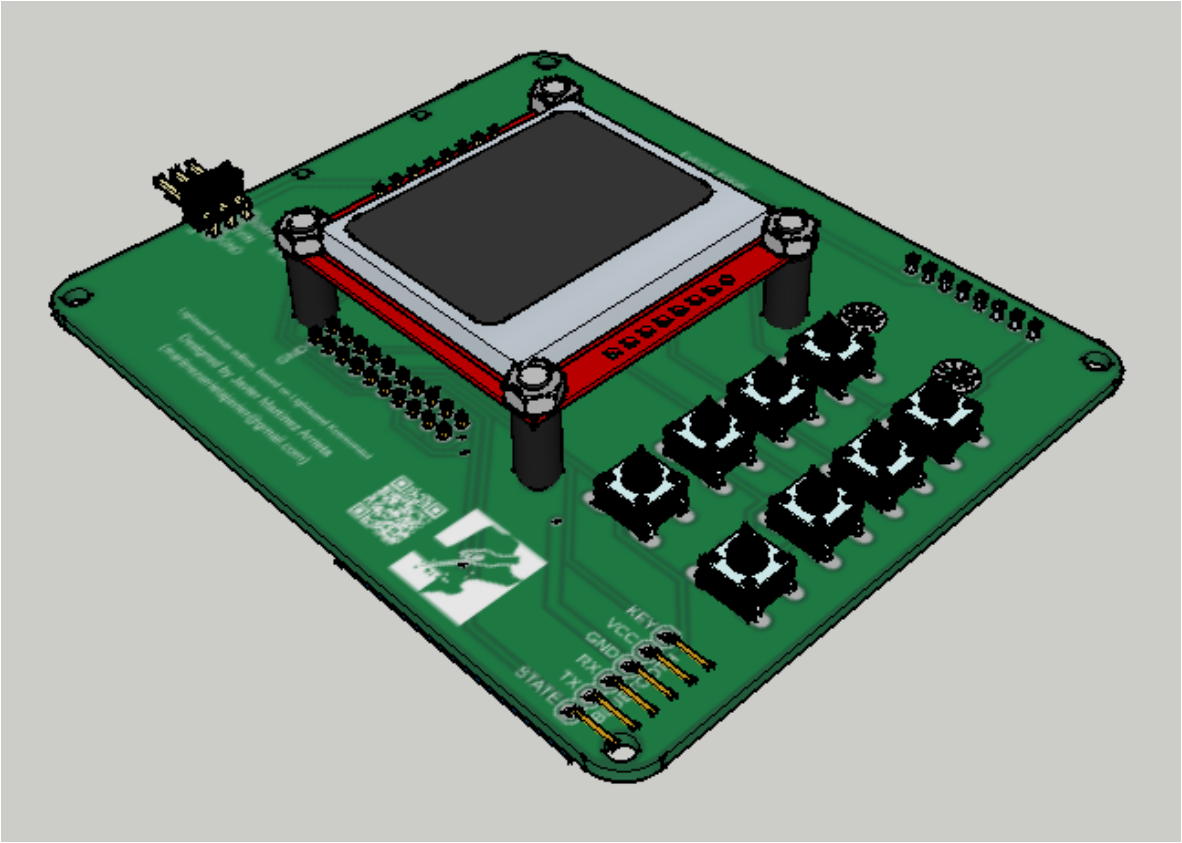
Lightwand Texas Edition

V 1.0



Designed by Javier Martínez Arrieta (martinezarrietajavier@gmail.com)

Available at https://github.com/JavierMA/lightwand-texas-edition

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1. About the author

This project has been developed by Javier Martínez Arrieta, a Telematics (Telecommunication) engineer who also likes electronics. In case of willing to solve a doubt, know more or consider a possible course you can write an e-mail to martinezarrietajavier@gmail.com

This and other projects are available at https://www.github.com/JavierMA

2. Acknowledgements

This project is based on Lightwand kosmonaut, developed by Pablo de Miguel Morales (https://github.com/pablodmm) who helped me in many parts of this project, so I would really like to thank him and some other people from AETEL for their help and support. Besides, Lightwand Kosmonaut is based on the light painting project that was developed by Michael Ross.

On the other hand, some of the functions available in the software are based or used from the examples of the course 'Embedded systems: shape the world' available in EdX and Jonathan Valvano's http://users.ece.utexas.edu/~valvano/arm/.

To finish acknowledgments, I would also like to thank Paul Stoffregen for his tutorial about understanding the FAT32 file system that helped me a lot to know how it works.

3. License

4. Compatible images

Compatible images for the Lightwand Texas Edition are PNM files, which can be created with programs like GIMP. A detailed tutorial can be found later in this document.

5. Soldering steps

The following steps will show what I think is the best way to solder all of the components into the board. As a general rule, the recommendation is to first solder the lowest components (the SMD ones in this case), and finish soldering the highest ones (the male pin headers that connect the TIVA to the board).

The steps to solder are the following:

5.1. Solder the SMD components (resistors, capacitors and the SMD buzzer):

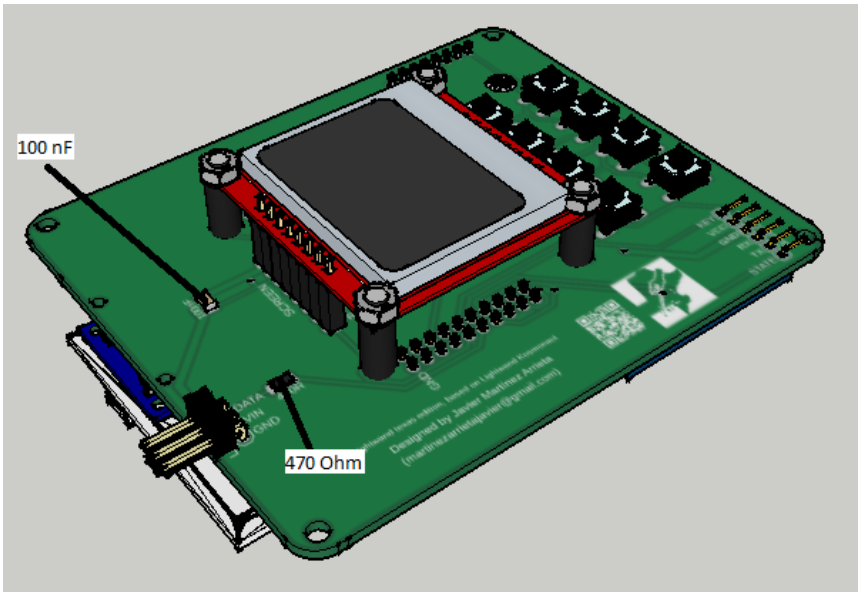

Figure 1: SMD soldering (top)

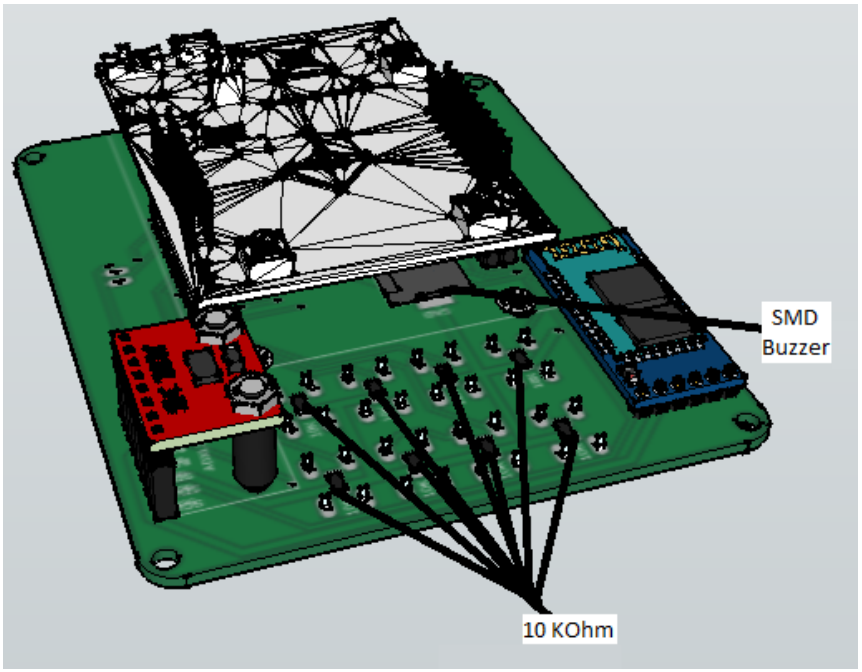

Figure 2: SMD soldering (bottom)

5.2. Solder the switches or buttons:

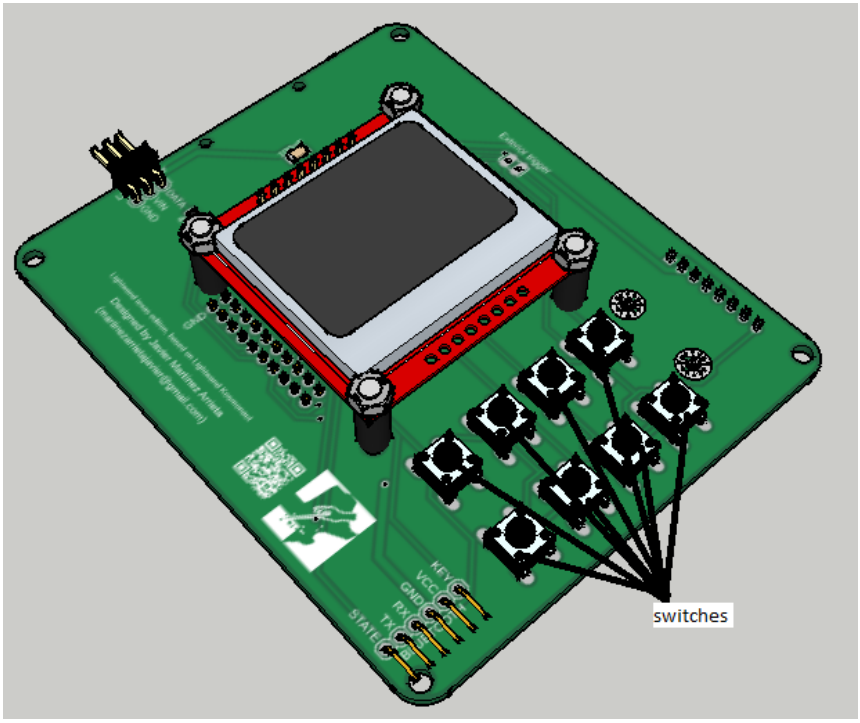

Figure 3: Buttons soldering

5.3. Solder the led strip connector:

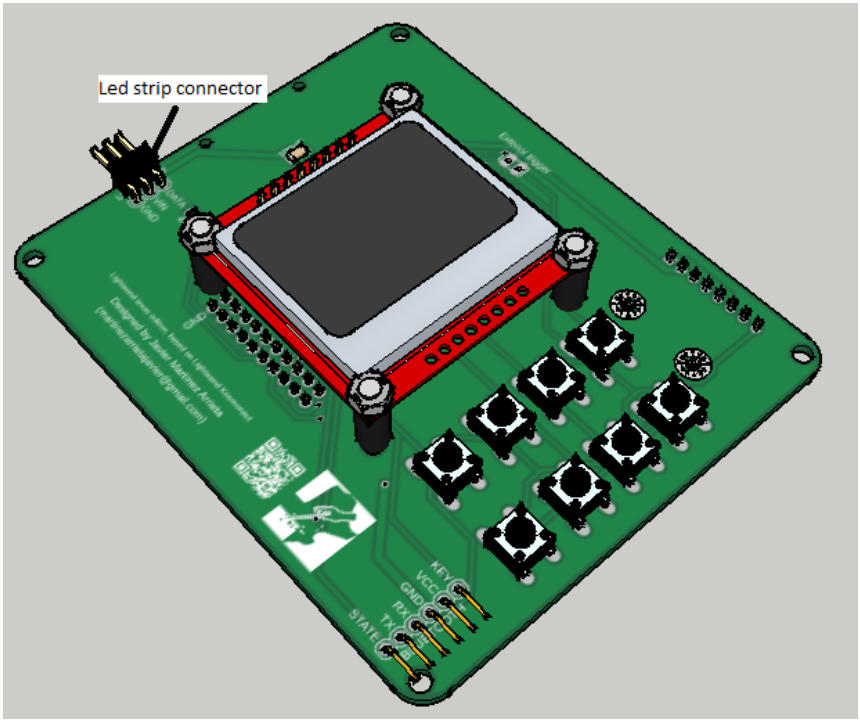

Figure 4: LED strip connector

5.4. Solder the bluetooth module (optional):

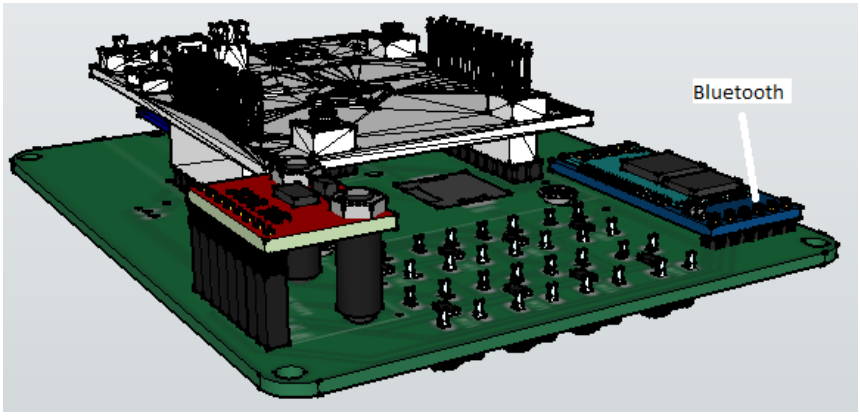

Figure 5: Bluetooth soldering

5.5. Solder the female pin header (8 pins) to connect the ADXL345 accelerometer (optional):

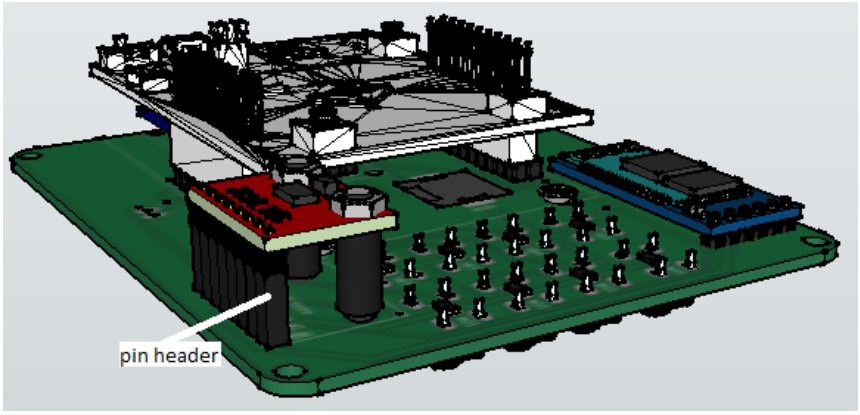

Figure 6: ADXL345 pin header

5.6. Solder the female pin header (8 pins) in order to connect the screen:

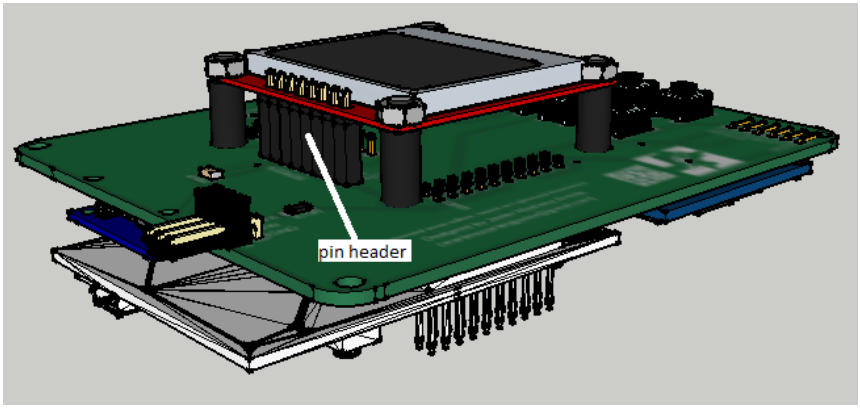

Figure 7: Screen pin header

5.7. Solder the SD card adapter:

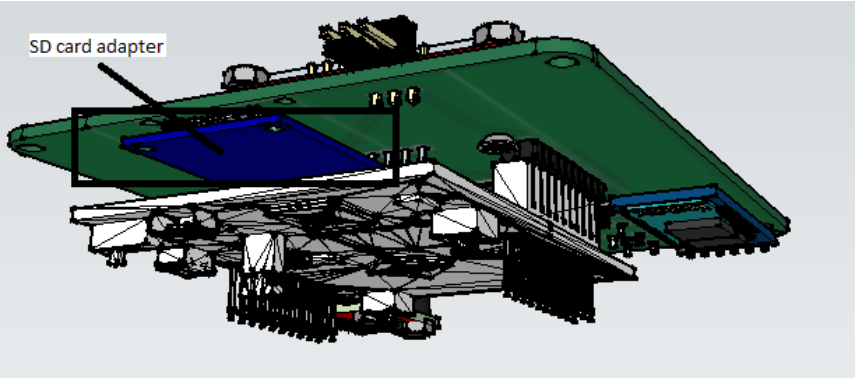

Figure 8: SD card adapter soldering

5.8. Next, solder the male pin headers (2x10):

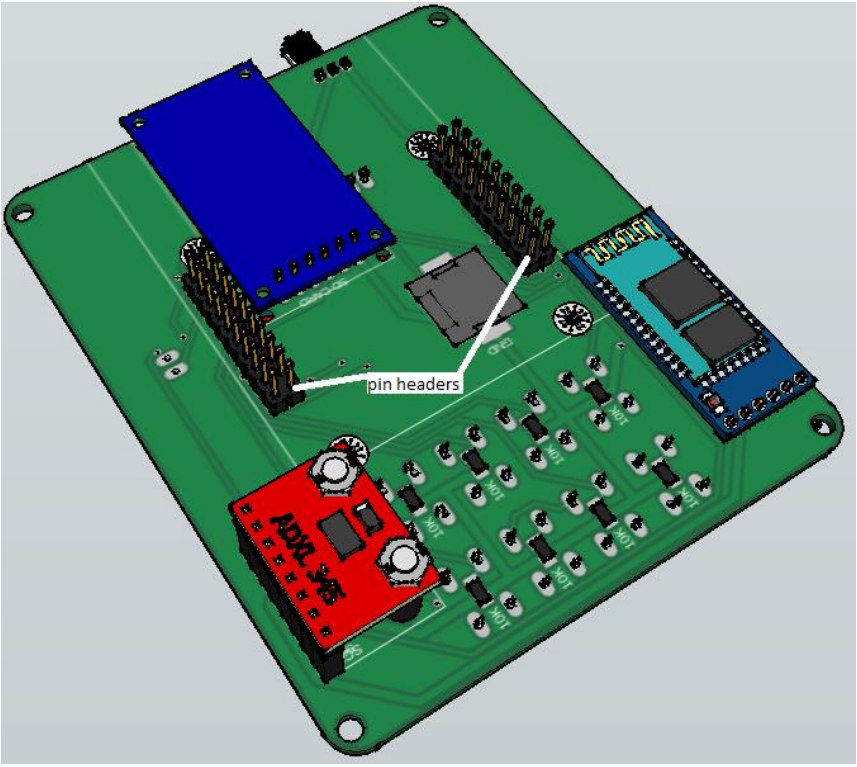

Figure 9: TM4C pin headers connectors

5.10. De-solder the cables from the LED strip, which can be reused to create a longer cable that can be connected to the board:

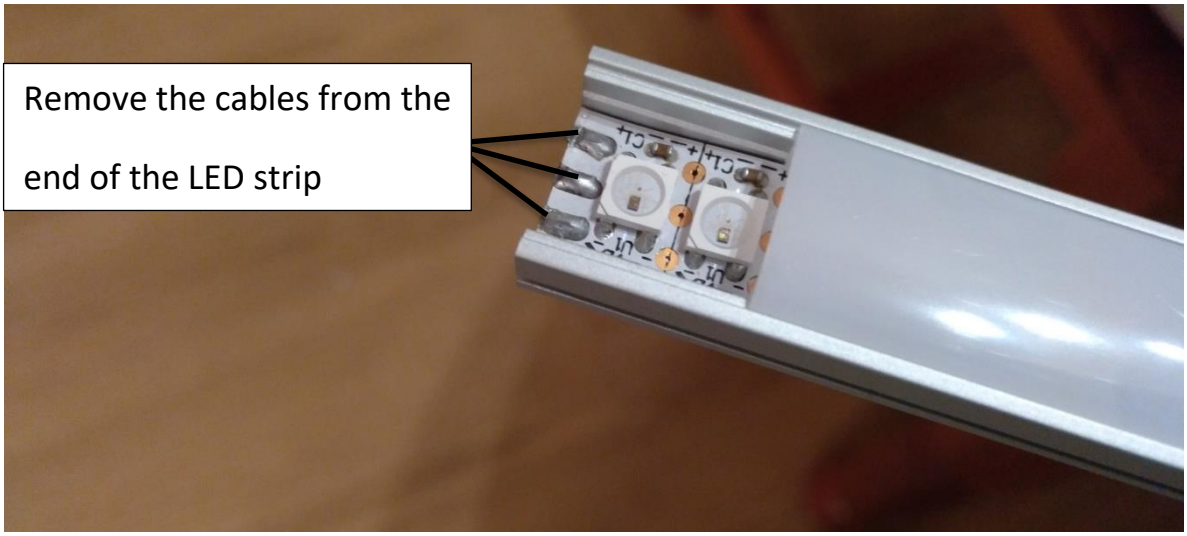

Figure 10: LED strip cable removal

5.11. Connect the free extreme of the cable to a female molex connector to have a result like the following:

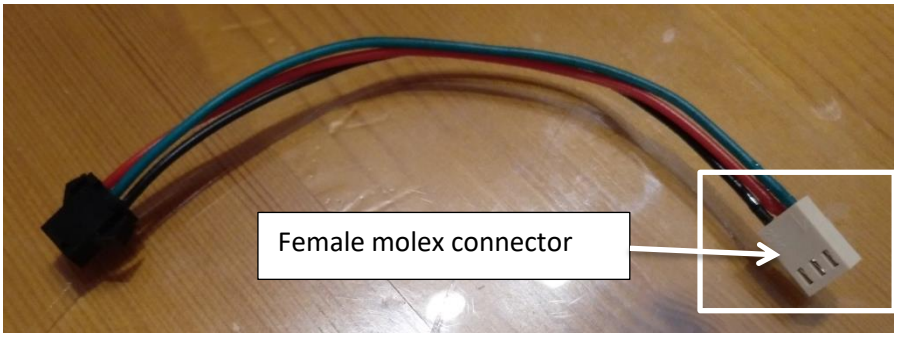

Figure 11: Female molex connector soldering

5.12. Connect the black connector of the cable to the one attached to the led strip:

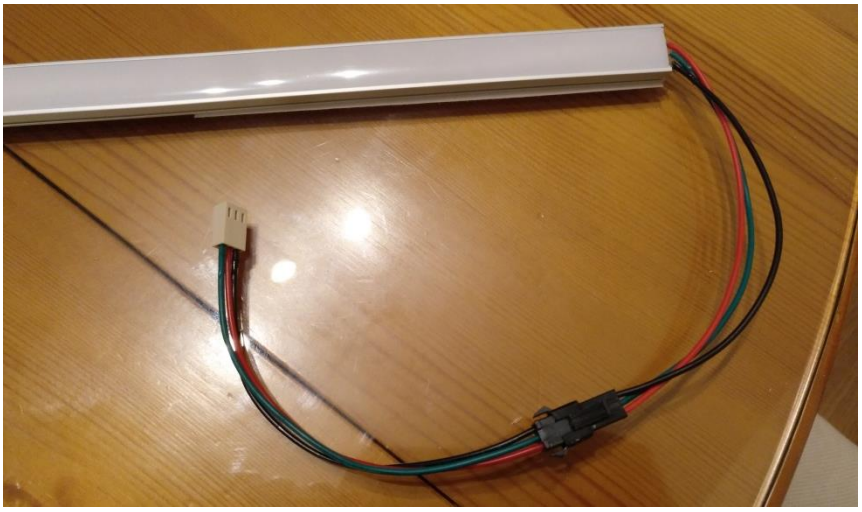

Figure 12: Extended cable connection

5.13. Finally, connect the female molex connector to the male one on the board:

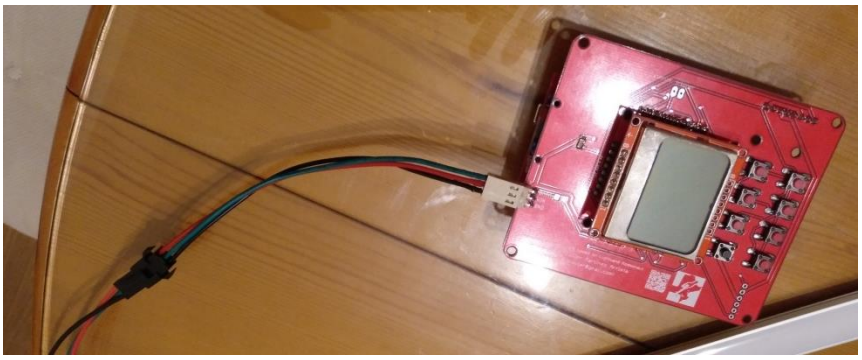

Figure 13: Connection between the LED strip and the board

6. Box mount

Now that all hardware is ready, the box can be mounted in order to have our final product as well as saving parts from dust or any other thing. In the following image you can see the different box parts.

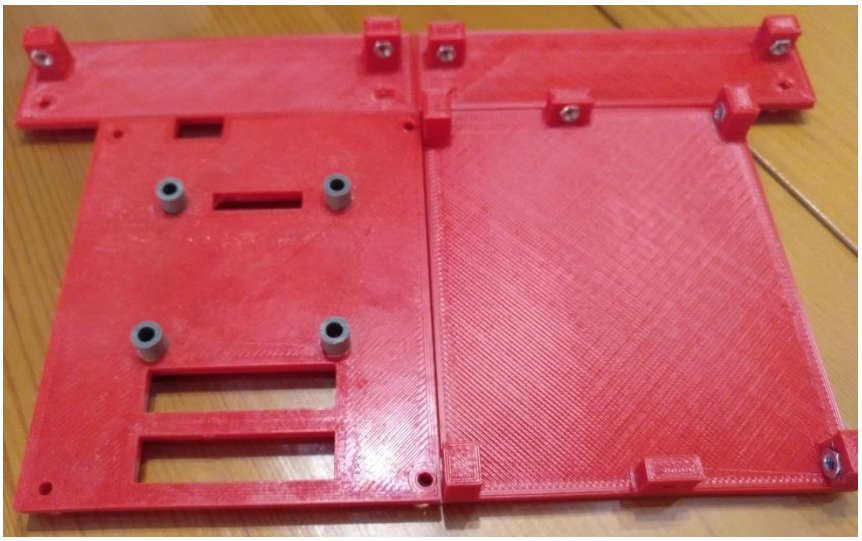

Figure 14: Box parts

Before starting to screw, nuts should be placed in their place. It may happen that it is needed to apply heat (for example, with a solder tin) to the nuts in order to place in the holes. All nuts and screws are M3, with the exception of screen, which are M2.

For the purpose of mounting the box, follow the steps indicated.

6.1. Place the top piece spacers and display

In order to place the top part of the box, first introduce the M3 separators in the holes so as to later put the display in its place. Once done, place the top part of the box as it can be seen in the picture below.

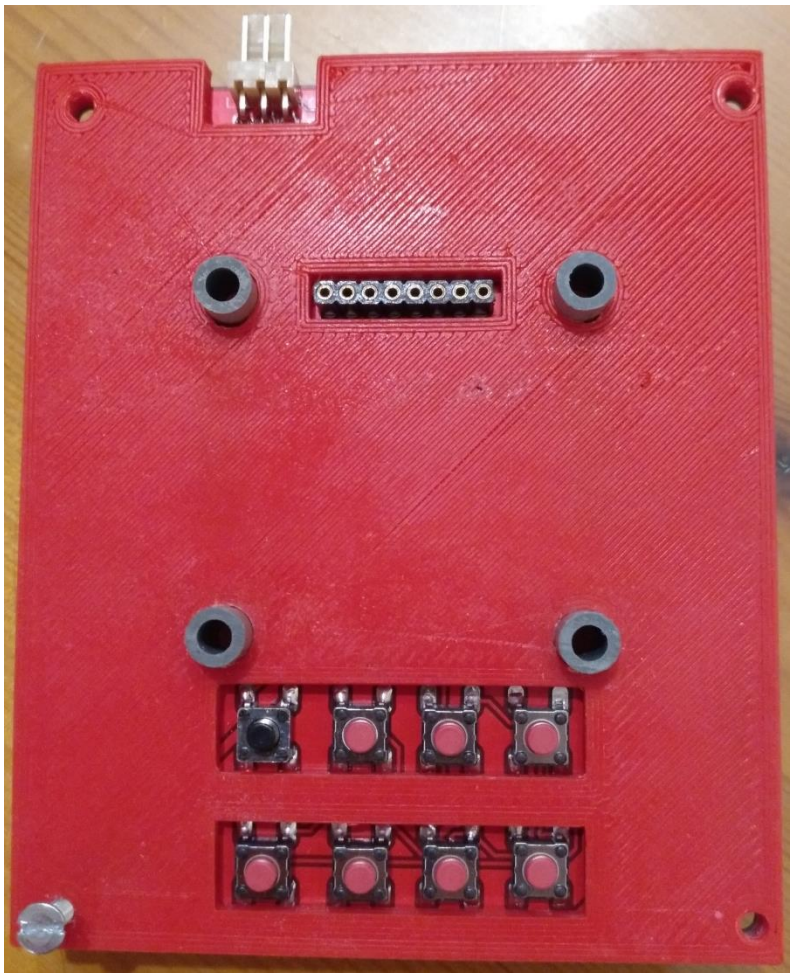

Figure 15: Top part of the box

Finally, introduce the M2x14 screws and the display as you can see in the next picture:

Figure 16: Display and box top joined

6.2. Place together the top and side parts:

For this step, note that the side parts are not equal, as on the right side holes are closer to the top edge. For the purpose of putting the different parts together, use at least M3x10 screws, though M3x14 would be better.

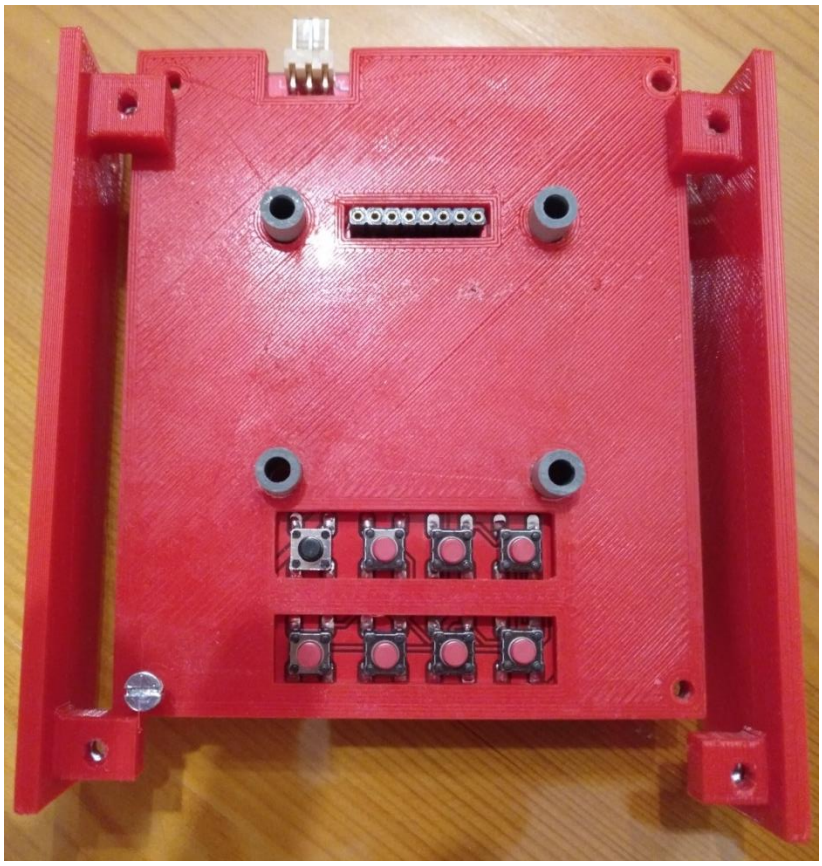

Figure 17: Top and side parts of the box

6.3: Joint the bottom, front and back parts with the screws

Unite the bottom, front and back box parts with at least M3x10 screws (M3x14 better). Before screwing, make sure that holes and nut holes will fit with the top and side parts.

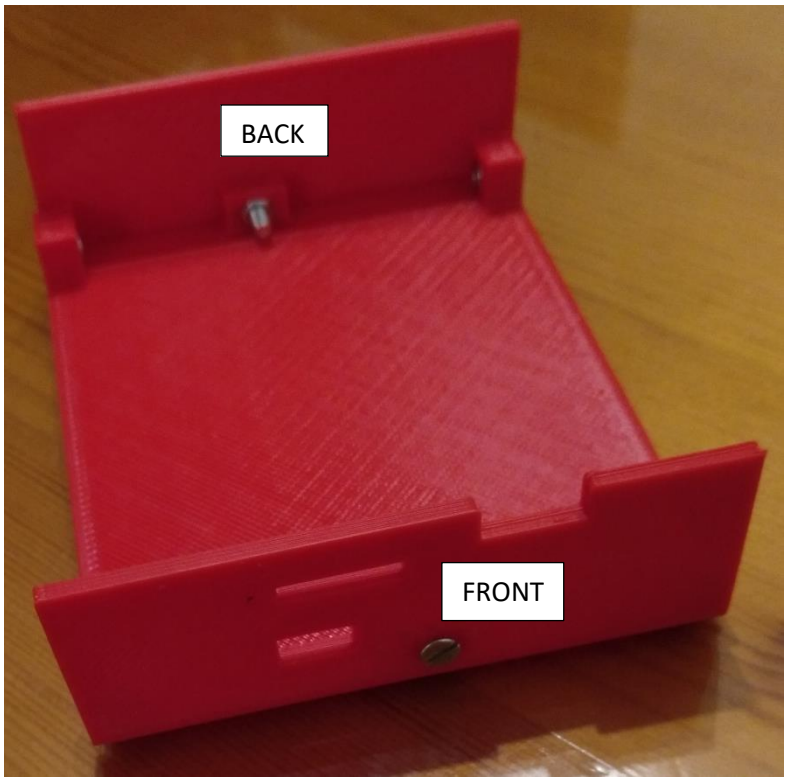

Figure 18: Joint of bottom, front and back parts

6.4. Joint all together

In order to finish mounting the box, place the M3x14 screws in the bottom part of the sides so as to unite it all together:

Figure 19: Mounted box

Now that the box mount is finished, put some velcro in both the bottom box and the aluminum profile as you can see in the following image:

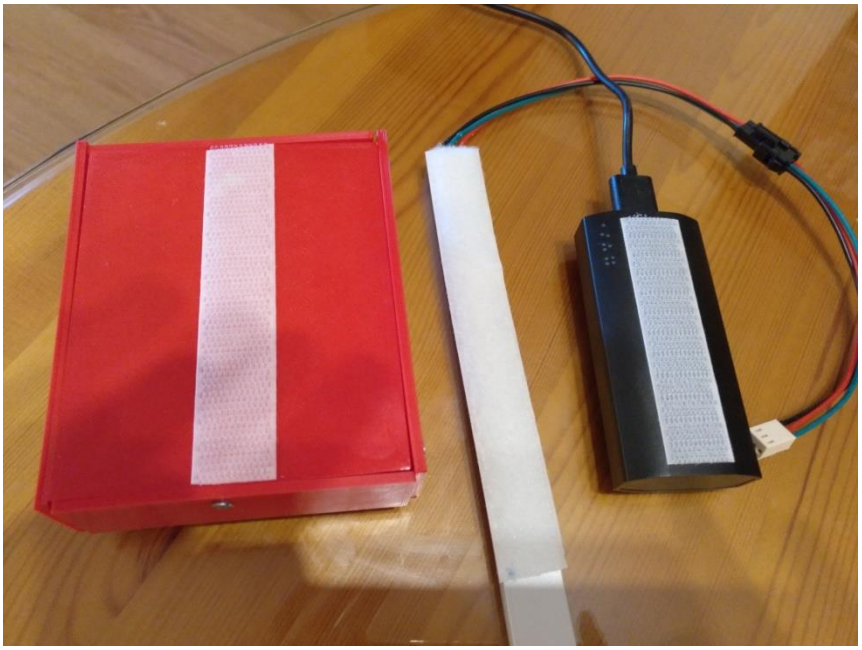

Figure 20: Velcro tape in box, battery and profile

That being done, ‘paste’ all parts and you will have your Lightwand completely mounted:

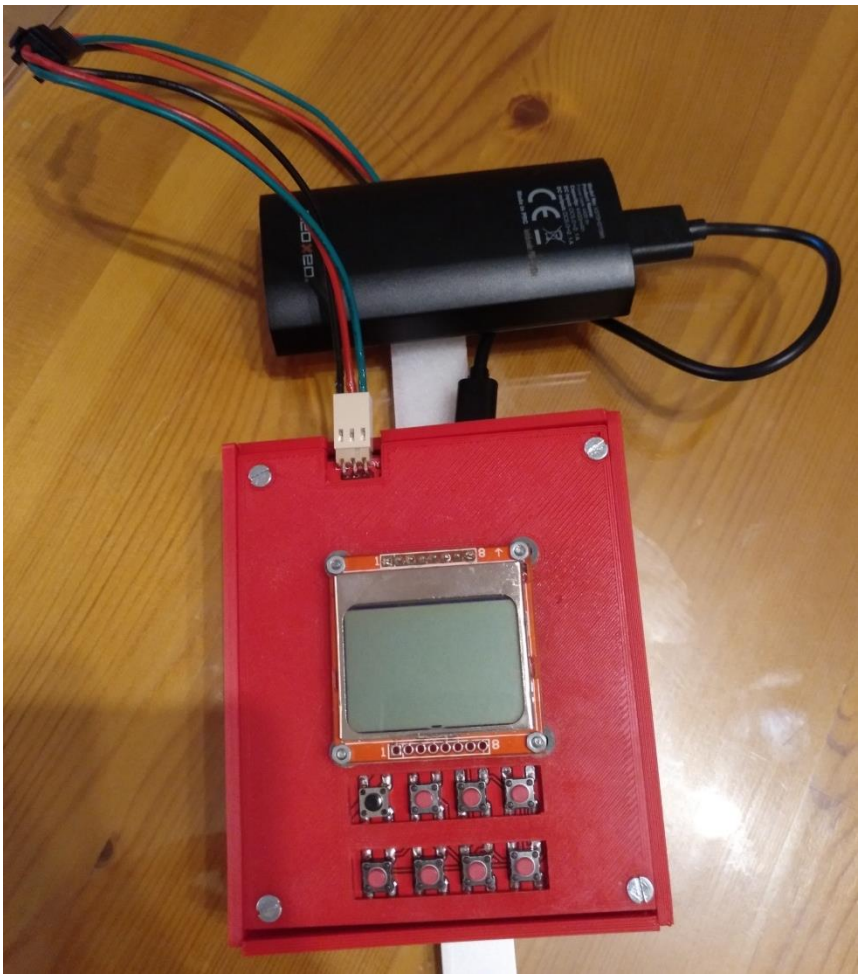

Figure 21: Lightwand fully mounted

7. Menus

Once the board is powered, the first thing that will happen is a check to verify if a MicroSD card with FAT32 format is connected.

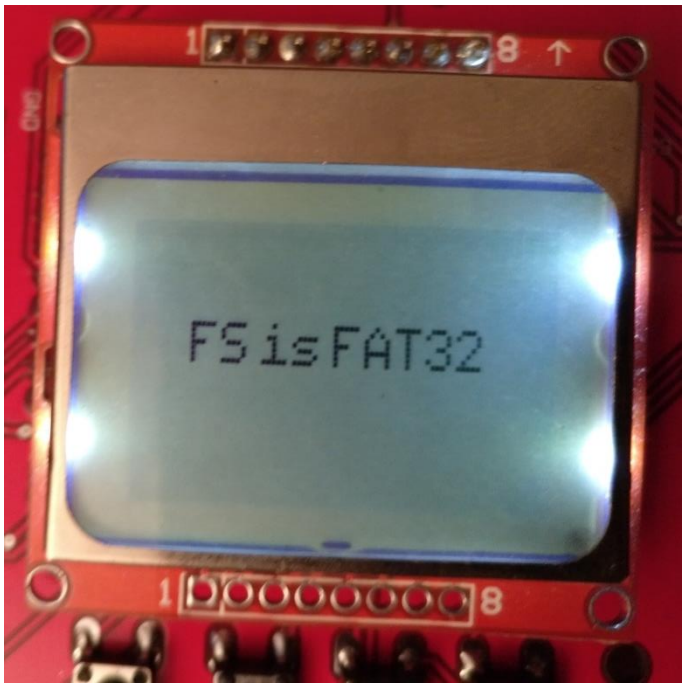

Figure 22: File system check

After the check, an initialization takes place and the main menu is shown:

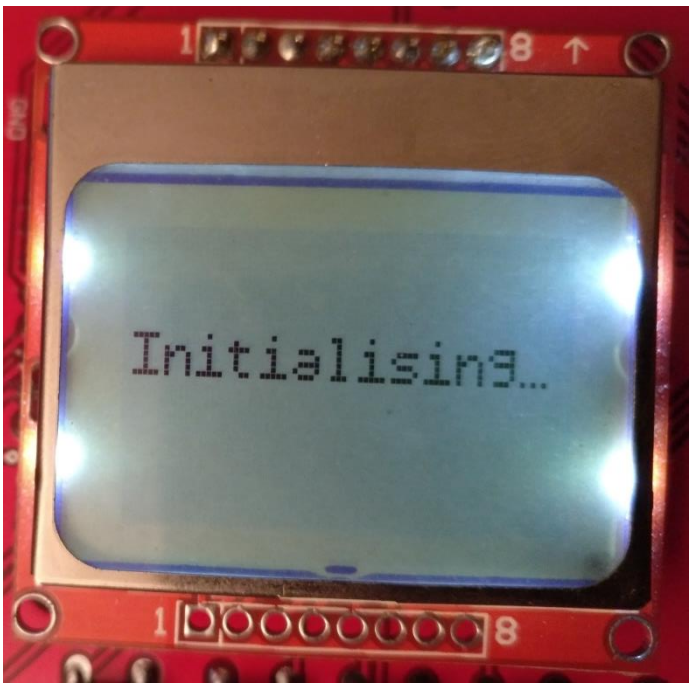

Figure 23: Initialisation

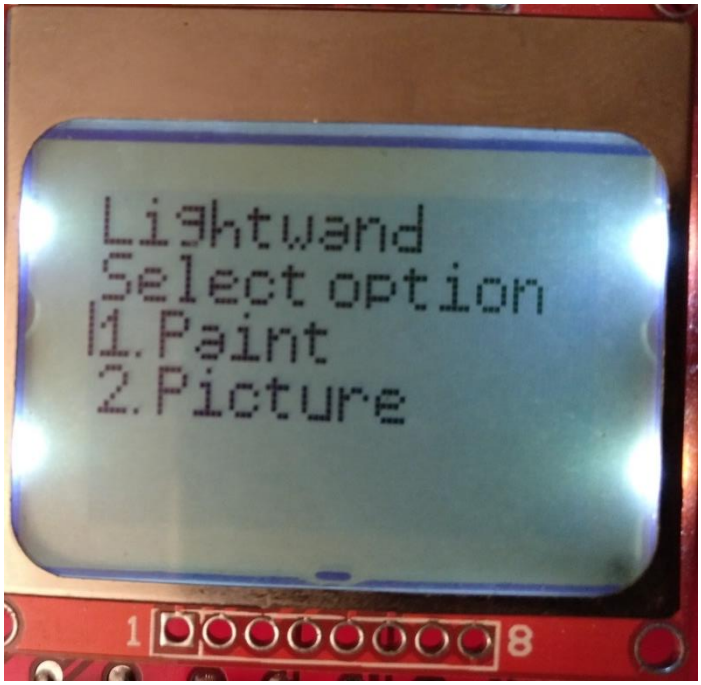

Figure 24: Main menu

You will find two menu options:

-Paint: This option will let you choose which LED(s) to be light and in which colours, so you can 'write' in the air like in the following example:

Figure 25: Lightwand writing example

-Picture: This option will let you choose an image as well as select the different options (brightness, delay and whether to play a sound in order to indicate the start). The following image shows and example:

Figure 26: Lightwand picture example

Menu controls:

Before showing the default configuration, take into account that the reset button cannot be changed in software. By default, the configuration is as follows:

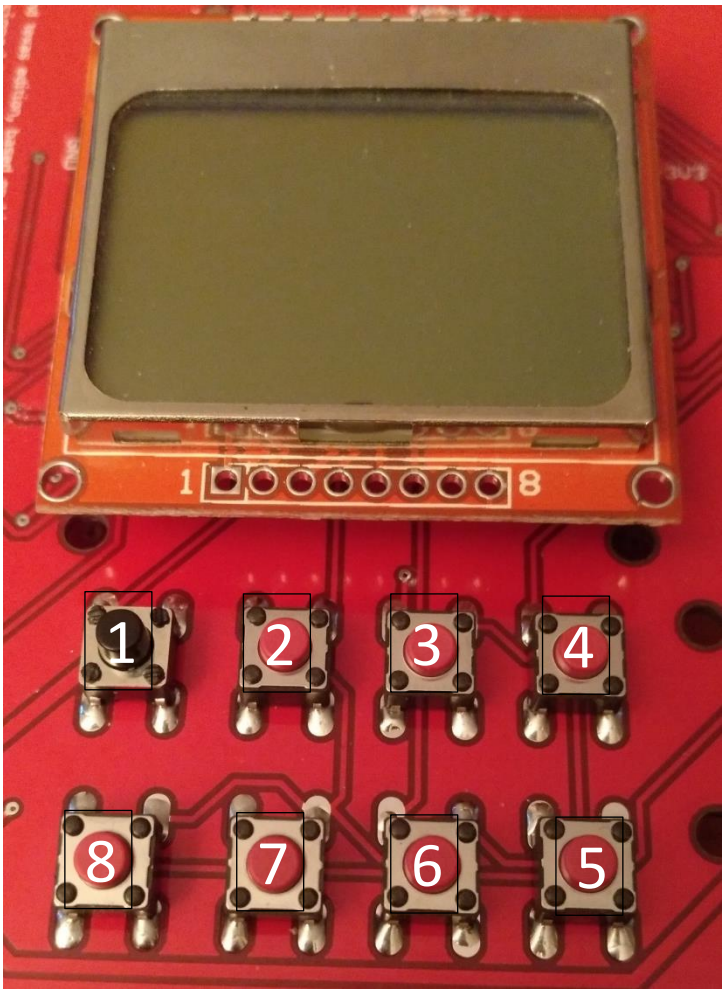

Figure 27: Options buttons

-Reset (1): This button is configured to reset the board in case it is necessary.

-Select (2): This button is configured to select the option. You can see a vertical bar on the left:

-Up (3): This button is configured to move up to the previous option in the shown menu.

-Backlight (4): Whether to set the backlight on or off.

-Increase (5): Increase the value of a setting like the brightness or the delay

-Down (6): This button is configured to move down to the next option in the shown menu.

-Decrease/go to the previous menu (7): Decreases the value of a setting like the brightness or go to the previous menu

-Start (8): In the case of the picture menu, starts reading the image and showing it by rows in the LED strip. In the case of the paint menu, lights the configured LEDs on or off.

Paint menu:

The first menu will let select the following:

-**Basic colours**: Whether to use the red, green or blue colour in the LED that will be selected later.

-**Random**: Randomly selects the colour of each LED, which will be shown once the start button is pressed.

-**Monochrome**: Consecutively lights the LEDs in white or black.

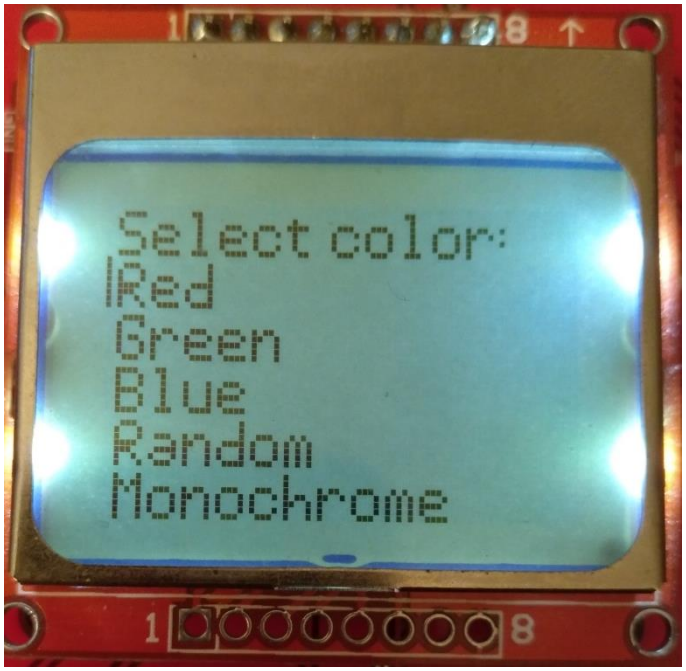

Figure 28: Paint colour menu

If the option selected is one of the basic colours, the next menu will let you choose to which LED or LEDS will be applied. It is possible to go to the previous menu and select another colour to apply it to other LEDS. Once the setting is done, press the select button to confirm the setting. Finally, press the start button to light on or light off the LEDs.

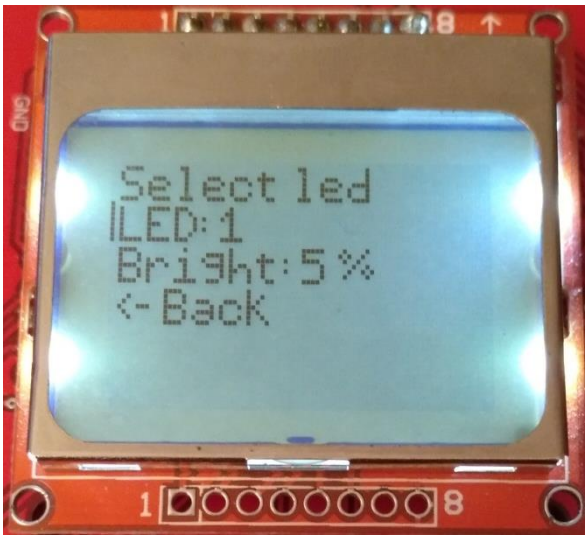

Figure 29: Paint menu, LED and brightness selection

Picture menu:

This menu will permit select the image, whether to play a sound when ready to start showing the image, brightness and delay. The brightness refers to the colour brightness and the delay sets the time between the image rows. A recommended configuration for brightness would be 5% and around 25-30ms in the case of the delay. Note than in the case of brightness even a 100% setting the colour may not be pure due to the power current.

In order to select the picture, move to the line below 'Current file' and press the select button, which will show the images found in the microSD card. Note that in this version a maximum of 12 images will be shown. Besides, the images can be even two directories deep, though it has been tested that putting them all in the root directory results in a faster read of available files.

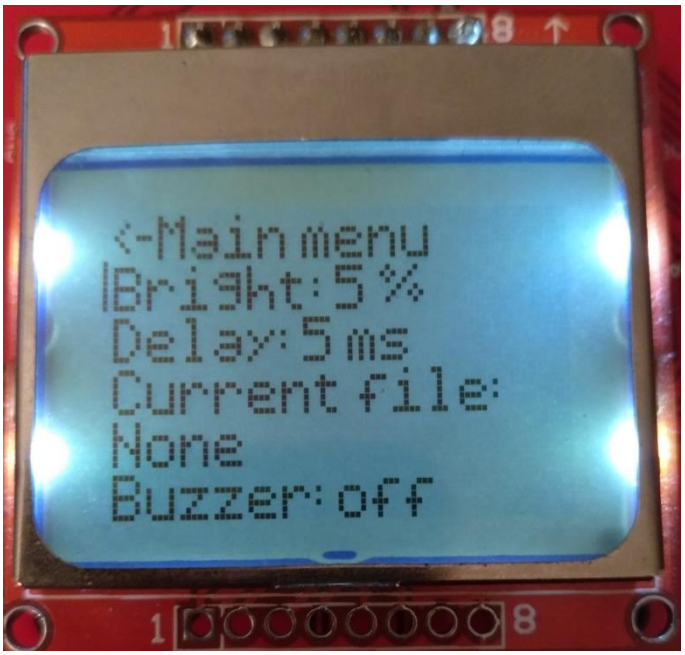

Figure 30: Picture menu

8. GIMP Image Formatting

Note: This section was entirely written by Pablo de Miguel Morales, with only a few additional notes from me.

The following Steps cover the preparation of a standard image into a *LightWand* .pnm compatible image usign the free software program GIMP.

7.1. Step 1: Choose an Image

The first step consists in finding a proper Image to be displayed with the *LightWand*. In general, the two things to be considered are:

- An Aspect Ratio not superior to 1x2. The reason for this is that, as it has a fixed 144LED 1m side, a larger Aspect Ratio will mean having final images taller than 2m. This can be challenging for the user holding the *LightWand*. In case the image is mean to be horizontal, no limits are considered.
- A not extremely detailed Image. Even do 144 Pixels are quite a good resolution, it cannot be expected for the *LightWand* to display an extremely accurate image.

For this guide, the image chosen has been “The Kiss” by *Gustav Klimt*[1]:

[1] The Kiss(Gustav Klimt)(1909), Wikipedia, http://en.wikipedia.org/wiki/The_Kiss_%28Klimt%29

Figure 31: Gustav Klimt Raw Image

The resolution chosen for this raw image is of 3768x5051. The higher the resolution, the better results will the final image have, as any change (contrast correction, brightness correction) in a LOW quality image will be a lot more noticeable.

Once a proper image has been chosen, the next step can be started.

7.2. Step 2: Open the Image with GIMP

The second Step consists in opening the image with GIMP through *File/Open*.

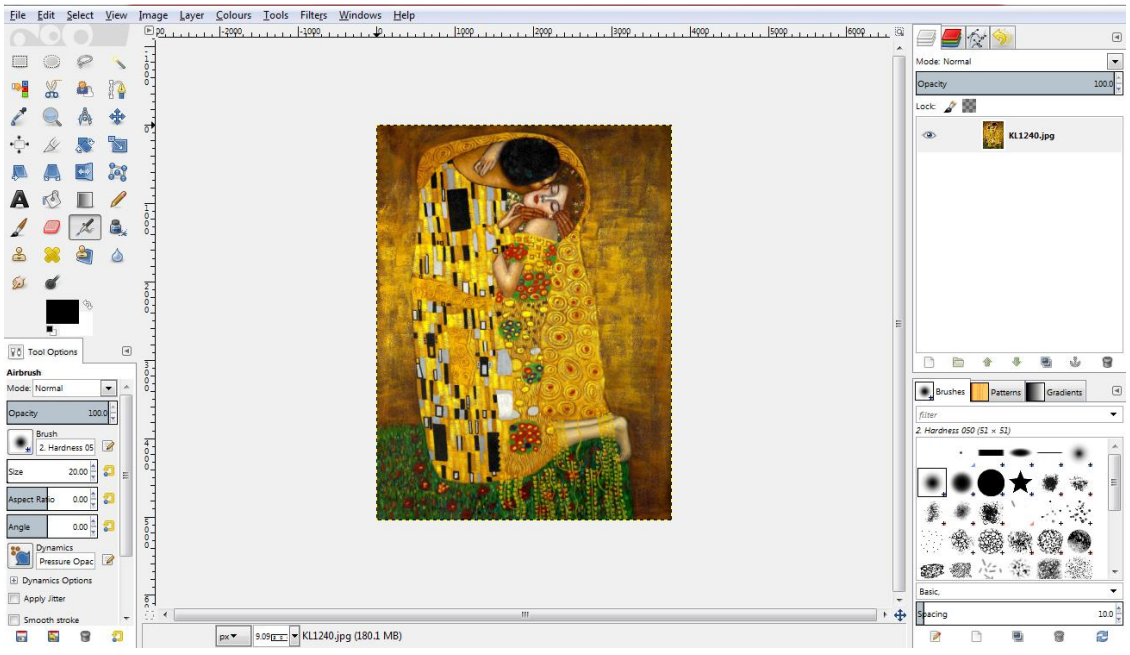

Figure 32: GIMP File Open

Once the Image has been opened, the next step can be started.

7.3. Step 3: Cut the desired section of the Image

The third step consists in cutting the part of the image that is to be displayed. This normally consists of separating the main figure from the rest of the image. Through this process the Canvas is eliminated, improving a lot the final image as no straight lines or edges exists. Without these straight lines, any mistake in the Photographic process is less noticeable.

To cut the desired Image, first duplicate the original layer doing right click in the layer in the *Layer Window* and selecting *Duplicate Layer*.

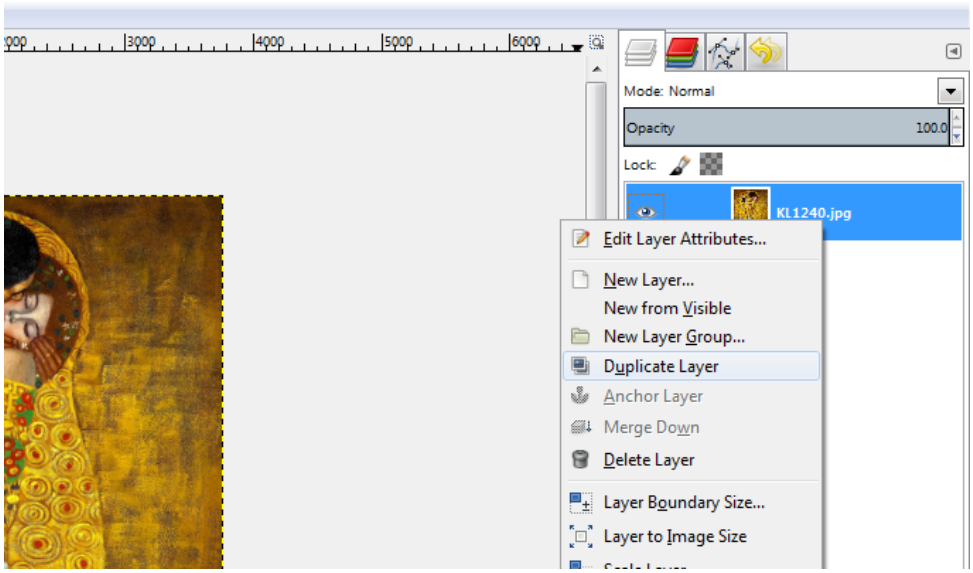

Figure 33: GIMP Duplicate Layer

Once the layer has been duplicated, cut the main figure with the *Free-selection tool* (*Shortcut I*). This process can be long and tiring. Once it has been cut, transfer it to a new layer using To new Layer (Shortcut Ctrl+Shift+N).

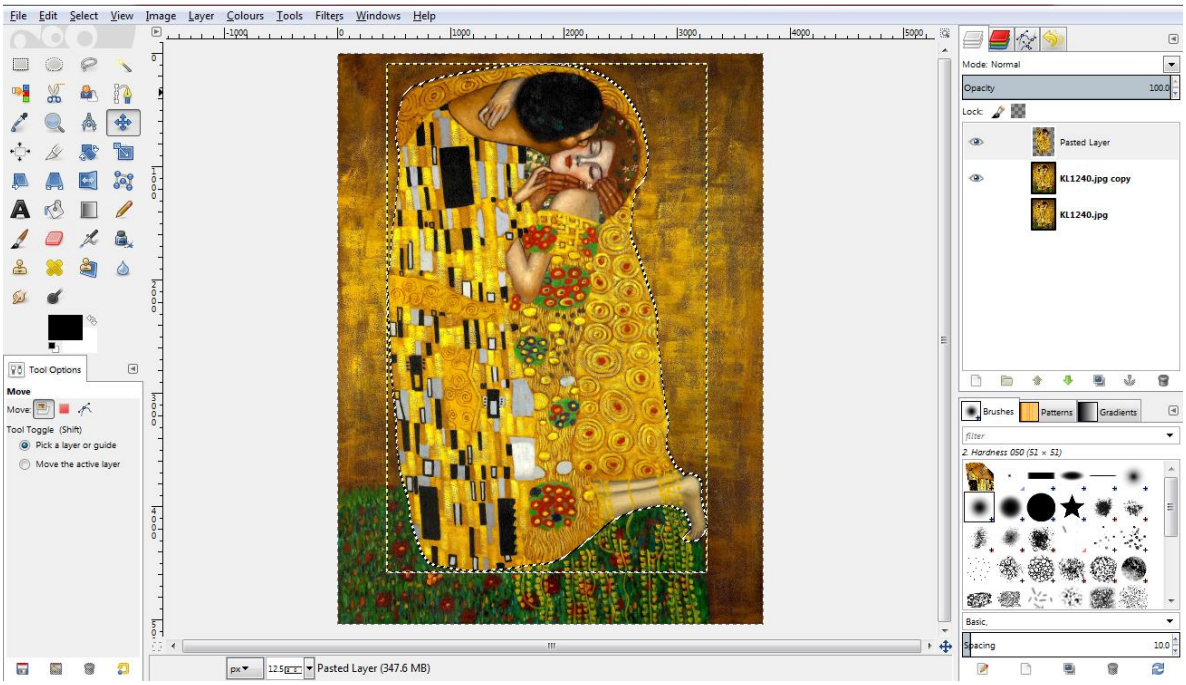

Figure 34: GIMP To New Layer

Once this has been done, delete the previous layer maintaining only the main figure.

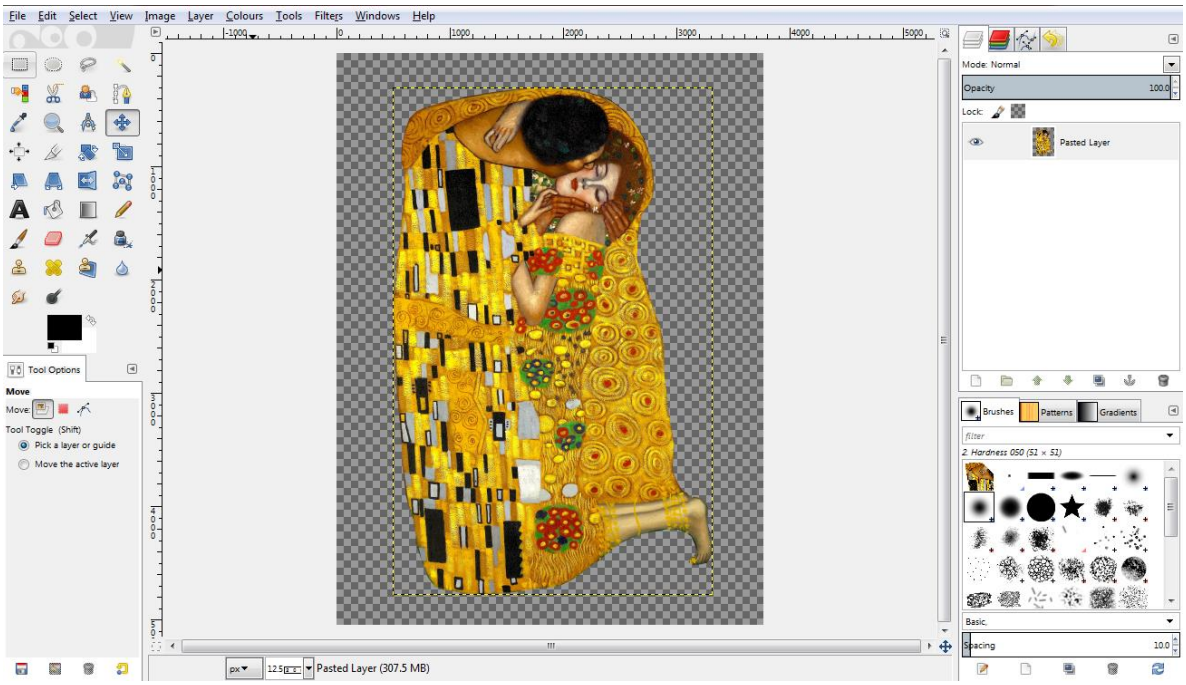

Figure 35: GIMP Main Figure

Once the main figure has been isolated, the next step can be started.

7.4. Step 4: Resize the Image

The fourth step consists in resizing the image for it to adapt to the 144 LED Strip. This means to have the horizontal dimension of 144 pixels. To do this, the tool *Scale Tool* (Shortcut shift+T) is used.

Once in the tool, first of all select the proportional scale option. Once this has been done, establish 144 as the *Width* parameter and press *Scale*.

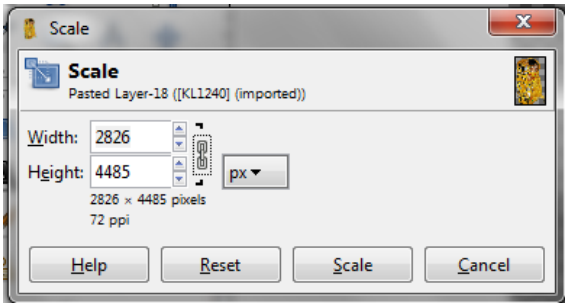

Figure 36: GIMP Scale Proportional

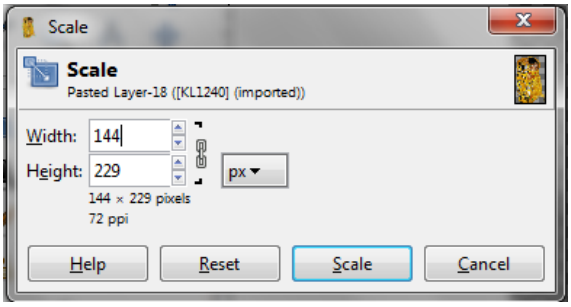

Figure 37: GIMP Scale Parameters

Once the image has been scaled, change the canvas size through Image/Fit Canvas to Layers. The new Canvas should have a 144 Width dimension.

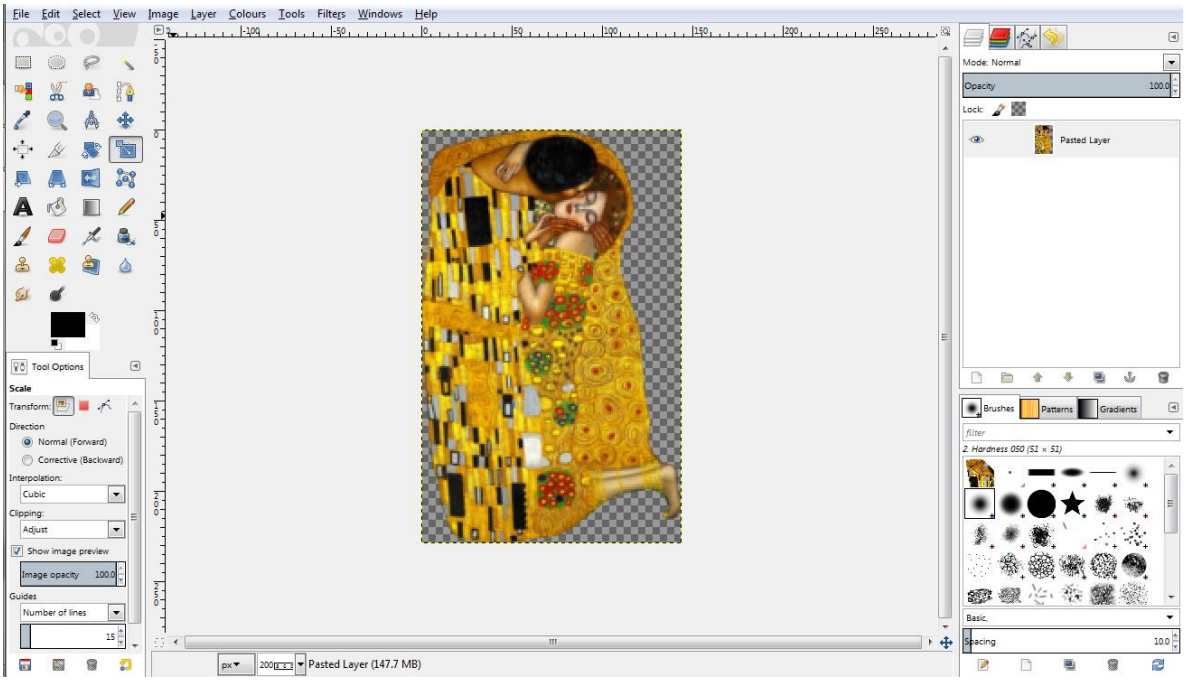

Figure 38: GIMP Resized Image Canvas

Once the Image has been resized, the next step can be started.

7.5. Step 5: Turn the Image 180º (only if moving the lightwand from the bottom to the top)

The fifth step consists in turning the image around for it to be displayed from down to up. This step is only important if the image has to be in contact with the ground. Otherwise, this step can be skipped. To turn the image use the *Rotate Tool (Shortcut Shift+R)* and make a 180º flip.

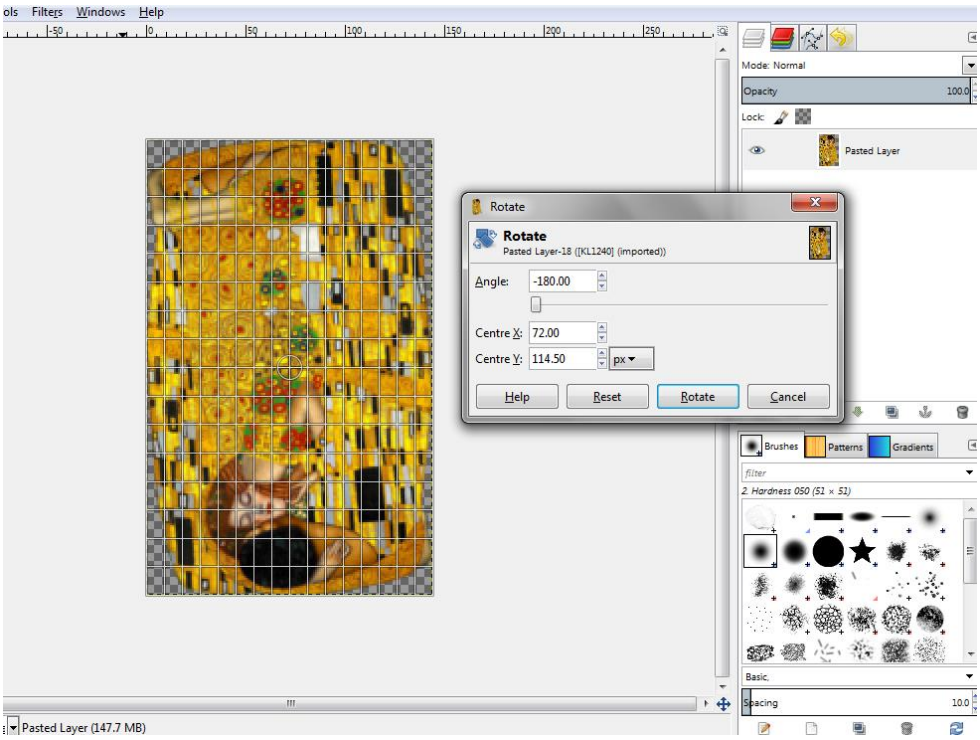

Figure 39: GIMP Image Rotation

The *LightWand* reads the images starting from the top pixel row, therefore, that is the first displayed.

7.6. Step 6: Add a Black Background

The sixth step consists in adding a black background to the image for it not to be displayed by the *LightWand*. This can be done in the Layer window by right click *New Layer/Foreground* Color.

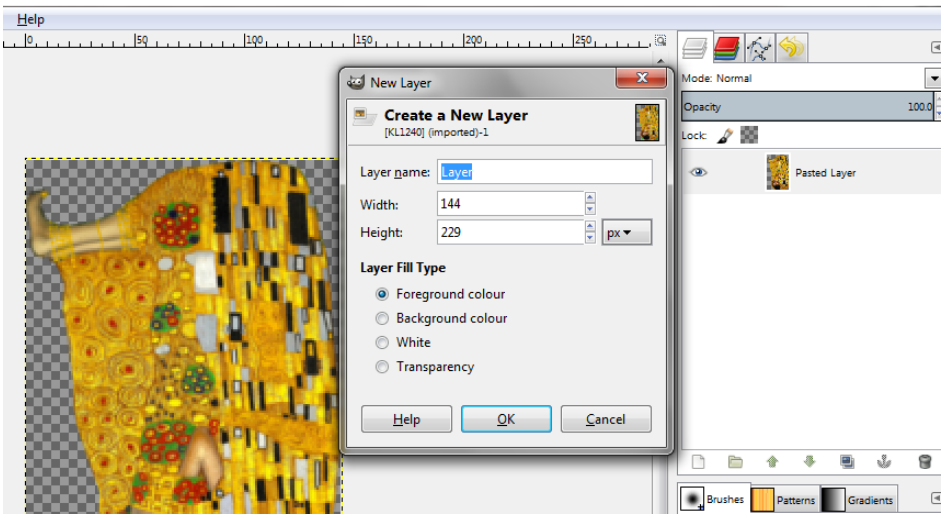

Figure 40: GIMP New Layer

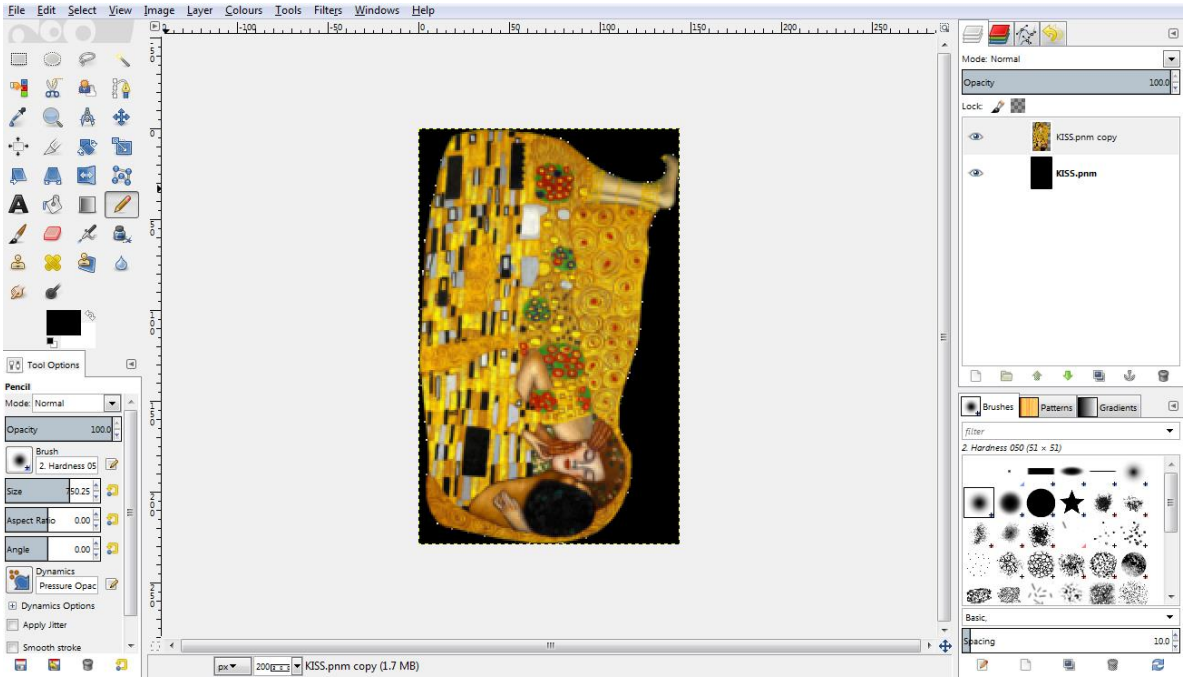

Figure 41: GIMP Black Background

Once this has been done, the next step can be started.

7.7. Step 7: Export .pnm File

The seventh step consists in exporting the image in a *.pnm* file that can be read by the *LightWand*. This can be done through *File/Export as* by setting a name with the *.pnm* termination. The *Select File_Type(By Extension)* must be selected.

When exporting the *Raw Data formatting* must be selected instead of *ASCII*.

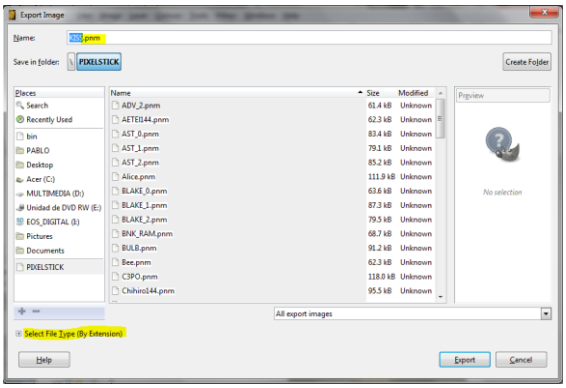

Figure 42: GIMP Export

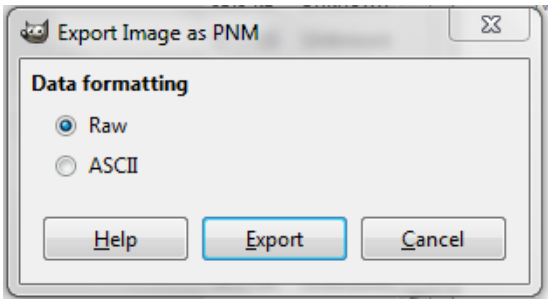

Figure 43: GIMP Raw .pnm Mode

Once this step has been done, the GIMP process is finished and the image file can be stored in the SD Card.

9. Mobile camera setup

In order to be able to take pictures with a mobile camera, it is required to use the light painting mode (if available) or set up a manual mode. You may find that your camera is not compatible, but most of the recent mobile devices have an improved camera that will let you take photos using light painting techniques. Applications like Camera FV-5 can be useful for this photography technique.

The following example shows how to set a manual mode using the camera of the Aquaris X5, which will be probably similar to other mobile devices:

- With the camera application open, press the circle with the A in order to later choose the manual mode (a circle with the letter M):

Figure 44: Press the Auto mode button

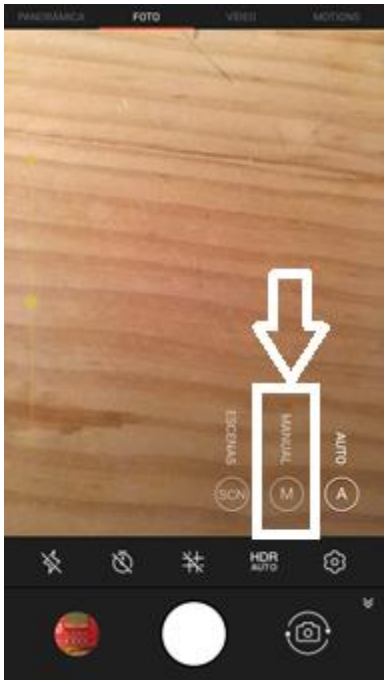

Figure 45: Press the Manual option

- Firstly, select autofocus, so the camera will do it by itself:

Figure 46: Autofocus selection

- Secondly, select an automatic white balance, so the camera will do it by itself:

Figure 47: White balance selection

- Thirdly, select the lowest ISO possible. This way, the images will have much less noise:

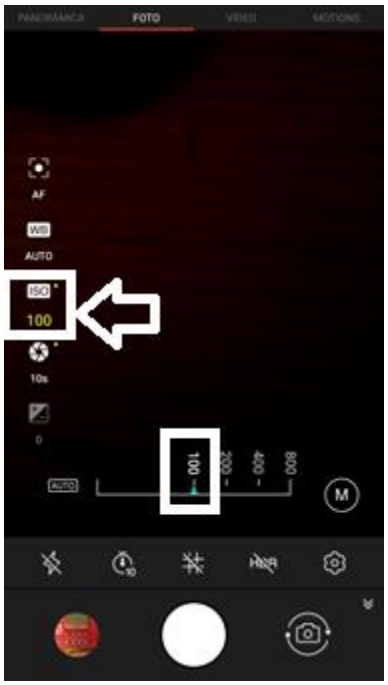

Figure 48: ISO selection

- -Next, select the shoot time. This time will depend on what is going to be photographed, but usually a 10 second shoot should be fine:

Figure 49: Shoot time

- Finally, select the delay time before taking the shoot, so you can have time to prepare unless someone else can press the button in the proper moment:

Figure 50: Start delay time

10. Power recommendations

In order to have images with good colour, it is recommended using a Power Bank with 5V and at least 2000 mAh. According to documentation, each LED can consume up to 60mA at full brightness, so 60mA x 144 LEDS = 8,64 A, so in case of willing taking full colour pictures you will need a Power Bank with higher output current.

11. Future work

In order to add more options or ease photographing pictures, a Bluetooth and an ADXL345 module were added in the board design, though are yet to be implemented.