Laser Sweep Control Script Documentation

I. Script Introduction

The objective of this Matlab script is to create a program capable of controlling the Thorlabs motors used to actuate the laser system, as to perform a linear sweep of any possible sample, while also being able to collect the corresponding data, step by step, from the connected Tektronix oscilloscope.

Before launching the program it is suggested to check with Kinesis whether the two motors are actually properly connected, if not, disconnecting and reconnecting them to the power may fix the issue.

The script assumes that both the oscilloscope set-up and the laser positioning has been done manually, prior to the launch of the script itself. Furthermore it assumes that only a maximum of two oscilloscope channels are used at all times, further expansions of the code to include more channel must also modify the auxiliary functions implemented.

II. Main function

A. Initialization

The main function is the "LASER_SW.m" script, the initial variables to be defined in order to make it work are

- **ch1_enable**: boolean variable which is used to tell the program which channel of the oscilloscope is being used, *true* if channel 1 is used, *false* if not.
- **ch2_enable**: same as the above variable but for channel 2.
- **hor_length**: defines the horizontal length (length on x axis) to sweep of the sample, to be given in $[mm]$.
- **lat_length**: defines the lateral length (length on y axis) to move of the sample, to be given in $[mm]$.
- **Step_Size**: defines the size, in $[mm]$ of each step to be done by the motors.
- **ParamSet**: it is the parameter that dictates the speed settings of the motors, according to the manufacturers manual two possible options can be chosen
  - ***'CONF_Z812B'***, *for normal motor speed*
  - ***'CONF_Z812B_slow'***, *for reduced motor speed*
- **OSCI_ID**: the oscilloscope IP address, needed to communicate with the instrument.

B. Motor Settings

Once the variables has been set the script will generate an APT graphic figure, associated to the controller of the two motors. The serial numbers will be obtained from the controller and the two motors settings are updated according to the **ParamSet** selected.

C. Noise Acquisition

Before performing the linear sweep of the sample and acquiring our data, an initial noise acquisition has to be made. A dialogue box will prompt the user to turn off the laser as this procedure is done to remove the noise component due to the oscilloscope and its connection. The script will then perform a scan in the initial position with the function **OscilloAcquisition**, returning a matrix containing the values of the noise for the enabled channel and the time vector.

D. Linear Sweep

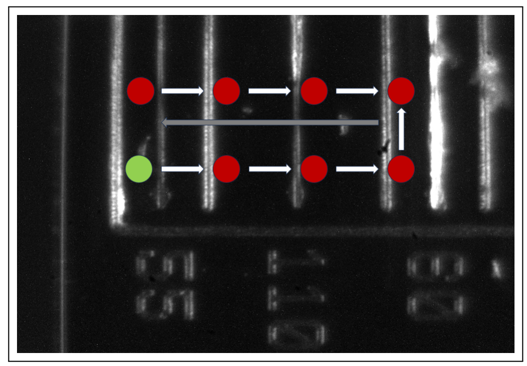

Fig. 1: Qualitative visualization of the sweeping algorithm. In green we have the starting position of the laser, in red the subsequent scanning positions. The white arrows shows the steps performed during the sweeping process whereas the grey one the repositioning to the initial X-axis position after each lateral step.

Once the noise has been extracted the script will once again prompt the user to turn on the laser, before proceeding it is important to be sure that the sample has been positioned correctly, meaning aligned properly with respect to the laser source, and that we are in the right starting point, as an incorrect position might result in poorly acquired data.
Assuming we did everything right we can proceed with the measurement, the program will sweep the sample with the laser, starting from the initial position up to, and included, the whole specified length. Thus the script follows a simple algorithm, of which we can see a visualization of in Fig. 1. The obtained waves from the sweeping of the sample are a mean of the waves obtained at different lateral step for the same horizontal one. Meaning that, for example, for 1000 horizontal steps and 5 lateral steps we will have 1000 waves obtained by performing the mean of the values obtained for the 5 lateral points at the same horizontal step.
Once the sweeping of the sample has been performed the laser is returned to its initial position and the waves obtained are saved in .txt files. Furthermore the maximum value of each wave is extracted, for each of them, and plotted as a function of the relative position of the laser on the sample. The obtained

Algorithm 1 Sweeping cycle Algorithm

$Lat\_value \leftarrow lat\_length \,/\, Step\_Size$
$Hor\_value \leftarrow hor\_length \,/\, Step\_Size$
for $i = 1 : Lat\_value + 1$ **do**
  for $j = 1 : Hor\_Value + 1$ **do**
    $tmp\_wave \leftarrow OscilloAcquisition$
    $wave \leftarrow tmp\_wave - noise\_wave$
    $\ldots$
    $X\_motor \leftarrow$ move by one step
  end for
  $Y\_motor \leftarrow$ move by one step
  $X\_motor \leftarrow$ return to initial position
end for

maxima are also saved in a .txt file alongside their respective position on the sample.

III. Main Auxiliary functions

A. *SetMotor function*

This function is used to properly set the parametric speed settings of a motor. It takes as input

- **h**: the motor object
- **SN**: the motor serial number
- **ParamSet**: the speed setting parameter

B. *APTrelease function*

Function used to properly release the control of the motors and close the APT graphical interface. It takes as input

- **control**: the controller object
- **Xmotor**: the X-axis motor object
- **Ymotor**: the Y-axis motor object
- **APTfig**: the APT figure handle

C. *OscilloAcquisition function*

This function is used to establish the connection with the oscilloscope and the subsequent acquisition of data. It takes as input

- **OSCI_IP**: the IP of the oscilloscope
- **ch1_enable**: enable/disable flag of channel 1
- **ch2_enable**: enable/disable flag of channel 2
- **num_wave**: the number of waves to sample
- **filename**: the .txt file name

and returns a $n \times 3$ matrix, where n is the manually selected length of the recorded wave by the oscilloscope, which contains in the first column the time vector, in the second the channel 1 data and in the third the channel 2 data. Moreover the output is saved inside a data folder in a .txt file named accordingly to the input name string.
Thus, from the oscilloscope we obtain the time vector and the data for the enabled channels, furthermore, depending on the number of sample specified, we perform a mean of the acquired samples. This function is primarily used to acquire the noise of the oscilloscope.
Once the acquisition phase is completed the oscilloscope connection is released.

A similar function, **OscilloAcquisition_notxt**, is also implemented to acquire the waves without saving the data into .txt files. This additional function is used to primarily acquire the data during the linear sweep without saving everything in separated .txt files as otherwise we would have an excessive amount of them.

D. *SaveWave function*

This function is used to save a wave in a .txt file inside the data folder. It takes as input

- **time_vec**: the time vector
- **ch1_vec**: channel 1 data vector
- **ch2_vec**: channel 2 data vector
- **filename**: the .txt file name

The saved .txt file will be a table, with first row used as identifiers of the data; namely time, channel 1 and channel 2.

E. *wait_stop function*

This function is used to wait to make sure that the script waits that the given motor object is still before progressing further. This waiting operation is needed to avoid jerk during the linear sweep or general positioning of the laser.