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Hyperspectral & Luminescence Microscopy Scanner

Software Documentation

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This software was developed to be used in experiments envolving nanosensing, like nanothermometry or nanomagnetometry. It performs sample scanner position control and acquire information, as luminescence, or spectra, from peripheral instruments.

1 To User

The instruments that interface with this software are:

- National Instruments DAQ, Library used: nidaqmx
  - Controls the sample position by a digital-analog converter, connected with a piezoelectric system.
- Arduino Due, Library: serial
  - Acquires the sample photon-counts from a Photon-Detector and sends via Serial (Digital) Communication by USB.
- Spectrometer, Library: astropy
  - Acquires the sample spectrum and sends a .fits file direct to the PC within a directory (/files).

This software has two distinct modes:

- COUNTER MODE
  - Reads continuously the counts from the Arduino Due, prints the actual value on the LCD, and save into a buffer which is plotted. The method does not stop until one presses 'Abort Measurement' pushButton. The Arduino must send a string through the Serial, via USB, with the first character 'A', followed by an integer number. Ex.: "A752". The total time the Arduino counts is called Time Integration. One can set from 1us to 10s. The changes will only be made if the 'Set' pushButton is pressed.

- SCAN MODE
  - LUMINESCENCE MODE: Controls the sample position, step-by-step, from left to right and bottom to top. At each pixel, acquire the Arduino's counts, save into a buffer and plot the curve. A 2D image is made with false colors representing the counts. The sample position control is made by a piezoelectric system, interfaced by a Digital-Analog Converter (DAC) manufactured by National Instruments, which is controlled by this software. The DAC sends 0V to 10V to a 10x Voltage Amplifier connected to the Piezo. A high voltage rate can damage the piezoelectric crystal, then the final voltage is achieved by a ramping signal. The Piezo's specifications, including the maximum voltage rate, can be changed in Settings Menu. The Arduino must send a string through the USB as in Counter Mode.
  - HYPERSPECTRAL MODE: Controls the sample position, step-by-step, from left to right and bottom to top. At each pixel, waits for the spectrum file to be created by the Spectrometer, then save all spectra. A 2D image is made with false colors representing the amplitude of the signal in that specific wavelength. The wavelength selected can be changed, then the colormap also changes immediately.

1.1 Relative and Absolute Position

The piezoelectric system has a total displacement of several micrometers, but one can perform a scan along a few micrometers. So, one can move the scan window through all available displacement. Relative Position represents the position relative to scan. Absolute Position represents the position of the scan relative to piezo's total displacement. The 'Lock' checkBoxes enable/disable the communication to DAQ.

1.2 Image Plot

The Image Plot is a colormap that represents the sample Relative Position. The toolbar in the upper left corner is attached to the ColorMap. By using the Point Selection Tool, one can click anywhere inside the plot region and all information about that point will be shown in the screen, depending on the Operation Mode Selection. One can change the wavelength in the bottom right corner, then the colormap will be automatically updated. If one Right-Clicks inside the image plot, a menu is opened and one can change the settings, like the axis, grids, and colors.

1.3 Curve Plot

The curve plotted here depends on the Operation Mode selection.

- Counter: Plots the buffer of the counts.
- Hyperspectral Scan: Plots the spectrum of the selected point in colormap
- Luminescence Scan: Plots the buffer of the counts during all the scan.

1.4 Scan Properties

Minimum, maximum and step size values are limited to the piezo's specifications. The changes only will be applied if one presses the 'Change Properties' pushButton.

1.5 Arduino Communication

The Serial Ports available are constantly actualized. So one can properly connect/disconnect the device anytime. The baud rate determines the speed of communication over a data channel. The value set must match with Arduino's baud rate.

1.6 Files

The .hss files are the internal data type to save all information about the experiment. One can add more information to the Experimental Notes Label. The .png and .txt files can

be exported by right-clicking in the corresponding plot.

2 To Developer

All scripts were developed in Python 3.7. The user interface is totally written using PyQt5 library and the graphs resources using QuiQwt. There is a Conditioning Circuit Stage between the Arduino and the APD (see the Arduino project reference??)

Project is in Development status: Please, contact the author to relate bugs, or anything necessary.