Spectrometer GUI description
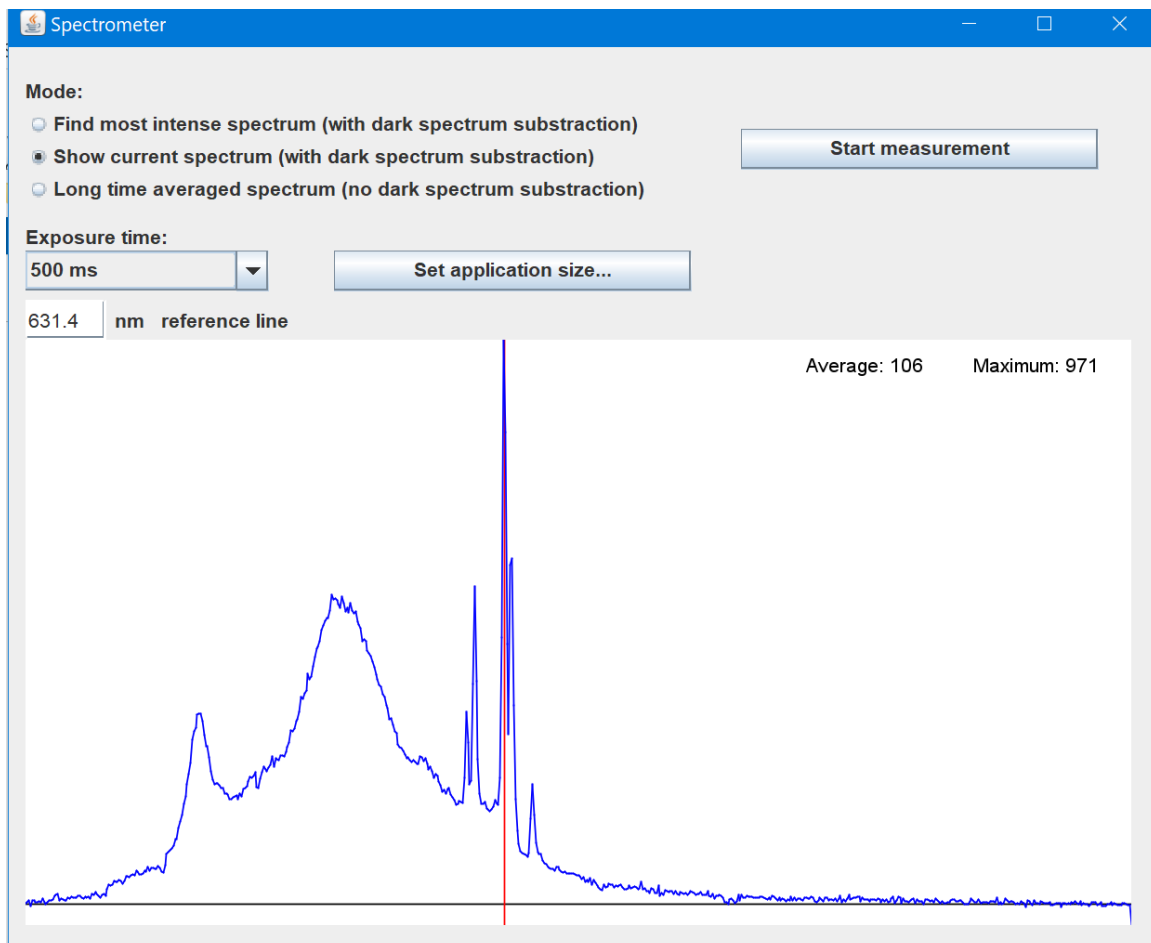
User guide, version 1.3.2022

Spectrometer.jar is a software (GUI) to control the Ocean Optics USB650 spectrometer. It is written in Java and it uses native OmniDriver written also in Java and distributed freely by Ocean Optics.

Please, run "**app_run.cmd**" file to start the application. The last recorded spectrum from "spectrum.dat" file is shown in the application and last used settings are loaded.

The software can control the spectrometer in 3 modes:

- Finding the most intense spectrum – suitable for searching of point light source
- Showing the current spectrum – continuous mode
- Long-time averaging – for noise suppression

The mode can be selected by radio-button:

The exposure time can be chosen in steps from 3 ms (minimum possible) to 50 s (maximum recommended by the producer of the spectrometer).

No boxcar smoothing is applied, we expect that user will smooth the spectrum in the post-processing phase if needed.

The internal averaging of the spectrum is applied if the exposure time is 100 ms or shorter, so the reading frequency of the spectrum is about 3 Hz for short exposure time.

The position of a reference line (red) can be set freely in corresponding text box (insert the value and press Enter-key).

The size of the application window and/or the size/face of the font can be set after pressing the "Set application size…" button.

Finding the most intense spectrum

Follow the steps:

1. Set first mode by radio button.
2. Press "Start measurement" button.
3. Cover the spectrometer input opening after the message box is displayed.
4. Press Enter-key, dark-spectrum is taken.
5. Uncover the spectrometer input opening after the message box is displayed.
6. Press Enter-key, the measurement starts.

If more intense spectrum is found, it is stored temporarily into "spectrum.dat" file (no calibration is applied) and shown. A sound signal (beep) is produced to inform the user that more intense spectrum was found. After you hit the point source, no more intense spectrum can be found and no more sound signals are produced.

7. Press "Stop" button. The text will change to "Finishing the measurement" while the currently running measurement ends. After that the most intense spectrum is copied to a spectrum_*.dat file. The name of the file contains date and time of the measurement. The same spectrum with the calibration applied is stored as spectrum_*_cal.dat file.

Any stored spectrum can be shown later using GNUplot (you have to install this free software first) by dropping the dat-file into "spectrum_view.cmd" file.

Showing the current spectrum

Follow the steps:

1. Set second mode by radio button.
2. Press "Start measurement" button.
3. Cover the spectrometer input opening after the message box is displayed.
4. Press Enter-key, dark-spectrum is taken.
5. Uncover the spectrometer input opening after the message box is displayed.
6. Press Enter-key, the measurement starts.

Each recorded spectrum (without any calibration) is stored temporarily into "spectrum.dat" file and shown.

7. Press "Stop" button. The text will change to "Finishing the measurement" while the currently running measurement ends. After that the last recorded spectrum is copied to a spectrum_*.dat file. The name of the file contains date and time of the measurement. The same spectrum with the calibration applied is stored as spectrum_*_cal.dat file.

Any stored spectrum can be shown later using GNUplot (you have to install this free software first) by dropping the dat-file into "spectrum_view.cmd" file.

Long-time averaging

This mode can be useful for dim light sources. The spectrum is taken again and again and averaged together, so the noise is significantly eliminated. The dark-spectrum is not taken because it can be time-consuming and can be done only once during the measurement session. We expect the user to subtract the dark spectrum in the post-processing phase.

Follow the steps:

1. Set third mode by radio button.
2. Press "Start measurement" button.
3. Uncover the spectrometer input opening after the message box is displayed.
4. Press Enter-key, the measurement starts.

The averaged spectrum (without any calibration applied) is stored temporarily into "spectrum.dat" file after each spectrum is recorded and is shown in the application.

5. Press "Stop" button. The text will change to "Finishing the measurement" while the currently running measurement ends. After that the averaged spectrum is copied to a spectrum_*.dat file. The name of the file contains date and time of the measurement. The same spectrum with the calibration applied is stored as spectrum_*_cal.dat file.

Any stored spectrum can be shown later using GNUplot (you have to install this free software first) by dropping the dat-file into "spectrum_view.cmd" file.

Spectrometer calibration

We have implemented some basic calibrations steps of the spectrometer:

1. Hot-pixels elimination.
2. Offset of the spectrum.
3. Spectral sensitivity of the spectrometer.

Hot-pixels elimination

Hot pixels are usually effectively eliminated by dark-spectrum subtraction. Only for very long exposure time the hot-pixels can be saturated and the process of subtraction can fail. User can define the positions of hot-pixels in "hotpixels.cfg" file. Such pixels are ignored and the average of neighbour-pixels is used.

Use this feature carefully – some tiny spectral lines can be lost if they fall into the hot-pixel. It is not necessary to have "hotpixels.cfg" file prepared. If no "hotpixels.cfg" file is found, no hot-pixel correction is applied to the spectrum.

The structure of "hotpixels.cfg" file is as follows:

```
USB650, S/N:USB2G55516, use for long time expositions
18
```

```
42
60
85
102
…
```
In the first line any comment can be placed. In next lines the pixel-numbers of hot-pixels are written.

Offset of the spectrum

The wavelengths of the spectrometer should be regularly calibrated (by the wavelength calibrated light source). However, the most common effect than can be observed is the offset of the spectrum about few nanometers. Such small shift can be automatically applied to the measured spectrum. The user has to specify the amount of the offset in the "offset.cfg" file. It is not necessary to have "offset.cfg" file prepared. If no "offset.cfg" file is found, no offset is applied to the spectrum.

The structure of "offset.cfg" file is as follows:

```
USB650, S/N:USB2G55516, after grid adjustment on 12.2.2021
-0.5
```

Any comment can be placed into the first line, the offset is to be placed into the second line. This number is **added** to every wavelength of the spectrum.

Spectral sensitivity of the spectrometer

If the spectrum of known continuous light source is taken, the spectral sensitivity of the spectrometer can be obtained and the correction can be applied. The relative corrections of individual pixels can be specified in "calibration.cfg" file. It is not necessary to have "calibration.cfg" file prepared. If no "calibration.cfg" file is found, no calibration is applied to the spectrum.

The structure of "calibration.cfg" file is as follows:

```
USB650, S/N:USB2G55516, demo (no spectral sensitivity calibration)
0    1
1    1
2    1
3    1
...
```

In the first line any comment can be placed. In all other lines a number has to be specified. The measured spectrum is **multiplied** by these coefficients.