DSuper8 User’s Manual

ver. 20231130

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1.- General description

The DSuper8 software is aimed at digitizing invertible films of any format. It works in combination with a modified projector with a stepper motor to transport the film, together with a nanocomputer and a Raspberry Pi HQ camera.

Digitization is carried out by the frame-by-frame procedure, that is, images are taken one after another of each of the frames that make up the film. These images are archived individually, each image in a different file. Only the images are digitized. The software does not contemplate the digitization of the audio of sound films.

In this version of the software it is possible to capture images in jpg and raw-dng formats. If we consider it appropriate, the captured images can be saved in both formats simultaneously.

The jpg files can be later assembled with other software, for example ffmpeg, to obtain the final video file.

Raw-dng files require development post-processing in order to trim unwanted edges, color adjustments, sharpness adjustments, etc. before editing the final video file. These operations can be carried out for example with the DaVinci software.

The system works according to the client-server model. A PC with Linux or Windows, or a Mac can be used as a client. The Raspberry Pi acts as a server, executing the commands from the client's GUI. It performs the functions of controlling the stepper motor, lighting and capturing images that are sent via LAN to the client for processing and archiving.

Alternatively, if we have a Raspberry Pi 4, it is possible to run both the client and the server on the same machine. The operation is correct, however, if we plan to capture images using HDR fusion, the fusion algorithm is noticeably slower in this case. For the rest of the capture options, the times are perfectly comparable to those obtained using, for example, a PC. If we decide on this option, it is highly advisable to use an external USB3 disk to save both the software and the captured image files, instead of doing so in the Rpi's microSD memory.

Initially this software was used mainly for digitizing films in Super8 format, hence its name DSuper8 (**D**igitize **Super8**), but in reality the software is independent of the format. To digitize a certain format, we must logically have a projector compatible with the desired format and an appropriate optical system for taking images of that format.

The server software has been tested with Raspberry Pi 2, 3 and 4, with a minimum of 1 GB of RAM.

Very important: it is currently not possible to run the server software on Raspberry Pi 5. The DSuper8 server uses, among others, the pigpio module. The GPIO port hardware on RPi 5 is very different from previous models and is incompatible with the current version of pigpio.

Today, almost all users use the Raspberry Pi HQ camera exclusively. For this reason, the old V1 camera is not supported in this software version.

In the case of captures in jpg format, once configured, the software performs the operations of capturing the images, inverting the images, cropping unwanted edges, rotating the image, rounding the corners and scaling the image up to the desired final resolution. All operations are carried out on the fly and only the final resulting image is saved on file.

It is important to note that the system does not use any type of sensor to detect the correct positioning of the frame to be digitized. With a modified projector this device is unnecessary. The projector mechanism itself places the frames successively correctly. Once the first frame is in position, the system automatically tracks the position of the film and the frames are accurately digitized.

For the system to work in this way, it is essential to use a stepper motor mechanically coupled to the main axis of the projector. Normally, each turn of the main axis moves forward/backward exactly one frame. For this reason, it is essential that the main shaft faithfully follows the movements of the engine. It is recommended to make the mechanical coupling using gears.

2.- Installation

2.1.- Install dependencies on client (main computer)

The client software consists of several files that contain Python scripts. This way it can run on any platform that has the dependencies installed.

The dependencies for client software version 20231130 are as follows:

- Python interpreter:

Python 3.10 or higher

- Additional Python modules:

PyQt6
numpy
opencv
matplotlib
PIL/Pillow
exif

Additional Python modules can be installed with the pip utility, by running the following commands as user:

pip install PyQt6
pip install numpy
pip install opencv-python
pip install matplotlib
pip install Pillow
pip install exif

The requirements.txt file contains a listing of all the necessary dependencies. To install them we execute the command:

pip install -r requirements.txt

In Linux environments, both the Python interpreter and the additional modules can also be installed through the package manager and the software repositories of our distribution.

2.2.- Install dependencies on server (Raspberry Pi)

First of all, it is highly recommended to update our Raspberry Pi with the latest version of the Raspberry Pi OS Bookworm operating system. This version has Python 3.11 and PyQt6 incorporated, which will allow us to run the client software on the Raspberry Pi itself.

Just like the client, the server software is also made up of Python scripts.

The dependencies of the server software version 20231130 are as follows:

- Python interpreter:

Python 3 (latest version of Raspberry Pi OS Bookworm. As of this writing it is Python 3.11.2)

- Additional Python modules:

picamera2
pigpio

Both the Python interpreter and additional modules are installed by default in the Bookworm version.

If necessary, they can be installed manually by executing the following command in **administrator mode**:

sudo apt install *package_name*

2.3.- Installation of the DSuper8 software

Both on the client and on the server, simply copy the files to a folder of our choice.

3.- Software configuration

3.1.- Client software configuration

- In Linux, edit the **DSuper8.py** file and modify the first line (shebang) so that it contains the path to our Python interpreter.

- In the **config.py** file modify the IP address of our server. We can do it with the IP in numerical format or with the server name. In the latter case we must have name resolution configured correctly. If we run the client and the server on the same RPi machine, the loopback IP 127.0.0.1 can be used.

- In the same **config.py** file, modify the paths of the folders that we want to use to save the files generated by the program. Examples are included for Linux and Windows.

Very important if we want to run the client software on our RPi: in the Bookworm version, by default, the traditional X11 graphics system has been changed to the Wayland system.

However, I have not been able to successfully run the DSuper8 client software with the Wayland system.

For this reason, we must configure the RPi so that, as a graphical system, it uses the traditional X11 together with the OpenBox window manager. As a graphical desktop environment, Lxqt gives very good results.

To configure X11-OpenBox:

sudo raspi-config

main menu option 6 (Advanced options) -> submenu option A6 (Wayland) -> sub-submenu option W1 (Openbox window manager with X11 backend).

Once the RPi is restarted, we will have the X11 graphics system up and running.

Installing Lxqt:

sudo apt install lxqt-core lxqt oxygen-icon-theme

To select Lxqt as the default desktop:

sudo update-alternatives --config x-session-manager

In the list that appears we select the **/usr/bin/startlxqt** option

After a new restart of the Rpi, we will find ourselves on the lxqt desktop.

3.2.- Server software configuration

In the server software, the pigpio library is used to control the motor and lighting.

The pigpio library uses the pigpiod daemon which must be running before starting the server program.

To do this, we need to copy the included **pigpiod.service** file to the **/lib/systemd/system/ directory**.

Once the file has been copied, we will execute the following commands in **administrator mode** to manage the daemon:

- Daemon start: **sudo systemctl start pigpiod**

- Daemon stop: **sudo systemctl stop pigpiod**

- Daemon status: **sudo systemctl status pigpiod**

- Enable autostart: **sudo systemctl enable pigpiod**

- Disable autostart: **sudo systemctl disable pigpiod**

Once these operations have been carried out, we can continue with the configuration of the server software:

- Edit the **DS8Servidor.py** file and modify the shebang, if necessary.

- In the **config.py** file there is the assignment of the GPIO port pins, which we must modify to adapt it to our case.

- The same **config.py** file contains the variable freq = 8000.

This variable determines the frequency in Hz at which the rotation pulses are sent to the stepper motor.

The frequency value should be as high as possible without loss of steps. Logically this value is related to the characteristics of our motor and to the mechanical characteristics of our projector.

For its determination there is no other solution than to carry out tests, starting with a reasonable value and increasing the frequency until reaching the upper limit, above which steps are lost.

This limit determines the maximum speed of rotation in our device.

The **DSuper8 Wiring Diagram.pdf** file is included, with the diagram that I use in my device and that is expressly adapted to the software.

4.- Raspberry Pi Server Configuration

Contrary to the old library, with the new picamera2 library it is not necessary to perform any special settings on the Raspberry Pi, such as enabling the camera or reserving memory for the GPU.

It is still highly recommended to activate an SSH server on the Raspberry Pi, in this way we can interact with the server from a console on the main PC or Mac computer.

It is recommended to configure the RPi by running the raspi-config utility in administrator mode:

sudo raspi-config

4.1.- SSH Server Activation

To conveniently use the server software from the client computer, the use of an SSH server on the Raspberry Pi is highly recommended:

main menu raspi-config option 3 (Interface Options) →submenu option I1 (SSH)

Once the Raspberry Pi has restarted, we would have the server ready to operate correctly.

5.- Run the DSuper8 software

To start a scanning session, we must first start the server software and then the client program.

5.1.- Server boot

We must open a console on the server. Let's see it for Linux and Windows.

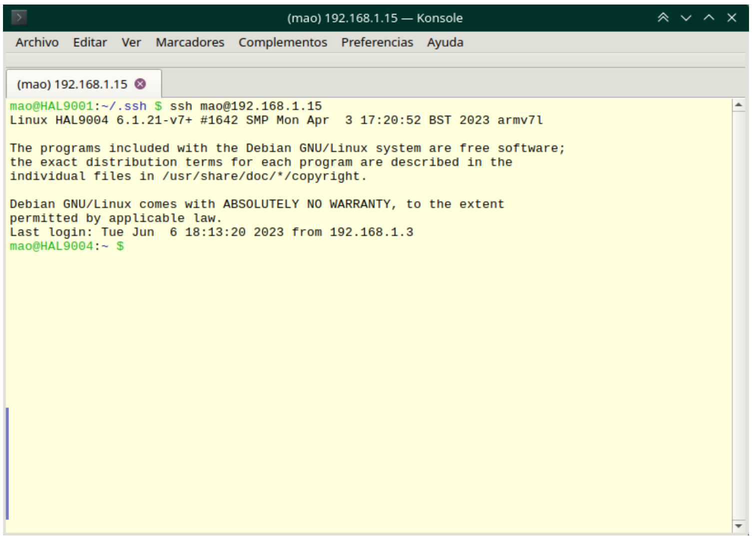
5.1.1.- Linux

We open a console on the client and through SSH we convert this console into a server console. We do it with the following command:

ssh user_name@Server_IP_address

For example ssh mao@192.168.1.15

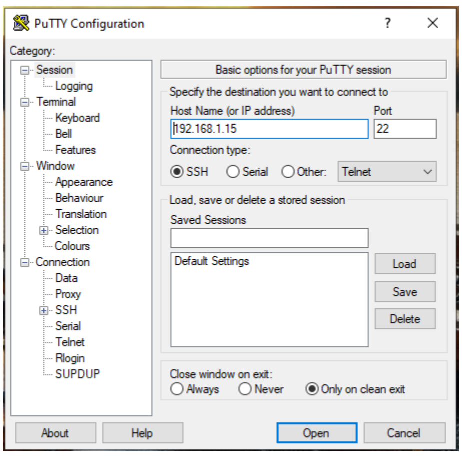
It will ask us for the user's password and once entered, we will have a server console.



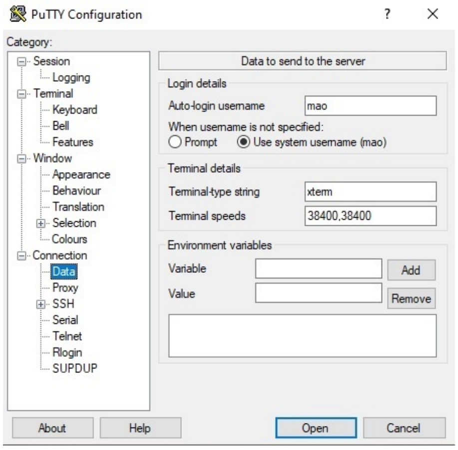
Only the first time will it ask us to confirm that we really want to access the server. Naturally we must give consent.

5.1.2.- Windows

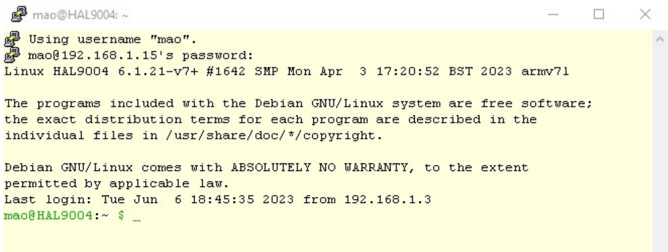
We run the putty program, where we must enter the IP of the server and the type of SSH session.



In the Conection-Data section we introduce the user with whom we want to open a session.



By pressing Open, we will open the console and once the password has been entered, we will already have a server console.



5.2.- Run the server software

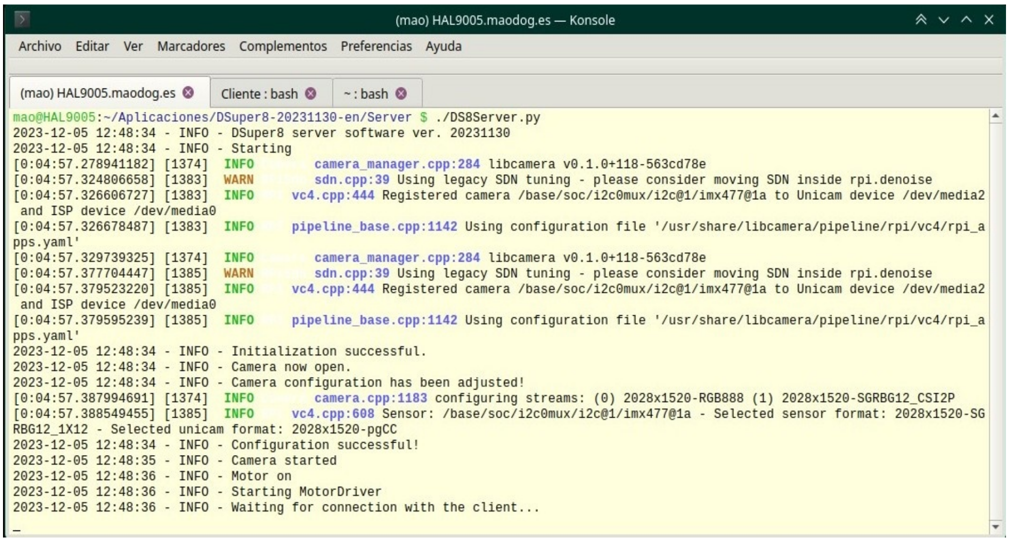
Once a console is opened on the RPi server, the next step is to run the Dsuper8 server program.

In the console that we have opened on our server, we go to the folder where we have installed the server software:

cd folder_name

Once in the installation folder, we start the server software:

./DS8Server.py



The server itself informs us that it is waiting for a connection with the client program.

5.3.- Client boot

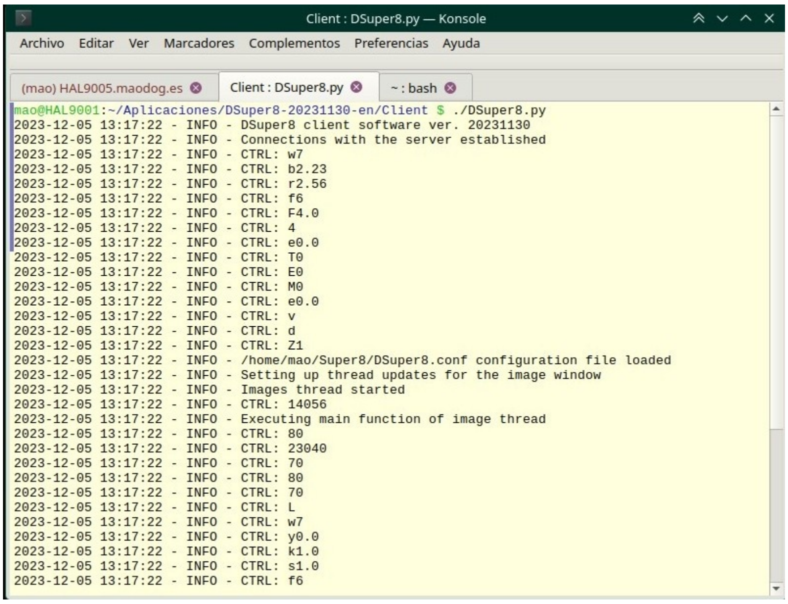
5.3.1.- Linux

We open a new console (a new tab or a new window) and we are located in the installation folder of the client software.

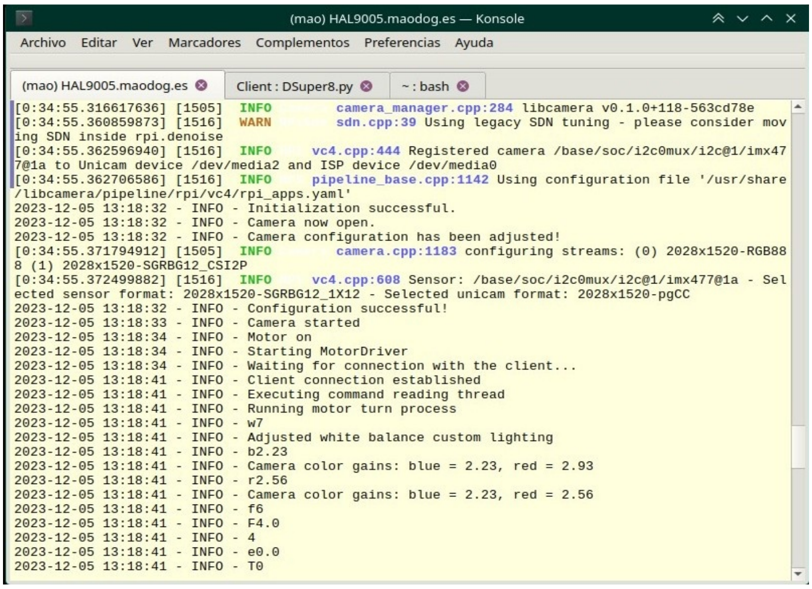
Once in the installation folder, we execute the script of the client program:

./DSuper8.py

The GUI should appear immediately.



The server console should show that the connection to the client is established.



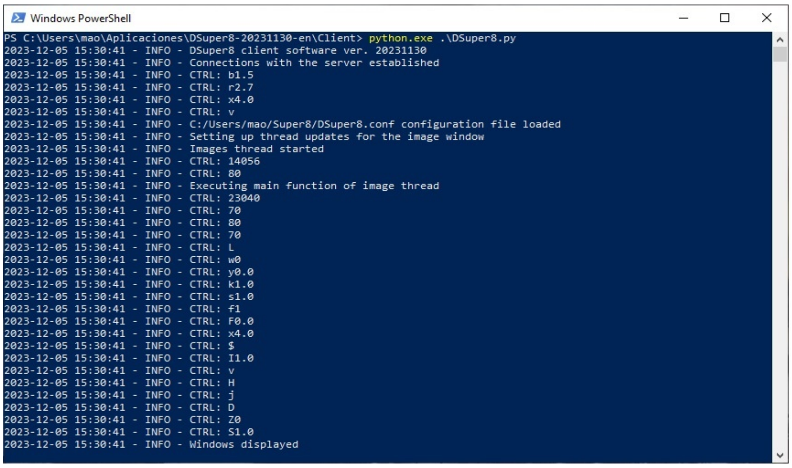
5.3.2.- Windows

We open a Windows console, for example Windows PowerShell and we are located in the folder where we have installed the client program.

Once there, we execute the script of the client program with the command:

python .\DSuper8.py

The GUI should appear immediately.



6.- Additional Settings

With the entire system configured and the software running, additional adjustments may be needed: white balance adjustment, image area selection for automatic exposure calculation, motor rotation direction adjustment, and motor rotation speed adjustment

The numbers in parentheses refer to the numbering of the controls that appear in red in the figures in section 7.

6.1.- White Balance Adjustment

Before proceeding to digitize a film, we must correctly adjust the white balance for the lamp that we have installed in our projector.

In the camera settings there are some presets (daylight, cloudy, shade, etc) that are those available in the picamera2 library. It should be noted that the white balance adjustment refers to our current lamp, not to the shooting conditions of the original film. It is recommended not to use the preset settings, but to adjust the white balance according to the procedure described below.

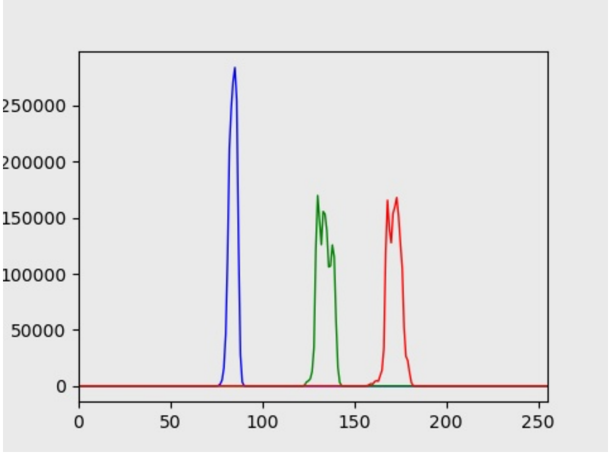
We start by turning on the lamp by checking the "Light" control (3) in the "Setup" tab. We should not load any film on the projector. The projection window completely free.

We leave the lamp on long enough for thermal equilibrium to be reached and thus the color of the light to stabilize.

Next we activate the preview by checking the "Preview" control (4).

Using the zoom dial, we adjust the preview view until a solid color appears in the image window. There should be no dark areas or the edges of the projection window.

In the "Capture" tab we adjust the exposure time (21) until the peak of the green curve of the histogram is approximately at the value 128.

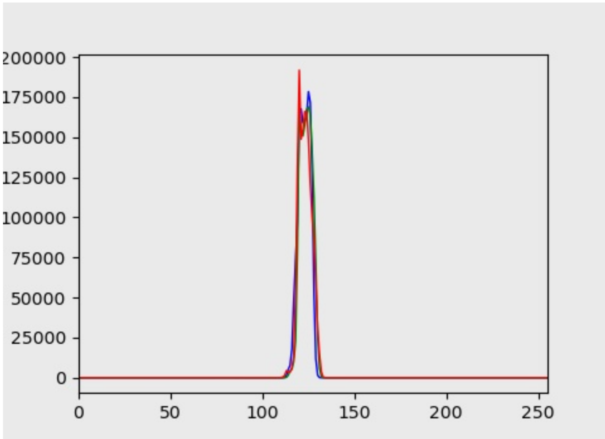


We set the camera's white balance control to “Manual” mode (76).

Next, gently, with the blue (77) and red (78) gain controls, we adjust the histogram until the three red, green and blue curves overlap.

In the image window we should see a uniform medium gray tone throughout the window.

The narrower the base of the curves and the better the overlap, the better the white balance setting. Thermal equilibrium will have been achieved when the shape and position of the three curves are constant.



Once the adjustment is achieved, we will take note of the red and blue gain values, which represent the optimal adjustment of the white balance for our lamp.

These values can and should be saved in a configuration file (14).

We can then customize the white balance combobox (75) to include our own lamp values.

To do this we edit the config.py file of the client software.

In this file are the variables:

```
# Camera custom color gains.

# They must be determined for the lamp that we are using in our device.
# customGains = (red gain, blue gain)
customGains = (2.56, 2.23)

# Name assigned to our lamp.
customLampName = "3300 K"
```

We must assign the values obtained experimentally for our lamp to the customGains variable.

We will freely assign a name that we consider appropriate to the customLampName variable.

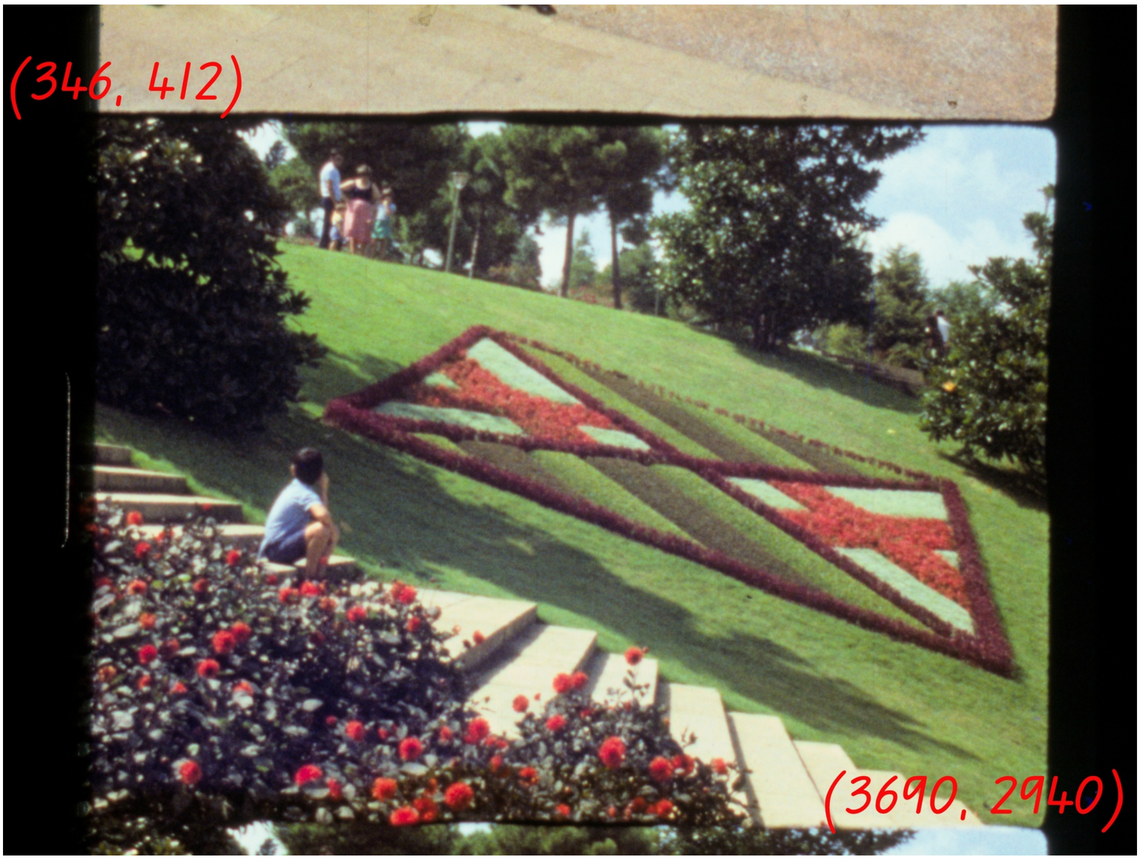
Once the software is restarted, the white balance combobox (75) will show the name that we have assigned to our lamp with the correct values of the blue and red gains.

6.2.- Selecting the image area for automatic exposure calculation

If you want to use automatic exposure, it is important to delimit the image area so that the algorithm does not take into account unwanted areas of the captured images, such as the film take-off hole or dark edges around the area of interest from image.

To do this, we capture a test dng image at the **maximum resolution of the sensor (4056 x 3040 px)**.

With the help of image editing software we take note of the coordinates in pixels of the upper left corner and the lower right corner of the desired area of the image, as in the following example:



It is important that the test image be taken at the maximum resolution of the sensor due to the requirements of the automatic exposure algorithm.

The following variable appears in the config.py file of the server software:

```
# In automatic exposure it is used to determine the metering area.
# AEScalerCrop = (x_offset, y_offset, width, height)
AEScalerCrop = (346, 412, 3344, 2528)
```

Where:

x_offset = x coordinate of the upper left corner (346 in our example)
y_offset = y coordinate of the upper left corner (412 in our example)
width = image width (3690 - 346 = 3344 in our example)
height = image height (2940 - 412 = 2528 in our example)

Once this variable is correctly adjusted, the automatic exposure algorithm will only use this area of the sensor to carry out the calculation.

6.3.- Motor rotation direction adjustment

The advance of the frames of the film depends on several factors, such as the polarity of the voltage applied to the coils of the motor, the mechanics of the projector itself, in principle the direction of rotation of the main axis of the projector that advances the film is unknown and finally, the logic level applied in the motor driver to the signal that controls the direction of rotation.

It is possible that, in our case, the motor rotates in the opposite direction to that desired for the advancement of the film.

If this were our case, logically we must invert the direction of rotation of the motor. To do this, we edit the config.py file of the server program.

The last three lines of the file are as follows:

```
# They are used to determine the direction of rotation of the motor.
backward = False
forward = True
```

We invert the direction of rotation leaving them as follows:

```
# They are used to determine the direction of rotation of the motor.
backward = True
forward = False
```

6.4.- Stepper speed adjustment

The speed of rotation of the motor depends on the frequency of sending the rotation impulses.

By default this frequency has been set to 8 KHz.

Depending on the mechanical characteristics of our motor-projector assembly, this frequency may be too high.

The most noticeable symptom is the loss of motor steps. In other words, the motor cannot rotate at the speed that we demand of it, which translates into a loss of precision in the angle rotated.

One possible solution is to reduce the frequency of the spin pulses.

To do this, we edit the **config.py** file of the server program.

In this file we locate the following lines:

```
# Frequency in Hz of the pulses to be sent to the motor driver.
# It should be chosen so that it is as high as possible but without the motor
# losing steps.
freq = 8000
```

We must reduce the value of the freq variable according to our needs until no loss of steps is observed and the angles turned are as expected.

Logically it is also possible to increase the speed of the motor, in this case increasing the value assigned to the variable.

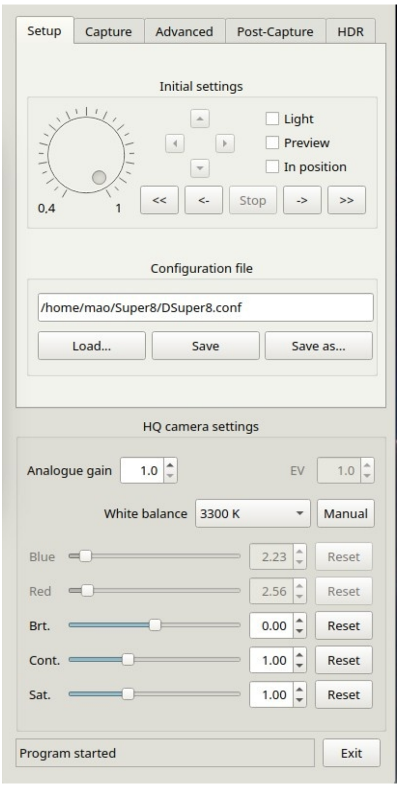
7.- Detailed description of the DSuper8 GUI

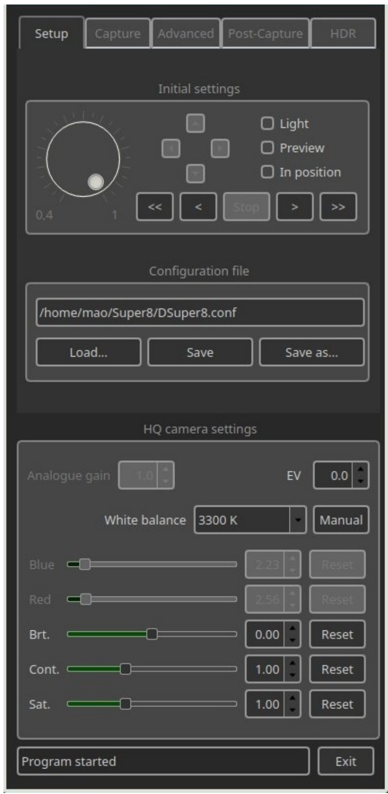
In the current version of the software, a new dark theme has been included for the GUI, which has been left as default given the current trend to use this type of themes in graphical user interfaces.

To change the theme it is necessary to edit the config.py file of the client software. In this file is the variable:

```
# GUI theme.
# GUITheme = "Light"
GUITheme = "Dark"
```

We will change the theme by commenting on the unwanted theme and uncommenting the theme of our interest.





The DSuper8 GUI is made up of three different parts: at the top there is an area with five tabs that allow you to execute different operations in order to configure and execute a movie capture.

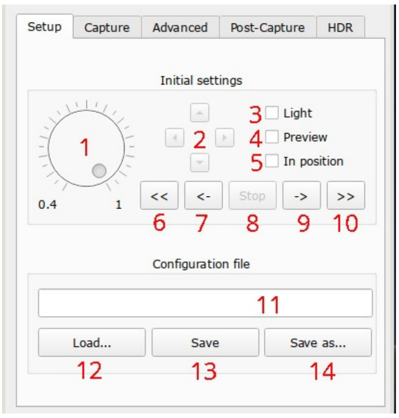
In the middle there is an invariable zone dedicated to the settings of the Raspberry Pi HQ camera.

Finally, at the bottom, there is another invariable area with a window that shows the program's status messages and the application's exit button.

We now turn to the description of the different controls offered by the GUI.

7.1.- Setup Tab

The controls on the Setup tab are used to position the first frame of the movie in the projection window, as well as focus and pan. This tab also contains the controls for saving and loading GUI configuration files.



1.- Zoom Dial

The zoom can be useful to facilitate the focus and to delimit the frame.

2.- Scroll arrows

Once the desired zoom has been adjusted with the dial (1), they allow you to move the camera in the direction indicated by each of the arrows.

3.- Light

Manual light on/off. It is activated automatically in the modes that require lighting: preview, capture and test.

4.- Preview

Activate/Cancel the sending of preview images to the client. The images are sent continuously at the maximum speed allowed by our system.

The preview images have as their main purpose the focus and framing of the captured images that are displayed practically in real time.

Two indices may appear superimposed on these images: Focus and Maximum.

These indices are intended to serve as an aid for the optimal focus of the image. They are calculated using some functions of the OpenCV library.

Our objective should be that the Focus index reaches the highest possible value. For this reason the index Maximum appears. In this way we can appreciate if we are approaching or moving away from the optimal focus position.

It is noteworthy that the indices of two different images should not be compared. The calculation of the indices is particularized for each image and therefore they are not comparable.

5.- In position

The DSuper8 software automatically keeps track of the frame number where the film is positioned at all times.

For this, it is essential that, once the film is threaded and located in the first useful frame, the control is checked.

Once checked, the software assumes that the film is in a known position and will keep the position indicator permanently updated, even if the film is advanced or rewinded by an arbitrary number of frames.

6.- « (continuous recoil)

Motor in continuous recoil. The primary use for this feature would be to rewind films after scanning is complete.

7.- ← (back of a frame)

Moves the movie back one frame. It is used to position the film at the first frame after threading.

You actually go back two frames and go forward one frame. This behavior is intentional and is intended to eliminate the small error in vertical scrolling that occurs when moving backwards in the movie.

8.- Stop

Stops continuous forward/reverse motor.

After rewinding, a frame is advanced, again in order to eliminate the error in the vertical displacement of the film.

9.-→ (advance of a frame)

Advances the film one frame. It is used to position the film at the first frame after threading.

10.- » (continuous advance)

Motor in continuous advance. It is used for threading the film after loading the reel into the projector.

11.- Configuration file box

Shows the configuration file that we have loaded in this session.

12.- Load...

Opens a file selection dialog in order to load a configuration file saved in a previous session. Configuration files have the extension “.conf”.

13.- Save

Overwrites the configuration file we have loaded with the current GUI configuration.

When the program execution is finished, the GUI settings are automatically saved.

14.- Save as...

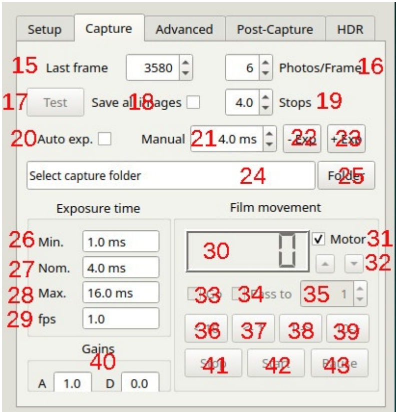
Opens a file selection dialog that allows the current GUI configuration to be saved under a name chosen at our convenience.

Configuration files have the extension “.conf”. If we leave the file without this extension, the program adds it automatically.

7.2.- Capture Tab

The Capture tab controls are used to configure the main capture parameters, such as the exposure time, the number of images to be captured per frame, etc.

The tab also contains controls that allow you to start, stop, and pause the capture, and controls that allow you to advance and rewind the movie to any desired frame.



15.- Last frame

In this spinbox the number of the last frame to be digitized is set.

Once this frame is digitized, the capture process stops automatically.

16.- Photos/Frame

This spinbox allows you to adjust the number of images that will be obtained from each frame to be digitized.

Multiple images are sent one after the other to the client, and once the last one is received, they are merged into a single HDR image.

17.- Test

It allows you to obtain a test image that is taken with the same settings that will be used to capture and digitize the frames.

The test image will give us a real image resulting from the adjustments made. These settings can be modified until you obtain an image with the best possible quality before starting the capture.

The program automatically generates test file names, in the format Testnnnn.jpg or Testnnnn.dng so that existing test image files are never overwritten.

18.- Save all images

If we check this control, the different multiple images in jpg format will be saved in separate files. The final HDR image is also generated and saved to another file.

The name of multiple image files is the same as the final image with an added suffix indicating the capture order number. For example if we have adjusted 6 multiple images and the name of the final file is img00001.jpg, the name of each of the files would be img00001-01.jpg ... img00001-06.jpg.

The exposure time of each multiple image is saved in the exif data of each image.

19.- Stops

Allows you to adjust the number of stops that will be used to calculate the different multiple exposures.

Each stop point increases/decreases by double/half the exposure time.

The number of stop points refers to the difference in exposure time between the fastest and slowest exposure.

20.- Auto exp.

It is used to tell the program to automatically calculate the exposure time. The calculation is carried out using the functions of the picamera2 library.

Although it can be used in any circumstance, when using jpg multiple exposures with the proper settings, auto exposure is not necessary.

Yes, it is advisable when we have decided to digitize with a single image per frame.

Due to the time spent calculating the exposure, the capture speed is slower compared to using manual exposure time.

21.- Manual

In this spinbox you can manually adjust the exposure time that the camera will use in the capture session.

With only one image per frame, this time will be used for all images.

With captures made with multiple images, this time will be used, together with the number of stops, as a basis for calculating the exposure time of each of the images.

During the capture, the spinbox window successively shows the exposure time of each of the captured images.

22.- -Exp

Reduces manual exposure time by 20%.

23.- +Exp

Increases manual exposure time by 20%.

24.- Capture folder box

Shows the folder where the system generated image files will be saved.

25.- Folder

Pressing the button opens a folder selection dialog that will allow us to choose the folder for saving the generated image files.

26.- Minimum exposure time information box

This box shows the minimum exposure time in case of capture with multiple exposures.

27.- Nominal exposure time information box

This box shows the nominal exposure time.

If automatic exposure is selected, it displays the exposure time calculated by the automatic exposure algorithm.

If we are using manual exposure, the displayed value matches the one set in the “Manual” spinbox (21).

28.- Maximum exposure time information box

This window shows the maximum exposure time in case of capture with multiple exposures.

29.- Camera framerate parameter information box

Shows the number of frames per second captured by the camera. This parameter is closely related to the exposure time. It changes to adapt to the different exposure times requested from the camera. It is for informational purposes only.

30.- Informative screen of the film position

Continuously shows the frame number where the movie is positioned at all times.

Initially it is disabled. It is activated as soon as the "In position" control (5) is checked and initialized with frame number 1.

From this moment on, it is continuously updated with the movement of the film, both forward and backward.

31.- Motor

In normal operation, the control is checked (motor activated). The motor is energized even when it is at rest. He rigidly holds his position.

If at a certain moment we want to manually move the axis of the projector, we must remove the check. The motor is no longer powered and it is possible to move it manually.

The motor is activated automatically whenever it is required for the movement of the film.

32.- ↑-↓

These buttons are used to increase/decrease the value indicated on the position screen. They are used to correct possible misalignments between the position indicated on the screen and the actual position of the film.

33.- Go

Once checked, it serves to place the film in the frame indicated in the spinbox (35).

The movement of the film can be forward or backward and will stop automatically as soon as the indicated frame is reached.

34.- Pass to

When checked, it transfers the value of the spinbox (35) to the film position indicator screen.

It is used to synchronize the indicator screen with the actual position of the film, in the event that we have stopped the film in a known position.

35.- Frame numbers spinbox

The number of the frame that we select in the spinbox will be used to place the film in the indicated frame, checking "Go" (33) or to transfer it to the indicator screen, checking "Pass to" (34).

36.- ←10

Rewind the movie 10 frames.

In reality, 11 frames are moved back and then 1 frame is advanced. It is done to compensate for the vertical displacement error that occurs in the movement backwards.

37.- ←1

Rewind the movie 1 frame.

In reality, 2 frames are moved back and then 1 frame is advanced. It is done to compensate for the vertical displacement error that occurs in the movement backwards.

38.- 1→

Advance film 1 frame.

39.- 10→

Advance the film 10 frames.

40.- Gains information boxes

Informative boxes of the analog (A) and digital (D) gains that the camera is using.

In manual exposure, we can adjust the value of the analog gain using the spinbox (73). For low noise it is recommended to keep the analog gain value as close to 1 as possible.

In automatic exposure when it is not possible to increase the analog gain, the picamera2 library automatically proceeds to increase the digital gain.

It is not possible to manually adjust the digital gain value. If the digital gain is not close to 1 it would denote a low level of illumination.

41.- Stop button

Stop capture.

42.- Start button

Start capture.

Several conditions must be met for the capture to start:

- Engine at rest.

- Preview inactive.

- Film located in position.

- Determined the capture folder.

- Selected jpg capture (47) or raw capture (48).

- In the case of jpg captures, configure a single photo per frame or configure more than one photo per frame and more than 0 stop points.

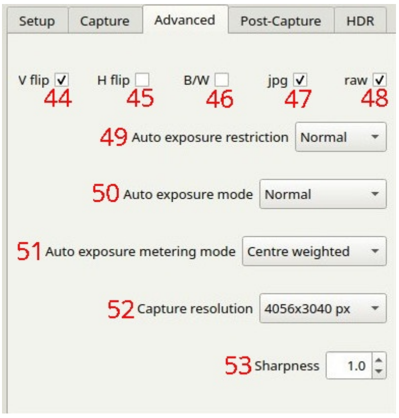
When the related conditions are met, the button is activated and the capture can be started.

43.- Pause button

One press pauses the capture. A second press resumes the capture.

7.3.- Advanced Tab

In the advanced tab there are some auxiliary image capture functions. These functions are performed on the server.



44.- V flip

Flips the image vertically.

Based on the physical orientation of our camera, we'll probably need to use it. The image in the movies is inverted and with this control we can orient it correctly.

45.- H flip

Flips the image horizontally.

46.- B/W

Scan images in black and white.

47.- jpg

Activates image capture in jpg format. Supports simultaneous capture of raw-dng images.

48.- raw

Activates image capture in raw-dng format. Supports simultaneous capture of jpg images.

49.- Auto exposure restriction

Setting the restriction mode for the AEC/AGC algorithm (Automatic Exposure Control / Automatic Gain Control).

Normal: normal metering

Highlight: meter for highlights

Shadows: meter for shadows

50.- Auto exposure mode

Sets the exposure mode of the AEC/AGC algorithm.

Normal: normal exposures

Short: use shorter exposures

Long: use longer exposures

51.- Auto exposure metering mode

Sets the metering mode of the AEC/AGC algorithm.

CentreWeighted: centre weighted metering

Spot: spot metering

Matrix: matrix metering

52.- Capture resolution

Adjustment of the capture resolution.

Resolutions of 2028 x 1520 and 4056 x 3040 pixels are supported.

53.- Sharpness

Image sharpness adjustment. Values between 0 and 16.

With the value 0 there is no increase in the sharpening of the image.

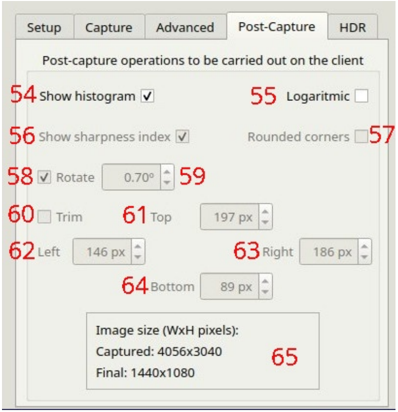
The value 1 is the default value. A normal sharpness adjustment is performed.

Higher values progressively sharpen the image.

Films with a lot of grain can improve with low sharpness values.

7.4.- Post-Capture Tab

This tab allows you to configure operations on the captured images that are performed in the client program once the image is received. Controls (56) to (64) are only activated with preview images.



54.- Show histogram

Shows/hides the histogram window. It is recommended to always have the histogram in view. It is a very useful tool for controlling the quality of digitization.

55.- Logarithmic

Makes the Y axis of the histogram with logarithmic scale.

56.- Show sharpness index

Causes the sharpness index to appear superimposed on preview images.

It is an index calculated with functions from the OpenCV library that helps to determine the optimal focus of the image.

It is about maximizing the “Focus” index while acting on the focusing mechanism of our optical system.

The "Maximum" index reflects the highest value reached so far, in this way we can appreciate if we are approaching or moving away from the optimal focus point.

It is noteworthy that the focus index is unique for each image. We should not compare the indices obtained from two different images. They are not related and therefore not comparable.

57.- Rounded corners

Makes the corners of the image appear rounded.

Rounding is done by applying quarter circle masks with a radius of 50 pixels.

58.- Rotate

It is used to correct the possible inclination of the captured images, due to the fact that the camera sensor or the frame to be captured (or both) are not horizontal.

When checked, the spinbox (59) is activated.

59.- Rotation angle box

Allows you to indicate the angle of rotation necessary to achieve the horizontality of the captured images.

The angle can be positive, to rotate the image counterclockwise, or negative, to rotate the image clockwise.

60.- Trim

It is used to remove borders and unwanted dark areas around the area of interest of the captured images.

When checked, spinboxes (61) to (64) are activated.

61.- Top crop box

Width in pixels of the band to remove from the upper part of the image.

62.- Left crop box

Width in pixels of the band to remove from the left area of the image.

63.- Right crop box

Width in pixels of the band to be removed from the right area of the image.

64.- Bottom crop box

Width in pixels of the band to remove from the lower area of the image.

65.- Informational box of the image size

It shows the size in pixels of the captured image, once zoomed and cropped, and of the final rescaled image.

By default, the final image is upscaled to full HD (1920x1080 px), which is considered sufficient for 8mm and Super8. The resolution of the final images can be modified in the config.py file of the client program.

The width of the final images must be an even number, otherwise the video file cannot be generated with the captured images. If this condition is not met, the program opens a warning dialog notifying this circumstance.

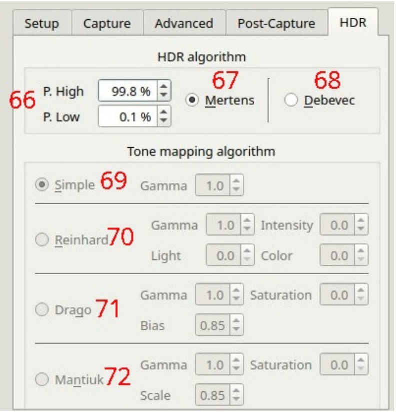
7.5.- HDR Tab

The dynamic range of the Raspberry Pi camera sensor is much less than the dynamic range of reversal film, so a frame captured with a single jpg image does not have all the hues of the original film frame.

The solution is to take high dynamic range (HDR) images.

They are achieved by taking several jpg images of the same frame with different exposure times. Subsequently, these images are sent to an HDR algorithm that takes care of selecting the best exposed pixels of each image and merging them into a single final image.

This tab is only activated when the necessary conditions are met to obtain an HDR image: in the Capture tab, more than one photo per frame (16) and more than 0 stop points (19) must be configured.



66.- High and low percentiles

When using the HDR Mertens algorithm, a small number of very bright pixels and very dark or black pixels typically appear in the final image.

If we keep these pixels in the image, the rest of the pixels appear compressed within a small range of values, resulting in a poorly contrasted image.

To improve contrast, you can apply a high percentile to ignore the brightest pixels and a low percentile for the darkest pixels.

Typically good results are obtained with high and low percentiles of 99.8% and 0.2% respectively.

The histogram of the image will be of great help to determine the optimal value of the percentiles.

67.- Mertens

Select the HDR Mertens algorithm (recommended).

68.- Devebec

Select HDR Debevec algorithm.

This algorithm, while giving good results, requires a tone mapping algorithm. In film digitization work, it has the drawback of needing a large number of images (around 15) to obtain good quality images.

69.- Simple tone mapping algorithm

Selects the Simple gamma corrected tone mapping algorithm.

Gamma parameter: positive value for the gamma correction. A gamma value of 1.0 implies no correction, a gamma value of 2.2 is adequate for most displays. Generally gamma greater than 1 brightens the image and gamma less than 1 darkens it.

70.- Reinhard tone mapping algorithm

Selects the Reinhard tone mapping algorithm.

Parameters:

Gamma: see epigraph 69.

Intensity: value in the range between -8 and 8. Higher intensity produces brighter results.

Light: light adaptation in the range between 0 and 1. If it is 1 the adaptation is based only on the pixel value, if it is 0 the adaptation is global. With intermediate values it is a weighted average of these two cases.

Color: chromatic adaptation in the range between 0 and 1. If it is 1 the channels are treated independently, if it is 0 the adaptation level is the same for each channel.

71.- Drago tone mapping algorithm

Selects the Drago tone mapping algorithm.

Parameters:

Gamma: see epigraph 69.

Saturation: Positive saturation enhancement value. 1.0 preserves saturation, values greater than 1 increase saturation, and values less than 1 decrease saturation.

Bias: Value for the bias function in the range 0 to 1. Values from 0.7 to 0.9 typically give the best results, the default is 0.85.

72.- Mantiuk tone mapping algorithm

Selects the Mantiuk tone mapping algorithm.

Parameters:

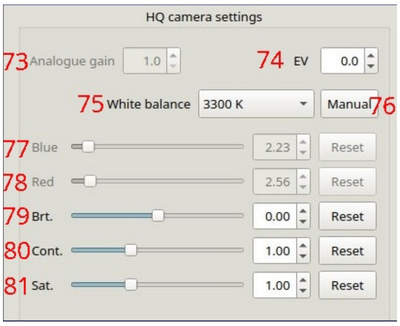
Gamma: see epigraph 69.

Saturation: see epigraph 71.

Scale: Contrast scale factor. The HVS response is multiplied by this parameter, thus compressing the dynamic range. Values from 0.6 to 0.9 produce the best results.

7.6.- Camera Settings

In this area of the GUI the shooting controls of the Raspberry Pi camera, HQ version, are grouped.



73.- Analogue gain

Sets the value of the analog gain applied to the camera sensor. Values between 1 and 16.

To get low noise images you should stay as close to 1 as possible.

74.- EV

Exposure compensation in stop points. Values between -8 and 8.

Adjusts the results of the AEC/AGC algorithm. Positive values increase the brightness of the image and negative values decrease it. Zero represents the baseline or "normal" exposure level.

75.- White balance

Sets the white balance mode of the camera.

The allowed modes are those offered by the PiCamera library.

However, for good results it is recommended to use Manual mode and set the custom white balance for our lamp as described in section 6.1.

76.- Manual button

Pressing the button quickly adjusts the white balance in Manual mode.

77.- Blue color controls

Slider and spinbox for blue gain adjustment. Values between 0 and 32. Default value 2.5.

The reset button allows you to quickly adjust the default value.

78.- Red color controls

Slider and spinbox for red gain adjustment. Values between 0 and 32. Default value 2.5.

The reset button allows you to quickly adjust the initial value.

79.- Brightness controls

Slider and spinbox for image brightness adjustment. Values between -1 and 1. Default value 0.

The reset button allows you to quickly set the initial value to 0.

80.- Contrast controls

Slider and spinbox for image contrast adjustment. Values between 0 and 3. Default value 1.

The reset button allows you to quickly set the initial value to 1.

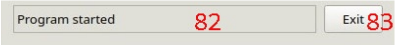
81.- Saturation controls

Slider and spinbox for adjusting the color saturation of the image. Values between 0 and 3. Default vale 1

The reset button allows you to quickly set the initial value to 1.

7.7.- GUI bottom zone

At the bottom of the GUI are the program status bar and the exit button.



82.- Status bar

At all times it reflects the status of the program and the last action carried out.

83.- Exit button

It is used to end the execution of the program.

Once pressed, a confirmation dialog appears that allows you to cancel or confirm the exit of the program.

Once the exit is confirmed, both the client program and the server are closed.

8.- The Histogram tool

The Histogram is a valuable tool in order to make good captures. Observing the histogram we can obtain information that will allow us to appreciate the quality of the digitalization of the images.

In the memory of our computers, an image is nothing more than a matrix of numbers.

If the image is grayscale, the matrix only has one plane.

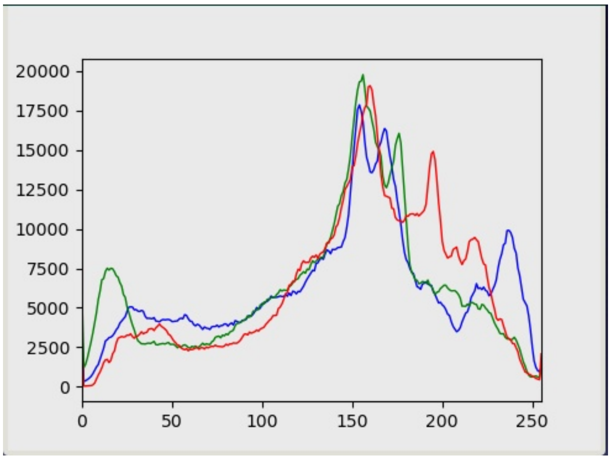
If the image is in color, the matrix has three planes, corresponding to the colors red, green and blue.

On the X axis of the histogram the values from 0 to 255 appear, corresponding to the values that a pixel with a color depth of 8 bits can adopt.

On the Y axis appears the count of the number of pixels that have the same value.

In the case of color images, three curves appear, with the histograms of each of the fundamental colors.

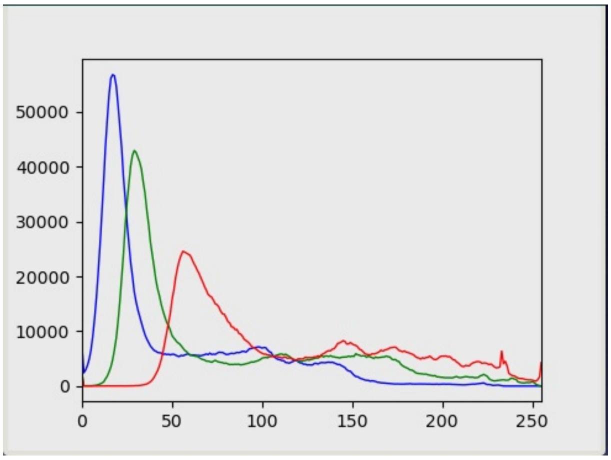
The figure shows the histogram of a correctly exposed image with good contrast.



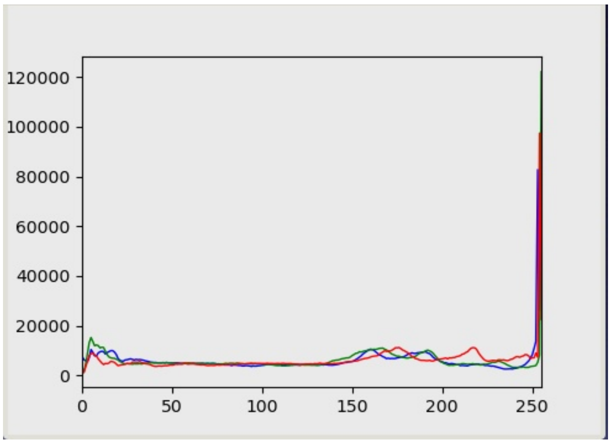
As can be seen, the three curves cover the entire extension of the histogram, that is, there are pixels that have all possible values between 0 and 255.

In the following examples we will see histograms of images with incorrect exposure.

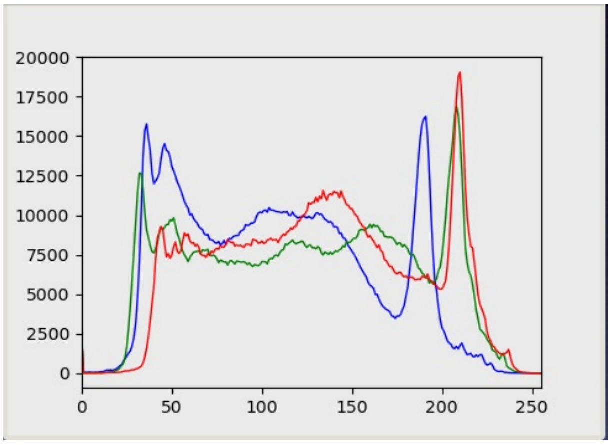
The following figure shows the histogram of a dark image. The vast majority of pixels have low values. Very few pixels are in the middle and high part of the possible values.



The following figure represents the histogram of an image with overexposed areas. Numerous pixels appear in the highest value 255 and very few in the central and lower zone.



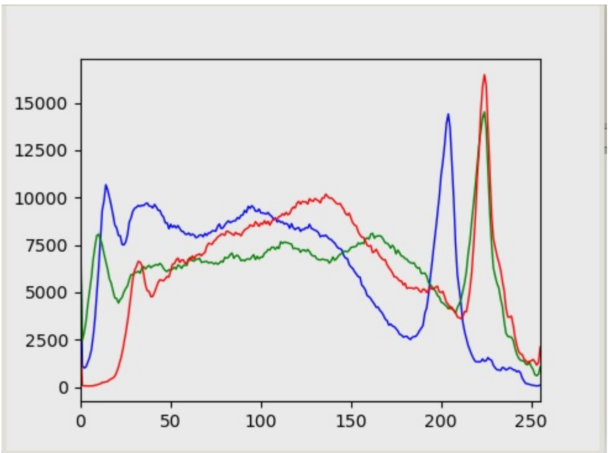
The following figure corresponds to the histogram of an image with poor contrast. The curves do not span the full extent of the graph. The vast majority of pixels are squeezed into the range of values between about 30 and 230, rather than occupying the entire range between 0 and 255. There are no black pixels or white pixels.



In this case, to improve the contrast, we can act on the contrast controls of the camera (80).

If we are using the HDR Mertens algorithm, we can also act on the high and low percentiles (66). Good results are usually obtained with a high percentile of 99.8% and a low percentile of 0.1 or 0.2%.

The goal is to get the endpoints of the curves to extend to the full width of the graph, as in the following and final example:



9.- Digitizing films with DSuper8

We are going to detail the procedure that we must follow to digitize a film. The numbers in parentheses refer to the numbering of the controls that appear in red in the figures in section 7.

We place the GUI in the "Setup" tab.

We load the film into the projector and proceed to thread it by advancing the motor continuously with the “»” (10) button.

We must stop the film at the first useful frame. To do this we will use the preview function (4) and the buttons related to the movement of the film «, ←, stop, → » (6 to 10).

Once the film is located in the first frame, we can mark the “In position” control (5). From this moment on, the software will track the position of the film, so that we can go back and forth at will to any frame.

Our next step will be to set an exposure time so that the preview images appear reasonably well exposed.

1 is recommended as the analog gain setting (73), which will produce images with very little noise.

We will adjust the exposure time in the spinbox marked as “Manual” (21) in the “Capture” tab.

With the preview images well exposed, we must now proceed to the correct focus and framing of the frame to be digitized.

For the focus, we will act on the device that we have planned in our optical system. We will help ourselves with the preview images (4) which, logically, should be as sharp and well defined as we can get.

Superimposed on the preview images are two indices “Focus” and “Maximum” (56). These indices serve as an aid to the optimal focus of the image.

They are based on a statistical calculation that is carried out with functions from the OpenCV library.

We must try to make the value of the "Focus" index as high as possible. To do this, we will observe the “Maximum” index which indicates the highest value achieved so far. In this way we can appreciate if we are approaching or moving away from the optimal point.

The indices are unique for each image. We should not compare the indices obtained with two different images. They are not related and therefore not comparable at all.

Once the optimum focus has been reached, our next objective will be the framing of the frame.

To do this, always in preview mode (4), we go to the "Advanced" tab.

In this tab we can flip the image vertically (44) and horizontally (45), if necessary.

In the same tab, we can select the capture resolution (52). A higher resolution generates larger images and files, which increases processing times.

Normally, for Super8 movies with the HQ camera a resolution of 2028x1520 px is recommended.

In this same tab you will find the jpg (47) and raw (48) controls. With them we will select the type of images that the software will generate. It should be noted that they are not mutually exclusive, that is, it is possible to digitize a film by generating jpg and raw-dng images in the same capture session.

Raw-dng images must be processed with additional software (e.g. DaVinci) before mounting the final video file.

On the contrary, a simple post-processing can be applied to jpg images. To do this, we next go to the “Postcapture” tab.

In this tab, you will find among others the controls of rotation (58-59) and crop (60-64).

If we look at the jpg image of the box tilted, we can correct this with the rotation control, while looking at the preview images.

Likewise, with the cropping controls, we can eliminate unwanted edges from the captured jpg images, leaving only the useful surface of the frame visible. With this, in addition to avoiding operations in a post-capture process, we reduce the size of the generated jpg files.

At the bottom of the tab (65) we have information on the resolution of the image captured by the camera once the cuts have been applied, and the final size of the image once it has been rescaled.

It is important to note that the final width of the image must be a multiple of 2, otherwise the final video file could not be assembled.

If the final width is an odd number, when starting the capture, the program will open a dialog box warning of this circumstance so that we can proceed to modify the final width.

With the cuts made and the image rescaled to full HD, there will be a final resolution of the captured images of about 1500x1080 px, enough for the Super8 format.

Well, we already have the film located in the first frame, and the image focused and framed.

We then go to the "Capture" tab.

In this tab we are going to configure the capture conditions of the thousands of images that normally make up a movie.

The first thing we must do is select the folder where the captured images will be saved. We do it with the “Folder” button (25), which will open a directory selection dialog. It is not possible to start capturing until a folder is selected.

In the "Last frame" control (15), we can configure the number of the last frame to be digitized. Once this frame has been digitized, the capture process will stop automatically.

Let's go to the most important part. For the preview we have marked an exposure time. For the capture, in order to increase the dynamic range of the jpg images, it is recommended to take several bracketed images that will later be merged using an HDR algorithm.

With 6 images per frame (16) and 6 stop points (19), good results are usually obtained, although we can freely try other configurations until we are satisfied with the results.

The HDR algorithm is selected in the “HDR” tab, Mertens (67) is recommended, with a high percentile of 99.8 and a low percentile of 0.1 (66).

In the “Capture” tab there is the “Auto exp.” control. (20). It is used to tell the software to determine the exposure automatically. If we decide to opt for automatic exposure, we must take into account that the capture times are slightly longer. If we are only going to capture in jpg format and we correctly configure the time manually and the bracketed exposures, the use of automatic exposure is totally unnecessary.

With the "Test" button (17), we can obtain images made with the same capture settings.

In addition to the image that appears in the window, we can use the histogram tool, as described in section 8.

After the appropriate tests and once satisfied with the results obtained, we can save the configuration made to use it in future capture sessions. To do this, we go to the "Setup" tab and press the "Save as..." button (14) to open the dialog box that allows us to save the file.

All that remains is to start the capture session by pressing the “Start” button (42). The session can be interrupted at any time and restarted later with the "Stop" (41) or "Pause" (43) buttons.

For my part, I wish you enjoy using the software and that you get good captures of your old movies.