PREFACE

Thank you for choosing this Cubert GmbH product!

This software guide points out the operating concept of the Touch application that is part of the Cubert Utils bundle.
Please keep this document at a safe location.

News and current information on this product can be found on our official webpage:

www.cubert-gmbh.com
2 Getting started

The online state is also indicated by the CUBERT logo

Offline: Online:

For running CubertUtilsCore please install the file on your computer.

2.1 Connecting with Cubert Utils Core

After starting Cubert Utils Touch, the program tries to connect to the IP "127.0.0.1", i.e. it expects Cubert Utils Core to be running on the same PC. If not, it will try to start an instance of Cubert Utils Core in the background. Depending on the camera system, you are required to enter a different IP / hostname (see your respective hardware operation guide).

To change IP / hostname, see the chapter 8.7.

After the connection is established, the following dialogue may appear to indicate, that the camera is offline or still initializing. In the offline mode, all acquisition options are not available; however the gallery mode, as well as the export and spectral plot views are available.

If the camera is connected and online, it will directly start acquisition (without recording).
3 Acquisition

The actual acquisition is controlled by the snapshot button, the record start button or the record stop button.

3.1 Integration Time

When in acquisition mode, the menu will contain the integration time button which opens the respective dialogue:

The number filed can directly be controlled by the keyboard or with the mouse.

The “Use Auto-Exposure” time will activate the self-finding of a good exposure time. This option will automatically be disabled, if a white (see chapter 3.2) is selected, but may be re-enabled. This option may not or not yet be available on your camera and may be grayed out.

3.2 Capture White

Capturing a white is crucial for comparable and relative measurements. Capturing a proper white takes some experience and training, please refer to the chapter 9.3.

When you press the White button from the menu, a snapshot will be taken, processed and stored.

The success is indicated by changing the color of the button.

While this white measurement is calibrated, all recorded data will be associated with this reference measurement, even when in "No spectra" processing mode. As such, later re-processing will be performed on the correct white.

Clicking the button again, will perform a new white calibration. A right click / long touch on the button will remove calibration.

If the white measurement is of poor quality and not recommended for usage, the button will turn red instead of green. Now, all measurements using this white reference will show a warning of poor measurement quality. (See also chapter 7)

3.3 Capture Dark

When you press the Dark button from the menu, a snapshot will be taken, processed and stored.
The success is indicated by changing the color of the button.

The dark should be taken after the white, in order to use the same integration time. To capture the dark, put a cap on the camera.

In general, the dark is used for compensation of the dark noise induced by heat, mainly. It is recommended to let the camera run a certain time before capturing the dark to allow the sensors to reach a constant temperature.

The dark may also be used to remove background (stray) light from a setup with an additional light source. Keep in mind, that the white measurement must be brighter than the dark.

While this dark measurement is calibrated, all recorded data will be associated with this reference measurement, even when in "No spectra" processing mode. As such, later re-processing will be performed on the correct dark.

Clicking the dark button again, will perform a new dark calibration. A right click / long touch on the button will remove calibration.

If the dark measurement is of poor quality and not recommended for usage, the button will turn red instead of green.

Now, all measurements using this dark reference will show a warning of poor measurement quality (see also chapter 7).

3.4 Frame Rate

When in acquisition mode, the menu will contain the frame rate time button which opens the respective dialogue:

The frame rate gives the speed of acquisition, i.e. the number of images taken per second. Depending on the camera and the operation, the frame rate might be limited to a certain value. Also, the integration time should allow the selected frame rate, e.g. if the integration time is 500 ms it is impossible to record faster than 2 Hz.

Note: Sometimes, no frame rate is selected. In these cases, the Cubert Utils core selected a frame rate that is not in the listing. Either you can overwrite this by selecting one, or you look at the log (see chapter log) to identify the actual frame rate and the reason for the current state.

3.5 Operation settings
When in acquisition mode, the menu will contain the frame rate time button which opens the respective dialogue:

The operation settings offer to switch between operating modes available to the camera system. In principle, the following modes are available:

- **The single shot** mode, or software-triggered mode represents the camera only triggers when the capture button is pressed.

- The **video** mode or internal-clock mode enables continuous acquisition. In this mode, the acquisition is permanently running, and recording or snapshot only means to save these images.

- The **trigger in** mode or external-trigger mode will only record images, if the camera is triggered by the electronic trigger in. Please refer to the camera’s hardware and operation guide for details on the electronics.

The **Camera** section shows details on the currently calibrated camera.

The **Advanced options** allow controlling components and manual processing steps, called **post-processors**.

The **Components** have a colored circle on the right hand side; green color indicates that a component is connected and able to acquire data. Red indicates a problem to either the device or its setup. For instance, a GPS will still be shown red, if it is connected but has no lock to satellites and consequentially provides no positioning data.

Some **components** provide options that are either read-only or can be set. For instance, the integration time factor allows setting a different integration time to one sensor which is relative to the main integration time (beware to remain in the valid range dictated by the frame rate).
The post-processors are applied after the cube calculation and are available for certain processing modes, each. They can be (de-)activated by clicking at the right hand color circle.

The details on the function of the post-processor depend on the calibration settings. The detailed description on how exactly the post-processors operate is provided by the respective operations guides or – for special solutions – in the respective technical notes.

Currently there are the following post-processors:

- The **Equidistant Spectrum** interpolates a non-equidistant spectrum to an equidistant one.

- The **WhiteBalancePS** utilizes the relative deviation of point spectrometer values to cancel out the aspects of changes in light conditions.

Please note, that the post-processors are only available on unprocessed images, if the camera’s factory calibration is installed. A (re-)processing of data with an instance that does not have the factory calibration does not contain the post-processing steps.

### 3.6 Snapshot

The snapshot concept draws the next frame from the currently running acquisition. It will not issue the acquisition but rather treat and store a single frame that is taken (for preview or for recording) separately. Thus, it may be clicked both with and without a running recording. The file location is determined by the backend.

### 3.7 Record

The record button starts/stops the recording mode of the camera. The recording mode has the complete same behavior as the live preview mode, except that it stores the measurements to the disk.

Note: The measurements are stored by the connected camera or, alternatively, the connected Cubert Utils Core instance. Thus, the file location may be on a remote machine.

Note: The actual storing of the cameras might decrease the frame rate due to performance issues. The fastest recording can be achieved in the processing mode "No spectra" (see chapter 4.1)
The mode button opens the processing and display mode menu.

4.1 Processing modes

The available processing modes are:

**No spectra (fast):** This mode of choice for fast data acquisition. Here, no spectra are calculated, which spares resources for fast image acquisition. Data recorded with this mode need to be exported once with the **Overwrite Source** option (see chapter EXPORT) in order actually perform the computation and write the computed files to disk.

**Raw:** This mode computes spectral cubes without regarding the dark subtract or the white reference measurement. However, the raw channels can be observed (see chapter 6). This is not the raw sensor data, but rather the raw processed cube of *sensor channels*. However, as no sensitivity correction is applied, it can still be used as a measure to indicate the used dynamic range of the sensors.

**Dark Subtract:** The dark subtract mode is only available, if a dark (see chapter 3.3) is set.

**Reflectance:** The reflectance mode is only available, if a dark and a white (see chapter 3.3 and 3.2) are set. In this mode, a list of views is available (see below). Hint: From the transition of *sensor channels* (Raw and Dark Subtract mode) to actual *spectral channels*, the number of channels may change on some systems. See the respective hardware guide as well as the quality assurance certificate.

Please refer to chapter 9.2 for further information about when to usage of these modes.

Note, that some modes may not be available for certain camera models. The option is grayed out then.

If your camera comes with a separate pan sensor, you may pan sharpen the views (see below) by selecting the **Pan-sharpen** check-box.

In the text box **Session Name** you may enter a name to be used for data stored to disk. Changing the session name will also change the directory of the stored data.

4.2 View Modes

View modes different then Preview are as available for all processing mode.

The view selection depends on your selection during the installation. Any
installed view mode is offered in its respective processing mode.

4.3 Display options

The display options are accessible via the advances symbol in the view modes.

It consists of three tabs: the orientation, rendering and processing tab.

The orientation tab sets the orientation of the view.

The rendering tab allows changing brightness contrast and gamma settings as well as the anti-aliasing in the view. It is important to notice, that these options are only applied on the view, not the Cubert Utils Core. They neither affect the actual measurements nor the spectra.

The third tab, processing, is only available for view modes other than “Preview” the UI elements strongly depend on the view mode and can be configured via the user plug-in configuration (see separate document).

Some view modes have options to enter scalars, wavelengths as input field or slider.

Also, some plug-ins allow entering color codes, which are HTML-style color codes.
5 Histogram

The histogram plot is available in all processing modes except “No Spectra” (see chapter 4). It generally shows the accumulated occurrence of groups of count values of the measurement and helps to distinguish the measurement quality.

To show or hide the histogram, click at the CUBERT logo spectral view button. If spectra have been selected (see chapter 6), the histogram is not available. Right click / long touch will clear the plot selection and re-enable histogram.

In Cubert Utils Touch, the histogram aggregates all available channels to one histogram curve. The “counts” depend on the selected processing mode (see chapter 4):

- Raw: The counts of the raw mode are related to processed cubes that have not been calibrated for quantum efficiency (spectral sensitivity). They show pre-processed sensor counts. Thus, the maximum counts are directly related to the sensor’s bit depth.
- Dark Subtract: Same as Raw, but with the dark counts subtracted.
- Reflectance: The counts have a range from 0 to 65535, where 10000 represent 100%. It is not possible to detect over-illumination from the histogram.
The spectral plot shows the spectrum of a selected position in a graph. The spectral plot is not available in the "No spectra" processing mode (see chapter 4).

To show or hide the selected spectra, click at the CUBERT logo spectral view button. Right click / long touch will clear the plot selection. Pressing the button, when no plot has been selected will open the histogram (see chapter 5).

To select a point spectrum, simply click into the image at a desired position. To select a rectangle, click and hold. The free-form can be selected by pressing the shift key prior click and hold.

When in acquisition mode, the plot selection will refresh if a new image is captured. In Gallery mode the plots can be selected in detailed view. When navigating back to the gallery mode, the plot selection is remembered and shown to the thumbnail images. The spectral plot will always show the plots from all selected images in order to enable comparing the spectra of multiple measurements.

Entering / leaving gallery mode will always clear the plot selection.
The spectral plot can be zoomed in by left-click and hold and drawing the desired zoom area.

Each zoom can be undone by a simple right-click.

Simple clicking at one data point of a spectrum will add a tool tip to the spectrum and copy the content of the tooltip to the clipboard.

Double-clicking the spectral plot will open an export dialog. The plot image can be exported as an image, or the spectral data of the currently visible plot can be exported to text, csv or Microsoft Excel (requires MS Excel to be installed).
For accurate spectral measurement the selection of optimal light conditions, calibration targets as well as correct camera settings is essential. In order to assist this process, obvious issues with measurement data is indicated by a red overlay.  

There are several reasons for a measurement to be indicated as poor.  
- The measurement is over-illuminated or outside the linear range. For complex sensors this may be very hard to determine manually.  
- A poor dark has been used for dark subtract mode or reflectance mode.  
- A poor white has been used for reflectance mode.  
- During calculation of the reflectance a numerical error has occurred (e.g. dark and white pixel of same value leads to division by zero)  
- The white contains an over-illuminated point spectrum for ambient light correction  
- The dark contains a too bright point spectrum for ambient light  

BEWARE: The measurement quality indicator is not available in the “No spectra” mode. Here, the proper integration time and environmental conditions should be cleared prior using this mode.
correction

- The measurement has been recorded with an over-exposed point spectrum.

For selecting a measurement as a dark / white reference, additional criteria must be matched:

- A dark reference must not be too bright
- A white reference must not contain too dark channels. Also the standard deviation of each spectrum must not be too great (these may be introduced when seeing the borders of the white target in the measurement)
- A dark reference’s point spectrum must not be too bright

Even the warning of poor measurements is quite prominent; there is no impact on the actual processing.
8 Gallery mode

Interaction with the gallery mode is done via buttons in the lower right corner of the window and icons in the main window.

To open the Gallery Mode, click the landscape icon in the lower right corner of the window.

To close the gallery mode, click the left-arrow icon. Closing the Gallery Mode will browse back to the acquisition mode (see chapter 3).

8.1 General Behavior

Opening the gallery mode displays directories and thumbnails of measurements. When first opening the gallery mode, the current measurement path is displayed.

By double clicking a directory the content of that directory is displayed.

To navigate to the parent directory of the currently displayed directory, click the icon in the lower right corner of the window, or the first item in the item list. The icon can also be used to exit detail view (see below).

To browse the file system directly or change to another partition, click the directory icon in the lower right corner.

Measurements and directories can be selected by holding shift and/or ctrl while
clicking them. To select all items of the current directory use ctrl+A. Selected items can be exported (see 8.3).

Double clicking a measurement thumbnail opens the detail view.

8.2 Set Dark / Set White

The dark and white buttons take the currently selected image and set it as a white or a dark reference. These references are set as new current references. Thus, they are used for both new acquisitions as well as post processing.

In details view, the set Dark / set White button will be used with the measurement opened.
8.3 Export

The export can be opened from the menu if at least one item is selected or opened in the details view.

The export dialogue will both process the measurements (if not already processed) and write the specified format to the disk. Cubert Utils Touch selects the same export location as the measurement location (i.e. remote data will also be exported on the remote location).

The **processing mode** selected applies for unprocessed measurements, only. (See chapter PROCESSING MODES).

The **format** can be

- Multi-channel tiff
  A tiff file where each pixel has N channels
- Multi-page tiff
  A tiff file with multiple single-channel pictures stacked to one file
- Single tiff
  Multiple tiff files with one channel each
- Envi
  A memory dump with ENVI header file.

The **export all** option allows to export the whole current date's directory. This will ignore the actual selection. When no image has been selected, this option will be assumed.

The **pan-sharpen** option allows for pan-sharpened export of the hyperspectral cube. Warning: this may lead to very large export files.
The advanced options are usually only needed for special applications.

The **Channels** option allows selecting distinct channels to be exported by their wavelength. Multiple selection is possible by separation with semi-colon “;”. Ranges can be defined with a minus “-“. If a range should have a specific step, a triplet can be defined with “:”, e.g.:

450-550; 600:20:800; 900

The **Interpolation method** gives the interpolation method for the up-scaling during pan-sharpening. It can either be bicubic or nearest neighbor for high quality and non-interpolation respectively.

The **Pan Image separately** will also export the pan image in full resolution separately as TIFF file.

The **Pan Image to cube** adds the pan image to the cube as the first channel. It will be resized to the same special resolution as the cube, if needed.

The **Write Labels** will write the channel’s wavelength as text overlay to the image. The availability of this option depends on the export format.

The **Export View** will also generate a view based on the selected view (see chapter 4.2) and export it to a separate TIFF file. With this option, for instance, you can generate the NDVI view of the whole measurement directory.

The **Overwrite Source** option is enabled by default. If a measurement is changed during export (e.g. because it was unprocessed and has now been processed), the changed measurement will be written to disk overriding the previous measurement. The raw sensor data will not be modified.

The **Force Re-Process** option will issue the processing, even if a measurement has already been processed.

The **Force Current References** option will force to ignore the references associated with a measurement, but use the currently selected dark / white (see Chapters 3.23.3 and 8.2) instead. If the measurement is already processed, this option should
always be used together with the **Force Re-Process** option.

Warning: Be careful of using the **Overwrite Source** option together with the **Force Re-Process** or the **Force Current References** options.

If the *current* calibration has post-processors, it is possible to (de-)activate them for the export. This will only be applied on

a) images taken with the sensor where the current calibration has been installed and

b) if a processing is performed at all (see above)

With confirming the export dialogue, the **export progress window** is shown. Detailed information about the status of the export is provided. Closing the window before finishing will abort the export.

If errors occurred, this is indicated in the summary field. The log button allows toggling the core’s log.
8.4 Measurement date

The Measurement date directory can be changed from the respective dialogue accessible by the date button from the menu.

Change the measurement date folder by selecting a date.

A fast switching between months and years is possible by entering the overview page via the title bar.

When in local mode (i.e. core running at 127.0.0.1), it is possible to change the measurement directory by selecting “Change local directory”. The directory will switch back to the current date, when leaving gallery mode.

8.5 Measurement details

The measurement details are available in details view, only.

The details shown refer the measurement saved to the disk, not the one currently processed. I.e., if you change the processing mode to a different mode, this is not visible in the measurement details. If the original processing mode is sensor raw, use the export function to process and save the measurement to a cube format (see chapter 8.3).

The first section of the measurement details contain general meta-data, camera and assembly details as well as cube details.

It also shows a comment field which can be edited and saved to the file on disk.

Below there is additional data showing advanced information about the measurement.

First, flags of the measurement will be shown. These flags provide explanation to reasons why a measurement might be rated “poor” or which references are currently used.
Measurement Details

Camera
S/N 170JE
Type FireEye 185 SE R2
Calib. date 12/07/2017
Assembly 2.1.0 64 Bit Windows (msc)

Cube
Capture Mode Cube_Raw
Width 50
Height 50
No. Channels 138
max pan factor 20

Meta-data
Name 000_Auto_005_snapshot.cub
Comment

Additional data
Flag FlagDataIsOvenIlluminated
Flag FlagDataUsesPoorReference Poor Dark!
Flag FlagDataUsesPoorWhiteBalancingReference
Load level at 1.133252
Flag FlagDataUsesPoorWhiteBalancingData
Load level at 1.152048
Flag PostProcessorInfo calculation without dark current!
Flag darkref C:\Users\arm.branc\documents\Cuber
Flag white ref C:\Users\arm.branc\documents\Cuber
Sensor PANIMAGEInfo

Gain 2
Integration Time 480 ms
Width 2040
Height 1084
PixelFormat MULTI8
User field

Save

Session Auto
Video No 0
Sequence No 6
Source Path C:\Users\arm.branc\documents\docur
Integration Time 600 ms
Averaging none.
Capture Time 12/15/2017 09:43:02:0000

Point Spectrum PointSpectrumQMingcorr

Wavelength [nm]

Graph showing data...
Below the flags (if any), the detailed sensor information is listed.

This can be either sensor meta-information or a spectral curve (point spectrum or correction line).

### 8.6 Misc

Cubert Utils Touch is designed for both mouse and touch-screen operation. It is possible to toggle to a full screen mode with the F11 function key.

### 8.7 Network settings

In general, the menu contains the network settings, where you can flip to a different core instance or camera (see chapter 2.1).

In the connection settings dialog, you can enter your camera’s IP and network port. The port is most likely always 8080, but may be different if the network connection is established through a port mapping of a router.

![Connection Settings](image)

The Suppress Pop-Up option prevents warnings or error message to cause the log window to pop up automatically.

The activate perClass link opens the perClass activation wizard.

### 8.8 Log output

In general, the menu contains the core’s log. The messages contain information about general acquisition performance as well as possible failures.

The Exit Button form the menu closes the Touch application. It will not shut down the camera.
Note: This chapter does not replace training.

Cutting-edge hyperspectral technology is still bound to physical restrictions. Thus, depending on the intended application, special attention needs to be put on the measurement preparation, the selection of the light source as well as the camera settings. Also, the recommended processing modes strongly depend on the kind of measurement that you want to perform.

9.1 Beware the light source.

Even when not measuring a light source itself, you are measuring the light from the light source. All non light emitting objects merely reflect, absorb or scatter the light source (or emit different light). Thus, without any knowledge of the light source, measuring an object’s spectrum is futile:

The objects optical behavior is still unknown, as it is impossible to say, whether an apparent effect originates in the light source or the object. Fortunately, Cubert Utils Core allows to automatically respecting the light source when provided with a good white reference measurement (see below).

The measured spectrum will also miss wavelengths that do not exist in the light source. For instance, a fluorescent light source has very bright and very sharp peaks in its spectrum and is not suited as a light source for spectral measurements. Broad light sources are e.g. halogen lights or the sun.

9.2 Purposes of processing modes

9.2.1 Raw processing mode

The Raw processing mode is strongly depends on the hardware of the camera. This mode has two main applications: First, this is the mode to properly record and check a white reference (see chapter CAPTURING A PROPER WHITE REFERENCE). Second, this mode is suited to measure light sources.

9.2.2 Dark Subtract processing mode

The Dark Subtract processing mode may be used for the same application as the Raw processing mode, with the difference that the dark current noise may be reduced by capturing a black image as dark-reference (cover camera).

Additionally, the dark subtract mode may be used to remove a baseline different than a black image. This may be useful in a dark room scenario, where a search light needs to remain turned on.

9.2.3 Reflectance processing mode

The Reflectance processing mode is the mode of choice for most applications. In this mode, the actual objects spectrum can be measured. This mode requires a dark and a white reference to be present. Then, automatically the properties of the light source are calculated out of the spectrum to yield the objects spectrum. Most indices and algorithms for processing of spectral
data require reflectance-mode spectral data.

9.3 Capturing a proper white reference

To measure a good white, place a spectralon or another qualified white reference in the field of view of the camera. Either activate auto exposure or adjust the integration time, until the preview image does appear gray. When manually adjusting the integration time, capture a measurement in Raw processing mode and check the spectra for over illumination (maximum count values are documented in the operation guide).

The spectralon should be placed in a way that is both evenly illuminated and approximately the same brightness as the measured object (you can use the Raw processing mode for a qualified comparison). Note that there should not be any shadows, or strong reflections of nearby objects neither on the reference target or the measured object.

Next, press the CAPTURE WHITE button. Here, the auto exposure will de-activate. The button should turn green. Next cover the camera (with a lens cap) and press the CAPTURE DARK button. After that, measure the spectralon again in Reflectance mode and verify that the spectrum is 100% on every channel.
Some constants are defined in the CubertUtilsTouch.exe.config file, which is located in the installation directory. This file contains some performance settings as well as communication options. The following options are safe to change:

- **FailSleepTime** time until next polling attempt for live image after failed polling (in ms). Default value: 5
- **NoFailSleepTime** time until next polling attempt for live image after successful polling (in ms). Default value: 0
- **ProcessingDialogDelay** delay time to show the "Processing ..." dialog (in ms). Requests that are done in a shorter time do not show the overlay. Default value: 200
- **MaximumErrorBarPolts** This option limits the number of error bars shown in the spectral plot view. Give "-1" to give no limit. Default value: -1
- **DefaultPORT** and **DefaultIP** This is the default IP and port that the system will connect to. If not given, the IP is 127.0.0.1, the port will be taken from the environment variable SOAPPORT, and if that is not present, it will fall back to port 8080. Port and IP setting can be overwritten by the user input in the network settings.

- With the **Rotation** field the image can be rotated by an arbitrary angle in degrees.

Also the behavior of CubertUtilsTouch strongly depends on the environmental settings of the core (see Cubert Utils manual, chapter 3.1.2)
In general, the technical support for Cubert Hyperspectral cameras is provided by your local distributor.

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