Newport Hologram Creation

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A close up of a hand

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I. Under the Hood: Software

i. UML diagram

A close up of a map

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ii. Class Descriptions

App:

Create graphical user interface apps with tkinter. App is designed to provide a simple framework to create a variety of GUI programs. Should be treated like an abstract class.

Members:

* root (tk.Tk) : main window

Methods:

* + set\_up\_frames : Create and organize a set of frames for any window.
  + apply\_scrollbars : Apply scrollbars to a tk master.
  + set\_up\_menu : Create a standard menu bar for any window.
  + help\_window : Create a 'help me' pop up window filled with instruction from a file.
  + test\_box\_fill : Creates a text box which will fill a window completely.
  + pop\_up\_window : Launch a centered pop up window on the affiliated window.

GenericHologramCreator

Create images upon a hologram. GenericImageCreator is designed to provide a simple user interface to facilitate the creation of image holograms upon a film. This class inherits from App and should be treated like an abstract class.

Members:

* window\_communication (tk.Toplevel) : contains the communication textbox
* text\_communication (tk.Text) : updates the user with program’s progress and errors
* laser\_maximum (float) : maximum power allowed by the laser
* laser\_pause (float) : how long the laser should pause for after changing power

Methods:

* image\_as\_array : Convert an image into an array and display array in a new window.
* generate\_exposure\_details : Generate the arrays to describe laser exposure lengths and laser power levels.
* setup\_serial\_port : Set up the serial port menu and write configurations to a file.
* get\_serial\_config : Read correct file to get serial configurations for a device.
* store\_previous\_data : Store data entered on the main screen in a .txt file for later use.
* laser\_settings : Displays a list of laser settings and saves/retrieves into a file.
* shutter\_settings : Displays a list of shutter settings and saves/retrieves into a file. Not yet implemented.
* motor\_settings : Displays a list of motor settings and saves/retrieves into a file. Not yet implemented.

SingleImageCreator

Create a single image upon a hologram. SingleImageCreator is designed to provide a simple, user interface to facilitate the creation of single-image holograms upon a film. This program inherits from

GenericImageCreator. There will not be a discussion of tkinter widgits such as labels, buttons, and windows in this discussion of data members. The purposes of these members are fairly self-explanatory when viewing the code. Additionally, these members are relatively unimportant as they only concern a visual aspect of the program.

Members:

* data\_collected (boolean) : determines whether the data has been processed or not
* xPix (int) : number of pixels in the image horizontally, after downsize
* yPix (int) : number of pixels in the image vertically, after downsize
* hologram\_width (float) : physical width of the hologram
* hologram\_height (float) : physical height of the hologram
* cropping (string) : determines how to crop the image
* exposure\_lines (list[string]) : the raw data from exposure textbox
* ignore\_lines (list[string]) : the raw data from ignore textbox
* laser\_lines (list[string]) : the raw data from laser textbox
* exposure\_arr (list[float]) : processed version of data from exposure/ignore lines
* laser\_arr (list[float]) : processed version of data from laser lines
* config\_shutter (tuple) : the port, baudrate, timeout, stopbits, bytesize, parity of shutter
* config\_motor (tuple) : the port, baudrate, timeout, stopbits, bytesize, parity of motor
* config\_laser (tuple) : the port, baudrate, timeout, stopbits, bytesize, parity of laser
* laser\_settings (tuple) : the maximum power, pause period for laser
* file (string) : the user selected image file
* img\_tk (Tk.PhotoImage) : the user’s image converted in a tkinter-usable form
* img\_tk\_mod (Tk.PhotoImage) : the user’s image, modified, in a tkinter-usable form
* img\_pil\_mod (PIL.Image) : the user’s image, modified, as a PIL image
* img\_as\_arr (list[list[int]]) : the user’s image converted into an array
* file\_save (string) : name of file to save experiment data to

Methods:

* image\_select : Get image from user, downsize version displayed on main window.
* get\_data : Collect and process all data from main window stored files.
* modify\_image : Convert to greyscale, downsize, and crops image.
* time\_estimation : Produce an estimation for the duration of the experiment.
* run\_experiment : Print image by controlling laboratory equipment.
* save\_experiment : Save the experiment inputs in a text file from a file dialogue box or
* from a specific file as argument and take a screenshot.
* open\_experiment : Open a previous experiment with either a file dialogue box or specific
* file as argument.
* clear\_inputs : Clear all input from the main window.

Control

Class to allow easy use of machinery that uses serial ports. Should be treated like abstract class.

Members:

* ser : Serial() : serial port object

Methods:

* from\_arguments : Construct serial objects from different data types. Classmethod.
* write\_command : Send any command to a serial port with/without carriage return.

Shutter

Class to control shutter. Derives from Control class.

Methods:

* toggle\_shutter : Open the shutter, pause for a certain amount of time, close the shutter.
* set\_operating\_mode : Alter the operating mode of the shutter.

Motor

Class to control motor. Derives from Control class.

Methods:

* move\_absolute : Move the stage to an absolute location, wait until motion is complete.
* wait\_motion\_done : Delay until the device is finished moving.
* configure\_axis : Configure the axis of the motor device.

Laser

Class to control laser. Derives from Control class.

Methods:

* get\_head\_ID : Get the head ID from connected laser.
* turn\_on\_off : Turn the laser on or off.
* change\_power : Change the power output of the laser, not exceeding max power.
* configure\_settings : Configure all settings on the laser.

imagemodification.py

Functions:

* convert\_grey\_downsize : Convert and downsize and image; both are optional.
* image\_for\_window : Downsize as needed and convert to a TK image for printing images to a main window.
* get\_image\_array : Convert image into an array.
* crop\_image : Crop an image according to specifications.

iii. Moving Forward

To implement further control of laboratory equipment, add additional classes to serialcontrol.py. Add additional methods to Control, Shutter, Motor, and Laser. To perform enhanced or altered single image experiments, add a class which inherits from SingleImageCreator. Avoid adding extra bells and wistles to SingleImageCreator. Create a child class instead. To perform other kinds of image experiments, such a multiple image creation, add a class which inherits from GenericImageCreator.

II. How to Use: Overview

i. Physical Setup

* Set "home" position on the motor. Turn motor on and manually move all axes to 0. Turn the motor off.
* Turn on motor. Turn the motor back on. Now it does not matter how you move the motor because home is set to 0.
* Turn on shutter. It is not required to click the "enable shutter" option on the device.
* Put the hologram into the cradle.
* Go to Program Setup

ii. Program Setup

* Film Information:
  + Enter how large the image should appear on the hologram.
  + Optionally include an estimation of how large each grating will appear.
* Image Selection:
  + Select the button to choose what image to print from file explorer.
  + Enter in how many gratings should be present in the final image, ie, how the image should be downsized.
  + Enter how you wish to crop the image.
* Exposure Information
  + Enter how long a certain pixel value should be exposed.
  + Enter which pixel values should be ignored.
  + Enter what power the laser should use to expose certain pixel value.
* Machinery Settings
  + Using the menu bar, enter in the correct serial port details for the shutter, motor, laser.
  + Using the menu bar, enter in the correct machinery settings for the shutter, motor, laser.
* Initialize Experiment
  + Select the button to update the experiment information and process the data you input.
  + Select the button to run the experiment.
* While Running
  + The list box offers three options which may be altered at any point during the experiment:
    - Run: when selected, the experiment will run.
    - Pause: when selected, the experiment will pause until the user selects run or abort.
    - Abort: when selected, will cancel the experiment entirely.
  + An estimation of when the program will complete is produced.
  + While running, the program will provide information about which pixel is being exposed and what parameters are being used.

III. How to Use: Detailed

i. Film Information

* Image Width on Film (float)
  + Enter, in meters, how wide the image should appear on the hologram.
  + This information is used to determine the path of motion for the motor.
* Image Height on Film (float)
  + Enter, in meters, how tall the image should appear on the hologram.
  + This information is used to determine the path of motion for the motor.
* Estimate Spot Size (string, optional)
  + Enter, in microns, the diameter of a typical grating that will be produced under the current conditions.
  + This information is purely visual and is not used in any computations.

ii. Image Selection

* Select an Image (.png, .jpeg)
  + Press this button to open up a file explorer to select an image for printing.
  + This program has been tested with .png and .jpeg images.
* Desired Horizontal/Vertical Gratings (int, optional)
  + Enter how many gratings should appear on the image in the horizontal/vertical direction.
  + The image will be downsized to this many pixels in the horizontal/vertical direction.
  + If left blank, the program will use the original size of image.
* Cropping (string, optional)
  + Enter how the image should be cropped in addition to downsized, optional.
  + Format:
    - (x1,y1),(x2,y2)
  + The program will only print the portion of the image lying within these coordinates:
    - (x1,y1) ; (x1,y2) ; (x2,y1) ; (x2,y2)

iii. Exposure Information

* Exposure Details (string)
  + Enter a mapping of how long the shutter should remain open for various pixel values.
  + Formats:
    - [{start range},{end range}]:{open time}
  + Notes:
    - {} - indicates where the user should insert a value
    - start range (int) – pixel value beginning the range, included in range
    - end range (int) – pixel value ending the range, will not be included
    - open time (float or string) – how many seconds the shutter should remain open. Capable of using a linear mapping of pixel values to exposure time, see example.
* Ignore Details (string, optional)
  + Describe which pixel values should not be exposed.
  + Overrides the mapping in Exposure Details.
  + This is optional input.
  + Format:
    - [{start range},{end range}]
  + Notes:
    - {} - indicates where the user should insert a value
    - start range – pixel value beginning the range, included in range
    - end range – pixel value ending the range, will not be included
* Laser Details (string, optional)
  + Enter a mapping of what power the laser should use for various pixel values.
  + Format:
    - Identical to Exposure Details
  + Notes:
    - Identical to Exposure Details
    - Laser may take several seconds to properly reach a new power level. See Maximum Laser Power in section III, subsection vii.
    - Do not include a value in this input that will go over the maximum laser power.

iv. Initialize Experiment

* Update all Information
  + Select this button to pull data from the main window and stored data from text files.
  + Data will be processed and stored into Previous Experiment text file.
  + It is necessary for the user to press this button before attempting a Save As.
* Dots Per Inch
  + The number of gratings which are in one horizontal inch of the hologram.
* Run Experiment
  + Select this button to begin running the experiment.
  + The program will become "unresponsive" at times. This is not a cause for concern.

v. While Running

* List box
  + Run – when selected, the program will run
  + Pause – when selected the program will pause; press run to un-pause
  + Abort – when selected the program will cancel the current experiment; user may start a new experiment immediately after
* Start Time
  + Time user started the experiment, when the run button was pushed.
* Experiment End Time
  + Records when the experiment terminates.
* End Time Estimate
  + Performs an estimation as to how long the experiment will take.
* Current Location
  + Describes the current pixel being exposed.
* Details
  + Descries the current pixel value, laser power value, and exposure time for current pixel.

vi. File Menu

* Quit
  + Select this button to safely close the application.
  + If an experiment is running, it is advised that you first abort the experiment, wait for the communication window to report that all serial ports were closed, then select close
* Save As
  + Select this button to save the input of the experiment in a text file for later use.
  + .txt extension will be added automatically.
  + A screenshot will be taken of the main window and saved with the same name you used above; the .txt extension will be replaced by .png
  + At the conclusion of the experiment, these files will be overwritten with a new (identical) .txt file and a new screenshot which allows the actual duration of the experiment to be captured and recorded.
* Open
  + Open any previous experiment stored in a .txt file.
* Open Sample Experiment
  + Open a sample experiment to display how to use this program.
* Open Recent Experiment
  + Open the previous experiment, which is automatically saved after pressing the ‘Update all Information’ button.

vii. Serial Configurations Menu

* This Menu allows the user to configure the serial connections with equipment.
* Configurations are stored in a file and will be used automatically in future experiments.
* The devices used during the writing of this guide all use similar configurations:
  + Port: user defined
  + Baudrate (motor and laser) : 19200
  + Baudrate (shutter) : 9600
  + Timeout: 0.1
  + Stopbits: 1
  + Bytesize: 8
  + Parity: None

viii. Equipment Settings

* Motor
  + Configure settings on the motor.
  + Not yet implemented because it was not needed for this experiment.
  + Feel free to implement this functionality!
* Shutter
  + Configure settings on the shutter.
  + Not yet implemented because it was not needed for this experiment.
  + Feel free to implement this functionality!
* Laser
  + Configure settings on the laser.
  + Maximum Laser Power (float)
    - Lasers have a maximum power they are permitted to use.
    - The user MUST specify the CORRECT laser power in milliwatts.
  + Power Change Pause (float)
    - Laser take several seconds to change their power level.
    - The user should specify how long they want the laser to pause between power changes.

x. Help Menu

* Select any of the options to open up one of various text files for help.

Below: Sample front panel displaying key features. Note: this image was taken on Mac OS.

A screenshot of a cell phone

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