Tetracam
Hawk
User's Guide

Notices

Trademarks

Version .1 - Last Modified April 2018

Contents

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Introduction

This User's Guide contains general information about Tetracam's Hand-held Agricultural Wireless Camera (HAWC or Hawk) imaging systems covering installation, operation, options and accessories, warranties, and technical support. The information is specific to firmware version 1.11.

Tetracam's Hawk is an updated version of the company's previously-manufactured ADC products. The Hawk is faster than earlier systems and offers superior features and programmability, such as color processing and vegetation index extraction for each picture taken.

The Hawk also features touch-screen LCD that allows the user to frame images, review captured images, and control system settings.

The system uses a Red-Green-NIR sensor. Images are 2 Mpix in normal mode. There is also an optional mode (slower) that captures images at 8 Mpix. The wireless link can be used to transfer data to a host PC. The camera image folder shows up as a shared network folder. (Samba).

Upward looking light sensors record the intensity of radiation at the time a picture is taken, a feature that is highly valuable for calibration, and adjustment of the color processing for indoor lighting, such as in greenhouses.

The purpose of this document is:

1. To guide the user through the installation of the product and its supporting software on its target host system.

2. To describe the basic camera operating procedures.

3. To describe the interaction between the camera's interface software and the image editing and archiving software it may be used with.

This document assumes that the user is familiar with the operation of an IBM compatible personal computer running the Windows 10 or earlier Windows operating systems. The user should be familiar with the use of spectroscopic signatures to identify materials of interest. Since the camera is controlled by embedded Linux, some familiarity with the Linux operating system is also useful

A PDF version of this manual is supplied on the installation CD.

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Quick Start Instructions

This section contains basic information needed to connect and use the Hawk or HAWC (Handheld Agricultural Wireless Camera). The Hawk is a wireless, battery powered, Linux-based, NIR/R/G multi-spectral camera designed primarily for vegetation analysis. A 6 to 24 VDC 3W minimum external power source can also be used to power the camera. An ILS (incident light sensor) is included and is under the white plate on the top side of the Hawk housing. The ILS feature can be enabled through the camera menu and may improve remote sensing accuracy under certain conditions. Orient the ILS so that the white plate on the Hawk housing is positioned with a clear view of the sky.

To begin using the Hawk camera, you may power it from one of the provided 9 V batteries or from the included 12 VDC power supply. Make sure that the switch is in the off position before attempting to connect power; the off position is when the switch is facing towards you when you are looking at the touchscreen.

The 9V batteries provided are specialized high capacity rechargeable LiPo types and should be charged in the provided charger prior to use. Do not use common 9V alkaline or Lithium batteries in the camera. These standard types of 9V batteries do not have enough capacity to power the camera and will not work. When installing the 9V battery, be sure to align the battery so that the polarity is correct and gently seat the battery into the camera battery contacts.

To power the Hawk using the provided 12 VDC power supply, insert the power connector into the power jack found on the right side of the Hawk housing. The power jack is located slightly above the position of the battery slot, near the blue plastic cover. Now, connect the provided 12 VDC power supply to the AC wall outlet.

Move the power switch on the top of the camera to the on position. The LED indicator on the camera will turn orange shortly after power is connected and the switch is in the on position, and will then turn to red during camera initialization. When the LED is green, the Hawk camera is initialized and ready to operate. This process typically takes from 30 to 60 seconds to complete.

The Hawk has an LCD touchscreen type display that should be used with the provided stylus. It is located on the left side of the case; it is the black protruding object below the blue plastic cover. Gently and firmly pull on it to release it from its protective slot.

When the Hawk is powered up and operational, a live view screen should be present on the LCD display. Take a picture by pressing and quickly releasing the white button on the top of the Hawk housing. The status LED will turn red and will change back to green when the picture has been saved. When you take pictures, the captured picture is displayed and the live stream stops until you click on the Resume button on the touchscreen.

The Hawk may be used in forward facing mode or ground facing mode. To switch it to ground facing mode, grasp the sensor housing and gently rotate it down until the sensor is facing down instead of forward. This is useful for unmanned or calibration purposes, and allows the ILS sensor to be oriented with a clear view of the sky while capturing images of objects or vegetation on the ground.

Clicking on Review takes you to the image review page. In the review page, you may view any picture by clicking on the top left drop down menu and selecting a picture from the drop down list. Once a picture has been opened, the raw image is displayed on the camera LCD screen. When Index Extractions are enabled, you will also be able to access an NIR/R/G color processed image, NDVI, or other index extractions as defined in the Edit Veg. Index page by clicking on the second drop down menu at the top of the screen and selecting the desired display format. Press the M button on the right of the screen to view the metadata of the picture. Return to Live View by clicking the Done button on the bottom right of the screen.

Clicking on Tools button gives you access to the following buttons: Set Date/Time, Erase Pictures, Advanced, Shutdown, and Format Disk. Clicking Done takes you back to Live View. By clicking the Advanced button in the Tools page, you can change the camera operation. A status screen is visible in the Advanced page. You may edit vegetation index definitions by clicking on the Edit Veg. Index button. Edit Settings lets you have access to useful functions that include Capture Mode, Auto Capture Delay, ILS Adjustments, Index Extractions, and Disable Raw Data options. See help details by pressing the Help button next to each item. Save changes to the settings by clicking the Save Changes button. Click Tools to return to the previous page. Click Done to go back to Live View.

For wireless access to the camera's web browser interface, you can connect it to a Wi-Fi enabled device, such as a PC, tablet, or smartphone. Open the Wi-Fi network settings on your device and search for the Hawk camera's Wi-Fi hotspot, indicated by the following hostname: HAWKXXXX, where XXXX represents the last four digits of your camera serial number. Once you have successfully connected to the Hawk Wi-Fi hotspot, open up a web browser on your device. In the web browser URL navigation field enter 192.168.1XX.1, where XX is the last two digits of your camera serial number. You should now see the Hawk Live View appear in your browser. Only Google Chrome and Mozilla Firefox browsers are currently supported.

Using a Windows 10 PC, you can directly access the files in the Hawk by connecting with the Samba file sharing service that runs in the camera. Open the Windows File Explorer and type \\192.168.1XX.1 where XX represents the last two digits of your camera serial number. TTCHAWK should come up as a network folder. Opening TTCHAWK will provide access to images, settings, log files, extractions, and the DOCS folder.

In order to be processed and analyzed, the original images saved by the camera in the HAWKJPGS folder must be converted to RAW format using PixelWrench2. Under the PW2 File menu, use the Convert Auk Jpeg to RAW

function. To process multiple images, use the Convert Auk Jpeg to RAW function found in the Batch tab of the IndexTools form. IndexTools can be launched from the "Index Tools" selection under the View menu, or by right clicking in the PixelWrench2 active window and selecting "Index Tools". Where XXXXXX is your Hawk serial number, note that opening the XXXXXX.cpf file from the Matrix tab in IndexTools is highly recommended before color processing RAW files. Refer to PixelWrench Help in the Help menu for detailed instructions.

As mentioned above, if the Index Extractions setting is enabled the Hawk has the capability to internally process and save images to TIF format under the EXTRACTIONS folder. Most common would be to enable the RGB Extractions in the Edit Veg. Index page to process and save NIR/R/G rendered images. Vegetation index extractions such as NDVI can also be created and saved in TIF format if those extraction types are enabled. Although camera performance and file storage space will be reduced, processing images in the camera can greatly simplify the data collection and management of images captured by the system.

There is a micro SD card installed in the Hawk. It is located underneath the blue cover next to the power connector. This micro SD card contains the Hawk system as well as stored images, settings, and log files. It is strongly recommended to not remove this micro SD card under normal use. There are multiple partitions on this micro SD card that will not be recognized properly on a Windows PC and the contents of the card could be corrupted. To access images, settings, and log files, please use Samba as directed in the previous paragraphs.

There is a folder called DOCS located in TTCHAWK, accessible via Samba. The DOCS folder contains this document as well as other documents and software. Please note that if you use the Format Disk function in the Hawk web browser interface, this folder will be permanently lost. The documents and software in the DOCS folder are also provided in a Tetracam CD.

The Hawk camera also has Ethernet and USB ports. A protective cover may be installed over both the Ethernet and USB connectors. For certain uses such as testing or hardwired only installs, it may be necessary to use the Ethernet connection instead of Wi-Fi. To access the Ethernet connector, remove any protective covers from the Ethernet connector and USB port. Plug a network connected Ethernet cable into the camera Ethernet connector to allow the Hawk to communicate on with the network via DHCP, and power up the Hawk. Once you have looked up the private IP address assigned by the network to the Hawk, you can access the Hawk web browser interface and Samba using this new IP address as well as the IP address associated with the Wi-Fi hotspot. A typical Ethernet IP address may be something like 192.168.1.XX, where XX are the two digits assigned by your modem or router.

The Hawk USB ports are intended only for use with an optional USB type GPS. If a GPS has been provided by Tetracam, before installing the GPS, make sure the Hawk is powered down. As noted above, slide and remove

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any protective covers to expose the Ethernet connector and USB ports. Install the GPS into the USB port. You may now power on the Hawk. When the GPS blinks a blue LED, it has obtained a GPS location fix, and will transmit position data to the Hawk. The GPS data is visible on the LCD screen, through the Hawk web browser interface, log files, and image metadata.

To power down the Hawk system from the touchscreen or from a web browser, select the Shutdown button in the Tools page. You may also power down the system by holding down the white button on the case until the LED blinks red and green rapidly; upon witnessing this, release the white button. The Hawk LED will turn red, orange, and then off. At this point, it is safe to turn the switch to the off position then unplug power from the system. The Hawk User's Guide should be consulted for more detailed product information.

Unpacking The Box

Your new Hawk multi-spectral imaging system is shipped with a variety of items to facilitate integrating the camera into a system:

- An Hawk digital still camera
- A CD-ROM with the installation software supporting the camera
- An AC power adapter and power input cable
- A white Teflon calibration plate
- Your Hawk comes with a one-year warranty against defects.

Auk Multi-spectral Imaging System

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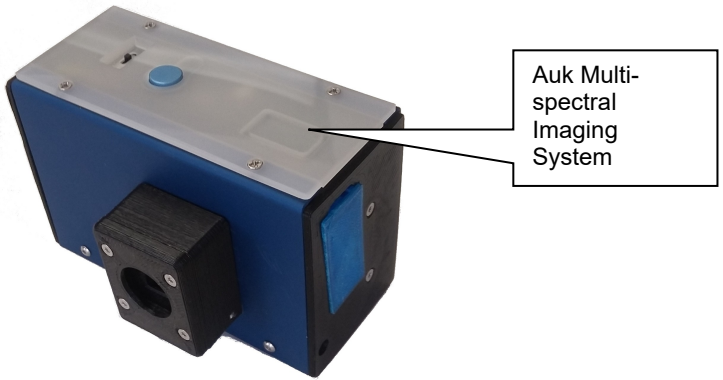
Product Description

Becoming Familiar With Your Hawk System

The Hawk sensor is mounted on a hinged platform that can look downwards while the top of the camera faces upwards. This allows accurate measurement of downwelling radiation when the picture is taken.

The hawk has serial port connector on the side with the battery opening. This connector can be used as a Linux system serial port, or as a listener for an external GPS serial port device. There is also a GPS USB option that consists of a USB based GPS receiver that plugs into the side of the camera opposite the battery.

Incident Light Sensors (ILS)

External Serial Port and Power Jack

Hinged sensor module

USB and Ethernet Ports

Touchscreen Stylus
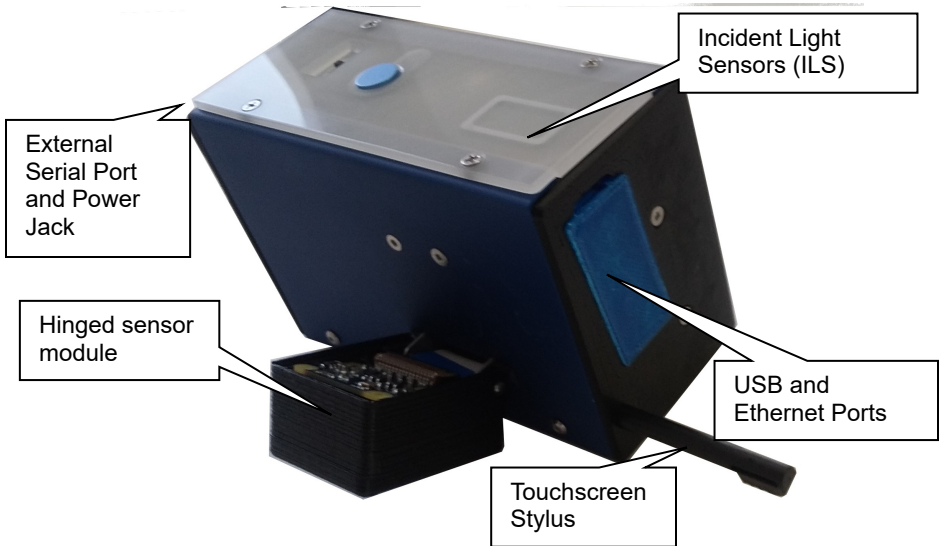
A stylus is stored at the corner of case. The stylus can be used to make touchscreen operation easier. An Ethernet connector allows the camera to be attached to a Local Area Network for unloading images and managing options

Power input can be any DC power supply from 6 to 24 volts. Current input is 200mA at 12VDC.

The Hawk can be configured by way of the user interface for auto capture. There are two auto capture methods.

1. Trigger on GPS offset in meters

2. Trigger continuously with an intervening delay.

The maximum reliable capture rate for the unit is one frame per second.

Hawk Images are captured to the system memory card. The standard card capacity is 24 GB of images. Very large cards (64GB, 128GB) can be supported, but they should be configured at the factory. Preparing a memory card with a correct Linux system implementation in the field is a complex operation.

Battery management is important when using your Hawk. The camera will automatically shut off the display if it is idle for 5 minutes, but power drain with the display off is still significant. With the display off in idle state the battery will drain in approximately 3 hours. It is much better to completely shut down the camera and set the power switch to off when the camera is not in use.

The light sensors on the top of the camera can be obscured by a stray finger if the user is careless. Make sure to hold the camera so the light sensors have a clear view of the light source when pictures are taken.

The easiest way to shut down the camera is to hold the picture taking button until the red LED begins to flash (about 5 seconds). The LED will cycle to red, orange, and back to green, at which point the power switch can be set to OFF. The camera can also be shut down by an appropriately labeled button in the TOOLS touchscreen display.

Two types of image files are saved by the Hawk. The JPG files contain the raw data captured by the camera, and reside in the ttchawk/HAWKJPGS folder. Images containing color processed results are .TIF files located in the ttchawk/EXTRACTIONS folder. File names are based on a 'TC' prefix, and number of the sequence in which the picture was taken. Thus, a JPG file might be named TCR00012.JPG, and the TIF extraction file associated with it would be TCX00012.TIF.

An option is provided to capture images to DRAM rather than directly to the micro SD card (Disable Raw Data). When this option is set only the jpeg preview is retained in the AUKJPGS folder of image partition. The EXTRACTIONS image files will contain processed data and raw bayer at the end.

Hardware Overview

The Hawk system hardware is housed within a sheet metal and plastic assembly. The Hawk is designed for use in as a hand-held agricultural camera.

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There is a single physical switch on the Hawk which is used to take a picture, or start a continuous capture sequence. The Status LED indicates whether the system is ready or not ready to take a new picture. When the Status LED is green, the system is ready to take a new picture. When the Status LED is red, the camera is busy capturing and saving images. After saving images, this LED returns to green indicating the camera is ready to capture a new picture. The Status LED is also made to blink when the unit detects a shutdown action.

USB Connectors – The USB 2.0 data connectors are located on the side of the camera opposite the battery . There is also a an Ethernet connector for attaching to a local area network. Note that the USB connectors are used primarily for an optional USB GPS.

The image partition has a linux EXT4 format, and can be formatted in the camera. It is generally advisable to format the drive only from the touchscreen or web browser interface because the palettes and special control files are restored in an orderly way.

Linux Operating System Memory

One of the partitions of the Hawk's internal memory card contains the Linux operating system, the executable programs required by the system, and data file backups for critical data. The memory card should not to be removed or replaced in normal operation.

Hawk Optical Configuration (Lens, Filters and Sensor)

Each Hawk optical channel consists of a lens, a spectrometric filter and a CMOS optical sensor. The lens focuses visible or near-infrared radiation through the filter and on to a CMOS sensor. The filter limits the wavelengths that are able to pass through it to a specific band of electromagnetic radiation. The CMOS sensor accumulates electrons proportional to the amount of radiation impinging upon the sensor at each of its 1640 X 1232 pixel locations. The size of the photo-sites that form the wells for each pixel are very near the size of the near-infrared wavelengths that the sensors are optimized to capture. Each well is cleared of its electron contents immediately prior to image exposure. This ensures that each image has high spectral fidelity and low image noise.

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The graph below shows the relative efficiency of the Hawk CMOS sensor for different bands of visible and NIR light. The NIR response band in gray is the

Sony-IMX219 (Vis) and Random CMOS sensor (to NIR)
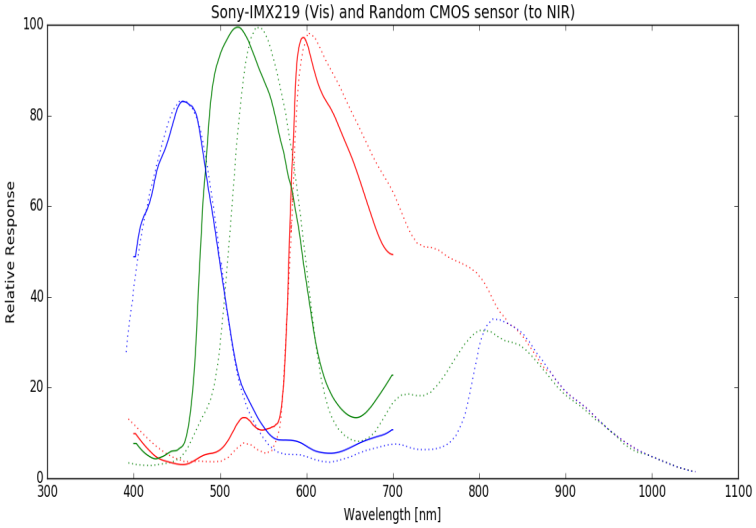
same for each of the red, green and blue bands when there is no blocking filter. The NIR response shown is empirically derived, and should not be used for precise calculations.

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System Setup

There are many configuration options for a Hawk camera. The camera ships from the factory configured for the following:

- English language
- Single image capture
- False RGB color, and NDVI processing enabled
- Normal Resolution (1640 X 1232) acquisition
- Brief metadata logging
- 16 bit TIFF file format for extraction, JPG for raw capture
- Auto-exposure average algorithm

The system can be reconfigured as needed using the touchscreen interface, or on a smartphone, tablet, laptop, or desktop computer equipped with a browser. The settings are changed by way of a set of option boxes which are clearly labeled and associated with help files. The Hawk is set up as a Wi-Fi hotspot that will show up in the Wi-Fi menu for the device with the browser as HAWKXXXX where XXXX are the last 4 digits of the serial number.The Wi-Fi configuration is displayed on a touchscreen startup page until the page is disabled by the user.

There is a background process definition file (indices.txt) which allows up to 8 band ratio / RGB calculations to be performed on each image that is captured. The calculated images are saved as a set in a multi-page TIFF image file in the EXTRACTIONS folder. The raw JPG images from which they are derived have the same numeric file attribute, and are found in the HAWKJPGS folder. If Disable Raw Data is enabled in the Settings, raw bayer data is appended to the end of the multi-page TIFF image files in the EXTRACTIONS folder, and JPG previews are saved in HAWKJPGs with no raw data written.

Using the Touchscreen Interface

There are six user interface screens that manage camera setup. Each is provided with help buttons to explain its use. The various screens, which are HTML pages resident in the camera in the /var/www/html/* folder are these:

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Startup Page

This page is used to display the Wi-Fi configuration of the unit so it can be attached to a personal computer or smart phone.

Host Name:HAWK0001
Hot Spot IP Address: 192.168.101.1
Login: ttcuser
Password: z9g5ji
Serial Number:270001

Do not show me this again   Start
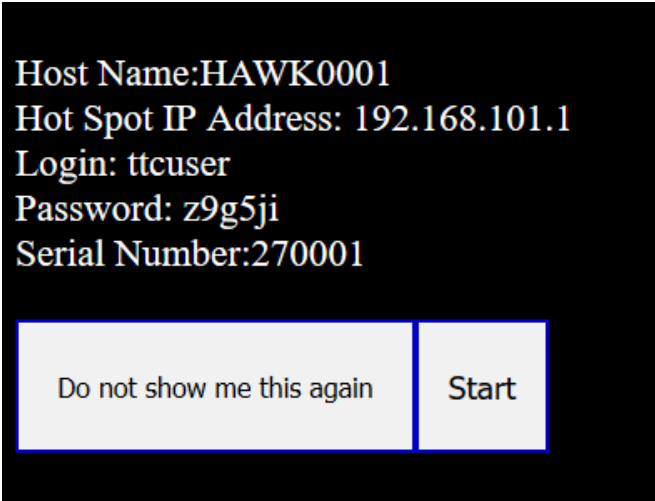
Live View Page

When the startup page is closed, the Hawk enters live view mode so that picture can framed, taken, and saved. From the live view scrren the user can access the TOOL screen or the REVIEW SCREEN. The TOOLS screen is used to manage the camera, the REVIEW screen allows captured pictures to be displayed.

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After each picture is captured using the picture taking button, the screen will freeze, showing the frame captured. Tapping RESUME re-establishes the live view.

The TOOLS Page
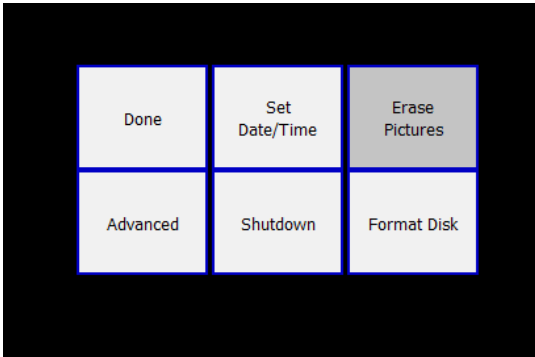
The tools page provides buttons for managing the state of the camera. Images can be erased, the image storage partition can be formatted, and the camera can be shut down. The page also has an ADVANCED button that allows the camera settings to be changed. The changes include control of vegetation index extractions, power off settings, capture modes, ILS adjustment settings, index extraction size settings, and others.

The REVIEW Page

Captured images are displayed in the image review menu. An image is selected from the dropdown box (TCA00002.JPG) and displayed by using the control buttons (Fwd, Back, Delete Image, etc.). These buttons are labeled symbolically:

>> = Forward
<< = Back
M = View Metadata
X = Delete image

There is also a dropdown box for selecting image extractions performed from the selected image. If no index calculations have been set up in the file indices.txt, no selections other than "Jpeg Preview" will be shown.
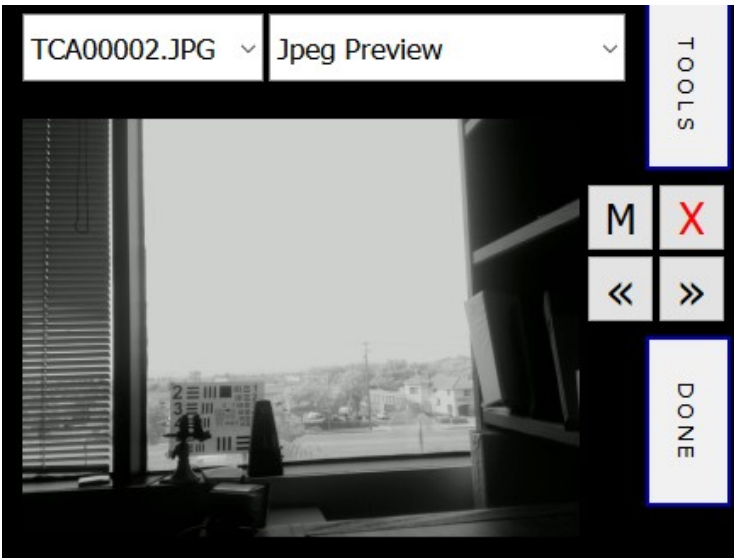
The Jpeg Preview image has been optimized for touchscreen viewing, and does not always reflect the brightness and contrast of the raw data. To see the finished picture quality, an RGB extraction should be used. The RGB extraction shows the illumination and contrast of the final image correctly.

ADVANCED Page

This page displays details about the current state of the camera, and allows various configuration values to be changed. These include basic settings, vegetation index recipes, and ILS calibration values .

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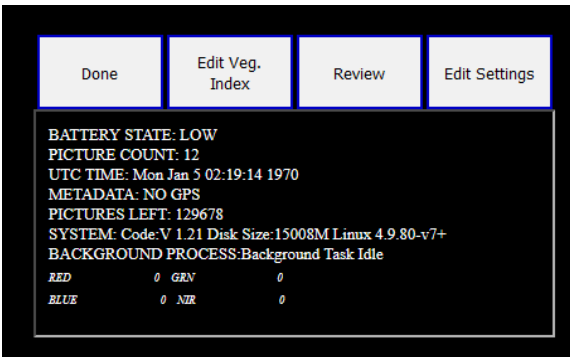
The status information is updated once per second. Battery state is shown, along with image counts and storage use. ILS measurements are shown in live bars at the bottom of the info screen.

The Settings Pages

The three settings pages provide selection boxes and help file links for all camera settings. The settings only take effect when the Save button is pushed. Each entry is an option box which shows the available choices in a self-explanatory list. Help files are also provided for each entry.

The first page shows the serial number and code version, and provides selections for language and picture capture. Image format is also adjustable here.

Save	Tools	Next	Done

Code Version	121	HELP
Serial Number	270001	HELP
Metadata	GPS NMEA	HELP
Console Baud	115200	HELP
Language	ENGLISH	HELP
Image Format	NORMAL	HELP
Capture Mode	TRIGGERED	HELP
GPS Trg Offset	25	HELP
Show Info	OFF	HELP

The second settings page provides control of index extraction processing, ILS data application and image capture exposure methods.

Save	Back	Next	Done

Capture Dly	1000	HELP
ILS Filtering	64	HELP
Bat Min.	11	HELP
Enable Logging	LOGGING BRIEF	HELP
Extractions	1/4 SZ EXTRACTIONS	HELP
No Raw Data	ON	HELP
ILS Adjustment	DISABLED	HELP
Fixed Exposure	0	HELP
Auto Method	CENTER AVERAGE	HELP

The third settings screen allows the user to set a palette scaling default value. Palette scaling is used to limit the color application to the range of NDVI values that could represent living plants.

Save	Back	Next	Done

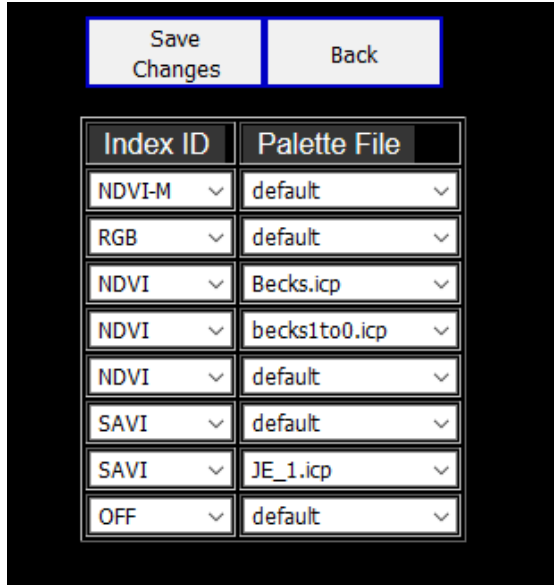|		
Palette Upper Limit	255	HELP
Palette Lower limit	240	HELP

Vegetation Index Recipes

The camera maintains a file named "indices.txt" which directs the post processing of a captured image. Up to 8 post processing operations can be selected. In practice, one or two are usually enough. Post processing is not completely necessary. PixelWrench2 is able to do the processing after the images have been copied from the camera.

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All operations are performed on the Red, Green, and NIR bands, which are the only bands captured in the images.

Different palettes can be assigned to the index extractions. The palettes are created and saved in PixelWrench2. A palette has to be copied to the camera folder PALETTES in the shared folder "ttchawk" for it to become visible to the edit box controls here.

The results of the calculations are saved as a multi-page TIFF file in the EXTRACTIONS folder in the image disk partition.

Index ID	Palette File
NDVI-M	default
RGB	default
NDVI	Becks.icp
NDVI	becks1to0.icp
NDVI	default
SAVI	default
SAVI	JE_1.icp
OFF	default

Save Changes   Back

In the setting "Disable Raw Data" is true, a plane with raw data is appended at the end of the index extractions. With this setting the jpeg file will contain only the jpeg image preview.

Palette Scaling

It is useful to apply the selected palette only a range of NDVI values in the extraction. By default the palette is applied to all pixels: 0 to 255. This has the undesirable effect of using up colors for index values that are uninteresting. The NDVI range is 0 to 255 (-1.0 to +1.0), but vegetation only has values between 128 and 255. (0 to 1.0).

The NDVI extraction will scale the palette to a range of pixel values of interest. The scaling is controlled in two places. First, for palette files that have no scaling values, the range is adjustable in the camera settings using the upper and lower "Palette Limit" options.

Some palette files have two scaling values at the end. If these values exist, they are always used to scale the palette instead of the values in the settings.

Pixels outside of the scaled range are rendered as monochrome.

ILS Adjustments

ILS adjustments can be performed (or disabled) when the band ratio false color images are created in the camera. Choosing "Reflectance" processing will cause the ILS values to be used to change each pixel in the image to a brightness proportional to the percent of downwelling radiation it reflects. If an object, for example, reflects 50% of the downwelling energy, the brightness of that image (for 8 bit pixels) will be set to 128. (128 / 256 = .50)

Choosing "Color Balance" processing will result in the image being adjusted for changes in the color of the downwelling radiation, eliminating the need for a calibration picture. If NIR radiation is weak because of cloud cover, the camera will automatically adjust the NDVI calculations so the values are accurate."

"Reflectance" ILS processing is sensitive to changes in attitude or position of the camera. The exact amplitude of downwelling radiation is needed to correctly calculate the percent of light reflected. Reflectance adjustments require that all pictures be taken without any tilting of the camera.

The Clock Setup page

This form allows the system clock in the camera to be set to any desired time: UTC or local. Normally the time kept in the camera is UTC time. The time is part of the image metadata, and UTC is the most transportable time representation. If local time is set, it may not match the time reported by GPS receivers, which is also included in metadata.

GPS Option Installation and Use

The Hawk will capture and append the most recent GPS/IMU position data to each image as it is taken. The GPS must be one of the Tetracam approved USB GPS units that plugs into a USB accessor socket, or an RS232 serial

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GPS with +/1 5 volt signals. For the serial interface, the following requirements apply: The GPS receiver must be configured to output the standard NMEA RMC and/or GGA sentences. The default output protocol for NMEA sentences is 115200 baud, 8 data bits, 1 stop bit, and no parity. The Tetracam Firepoint serial GPS option comes correctly configured. Any alternative receiver should allow you to configure it for RMC and/or GGA at 115200:8:1:N.

The GGA sentence is emitted once or twice per second and contains the following fields:

1. Time UTC
2. Latitude and Longitude
3. Fix quality
4. Number of satellites tracked
5. Horizontal dilution of position
6. Altitude in meters MS
7. Height above MSL

Attach the optional serial cable to the serial port connector (see the illustration in the Hardware Installation section of this manual). Attach the other end to the serial port of the GPS/IMU.

The most recent GPS position data sent to the camera will be appended to the image data file. You can view the GPS data in the image using a web browser, or with PixelWrench2. The camera firmware also supports an event, or position, logging system that will exactly place the GPS locations at the time pictures are taken, with a resolution of 1 millisecond.

The GPS messages are saved in each image as it is taken, and in the camera log file. Bad GPS sentences are not included in the log file unless logging is set to "verbose" mode in the capture setup screen.

Event Log File

When 'Enable Logging' is set to LOGGING BRIEF, the camera will maintain a file with a record of key events that can be used to accurately position the location at which the picture was taken. This feature is used most often with aerial photography but can be useful for handheld picture so large fields

When the option is enabled, the camera creates the file CURRENT.LOG on the memory card in the root folder of the image partition. If there is a pre-existing CURRENT.LOG file, the file is moved to the image folder (ttchawk/HAWKJPGS) and renamed according to the system UTC time, seconds, at the time the file is saved.

A typical Event Log file is shown on the next page. Each line shown is one record in the file, terminated by a newline character. Additional line feeds are added for clarity in the illustration.

You can use PixelWrench2 to manage image and GPS log files.

CLK 000000000104 Date/Time: 10/22/2009 15:15:01

GPS 000000002006 00217 $GPRMC,192254.00,A,2942.79012,N,08223.30667,W,000.0,000.0,221009,03.3,W,A*0B

GPS 000000002064 00217 $GPRMC,192254.00,A,2942.79012,N,08223.30667,W,000.0,000.0,221009,03.3,W,A*0B
$GPGGA,192255.00,2942.79047,N,08223.30663,W,1,04,2.58,00040,M,-031,M,,*5D

IMG 000000003049 00218

GPS 000000003102 00218 $GPRMC,192302.00,A,2942.79461,N,08223.30899,W,000.0,000

GPS 000003280 00219 $GPRMC,192302.00,A,2942.79461,N,08223.30899,W,000.0,000.0,2
$GPGGA,192303.00,2942.79517,N,08223.30922,W,1,04,2.58,00062,M,-031,M,,*55

You can use PixelWrench2 to manage image and GPS log files. See the PixelWrench Help file and the PixelWrench2 User Guide for more information on how PixelWrench2 uses the distilled log files to refine the embedded GPS data in each image. The latest edition of PixelWrench2 available at www.tetracam.com/PWversion.htm

Triggering the Hawk at Specific GPS Coordinates

There are several ways to trigger the Hawk with respect to GPS position. The first, and simplest, is to configure the camera for GPS offset capture, and enter the number of meters of separation between GPS points that should cause the trigger.

The second method is to use the console input to send trigger commands from an external controller that has a GPS input stream. The console serial port is wired to the 6 pin multifunction connector. A compatible cable and signal breakout connector are provided to simplify connection. The third method is to toggle the external Take Picture line when the controlling device reaches a desired GPS trigger point.

Capturing and Processing Hawk Images

The Calibration Image

In order for the Hawk system to capture accurate reflectance images. it is necessary to obtain a reference calibration image prior to or during each imaging mission. Calibration consists of taking an image of the Teflon calibration tag under the same lighting conditions as the images under study. This image is used to teach the application software what the spectral balance of that day's sunlight is. The ratio of red/NIR or green/NIR is then applied as an offset to the calculation of the various vegetation indices

Place the calibration target on the ground, or hold it level with the ground, and photograph it. It need not fill the entire frame and it must not be overexposed. Make sure to avoid a direct reflection of the sun. The sample image above is of a properly exposed calibration target. When the pictures are imported to the host computer, the calibration image will be used to refine the vegetation index calculations.

In place of the Teflon Calibration Tag supplied with each system, you may also use Multi-spectral Ground Calibration Targets that provide a relatively flat response to incident radiation throughout the VIS-NIR wavelengths. These have that added advantage of acting as Ground Control Points for geo-referencing images.

The camera is calibrated once at the factory, and this calibration in conjunction with ILS "Color Balance" processing eliminates the need for recalibration in the field. If the camera is recalibrated, the new calibration will also work for the "Color Balance" algorithms.

Flying Aerial Imaging Missions

Typically, a user's initial concern at the start of an aerial imaging mission is the ground resolution they will need to achieve in order to identify the detail they require in their images. Use the FOV Calculator in PixelWrench2 to determine the above ground level altitude you need to fly in order to obtain that resolution. You can also use this calculator to determine the airspeed you will need to fly in order to obtain sufficient frontal and side image overlap.

Aerial missions involve making successive passes back and forth across an area of interest usually in an east-west direction. This flight line ensures consistency in orientation and sun angle. The orientation of images is generally at 90° to the flight lines. Images are generally captured at a nadir

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angle with the Hawk system pointing straight-down. Using the nadir angle minimizes occlusion of subject matter by hills or other intervening objects. In order to permit splicing multiple images together, vendors of mosaicking software recommend a high overlap percentage for adjacent images. Icaros OneButton, for example, recommends a minimum of 75% forward overlap and 60% side overlap.

Images are captured and saved to the micro SD card FAT32 partition. Tetracam recommends always using the built-in Hawk browser interface function to format this part of the micro SD card prior to each mission. This guarantees that the card will not be fragmented, and image save times will be optimal.

Managing Hawk Images in PixelWrench2

Upon landing, images may be transferred from the Hawk system to the host computer. With the camera powered on, connect the camera directly to a host computer with the Samba interface. Files can be dragged to and from the disk, and PixelWrench2 can be used to open the files directly.

If band ratio and false color conversions have not already been performed by the camera during the mission, PixelWrench2 can do this quickly, using its built-in batch functions. Read the PixelWrench2 help file for a detailed description of this software and its use with Tetracam multi-spectral imaging systems.

If these conversions have already been performed by the Hawk, the user can simply transfer the multi-page TIF extraction files to the PC and view the results with PixelWrench2. Some mosaic building software may be able to use the Hawk images as-is to immediately produce a mosaic image of the mission.

The Hawk is configured for wireless access to all images, logs, and settings files. This happens through the Samba interface. Using a Windows 10 PC, access all of these files using Samba by following this procedure:

1.   Connect to the Auk Wi-Fi hotspot using your PC Wi-Fi settings. It should be indicated by HAWKXXXX, where XXXX is the last four digits of your Auk camera serial number.

2.   Open a Windows File Explorer.

3.   Enter \\192.168.1XX.1, where XX is the last two digits of your Auk camera serial number.

4.   Open TTCHAWK.

5.   All the images, logs, and settings should be accessible from TTCHAWK. A DOCS folder is also present that contains all of the files that are on the Tetracam CD. Note that the DOCS folder will no longer be present after the Format Disk function has been used once from the Auk web browser interface.

Handling GPS Data

Pixelwrench has built into it the code to recognize either IMU data or GPS data, and create interpolated positions in the final TIF image files. The GPS and IMU strings can be found in both the log file and raw image metadata.

GPS strings are in standard GPS NMEA format as described at: https://en.wikipedia.org/wiki/NMEA_0183.

PC Software Overview

PixelWrench2

The installation CD included with your Hawk system contains PixelWrench2 as well as other utilities, files, and documentation that are helpful for setting up and operating your system. PixelWrench2 is a powerful image editing program that is included with each Hawk system. This software runs on any IBM-compatible personal computer running Windows 10 or earlier operating system (see PC System Requirements for additional details). The licensed software includes tools specific to multi-spectral images.

It provides tools for management of Hawk JPG and multi-page TIFs, color processing of band data and complex batch processing tools for extraction of several vegetation indexes. The application includes a comprehensive suite of image editing tools. Pixelwrench2 translates the Hawk formats into other standard image file types. (BMP, JPG, TIF, PNG etc.)

Many of the PixelWrench2 batch processes can also be performed in the camera by configuring background processing to generate the desired band ratios and false color images.

PixelWrench2 also includes a Field of View (FOV) Optical Calculator. This tool enables users to input camera parameters along with the distance from the camera to the subject in order to calculate variables including the observable field of view (FOV) in meters and the image resolution in millimeters per pixel. Additional variables including the required speed to fly to obtain a desired image overlap may also be calculated using this tool.

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PC System Requirements

Any computer with a Wi-Fi or Ethernet interface can be used to retrieve pictures from the Hawk system. You should select a computer with resources that can support manipulation of images that are this large. Our recommendations for a minimum configuration are:

- 1 GHz or better processor, Intel or AMD
- Windows 10 or earlier operating system
- 1 GB megabytes of SDRAM
- 24 bit color graphics adapter at 1024 x 768 or better resolution
- 1024 x 768 or higher display
- Large hard disk drive with 100 GB or more free space

Software Installation

Remember that the PixelWrench2 setup files are located on the installation CD. In order to install PixelWrench2, run the file "setup.exe" located in the PixelWrench2 folder either directly from the CD or after copying the PixelWrench2 folder to your PC.

The default installation target is this:

"C:\Program Files\Tetracam\PixelWrench2"

Please read the PixelWrench2 help file for further information.

If your computer does not have the Microsoft .NET Framework 3.5 installed, please be sure to use Windows Update to acquire it.

The PixelWrench Update page at the Tetracam website has the most up-to-date version of PixelWrench2; please refer to it periodically for the latest updates.

Options and Accessories

GPS Receiver

Tetracam offers a pre-configured serial port GPS/ device that can provide the NMEA strings needed to reference the captured images geographically. The unit comes with a cable wired correctly for the Hawk accessory serial port, and has a separate 8V to 15V DC power connection. Tetracam also offers a GPS receiver that plugs into one of the Hawk USB accessory ports. This unit is also pre-configured for NMEA string output.

The Hawk ILS is built into the unit. The sensors are behind the window in the product label of the unit. This window should have an unobstructed view of the sky when the unit is in use.

The values (Red, Green, Blue, NIR) from these sensors are appended to each image as metadata which can later be used by PixelWrench2. The values are used during index extractions in both the camera and PixelWrench2 to calculate the true reflectance or Color Balance of the subject plants, and compensate for reduced NIR when calculating NDVIs. NIR radiation varies with cloud cover, season, and time of day, so the use of the ILS data allows operation of the Hawk in a wide range of environments.

Advanced Topics

Logging into the Hawk Linux Operating System

The camera operating system is a version of Debian Linux that supports multiple users. There are two user accounts already set up for use:

> Login: tetracam
> Password: z9g5ji

> Login: ttcuser
> Password z9g5ji

Logging in on the serial port console using PuTTY must be done during the camera boot cycle. After networking is started, and the apache web server is launched, the startup script will launch a camera application, unless a key is hit within four seconds. Striking a key will result in the console being logged into a GNU Bash command shell as the user tetracam. An alternative (and better) way to log in is to use Aan SSH connection over the wireless interface. When logging in via SSH, the user is prompted for a username and password; it is recommended to log in as ttcuser to avoid interfering with the camera application and to ensure straight-forward system administration when it is needed. In a Windows environment, PuTTY is recommended as a good terminal client for both the serial console and an SSH Wi-Fi login. On Linux machines an ssh client can be invoked directly.

Preventing the launch of the camera application on the serial port is a good way to prepare the unit for an update; it is also useful when debugging, since it allows the opportunity to start Hawkmain manually by the command 'sudo ./ hawkmain'. When hawkmain is launched manuall it displays useful information on the console window that launches it; otherwise, this information goes into a log file in the tetracam home folder.

PuTTY and Xming installation files for Windows can be Downloaded from the web. Xming allows the use of X11 graphical interfaces on the remote (Windows) host. More information is available below in the discussion of host interface software packages.

Updating the Hawk System Files Using Hawk Update

When updates are made to the Hawk system files, the changes are distributed by Hawk_V0XXX files, where XXX is the firmware version. The process to update the Hawk with a Windows 10 PC is as follows:

1. Power up the Hawk and wait until it has a green LED.

2. Extract the ZIP to receive the HAWKUPDATE.tar.gz file.

3. Connect to the Hawk via Samba as described in the Managing Hawk Images in PixelWrench2 section.

4. Place the HAWKUPDATE.tar.gz file onto the root of TTCHAWK.

5. Close the File Explorer window.

6. Power off the Hawk.

7. Power on the Hawk, and when the LED is green, the Hawk should be updated.

Stopping the Camera Application (hawkmain)

If the camera application, hawkmain, ever closes, it is restarted automatically by a parent process called hawkstart. In order to terminate the camera process so that a new hawkstart can be installed, or to eliminate the camera application overhead, the hawkstart process must be identified and killed. "killall hawkstart" will terminate the parent, followed by "killall hawkmain" to wipe out the camera application.

Camera Control Files

The Hawkmain application and its touchscreen interface use text files to configure the behavior of the application, and provide forms for the user to modify. There are four control files, and a palettes folder:

settings.txt

bayer.cpf

indices.txt

ttcron

/home/tetracam/PALETTES

These files are permanently installed in the application home folder: /home/tetracam. They are copied to the image partition of the micro SD card when it is mounted or formatted, and they are updated with changes when Hawkmain exits.

Image Capture Partition Organization

The mount point for the image capture disk partition is /home/tetracam/TTCHAWK. The control files referenced in the previous paragraph will also exist in this folder. Subfolders under TTCHAWK contain the results of the camera application:

TTCHAWK/HAWKJPGS holds captured raw images in modified JPG format.

TTCHAWK/PALETTES holds the palette files known to the system. New palette files may be generated using PixelWrench2.

TTCHAWK/EXTRACTIONS holds the vegetation index images extracted in background processing during a mission. These files are multi-page TIFs.

The image disk partition is best reformatted from the camera touchscreen. The filesystem is set as Ext4 with disabled journals for best possible save times. The partition is exported to Windows systems via a Samba server, so it can be browsed directly from a Wi-Fi enabled computer.

Host Interface Packages for Microsoft Windows:

PuTTY remote terminal utility

XMing X Windows client

WinSCP file transfer utility

Once these packages are installed on the Microsoft Windows host, the user can connect to the camera through its SCP/SSH server. This is done by configuring the packages with the IP address used by the camera Wi-Fi server: 192.168.1XX.1. XX will be different for different Hawk cameras; it depends on the last two digits of the camera serial number. The IP address can easily be determined from the startup page on the touchscreen display.

Detailed information on PuTTY, Xming, and WinSCP can be found on the web. The most current versions of these utilities are available for download from their parent websites.

PuTTY is the most basic of the support utilities. It does not require Xming or WinSCP to operate, and can be used for both the serial port console connection and SSH login via Wi-Fi. When launching PuTTY with the camera IP address as the target using SSH via Wi-Fi, the user should log in as "ttcuser" for the most convenient experience, since it won't interfere with the camera application activity. When using the serial port, connect by the COM port to which the camera serial interface is connected, and that will bring up a login prompt after the Hawk boots up; however, it is necessary to strike a key after boot up to abort the startup of the Hawkmain process. Once aborted, the serial port will present a GNU Bash shell logged in as the user tetracam, in which case the user may start Hawkmain manually by entering 'sudo ./hawkmain'.

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To use software with a GUI, the user must be logged in with PuTTY over the Wi-Fi SSH link, and Xming must be running. PuTTY will not do X11 forwarding when the connection is a serial port.

WinSCP provides a Windows Explorer style of user interface for moving files back and forth between a host PC and the Hawk. In situations where physical connection is difficult, it may be the preferred way for downloading pictures from the camera. PixelWrench2 interfaces directly to the Hawk over the wireless link and Ethernet. The shared folder "ttchawk" appears as a shared network folder over the Ethernet network, or the Wi-Fi network. The same is true for Icaros OneButton and Agisoft PhotoScan mosaic building utilities: they can operate directly from the Ethernet or Wi-Fi link.

Image File Formats

The Hawk system uses a modified version of the JPG standard for storing image data. The raw data are appended to the JPG data. The JPG header for each file contains many extensions (EXIF, GPS) and private tags that contain metadata that can help with image post processing.

The camera can perform vegetation index extractions and false color RGB renderings after a raw image is captured. These renderings are saved in a multi-page TIF. Metadata is only present in the first TIFF header.

Pixel data in the captured files can be either 8 or 16 bit. 16 bit data are more accurate, 8 bit data can be captured faster. Average capture times for 8 bit files is 800 ms. For 16 bit files, 1000 ms.

Hawk RS232 Serial Control Commands

Camera serial port command strings consist of a lead-in character (#), a command character (A – Z, a - z), and a number of numeric arguments. The numeric arguments are strings of Hex ASCII digits either 4 or 8 characters long depending on the magnitude of the value (16 bit or 32 bit). Separators are not required between the argument values, or between the command character and an argument. Spaces can be used as separators if desired.

Below is a table of the command characters currently implemented, and a description of the responses to be expected from the camera. Arguments are shown as <ARG16> or <ARG32> depending on their magnitude (16 or 32 bits).

#E

Erase all image files stored in the camera's image file system.

#T

Take a picture and save the image to the image partition.

#X<ARG16>

This command controls the camera exposure for the next image with the value in the argument. If the value is 0, the camera performs a light measurement operation, and calculates a reasonable exposure itself. Otherwise, the exposure is set to the number of milliseconds given in the argument.

Support Info

Your Hawk system comes with a one-year warranty against defects or hardware failures. For help with problems, contact

Technical Support:

Tel: +1-818-288-4489 (8 A.M. to 4 P.M. Pacific Standard Time)
Email: support@tetracam.com
Web: www.tetracam.com

Specifications

Specification	Description/Value	Remarks
Basic		
Typical Application	Remote sensing of vegetation	
System Hardware	Sheet metal and plastic housing single system trigger / start button. Serial port and power connectors for. accessories or testing. 9 vold battery for untethered operation. Built-in ILS sensors System CD with PixelWrench software 12 VDC external power supply White Teflon calibration plate	
System Inputs	Power (see below) Wi-Fi shared folder read/write Ethernet data connection, RS232 serial (NMEA GPS sentences),	
System Outputs	Ethernet connection, Wi-Fi data from apache2 http server viewable with any web browser	
System Software	PixelWrench2 is included with each purchase of a Hawk. Full featured Debian Linux operating system with SSH, Samba, and HTTP servers.	
Commonly Ordered Options Available from Tetracam	Hawk USB GPS Ground Calibration Targets	

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Specifications (Continued)

Specification	Description/Value	Remarks
Physical		
Weight	*120 g*	
Dimensions (mm)		
Environmental	*Temperature* *0 degrees Celsius to 40 degrees Celsius (32 degrees Fahrenheit to 104 degrees Fahrenheit)* *Humidity* *Less than 85% relative humidity, non-condensing*	Note: the camera will operate outside of the recommended environmental range, however performance may be degraded.
Power		
Voltage Input	+ 9 VDC to + 28 VDC Center Positive, or 9 Vold LiIon battery	
Current Draw at 12V:	340ma typical	
Sensor		
Description	8 Mpix sensor operated at ½ resolution (1640 X 1232)	
Sensitivity	~420 nm to ~ 950 nm	
Dimensions	4.6mm diagonal	
Pixel Size	1.2 microns	

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Specifications (Continued)

Specification	Description/Value	Remarks
Filters		
Filters	RGB bayer with blue blocking.	Blue pixels see only NIR
Lens		
Focal Length	3.04 mm fixed lens	
Aperture	F2.0	

Specification	Description/Value	Remarks
Images		
Horizontal Angle of View	59.7 degrees	
Vertical Angle of View	58.3 degrees	
Default Depth of Field	~2 meters to infinity	
Image Triggering Mechanisms	Manual shutter switch, auto-timer (Menu-settable), GPS offset (menu settable), external trigger, host PC trigger via Wi-Fi browser interface, or RS232 serial.	
Image Exposure time	Auto or menu-selectable in µsec.	
Default Image Dimensions	1640 X 1232 pixels (2 MPel)	Hawk image size may be adjusted to a high resolution image size of 3280 X 2464. Not Recommended
Default Image Storage	Images are stored in a dedicated Ext4 partition in modified JPG format.	
Native Image File Formats	16 bit multi-page TIF for index extractions (no compression) Modified JPG for raw data. Full of half size image capture	Other file formats can be generated by using Pixelwrench2 as a converter, or built in Linux (Imagemagick) conversion routines in the camera
Image Capacity	JPG size: 2.7MB per image	8000 pictures in 16 GB FAT32 partition. 2000 images in high resolution mode.
Image Capture Rate (Single Shot)	1000ms (1 per second) without background processing	

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