PiLoupeX

Raspberry Pi based Measuring Microscope

PiLoupeX

Introduction

This document describes an enhanced version of PiLoupe. Having used a USB connected camera with the original PiLoupe, I decided to experiment with a high quality Raspberry Pi camera connected via the camera interface. This was done in the hope that the lag introduced by a USB connected camera could be eradicated.

The camera used for this project is the Raspberry Pi High Quality Camera Module coupled to a microscope lens.

Having already developed software for PiLoupe using a USB connected camera, I hoped that it would require minimal modification. This proved not to be the case as the picamera interface bypasses the windowing system. This meant that it was necessary to have two separate environments, one for control and another for viewing.
At the outset it was the aim to provide all the functions available in PiLoupe. In the event these have been improved in PiLoupeX despite the requirement to switch environments between controlling and viewing the camera.

So what's changed?

PiLoupe to PiLoupeX Changes

In addition to a 40 by 40 grid, there is now a 10 by 10 grid and crosshairs. The crosshairs have been introduced to enable measurements by moving the object under investigation on an XY table with micrometer scale adjustment. Whereas the grid must be set to a pre-measured object or a micrometer microscope slide.

Another enhancement is the ability to set the grid angle within one degree. This enables the measurement of objects that are set on an angle, as well as the ability to determine the angles of facets on an item under observation. The crosshairs cannot be angled, only the grids.

With regard to superimposed images, nothing has changed. They can still be superimposed, zoomed and faded.

The facility to take a snapshot (write a PNG file) of the item under observation along with any displayed grid and superimposed image, has been improved. It is now much quicker.

The main improvement, of course, is the speed of frame delivery. The picamera bypasses the window system and streams its output directly to the screen. As PiLoupe read and displayed frames through the window system, annoying delays were experienced when trying to interact with a moving object (e.g. watch movement). Any delay in the delivery of frames using PiLoupeX is imperceptible.

The controls for PiLoupeX are more comprehensive than PiLoupe and many have been migrated to windows menus. The principal of controlling everything with a two button mouse has been retained.

The quirk of having to manage the two environments of controlling and viewing is managed by right-clicking the mouse to enter and exit ‘camera’ mode. This necessary nuisance takes a bit of getting used to and can result in a lack of right-click response if the mouse is already hovering over a widget. Also when in camera mode, the mouse will be unresponsive when outside the window. This situation is indicated by a yellow border and a darkened screen image.

Menus

Screen

Large	Sets the screen width to 1440
Standard	Sets the screen width to 1280
Small	Sets the screen width to 1024

The screen height is calculated to maintain the correct buffer size.
To implement a change in screen size the program must be restarted.

Camera

FPS

15	Frames per second
30	Frames per second

Default is 15.

WarmUp

0	Seconds
1	Second
2	Seconds

This warmup time allows the camera to better adjust when switching over. Default is 0 seconds.

Rotation

0	Degrees
90	Degrees
180	Degrees
270	Degrees

Default is 180 degrees.

Grid

GridSize

X Hairs	Sets grid to crosshairs
10	Sets grid to a 10 by 10 matrix
40	Sets grid to a 40 by 40 matrix

Colour

Multi	Sets Colourful grid or blue crosshairs
White	Sets grid pattern to white
Grey	Sets grid pattern to grey

Angle

Zero	Sets grid angle to 0 degrees
+1deg	Adds 1 degree to grid angle
-1deg	Subtracts 1 degree from grid angle
+45	Sets grid angle to plus 45 degrees
-45	Sets grid angle to minus 45 degrees

This menu is a ‘tear-off’ so clicking on ‘- - - - -‘ causes it to remain available on screen.

Image

Load

This brings up a file-menu which can be navigated to the image required.

Flip

Flip<>	Flips the image left to right
Flip ^v	Flips the image top to bottom

Fade

0%	Image is not faded
20%	Image is 20% faded
40%	Image is 40% faded
60%	Image is 60% faded

Photo

Colour	Creates a PNG file in colour
B&W	Creates a PNG file in Black and White

Widgets

The widgets are displayed along the bottom of the PiLoupeX window.

ImageOnOff

Display or hide the superimposed image.
N.B. Menu ‘Image Load’ does not override this, so after loading an image it must be switched on.

GRID Mode/IMAGE Mode

Toggle GRID/IMAGE Mode. Because all actions are carried out using the mouse it is necessary to be in the correct mode when moving or zooming.

GridOnOff

Display or hide the grid.

Angle__

Displays the current angular value of the grid in degrees.

N.B. On closing PiLoupeX all current set values are retained for the next restart. This information is written to and preserved in file ‘PiLoupeX.dat’ in the current working directory. To reset everything to factory values, delete this file. It will be recreated on the next restart.

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Mouse

Left Click

To select menu items, invoke widgets and move grid and image to new location.

Left Click and Drag

To zoom grid or image. Vertical movements are interpreted as a zoom value.

Right Click

To switch from control (window) mode to camera mode and visa versa. Menus, but not Widgets, can also be selected with Right Click.

Software/Hardware

To date PiLoupeX has only been extensively tested on a Raspberry Pi 3A+ running Raspbian GNU/Linux 11 (bullseye).

The software is distributed as a ‘onefile’ installation. This means that all the relevant dependencies are distributed as a bundle which is automatically expanded on invocation.

After initial download PiLoupeX will need to be made executable. To do this in File Manager select file properties>permissions and set execute to anyone. Or in Terminal go to the directory where you’ve downloaded it and type

‘**chmod +x PiLoupeX**’

All generated photos (‘png’ files) and PiLoupeX.dat are written to the current working directory, that is from wherever PiLoupeX is executed.

