Senop Hyperspectral Camera
HSC-2
User Guide

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Purpose

This guide will help you to start the use of the Senop Hyperspectral Camera HSC-2 and the Senop HSI-2 software.

Key Features of Device

The device is meant for Hyperspectral imaging. It can take images of specified wavelengths inside its operational wavelength range. Device can change wavelength rapidly and use pre-set list of wavelengths to construct (envi) data cubes where same or almost same object or landscape is represented with multiple narrow band wavelengths.

The Senop Hyperspectral camera can work independently with only power supplied to it, with integrated memory or it can be used with computer. It can be connected either directly to a computer or to an Ethernet network.

Handling Hyperspectral Camera

This device is a precision instrument. Do not drop it or subject it to physical shock.

Device is calibrated to operate as specified in this document. Re-calibration is preferred occasionally depending conditions where used and after physical shock, vibration etc.

Regulatory information

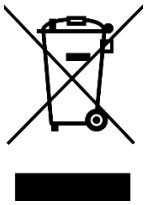
This Device is tested under CE & FCC requirements as descripted below:

CE

Hereby, SENOP declares that the HSC-2 is in compliance with directives and regulations listed below

- 2014/53/EU (The Radio Equipment)
- 2011/65/EU (RoHS)
- 2012/19/EU (WEEE)

In accordance with Article 11(2) in Directive 2012/19/EU (WEEE), products were marked with following symbol: a cross-out wheeled waste bin with a bar beneath as below:



The full text of the EU declaration of conformity is available at the following internet address: http://senop.fi/compliance

FCC

FCC Information for the User

This product does not contain any user serviceable parts

FCC compliance statement:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Safety information

Use the following safety guidelines to help ensure your own personal safety and to help protect your equipment and working environment from potential damage.

IMPORTANT NOTICE FOR USE IN HEALTHCARE ENVIRONMENTS:

Senop HSC-2 product is not a medical device and is not listed under UL or IEC 60601 (or equivalent). As a result, it must not be used within 6 feet of a patient or in a manner that directly or indirectly contacts a patient.

General Safety

Place the equipment on a proper stand or holder, like tri-pod, or gimbal in drone. Fix it securely. Never place it in a closed- unit, or on a sofa, rug or bed. The equipment is not indented to be used as hand-held.

Equipment metal bottom plate may be warm during normal operation.

Leave 10 cm (4 in) minimum of clearance on all sides of the device to permit the airflow required for proper ventilation. Restricting airflow can damage the equipment or cause a fire.

Do not stack equipment or place equipment so close together that it is subject to recirculated or preheated air. Keep your device away from radiators and heat sources. Keep your equipment away from extremely hot or cold temperatures to ensure that it is used within the specified operating range.

Ensure that nothing rests on your equipment's cables and that the cables are not located where they can be stepped on or tripped over.

Do not use your equipment in a wet environment, for example, near a bath tub, sink, or swimming pool or in a wet basement.

Do not spill food or liquids on your equipment.

If your equipment does not operate normally - in particular, if there are any unusual sounds or smells coming from it - unplug it immediately and contact an authorized dealer.

Hot Surface

There is “Hot Surface” label in device metal bottom plate

Hot Surface label indicates possibility to surface get uncomfortable hot or even cause burn when touched. Especially if air circulation around device is prevented and device is used long times continuously.

Be careful not to touch any hot surfaces!

Socket outlet

Do not install or use in an area that impedes access to the power plug. Disconnecting the power plug is the only way to completely remove power to the product and the plug must be readily accessible at all times!

Warranty Statement

- Warranty period 12 months, unless otherwise agreed.
- Registration of the product may be required to validate the warranty
- Proof of purchase may be required
- The repair or replacement of a faulty product within the warranty period remains at the discretion of Senop
- The Senop HSC-2 warranty covers defects in parts or workmanship but does not cover fair wear and tear, defect resulting from misuse, unauthorized modification, operation or storage outside the environment specification for the product or in-transit damage.

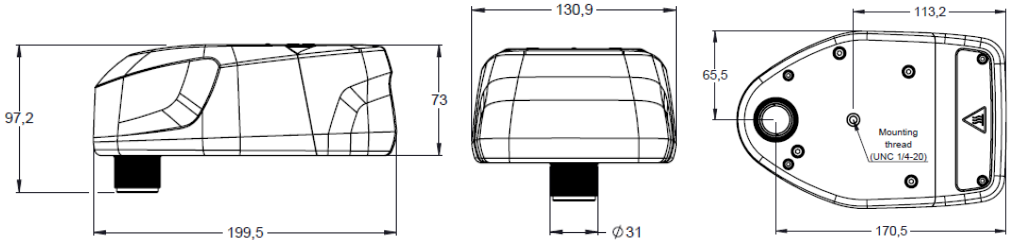
Open Source Software Notice

This product contains Senop HSI-2 software which is licensed under the GPL and LGPL. Copy of the licenses is provided along with this product. Also available on website https://www.gnu.org/licenses/.

Senop Oy will provide open source code used in product for charge covering the cost of performing such distribution upon request. This offer is valid for three (3) years from the date on which the product is purchased.

Contact: http://senop.fi/

Specifications



- Frame Based Digital Hyperspectral camera
  - True global shutter snapshot sensor.
- Size: 199,5mm x 130,9mm x 97,2mm (73mm without lens)
- Weight 990 g (without connector cover)

Powering

- Device Voltage supply 7 – 17 VDC
- Maximum current consumption (@7V) peak 2,2A, nominal 1,6A
- Maximum power consumption 12W, peak 16W
- Wall power 100-230 VAC 50/60Hz

Operation conditions

- Temperature range 5 – 40°C in free air
  - If temperature range is exceeded, imaging will be inhibited to prevent damages
- Relative humidity less than 85%, not condensing

Optics

- F#3,28
- FOV 36,8 deg
- Focus distance: 30cm to ∞, limited FOV with less than 30cm distances

Imaging capability

- Image frame size: 1024 x 1024 pixels
- Frame rate (single image or video)
  - 12-bit frame: max 74 f/s
  - 10-bit image: max 149 f/s
  - min 1 f/s
  - viewfinder gets slow if the frame rate is set too slow
- Internal memory, with maximum frame rate
  - 12bit: 1h45min
  - 10bit: 1h17min
- Exposure time: can be set freely
  - maximum frame rate may be limited if exposure time is long
- Radiance accuracy for all pixels < 5% (12bit), < 10% (10bit)

Spectral capability

- Wavelength area (Serie A)
  - 500nm – 900nm

- Up to 1000 spectral bands
- normal, narrow and wide FWHM selectable per wavelength

- Spectral FWHM bandwidth: Narrow <15nm, Normal <20nm, Wide <25nm (where applicable)
- Spectral accuracy over operating ambient temperature range <2nm
- All pixels are true pixel, no interpolation used

Connections

- Gigabit ethernet connection RJ-45
- USB 2.0 type-C
- mini-Displayport v1.2
- AUX port with UART, Trigger, Sync and 2GPIO pins.
- MMCX for external GPS antenna, if needed

Peripherals

- Internal Hard Drive 1TB
- Integrated GPS
  - Internal antenna for GPS
  - Internal antenna is located next GPS connector, facing up.
  - External antenna (not included) thru MMCX connector for GPS and Glonass
- Integrated IMU
  - Accuracy typically 1°

Device UI

- Display
  - Resolution, 128 x 64 pixels
  - Black and white
- 4 button, (up, down, back, select)
- Indicator RGB -led

Sales Package Contents

- Senop HSC-2-x Hyper Spectral Camera, where x is
  - C – 500nm – 900nm
- Wall Power Unit
  - 90 - 264 VAC / 12VDC 24W
  - CUI SMI24-12-V-P6
- Power cable
  - 2.5mm ID, 5.5mm OD Plug to Wire Leads Flat 6.0' (1.83m)
  - Tensility 10-01060 (or similar)
- Ethernet Cable
  - CAT 6, 3m (9,84’), Double Shielded, Blue
  - Assmann WSW Components A-MCSSP60030/B (or similar)
- IO Cable
  - Samtec S2SDT. Teflon insulated wires.
- USB memory with softwares and manual
- Camera Case

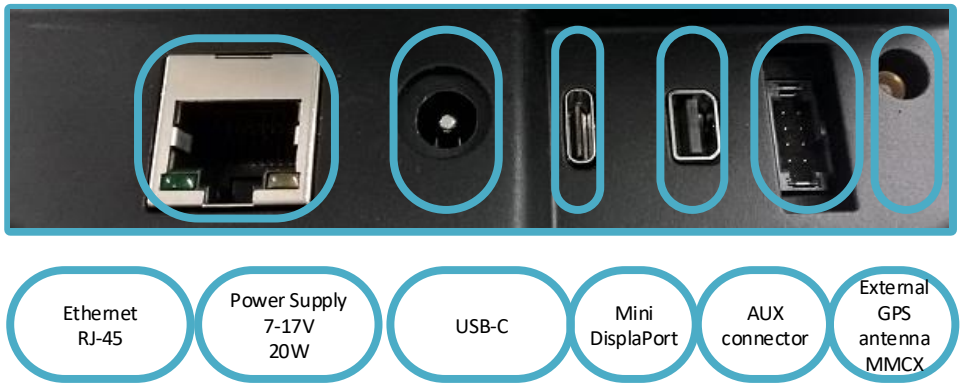
- Customized Peli 1400

Display and Keyboard

When HSC-2 Hyperspectral Camera is not controlled directly by computer there are certain functions that can be operated from the device own user interface

- Run script
- Single shot
- Settings for
    - Time and Date
    - Ethernet
    - Camera
        - Bit Depth
        - Frame rate
    - GPS
    - Storage
- Data storage
- Display port
- About

Connections and Connectors



There are six connectors on the device

- Ethernet RJ 45 connector
- Power connector
- USB connector
- Display port connector
- AUX-Connector
- GPS antenna connector

AUX connector

AUX connector functions

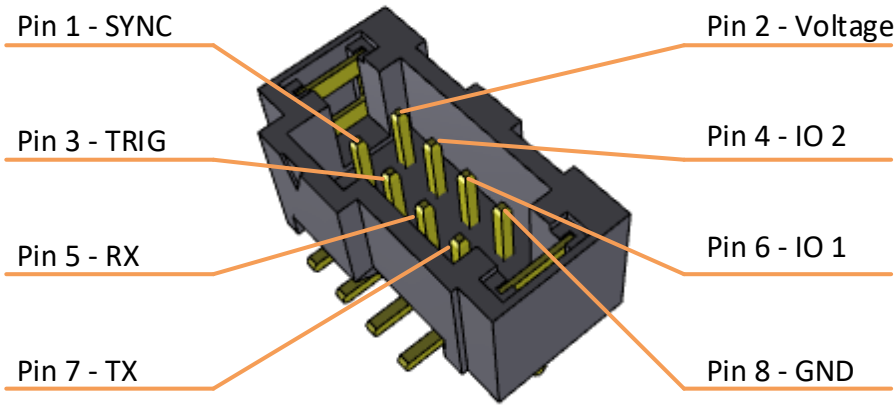
- TRIG, Input, Realtime pulse, trigger to enable script
- SYNC, Output, Realtime pulse, to Synchronize device operation
- 2 IO pins, direction configurable, to control selectable function. No SW support currently.
- UART to communication. No SW Support currently.
- Interface voltage supply (Input).

AUX connector specification

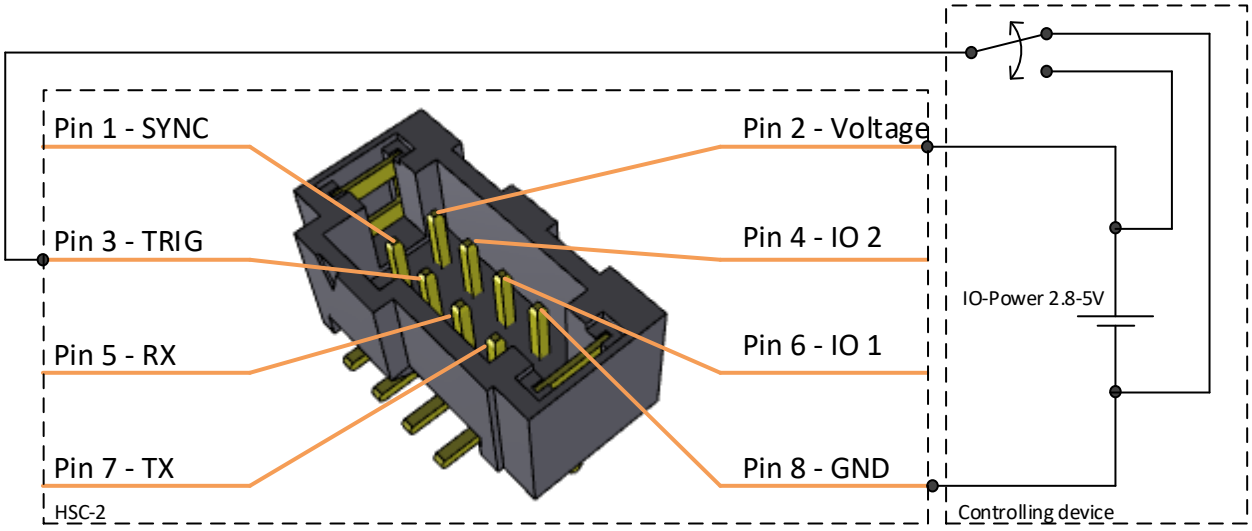
- Voltage should be supplied for interface from device connected to.
    - Connector is isolated from HSC-2 voltage domains.
    - Voltage range: 1.65V – 5.5V, Used buffer: SN74LVC1T45
    - Interface is enabled only when voltage is supplied.
- Connector type is Samtec T2M 2.00 mm Tiger Eye™ 8 pin.
    - Supplied cable type is Samtec S2SDT. Teflon insulated wires.
- Absolute Maximum Ratings
    - Supply voltage, Input voltage -0.5V – 6.5V
    - Continuous output current 50mA
    - Stresses beyond Absolute Maximum Ratings may cause permanent damage to the device
- Recommended Operating Conditions
    - Supply voltage 1.65V – 5.5V
    - High-level input voltage
        - When VccI is 1.65 to 1.95V: Min VccI× 0.65V
        - When VccI is 2.3 to 2.7V: Min 1.7V
        - When VccI is 3 to 3.6V: Min 2V
        - When VccI is 4.5 to 5.5 V: Min VccI × 0.7
    - Low-level input voltage
        - When VccI is 1.65 to 1.95V: Max VccI× 0.35V
        - When VccI is 2.3 to 2.7V: Max 0.7V
        - When VccI is 3 to 3.6V: Max 0.8V
        - When VccI is 4.5 to 5.5 V: Max VccI × 0.3
    - Output current, High and Low level
        - When VccI is 1.65 to 1.95V: Max |4mA|
        - When VccI is 2.3 to 2.7V: Max |8mA|
        - When VccI is 3 to 3.6V: Max |24mA|
        - When VccI is 4.5 to 5.5 V: Max |32mA|
- Pin configuration
    - Pin 1 – SYNC, Output, Function configurable, Synchronous, 50Ω serial resistor in buffer
    - Pin 2 – Voltage (VccI), Input 1.65V – 5.5VDC, 300nF Filtering.
    - Pin 3 – TRIG, Input, Function configurable, Synchronous, 10kΩ PD to GND
    - Pin 4 – IO2, Input or Output, Function configurable, 10kΩ PU to VccI
    - Pin 5 – RX, Input, UART RX pin, 10kΩ PU to VccI
    - Pin 6 – IO1, Input or Output, Function configurable, 10kΩ PU to VccI
    - Pin 7 – TX, Output, UART TX pin, 50Ω serial resistor in buffer

- Pin 8 – GND, Common GND to device.

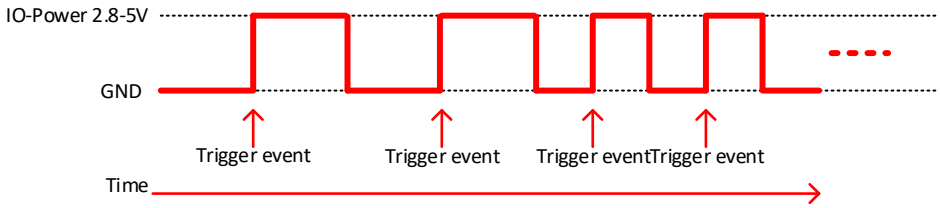
AUX connector pin order



AUX TRIG pin usage principle



- TRIG pin is functional only when IO power (1.65V-5.5V) for interface is supplied
- TRIG pin should be kept all the time in either GND or IO-Power voltage (1,65V-6.5V)
  - This can be done for example ON-ON type control
  - TRIG pin is tied to GND with 10kΩ resistor internally
- TRIG pin impedance is high, IO-Power consumption is very low.
- TRIG IO power can be connected independently, regardless of HSC-2 power supply



- Only rising edge trigger is supported by SW currently
- It is not possible to trig new sequence when previous sequence is still ongoing.

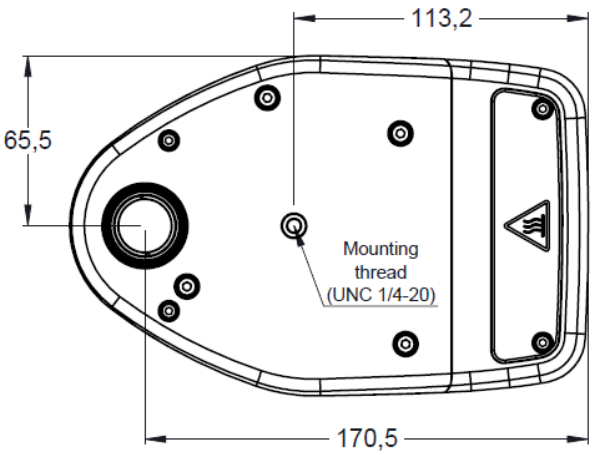
Attaching the HSC-2 to a Drone.

When using the HSC-2 camera in drones it is always advisable to use professional gimbal, compatible with drone. Gimbal insulate drone vibrations and keep camera steady. Use also high-quality drones.

HSC-2 requirements when used in drone:

- Safe and sturdy installation. The HSC-2 will not survive dropping from heights.
- Power supply. HSC-2 needs power supplied from external source.
    - Device Voltage supply 7 – 17 VDC
    - Maximum power consumption 12W, peak 16W
    - Power consumption is highly depended on the usage of the device.
- Good weather
    - HSC-2 is a high precision device and not insulated from water
    - Hyperspectral imaging during rain will not work.

Mechanical fixing



There is a UNC ¼-20 mounting thread installed in device aluminum base plate. It is advisable to attach baseplate directly against gimbal (metal) fixing plate. This also improve cooling for device. Do not cover base plate with insulating material, like printed plastic plates. This may reduce device operation or even cause thermal shutdown during operation.

Fixing may be secured with for example strap over device. Locate strap front side of display area. There may be other “Upper Mounting Plate” features also in gimbal, use those if possible.

Fixing the cables

The camera is provided with a protective cover for the connectors. There are 4 distinct parts which can be removed for example with plyers, to route the necessary cables through the protective cover.

Removable parts for routing cables.

Electrical connection

Power should be supplied to HSC-2, possible sources are drone itself, gimbal or external battery. There is power cord supplied with HSC-2 without connector in battery/drone/gimbal end. There is also possibility to connect AUX connector, USB connector, Ethernet or Mini-DisplayPort if supported by the drone/gimbal.

Power connector type (in cable): Barrel Plug, 2.5mm I.D. x 5.5mm O.D. Positive Center.

GPS in Drone Use

Internal Antenna for Integrated GPS is located so, that is functional in most cases when HSC-2 is attached to Drones. Location is just front to GPS external antenna connector. Antenna is sensitive to all directions above base plate

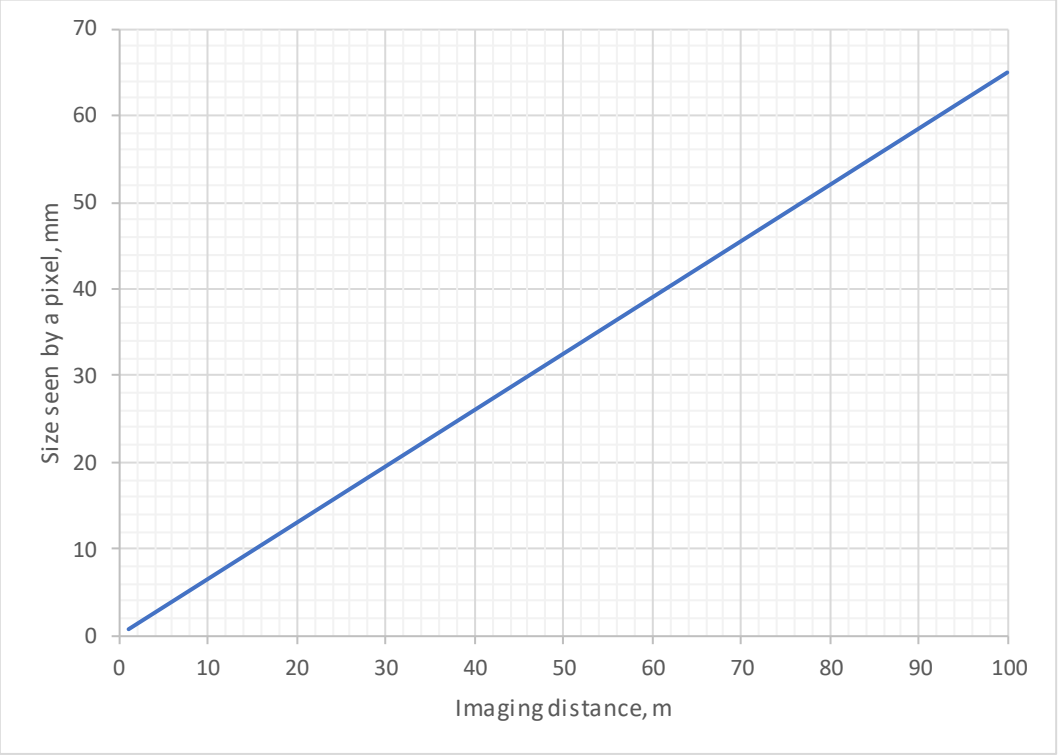
External antenna (not included) thru MMCX connector can be used for example if drone causes too much interference for GPS. With external antenna also Glonass in possible to use

DJI Matrice 600

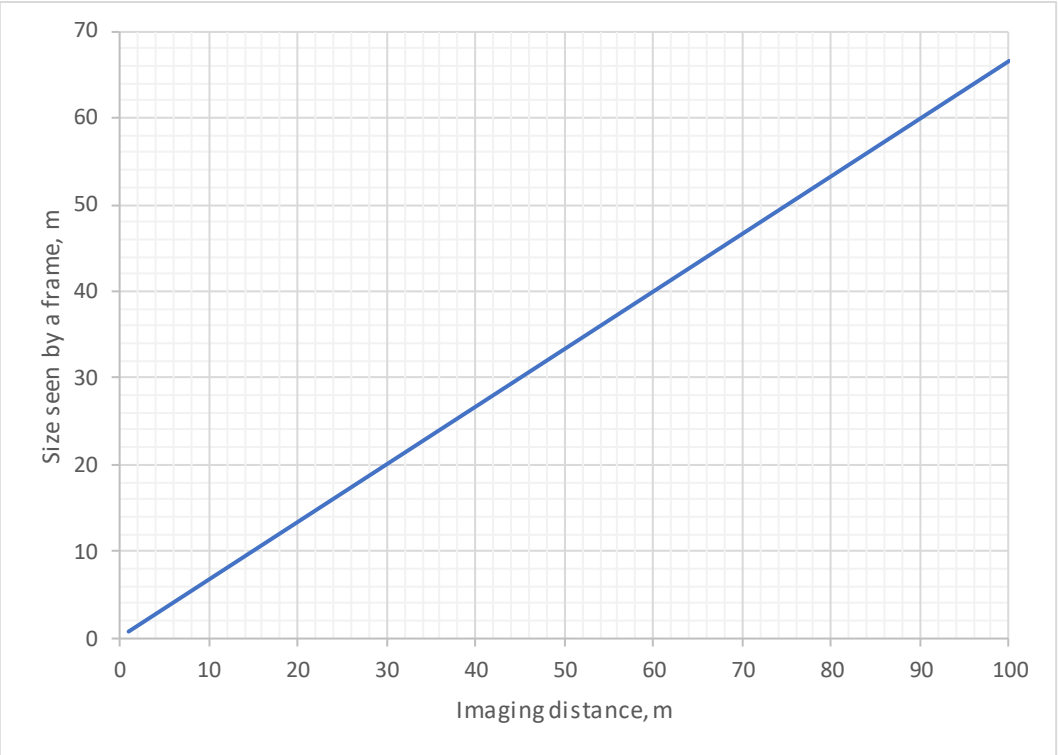
Instructions above are compatible for example with DJI Matrice 600 drone & Ronin-MX gimbal with enough battery capacity.

Imaging from a distance

When the HSC-2 camera is used to image from a great distance, it is useful to consider the affect of the resolution of the image. The graph below shows the size what one pixel sees at a given imaging distance. For example, when the image is taken 100m from the target, the image is formed from 65mm x 65 mm resolution.



The image below shows the size what the camera can see at a given imaging distance. For example, when the image is taken 100 m from the target, the camera can see an area of 66 m x 66 m.


70
60
50
40
30
20
10
0
Size seen by a frame, m
0
10
20
30
40
50
60
70
80
90
100
Imaging distance, m

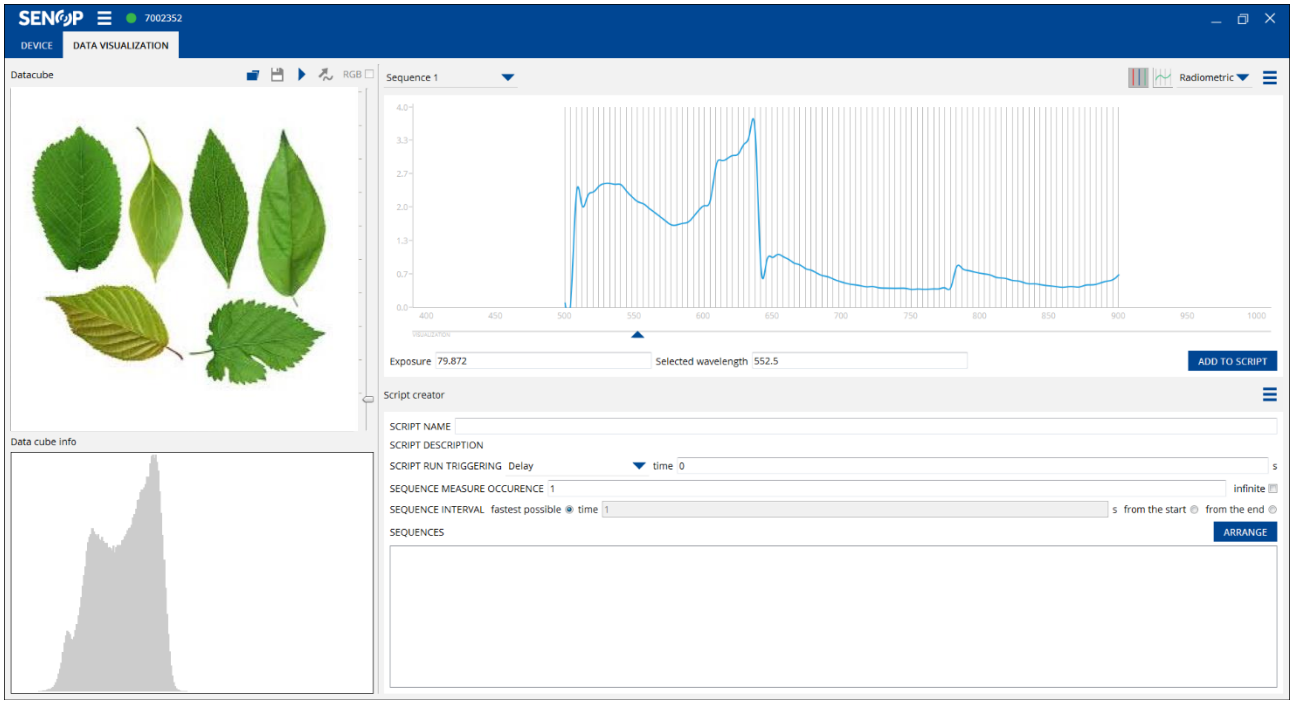
Senop HSI Software

Senop Hyperspectral camera HSC-2 can be used as a standalone device but HSI software or some other compatible software is needed to initialize or control the device.

Senop HSI-2 Software can be used to:

- Viewing live image for camera
- Data browsing
- Data visualization
- Sequence editing
- Script editing
- Device configuration and updating

HSI Data Visualization view



In HSI-2 Data Visualization view it is possible to view and analyze either live images or stored data cube. It is also possible to create and modify scripts.

Main menu

- Save as image: Saves the current image as .png-file
- Save as CSV: Saves the current spectrum as .csv-file.
- About

Connection Status Indicator

- GREY: Device not connected
- GREEN: Device connected
- RED: Device connected and recording

Data Visualization Toolbar

- Data cube name
    - If live stream enabled: Live stream, RGB / WL
    - If snapshot taken: Snapshot, script name
    - If opened data: Data cube name
- Open data
    - Opens file manager
- Snapshot
    - Pause / Play

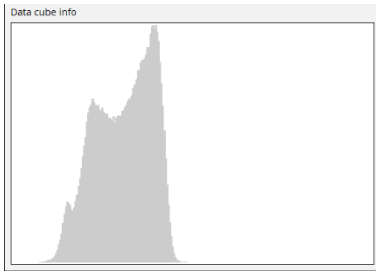
Visualization area

- Live stream: False RGB or Grayscale
- Snapshot: still image, paused from live stream with defined sequence
- Saved data: opened from file
- Picker tool: pick a pixel from the data visualization area to see intensity values of the sequence wavelengths to the sequence visualization area

Exposure slider

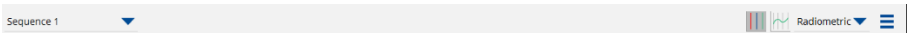
- User can adjust exposure by using exposure slider

Data cube info



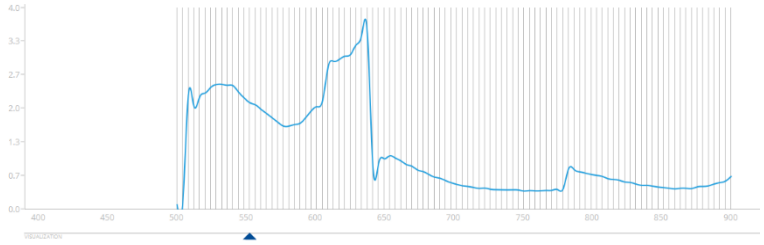
- Histogram from either RGB image or selected wavelength.

Sequence toolbar



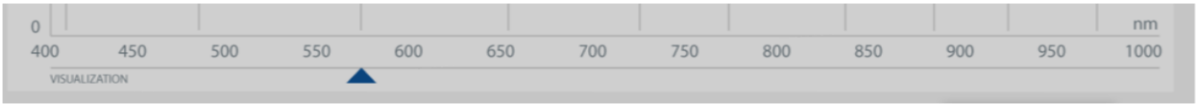
- Sequence toolbar contains the following features and tools.
    - Sequence name
    - Spectrum visualization method: Dots/point-to-point line/Smoothened
    - Data presentation method: Radiometric/Relative in the units of mW/(sr*nm*m^2)
    - Menu
        - New: Opens sequence editor for creating new sequence.
        - Copy: Opens sequence editor with copy of the currently selected sequence for copying sequence.
        - Remove: Removes current sequence
        - Edit: Opens currently selected sequence to the sequence editor for editing sequence.
        - Clear all: Clears all sequences from the sequence list except default sequence.
        - Add to script: Lists sequence to the sequence list of the script

Sequence visualization



- Shows selected sequence: from the opened data, default sequence, sequence defined with sequence creator or sequence picked from the defined script

Sequence slider

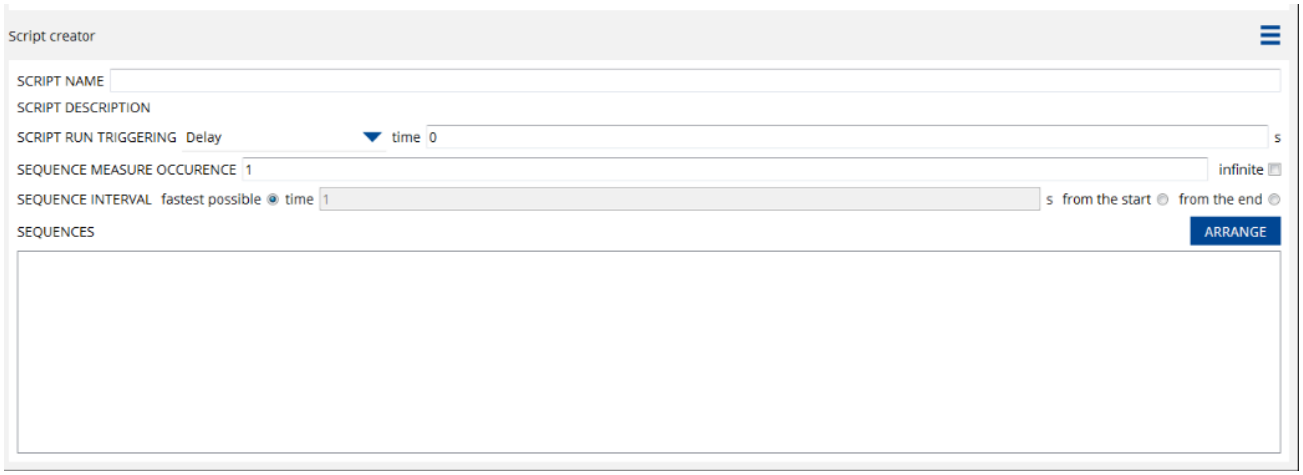


- Select wavelength to visualize it on the data visualization area.

Exposure setting & Add to Script

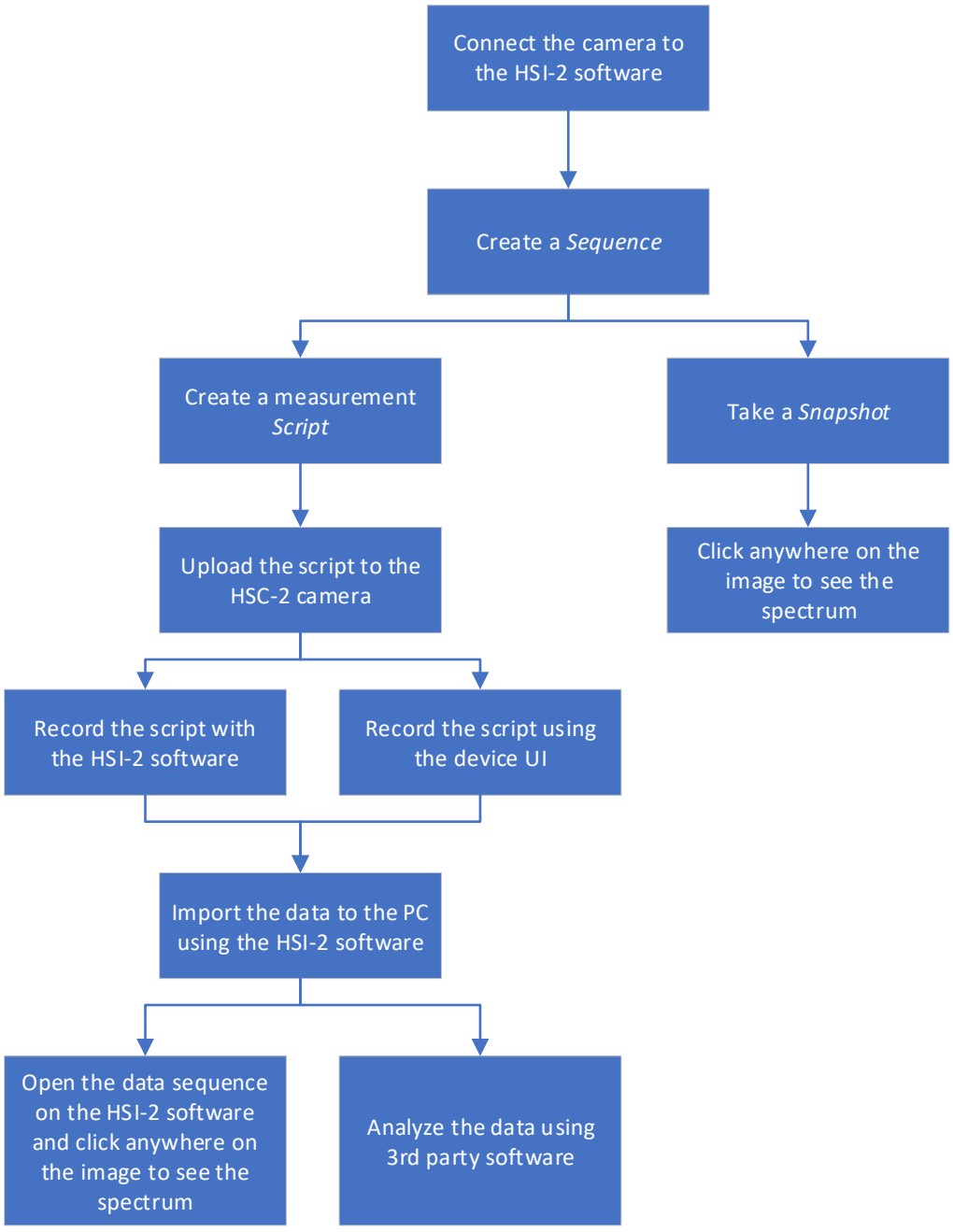
- Adjust exposure time by typing value directly to the line edit
- Add current sequence to the script by pressing add to script

Script Creator



- Menu
    - New: Clear script content and start creating a new script
    - Open: Open saved script from computer
    - Save as: Save created script to the computer
    - Edit Description: Add or edit the description of the script
    - Upload: Directly upload script to the device
- Script name: Add name for the script
- Script run triggering: Define triggering method for the script running
    - External trigger rising
    - External trigger decreasing – Not supported by the software at the moment
    - Delay
- Sequence measure occurrence: Number of occurrences or infinite occurrence
- Sequence interval: Interval between two measurements
    - Fastest possible
    - Time
    - From start to start
    - From end to start
- Sequences
    - Arrange sequences by pressing arrange button
        - The order of the sequences is the running order in the script
    - List of sequences
        - Sequence name
        - Exposure time for the sequence
        - Width settings
    - Sequence can be removed by pressing ‘X’ symbol from the end of the sequence list row

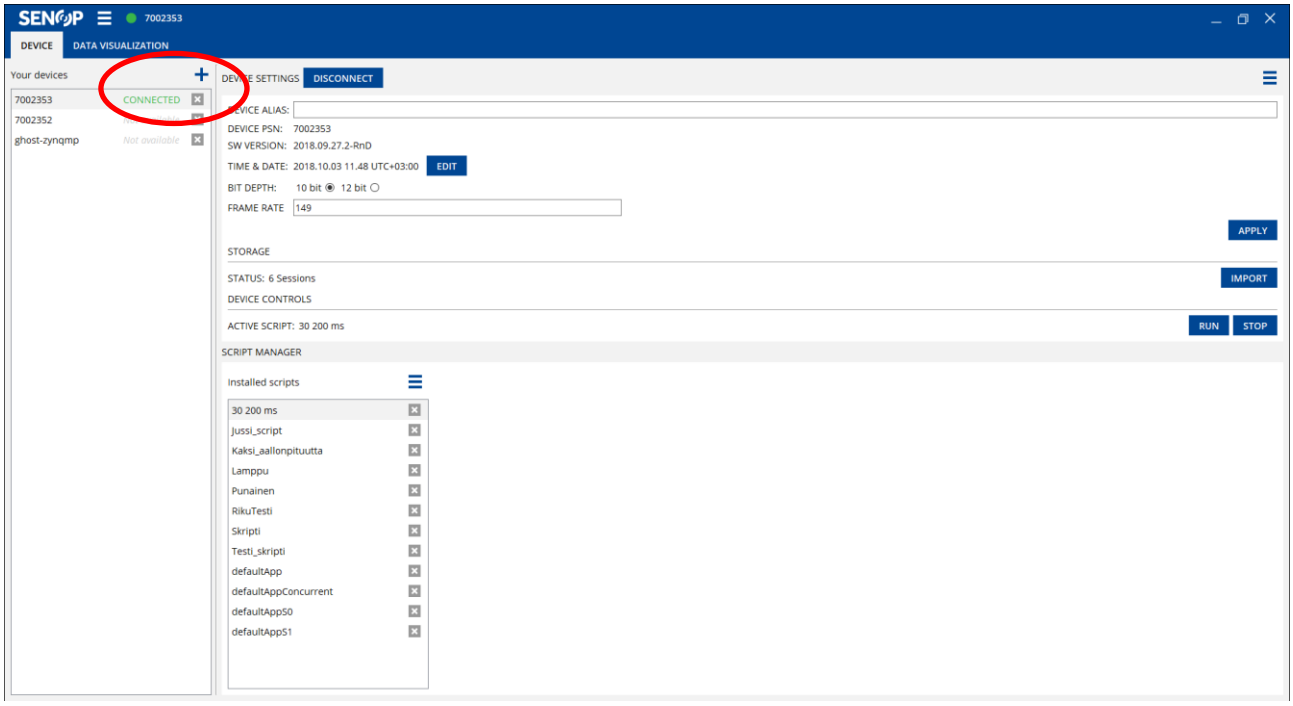
A typical use case scenario is shown on the flow chart image below. All the necessary actions are discussed in more detail in the text.



Connecting to the HSC-2

Power up the HSC-2 device by connecting the DC Voltage cable and connect the Ethernet cable between the HSC-2 and a PC. Start the Senop HSI-2 Software. On the *Device* tab, press the + sign. On the opened window,

select your device from the *Available Devices* list and click OK. The device will now be listed as *Available* on *Your devices* list. Click on the device to connect. Wait until the device is connected and the status of the device is switched to *CONNECTED*. This may take several minutes. The device alias can be changed from the DEVICE ALIAS window.



Taking a snapshot using the default Sequence

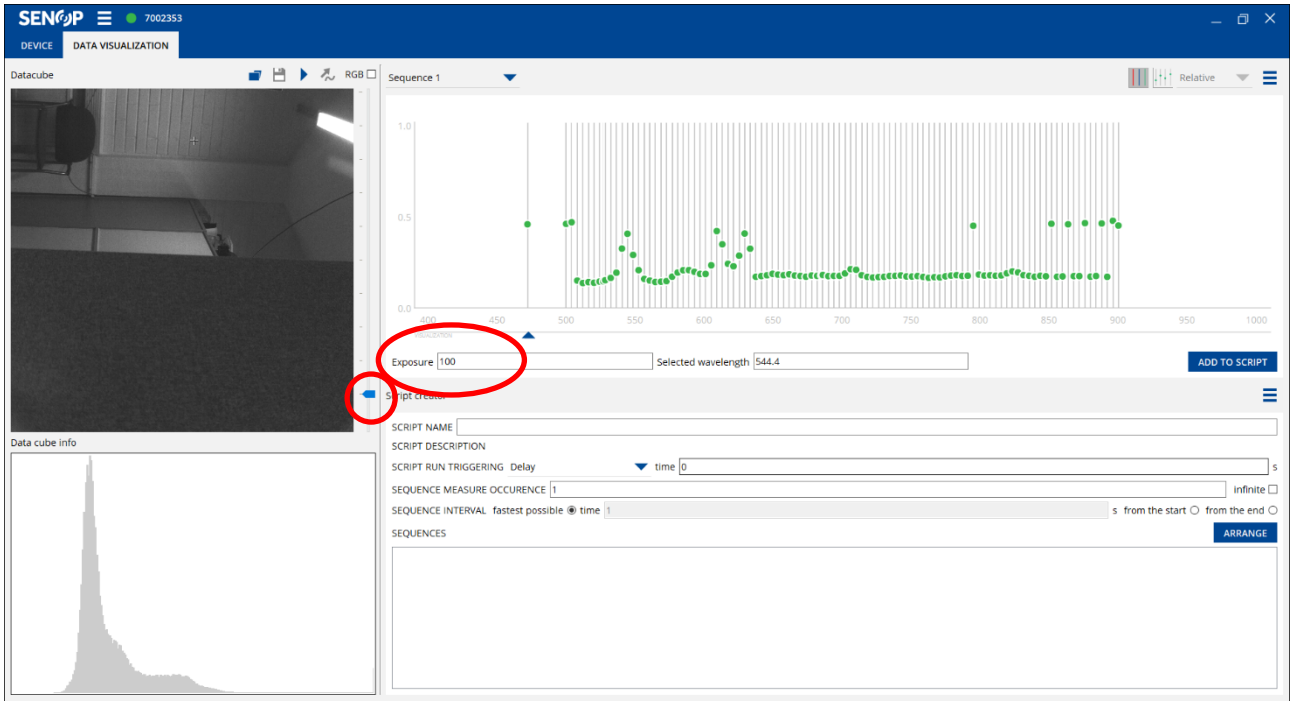
A snapshot function on the HSI-2 software enables the user to measure one Sequence (i.e. data cube) and see the spectrum of the imaged scene. Once the camera has taken the data, the spectrum can be seen on the software by clicking on the image.

Go to the *DATA VISUALIZATION* sheet. First, you will see an RGB image, which mimics a typical digital camera image. To see the image at a certain wavelength, uncheck the RGB box and use the slider to navigate to the desired wavelength. On the top right corner, there is a Visualization window, which shows the selected wavelengths for the sequence. There is a default sequence shown, which has 13 measurement points, i.e. frames, between 400 nm – 1000 nm. The exposure value can be changed by adjusting the slider on the right side of the live image or by setting a value to the *Exposure* dialog box. Under the live image window, there is a histogram window, which shows the histogram of the current image. The exposure value should be selected in such a way, that the image does not saturate to black or white.

To take a snapshot with the default sequence, click the ⏸-button. The camera will now take the 13 frames, as defined in the default sequence, and a status window shows, when the measurement is done. Next, the spectrum can be acquired by clicking the image at the desired location on the image. The spectrum will be shown at the Visualization window. The image acquired at certain wavelength can be seen by using the slider at the desired wavelength on the visualization window. The y-axis of the spectrum can be either Relative or

Radiometric in the units of mw/(m^2*nm*sr). The selection can be done from the drop-down menu at the top right corner.

The image shown on the top left corner of the software can be saved by clicking the -button on the top of the window and selecting SAVE AS IMAGE. The spectrum can be saved by using by selecting the SAVE AS CSV.



Creating and measuring a custom script

Creating a custom sequence

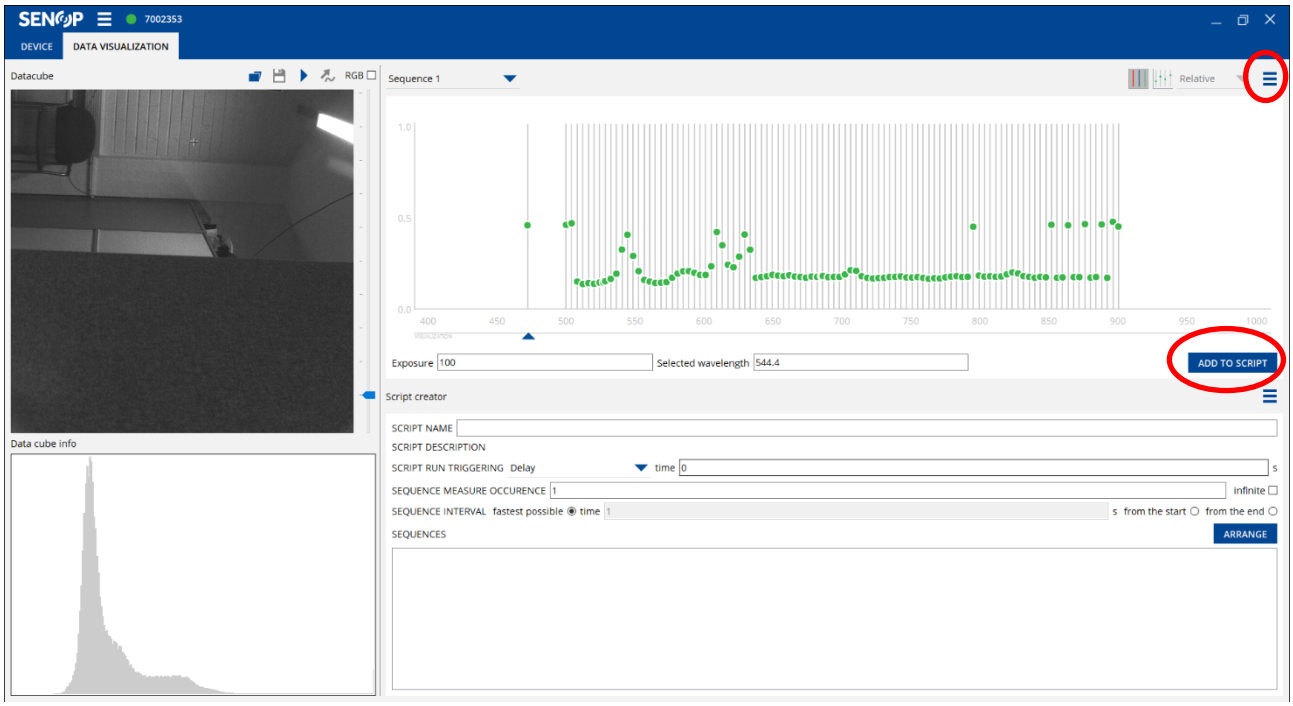
A *sequence* defines the optical parameters, i.e. the wavelengths to be measured, the bandwidth selection and integration time (exposure). The sequence parameters are located on the top right corner of the HSI-2 software. To create a new sequence, click the - button from the Sequence window and select *New*. In the opened window, select desired wavelength range, number of measurement points, spectral width and name of the sequence. *Add*-button adds the measurement points to the list. Click *Apply*-button to return.

The created sequence can be saved by clicking the -button at the Script Creator line and selecting SAVE AS. Also, previously saved sequences can be opened by selecting OPEN. The sequences are stored as .json files. After imaging with a sequence, the name of the sequence is changed to form -1 at the top of the Sequence window. Further changes to the sequence increase the number. To image with the original sequence, select the sequence from the drop-down menu.

Creating a custom script

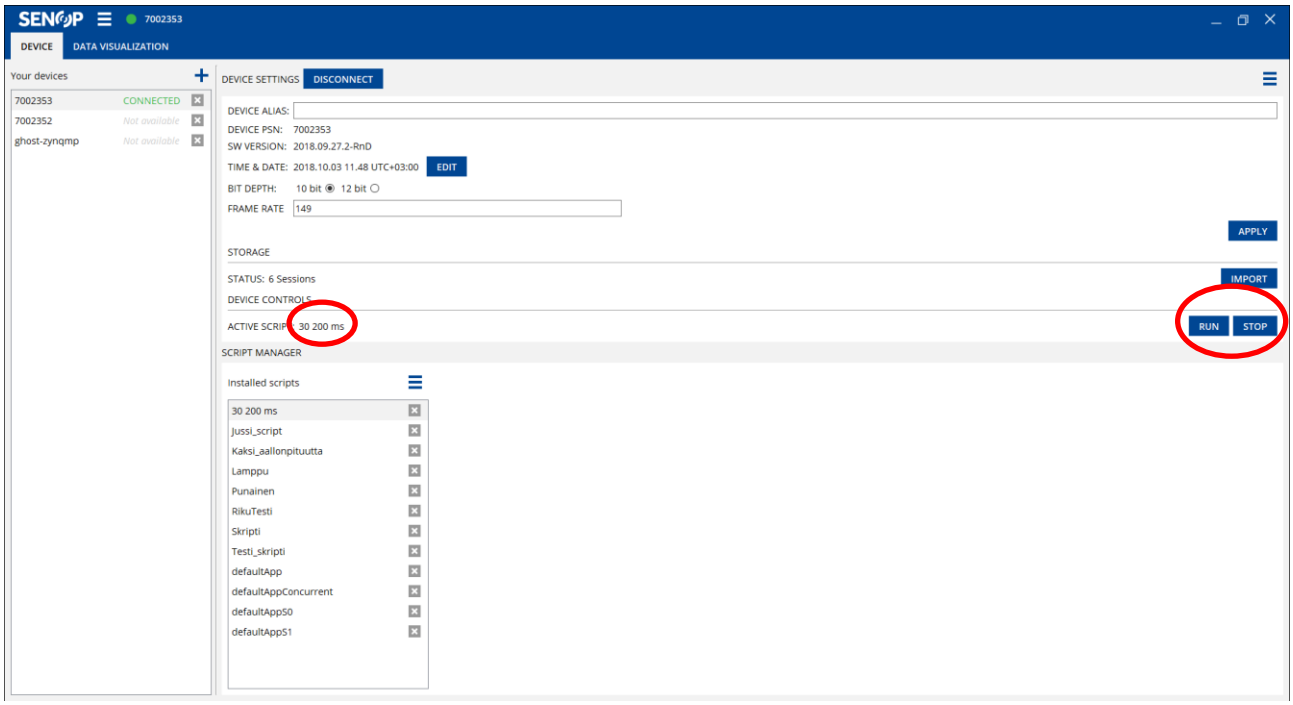
A Script defines the measurement parameters such as how many times a sequence is to be measured, how the recording is started etc. All the script parameters are located on the bottom right corner of the HSI-2 software. Once the sequence is created, select the desired Exposure value and then click ADD TO SCRIPT. Script parameters can then be modified from the *Script creator* window. Trigger parameters can be adjusted by using the SCRIPT RUN TRIGGERING. The *delay* parameter means that the imaging starts after certain time or if 0 s is selected, the imaging starts immediately after the recording is started. An external trigger can also be used. If the *Rising Edge* is selected from the drop-down menu, an external trigger pulse starts the recording. The use of the trigger is explained in more detail in the Chapter *AUX TRIG pin usage principle.* The SEQUENCE MEASURE OCCURRENCE parameter defines how many times the sequence is to be measured within the script and the SEQUENCE INTERVAL parameter defines what is the time interval between adjacent measurements. Multiple sequences can be added to a script and their order can be changed by using the ARRANGE button.

In order to measure with the created script, it needs to be transferred to the HSC-2 camera. After the Script Name has been created, click ☰-button from the Script Creator window and select UPLOAD. The selected script will now be transferred to the HSC-2 device. Next, return to the *DEVICE* sheet. The uploaded script will now be shown in the SCRIPT MANAGER list. To make the created script as active, select the script from the list and click the SET ACTIVE from the ☰-list.



Measuring the script using the Senop HSI-2 software

The recording with a script can be done from the DEVICE sheet. Select the desired data format, either 10 bit or 12 bit and set the frame rate. Press APPLY button. The recording is started by clickin the RUN-button. The camera will now start to measure the script, and if the script was selected to have infinite amount of sequence measurements, the measurement can be stopped by clicking the *STOP*-button.



Measuring the script using the HSC-2 camera menu

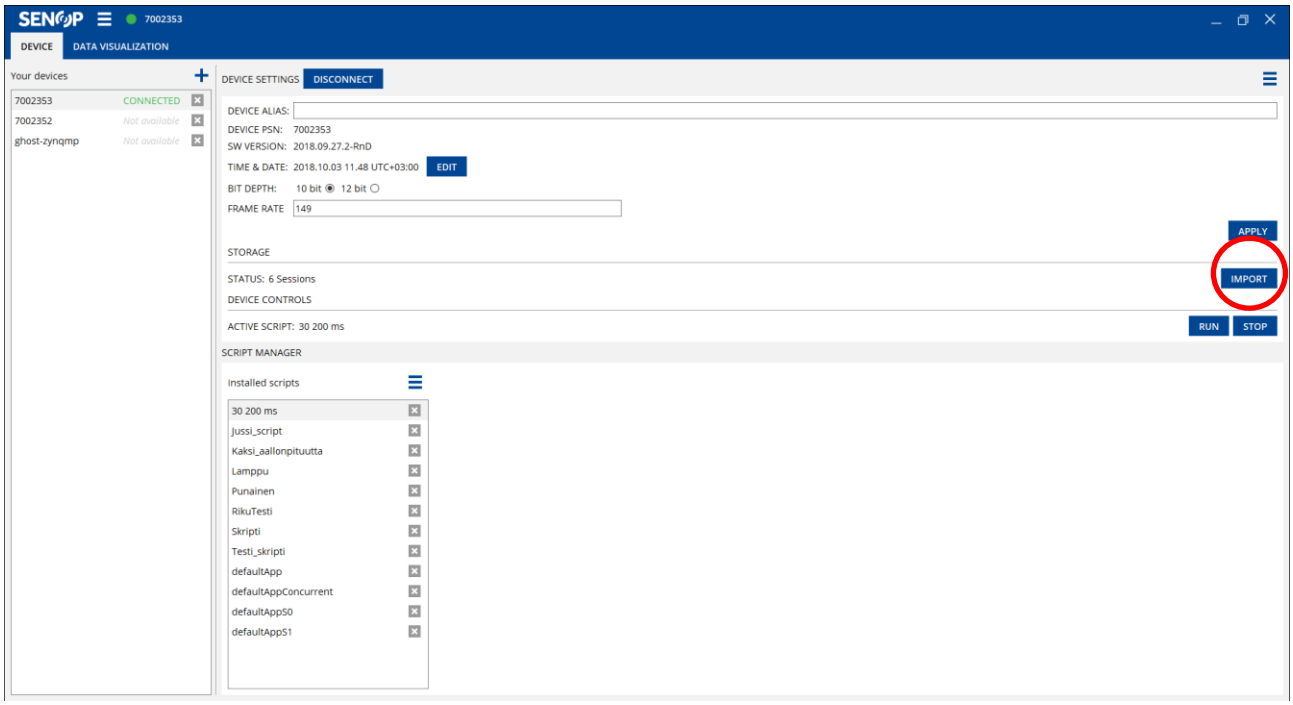
The created scripts can also be measured using the HSC-2 menu and buttons on the device. The Ethernet cable can be disconnected, and the device only needs an external voltage source. Use the device menu buttons to navigate to the *Settings/Camera* and select desired *bit depth* and *frame rate*. Return to the main menu by pressing *back*-button. Select the *Run script* and then select the desired script from the list. The information of the script is shown on the display. To continue, press *select*-button. Select *No* to *Record Reference* question. The measurement starts by pressing select.

If the selected script has an External trigger selected, the device waits for the trigger pulse for starting the recording. Once the recording is done, press OK, and back-buttons to navigate to the main menu.

The HSC-2 camera has a Display port, which can be used to transfer the video to and external display. From the device menu, navigate to the Display port and select *Enabled*. Connect the HSC-2 camera to an external display. It is suggested that a cable without any converters is used as some of the video converters are not supported by the camera. The video is shown at the external display, while a recording with a script is running on the camera.

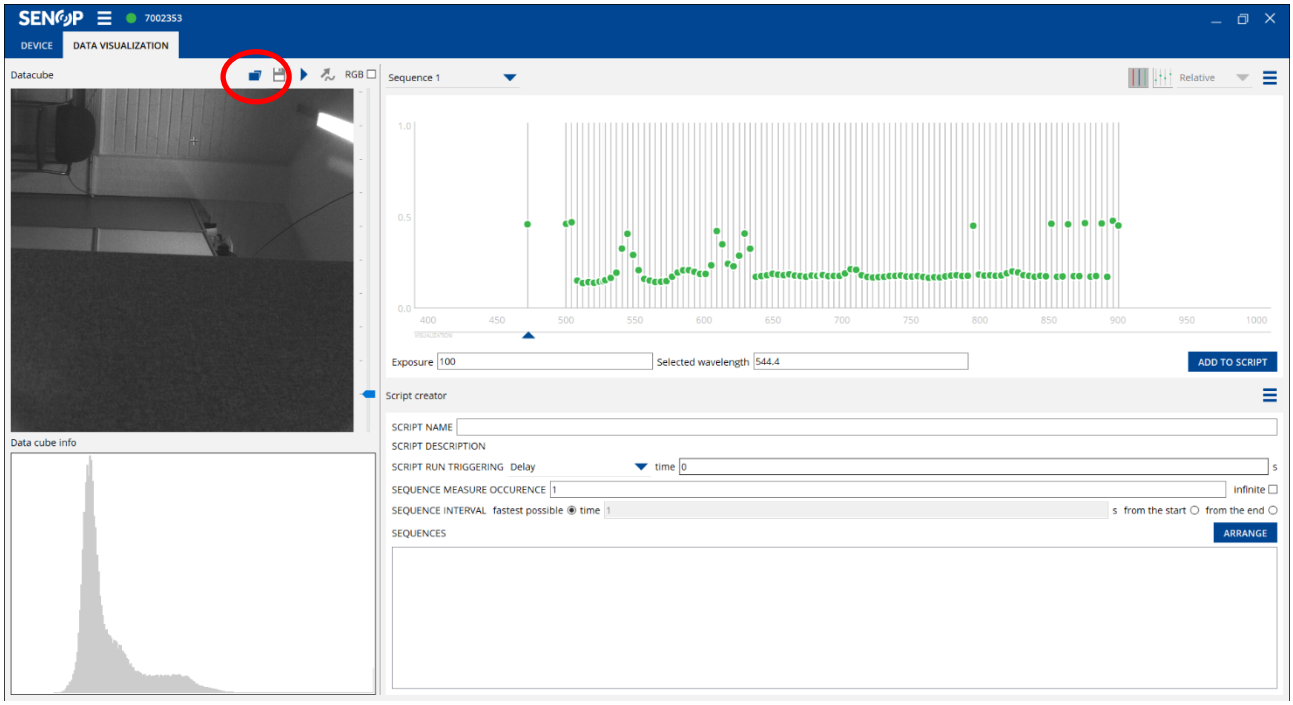
Importing the data to the PC

The data taken with the script, is saved into the HSC-2 internal memory. To analyze the data, it needs to be transferred to a PC. The data can be imported with the HSC-2 software by pressing *IMPORT*-button on the *Device* sheet. From the opened window, select the desired script and folder where the data is saved. The transfer will start by pressing Ok.



Open the data cube in HSI-2 software

To open the stored data cube, press the open icon at the *DATA VISUALIZATION* sheet. Select the desired sequence from the folder and click OK. The data cube opens, and the spectrum can be viewed by clicking the image.



ENVI Data type

The stored data can be analyzed using a 3rd party software. All the sequences in a given script are stored in the same folder. There is a .png preview images of every frame, the actual data in Envi file format and a header file, which contains information about the recording parameters.

By default, HSC-2 uses ENVI type image cubes.

- .dat file is ENVI type flat binary file.
- Corresponding Envi Header file (.hdr) is key to open data file.

Header file specifies metadata needed to use .dat file.

- For example: “wavelength = {500.0, 640.0}”
    - In this example there is 2 images in Envi hypercube (.dat), first one taken at 500nm wavelength and second at 640nm.
- There is lot of other information also in header. Like: “Data type = 12” (16-bit unsigned integer), “byte order = 1” (most significant byte first (MSF)), “data gain values = {0.000542, 0.000557}” (These values are used to convert integer values in cube to SI unit, different for each image.) etc.

Free programs are available to open ENVI files, as there is libraries to handle ENVI in MatLab or similar programs.

Below is a list of all the data contained in the header file.

Envi header name	**Example**	**Description**
Envi	-	Type of the header
description	Senop Hype2.0 Image	Camera name
wavelength units	nm	Unit of the wavelength
samples	1024	Number of pixels in horizontal direction
lines	1024	Number of pixels in vertical direction
file type	ENVI	Type of the file
interleave	BSQ	Data Interleave type, BSQ=Band Sequential
byte order	1	Byte order, 1=Most significant byte first (MSF)
data type	12	Type of data representation, 12=Unsigned integer:16 bit
senop sequence name	Sequence	Name of the recorded sequence
bands	5	Number of measurement bands
acquisition time	2019-03-22T09:36:31.940629000Z	Time of the acquisition
wavelength	{500.0,600.0,700.0,800.0,900.0}	Measured wavelengths in the sequence

fwhm	{5.0,5.0,6.8,7.7,8.0}	Full Width at Half Maximum values at each measured band in nm
data gain values	{0.000000,0.000137,0.000203,0.000278,0.000387}	Gain values to convert the intensity values to units mW/(m^2*nm*sr)
geo points	{1.0000,1.0000,62.26495167,26.37994000}	Geographical coordinates, pixel_x_coordinate, pixel_y_coordinate, latitude, longitude
senop sequence order	{0,1,2,3,4}	Order of the requested bands
senop order	{0,0,0,0,0}	Wavelength order of the measured bands, 0=Wide, 1=Normal, 2=Narrow
senop timestamp	{0,55067000,165198000,220266000,110132000}	Acquisition time of the bands compared to the first measurement in nanoseconds
senop sensor	{N/A,N/A,N/A,N/A,N/A}	Used sensor, N/A
senop frame counter	{0,1,3,4,2}	Order at which the bands are measured
senop user counter	{-1,-1,-1,-1,-1}	N/A
senop repeat	{-1,-1,-1,-1,-1}	N/A
senop integration time	{50.0,50.0,50.0,50.0,50.0}	Integration time in ms used in each band
senop gps	-	GPS coordinates for each band
senop acceleration	{"-0.330096,9.601488,1.556594","-0.330096,9.601488,1.556594","-0.317538,9.604478,1.555398","-0.333086,9.588332,1.563172","-0.330096,9.601488,1.556594"}	Accelerometer values for each band
senop gyroscope	{"-0.009027,-0.031365,0.000153","-0.009027,-0.031365,0.000153","-0.011628,-0.031671,0.000612","-0.007650,-0.031518,0.000459","-0.009027,-0.031365,0.000153"}	Gyroscope values for each band

Updating the device software (firmware)

The HSC-2 camera software can be updated using the HSI-2 software. First, you should have received a software package from an authorized dealer. The software is packaged in -tar.xz file format. The package should be extracted using for example 7zip software or similar. The xz-package should be extracted first and then the tar-package. After the extraction, connect the HSC-2 camera to the computer using the Ethernet cable and connect the camera to the HSI-2 software. From the Device datasheet, select the menu from the top right corner and click on the FIRMWARE UPDATE. Navigate to the folder, in which the software was extracted and click OK. After that, the software update starts. DO NOT POWER OFF THE DEVICE DURING THE UPDATE. When the update has completed successfully, reboot the device.