Diameter	∅80mm
Height	107.1mm
Mount	M42Fx0.75mm

4.3 Camera Outline and Interface

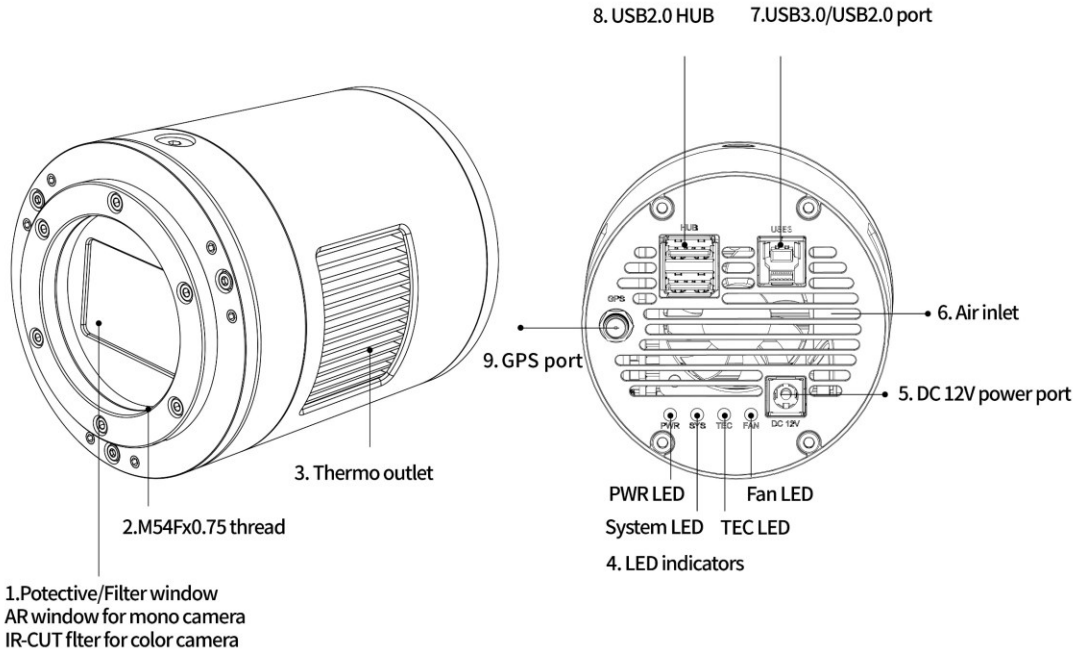

Figure 10 Camera Outline and Interface

Table 8 Camera Outline and Interface List

Item	Specification
1	Protective window, AR window for mono camera, IR-cut filter for color camera
2	M42F × 0.75 thread
3	Thermal outlet or radiator
4	LED indicators: 1) Power LED. 2) System LED. 3)TEC LED. 4)Fan LED
5	DC 12V 3A power port, 5.5 × 2.1mm
6	Air inlet
7	USB 3.0/ USB 2.0 port
8	USB 2.0 HUB
9	GPS Interface

4.4 Camera Mechanical Connection with Adapter

ATR992M can be connected to a telescope with proper adapter, or the camera lens. The most common adapters are already included in the package, but we also provide some specific adaptors based on the requirement.

The female flange to the sensor is 17.5mm. ATR992M comes with M42x0.75 mount and can connect to telescope with the M42x0.75 thread in a direct way.

ATR992M can also connect to the telescope who use 1.25” or 2” eyepieces by M42M-1.25” or M42M-2” adapter. 0 shows the connection of the camera and the adapter. After the adapter is screwed to the camera, the camera can insert into the telescope’s eyepiece tube. Table list the details of the camera and adapter parameters.

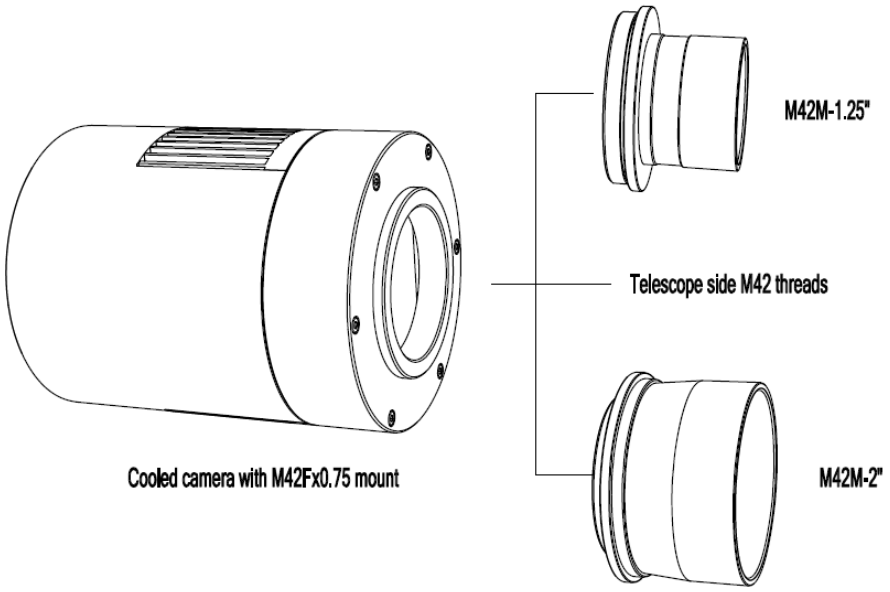

Figure 11 The Connection of the ATR Camera and Adapter

Table 9 Camera and Its Adapter Connections

Item	Specification
Back Focal Distance	17.50mm
M42M-1.25” Adapter	M48M-1.25” adapter for 1.25” telescope
M42M-2” Adapter	M42M-2” adapter for 2” telescope

4.5 Camera Mechanical Connection with Lens

Figure shows the connections of the ATR camera and the lens.Table list the connection's parameters.

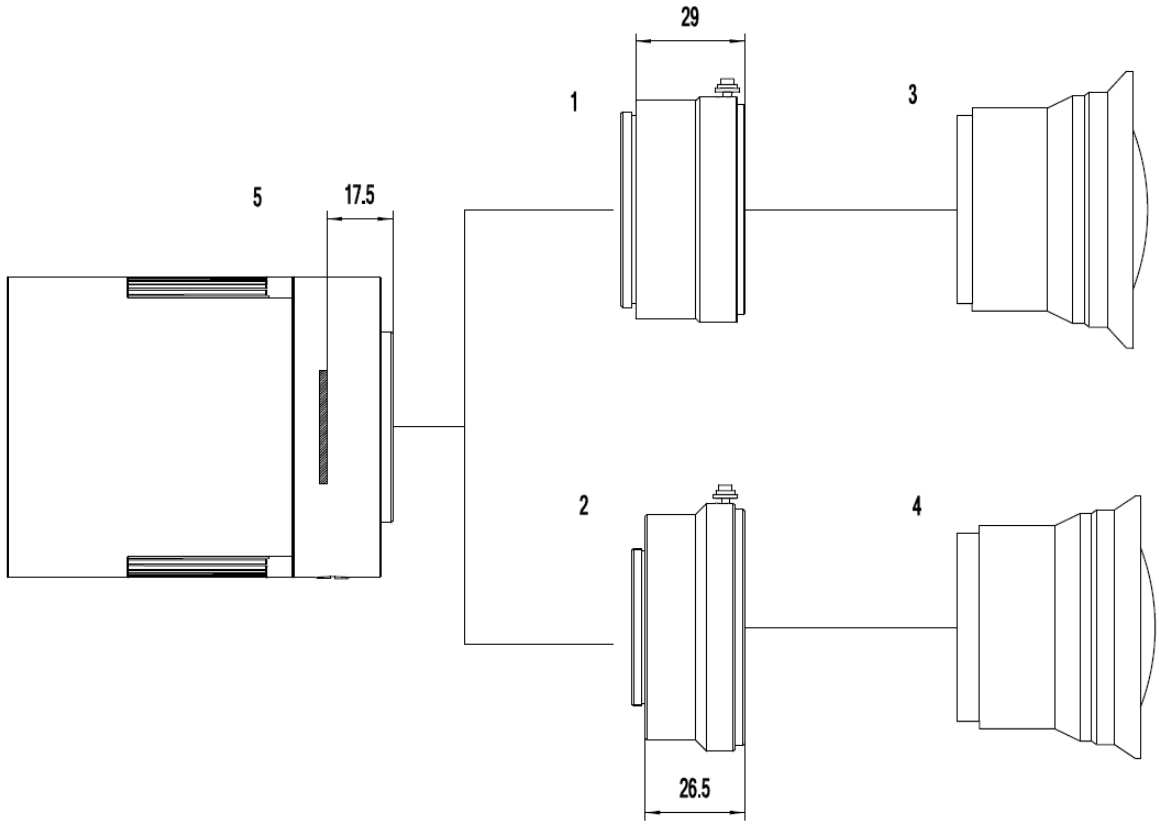

Figure 12 Nikon F/Canon EF Lens with ATR Camera

Table 10 Camera and Lens Connection

Item	Specification
1	Nikon F-M42 adapter (TBD)
2	EOS EF-M42 adapter
3	Nikon F-mount lens
4	Canon EF-mount lens
5	ATR camera with M42Fx0.75 mount

4.6 Camera Electric Connection with Accessories

On the back side of ATR992M, there are 3 connection ports: DC 12V/3A power port, USB3.0/ USB2.0 port and USB-HUB.

Due to the significantly larger power cunsumption of IMX992, ATR992M (including the cooling system) is now booted up only by 12V/3A power supply. USB3.0 no longer workds as a power source but only as a data communication method. The USB-HUB provides connection with other devices, which allows user to avoid the mess of cable management. Once another device is connected through the USB-HUB, it will be connected to PC device through the USB3.0/USB2.0 port.

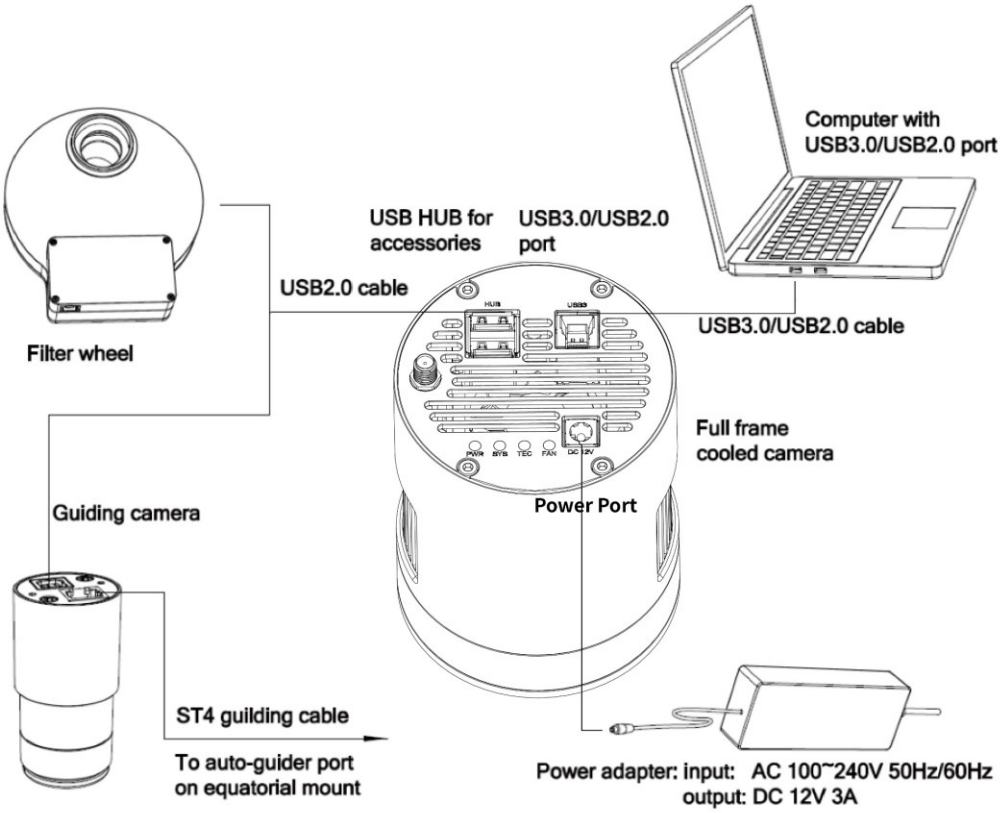

Figure 13 Camera Electric Connection

Table 11 Camera Electric Connection Details

Item	Specification
USB3.0/USb2.0 Port	To computer with USB3.0/USB2.0 cable
USB HUB for Accessories	To filter wheel with USB2.0 cable
	To guiding camera with USB 2.0 cable
Power Port	DC12V/3A

5 ATR992M and Its Software

5.1 Application Installation

For software, customers are welcomed to go to our software website: https://touptek-astro.com/downloads/, to download the latest ToupSky. The ATR can also be used with ASCOM, DirectShow SDK. If the third-party software is compatible with these SDK, customers can also download the software driver from our website and install the drivers into the third-party software.

ToupSky is ToupTek astronomy camera's Windows application. ToupSky is a professional software integrated with camera control, image capture & process, image browse, and analysis functions. ToupSky is born with the following features:

Windows:

- x86: XP SP3 or above; CPU supports SSE2 instruction set or above
- x64: Win7 or above

Features

- Full control of the camera
- Trigger mode and video mode support (raw format or RGB format)
- Automatic capture and quick record function
- Multi-language support
- Hardware ROI and digital binning function
- Extensive image processing functions, like image stitching, live stacking, flat field correction, dark field correction, etc.

Supported Camera:

- All ToupTek astronomy cameras

5.1.1 User-friendly UI Design

- Well-arranged menus and toolbars ensure quick operating;
- The unique design of 3 sidebars -- Camera, Folders, Undo/Redo are orderly classified;
- Convenient operating method (Double click or right-click context menu) as much as possible;
- Detailed help manual;

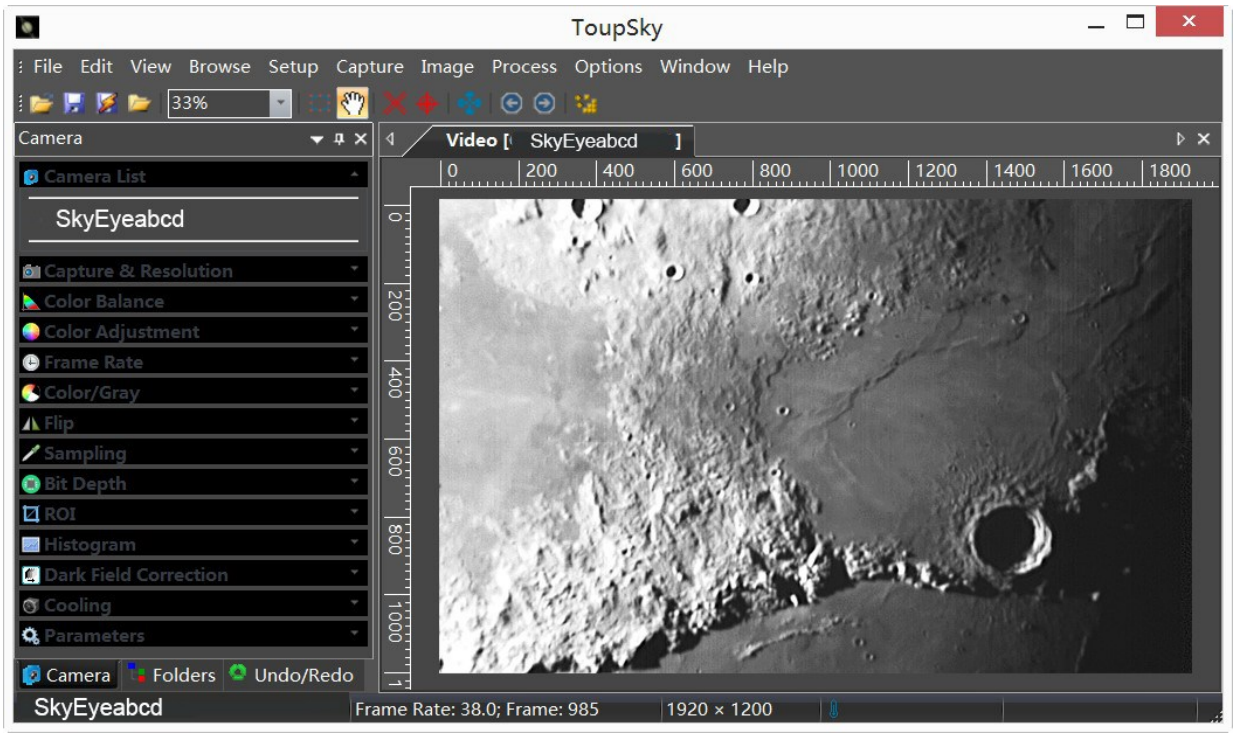

Figure 9 ToupSky and Its Video Window

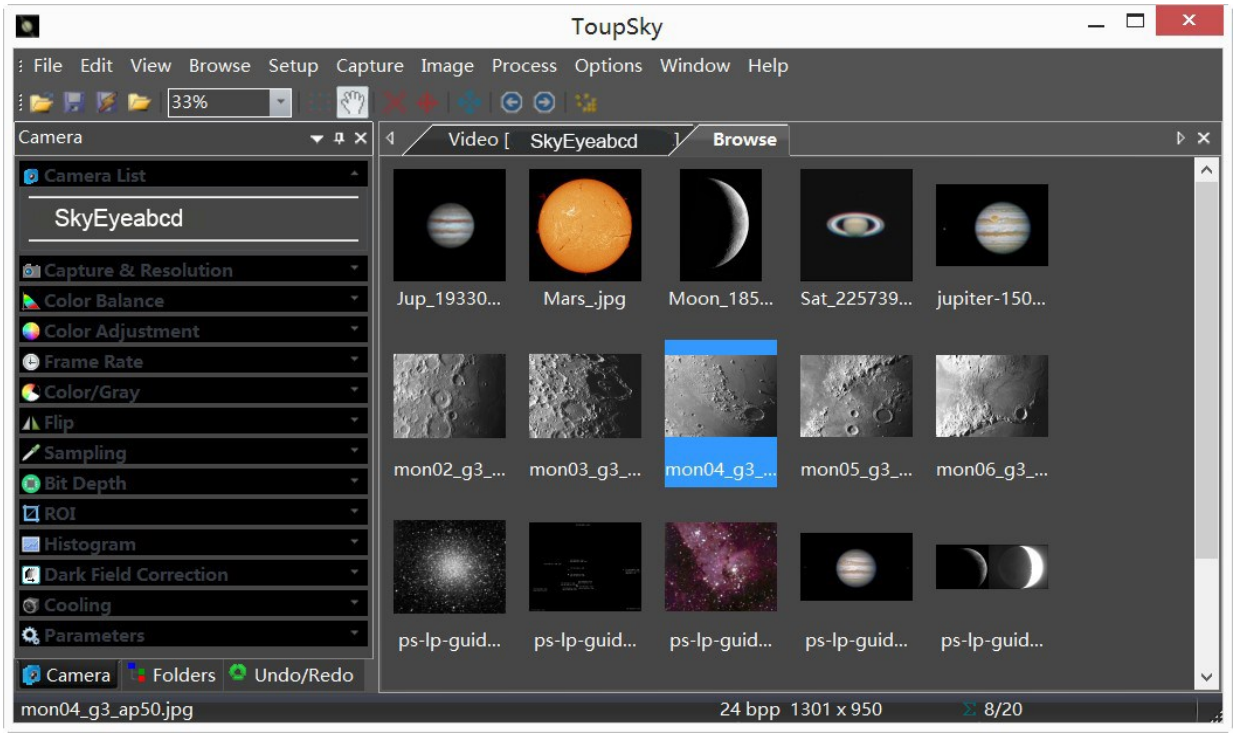

Figure 10 ToupSky and Its Browse Window

5.1.2 Professional Camera Control Panel

Capture & Resolution	Set the live and snap resolution and snap the image or record video;
Exposure & Gain	Auto exposure (exposure target preset) and manual exposure (exposure time can be inputted manually); Up to 5 times gain;
Color Balance	Advanced single-click intelligent white balance setting, temperature and tint can be manually adjusted;

Color Adjustment	Hue, saturation, brightness, contrast, gamma initialization adjustment;
Frame Rate	Adjustment of frame rate available for different computer configurations;
Flip	Check the “horizontal” or “vertical” option to correct the sample direction;
Sampling	Bin mode can obtain low noise video stream; Skip mode obtains sharper and smoother video stream. Support video stream histogram extension, Negative and positive switching, Gray calibration, Clarity factor for focusing etc.
Bit Depth	Switch between 8 bits and 16 bits. 8 bits is the basic Windows image format. 16 bits will have higher image quality but moderate FPS.
ROI	ROI, Region of interest. This function can set the ROI on the video window. When the ROI group was expanded, a dotted rectangle with "Handles" will appear around the video window that will let you alter the ROI. Use mouse button to adjust the ROI size. If ROI is ok, click Apply will set the video to ROI size, Defaults will return to the original size.
Dark Field Correction	To Enable the Dark Field Correction, one should capture the dark field image first. After the images are captured, the Enable button will be clickable. Checking the Enable button will enable the Dark Field correction. Unchecking it will disable the Dark Field Correction.
Cooling	Set the TE-Cooling target temperature and set the fan On/Off;
Parameters	Load, save, overwrite, import, export self-defined parameters of camera control panel (including calibration information, exposure and color setting information);

5.1.3 Practical Functions with Good Results

Video functions	Various professional functions: Video broadcast; Time lapse capture; Video record; Video stream grid; Image stitch; Video scale bar, date etc.
Image Processing and Enhancement	Control and adjust image by denoise, sharpen, color toning deinterlace, all kinds of filtering algorithm and mathematical morphology algorithm, range, binary, pseudo color, surface plot and line profile ital..
Image Stacking	Image stacking adopts advanced image matching technology. With the recorded video, regardless of shifting, rotation, scaling, the high-fidelity image can be stacked to decrease the image noise.

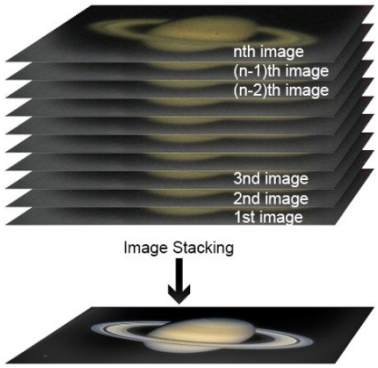

Figure 11 Image Stacking

5.1.4 Powerful Compatibility

Video Interface	Support Twain, DirectShow, SDK Package（Native C++、C#/VB.NET）
Operating System	Compatible with Microsoft® Windows® XP / Vista / 7 / 8 / 10 / 11 (32 & 64 bit), Mac OSX, Linux
Language Support	Unlimited language support, currently available in Simplified Chinese, Traditional Chinese, English, Russian, German, French, Polish and Turkish

5.1.5 Hardware Requirement

PC Requirements	CPU: Intel Core 2 2.8GHz or higher
	Memory:2GB or more
	USB port: USB3.0/USB2.0 port
	Display:17” or larger
	CD-ROM

5.2 ATR992M and Dshow

DshowAstro is an interface driver providing Dshow standard support for ToupTek USB astronomy camera

Supported OS: Windows:

- x86: XP SP3 or above; CPU supports SSE2 instruction set or above
- x64: Win7 or above

Supported Camera:

- All ToupTek astronomy cameras

5.3 ATR992M and the 3rd Party Software

5.3.1 Support Software

No.	Software	Version	WDM	ASCOM	Native
1	PHD Guiding	2.3.0(2014)	√	√	√
2	Nebulosity	3.2.2(2014)	√	×	/
3	MaxIm DL	5.23(2013)	√	×	/
4	SharpCap	2.1(2014)	√	×	/
5	MetaGuide	5.2.0(2014)	√	/	/
6	FireCapture	2.4.05(2014)	√	/	/
7	Astroart	5.0(2014)	√	×	/

5.3.2 N.I.N.A

Powerful open source astronomy equipment management system for deep sky photo shooting, free.

5.3.3 INDI

A popular third-party driver software for astronomy devices, often used on Linux and MacOS.

5.3.4 ASCOM Platform

All AstroCam telescope camera drivers request to install ASCOM platform, free.

http://www.ascom-standards.org/index.htm

You can download the ASCOM package from : http://ascom-standards.org/Downloads/Index.htm

5.3.5 PHD Guiding

A popular free guide software: http://openphdguiding.org/

ToupTek's telescope camera support Native/ASCOM/WDM driver to run the video.

5.3.6 Nebulosity

A popular cooled camera control/image process software directly supported via ASCOM.

5.3.7 MetaGuide

Autoguiding software with novel method to avoid the atmospheric agitation. The latest version support GCMOS01200KPB and the guide port: http://www.astrogeeks.com/Bliss/MetaGuide/

5.3.8 MAXIMDL

Famous full functional CCD Control/Image Process software. Popular used in US.

5.3.9 AstroArt

Famous full functional CCD Control/Image Process software. Popular used in Europe.

5.3.10 FireCapture

Great free planetary capture software. Support part of AstroCam series telescope camera.

5.3.11 SharpCAP

A nice free planetary capture software support WDM cameras includes AstroCam series telescope camera.

5.3.12 Registax

A popular free planetary stacking and processing software.

5.3.13 AstroStack
A planetary stacking and process software.

5.3.14 DeepSky Stacker
A free deep sky image stack and process software.

6 Service

For software upgrades, please refer to “Download” on our official website: https://touptek-astro.com//

For customers who purchase the cameras from local dealer, please contact your dealer for more inquiry.

For technical support, please contact e-mail address: astro@ToupTek.com.