

# Multispectral Cube SW – UNS61000

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# 1 Liberty Analysis Software – Version 1.3

Liberty's analysis software add-ons include the following functionalities:

- a) Spectrum profile - plotting the average spectrum of a selected ROI.
- b) False colour - a set of methods used for false-colour visualization.
- c) Classification - a set of classification methods.

The analysis software also includes 2 modules:

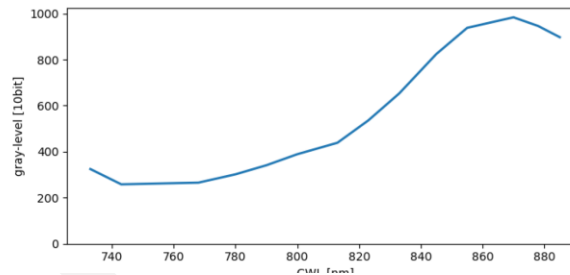
- a) Pre-processing – functions for different pre-processing options of the multispectral cube.
- b) Analysis display – functions for different presentation options of the analysis results.

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## 1.1 Spectrum profile

This option is used for investigating the spectral response of a selected area in the multispectral cube. The output is a graph of the average spectrum of the selected ROI.

Example – spectrum profile of LED in 850nm:



The Y-axis represents the average grey value.

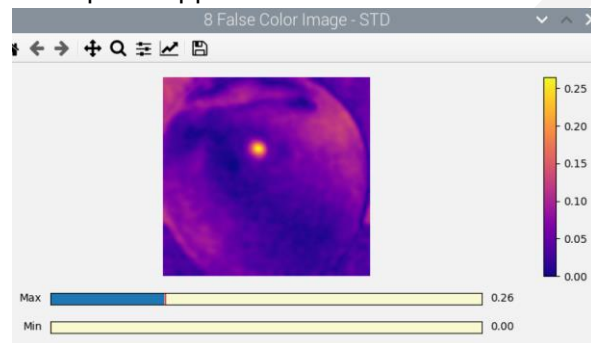
The X-axis represents the CWL of the multispectral bands.

## 1.2 False color

Methods:

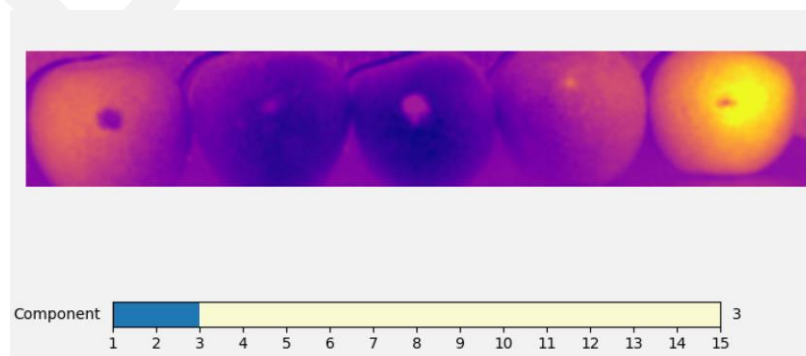
### 1. STD

- Calculates a normalized STD of the multispectral cube in the spectral dimension. The STD is normalized by the average pixel intensity.
- It is recommended to use this method with the "Normalize cube" option for spectral anomaly detection.
- Returns a single channel array.
- The output of this method is presented with a contrast adjustment tool for manual thresholding. The min and max sliders set the minimum and maximum intensities for the contrast stretching.
- Example – apple with a bruise:



### 2. PCA

- PCA (principal component analysis) is a linear unsupervised dimensionality reduction technique. This option calculates the PCA of the multispectral cube in the spectral domain and presents the calculated components according to a descending order of importance.
- It is recommended to use this method with the "Normalize cube" option and "Denoise" option.
- Returns a multi-channel array.
- The output of this method is presented with a slider for component selection.
- Example – apples with bruises – choose one of the first components to see the bruises:



### 3. NDVI

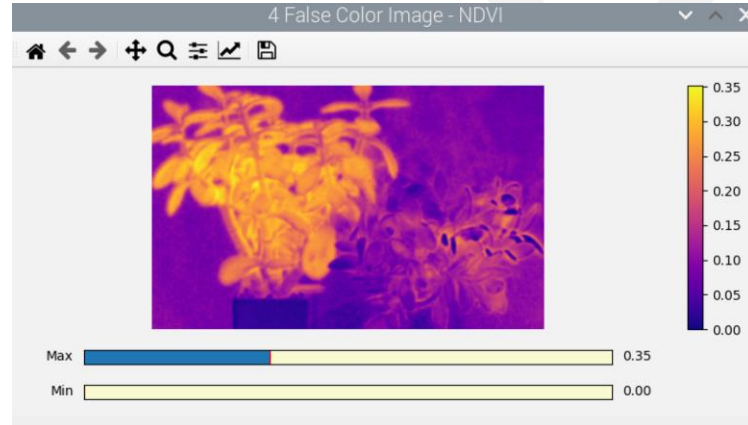
- Calculates NDVI - Normalized Difference Vegetation Index. This index is used in agriculture as an indicator of a plant's health.
- Equation:

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

The red band is the closest band to 670 nm

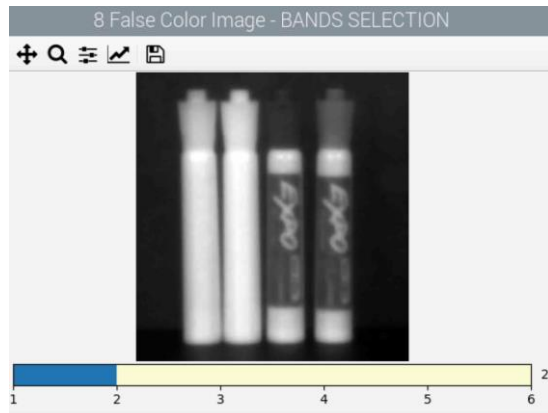
The NIR band is the closest band to 800 nm

- It is recommended to use this method with the "Normalize cube" option.
- Returns a single channel array.
- The output of this method is presented with a contrast adjustment tool for manually thresholding. The min and max sliders set the minimum and maximum intensities for the contrast stretching.
- Example:



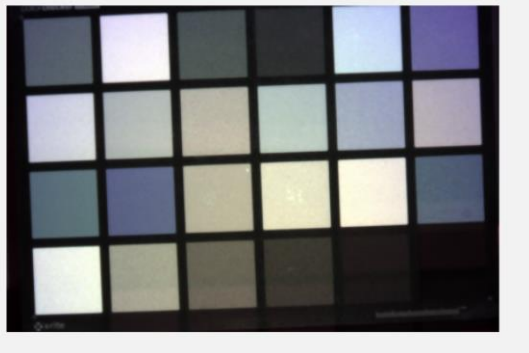
#### 4. Bands selection

- This option is used for presenting the multispectral cube with a slider for band selection.
- Example – 6 bands multispectral cube:



#### 5. 3 bands

- Selects 3 bands in the multispectral cube that are equally spaced along the spectrum and presents it as an RGB image.
- Example:



## 1.3 Classification

Methods:

In this window, additional multi-options button is added for selecting the required number of classes.

### 1. SAM

- Calculates the spectral angle between the spectrum of each pixel in the multispectral cube to a reference spectrum.
- When selected, a UI is opened for selecting the reference points that represent the different classes.
- Returns a multi-channel array.
- If the number of required classes is 3, then, the output will be presented as a false color RGB image. Otherwise, it will be presented with a slider for class selection.
- Example – number of wanted classes = 3:



### 2. Kmeans

- Unsupervised classification using Kmeans clustering.
- Returns a false-color image in which each class is assigned with a different color.
- The number of output classes can be less than the number of wanted classes due to the way Kmeans algorithm works.
- Example:



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## 1.4 Pre-processing module

Functions:

1. **ROI selection** – Manually select ROI.
2. **Face detection** – Detect a single face in the image and define the ROI accordingly.
3. **Spectral white balance** – Normalize the multispectral cube by the estimated illumination spectrum.
4. **Spatial denoising** – Spatial denoising of the multispectral cube.