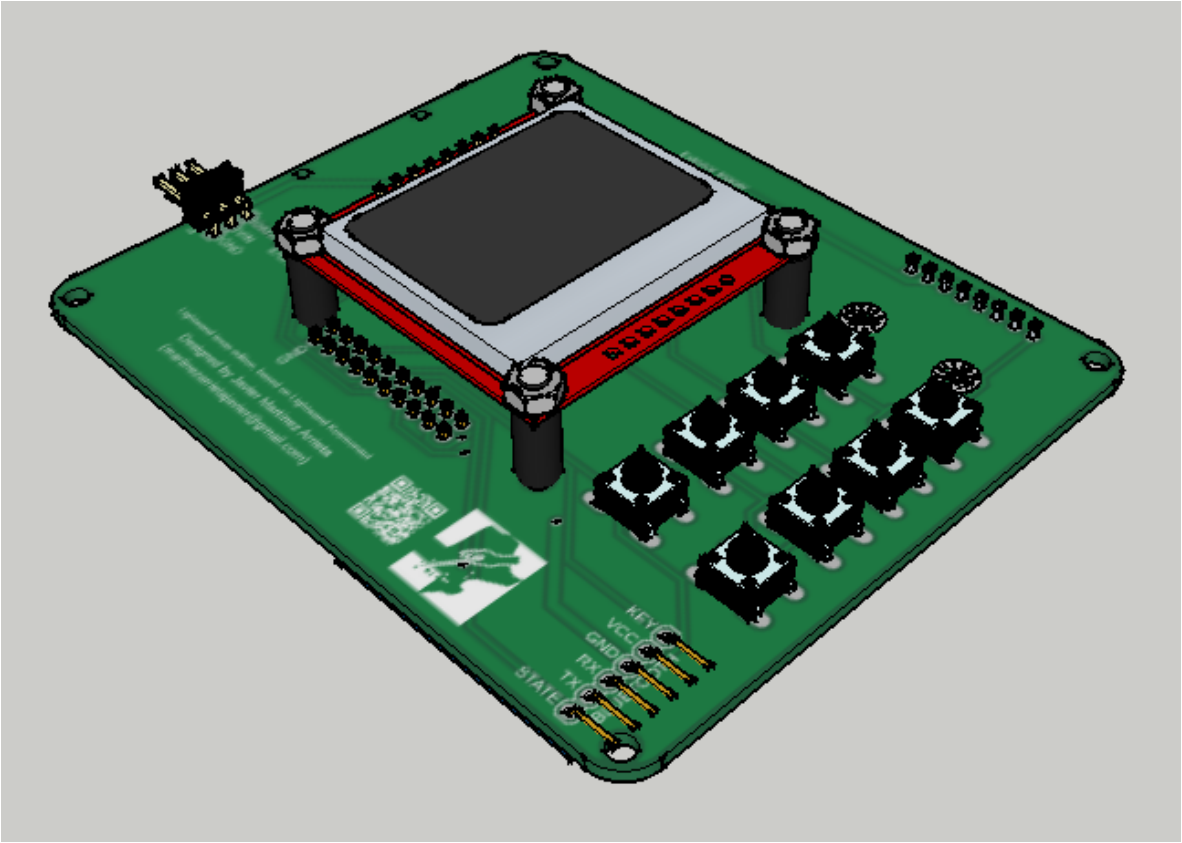
Lightwand Texas Edition

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):

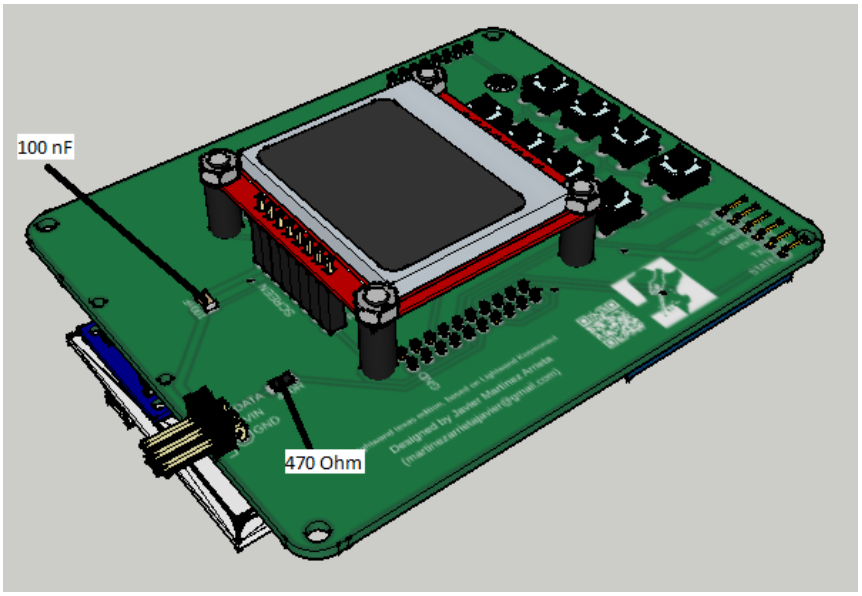

Figure 1: SMD soldering (top)

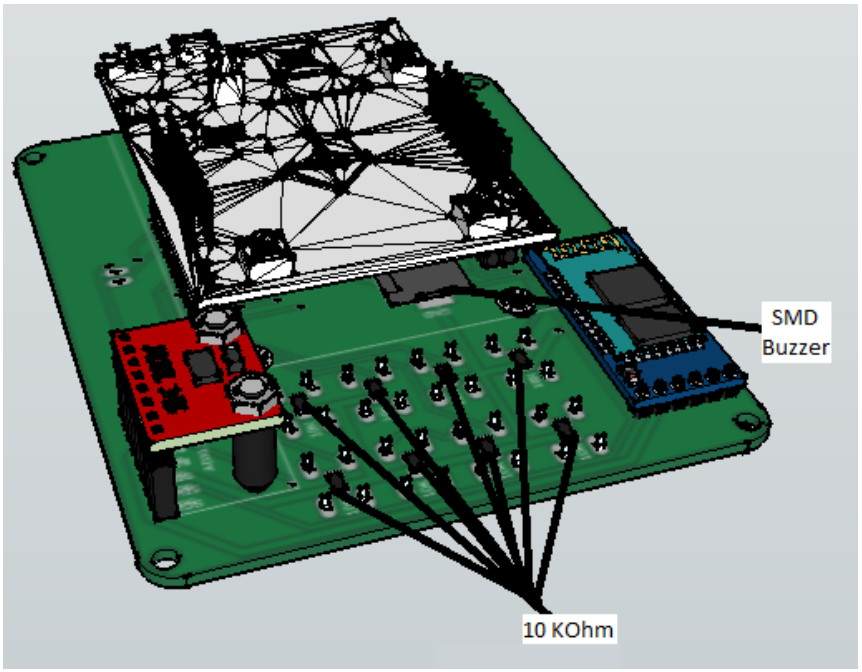

Figure 2: SMD soldering (bottom)

5.2. Solder the switches or buttons:

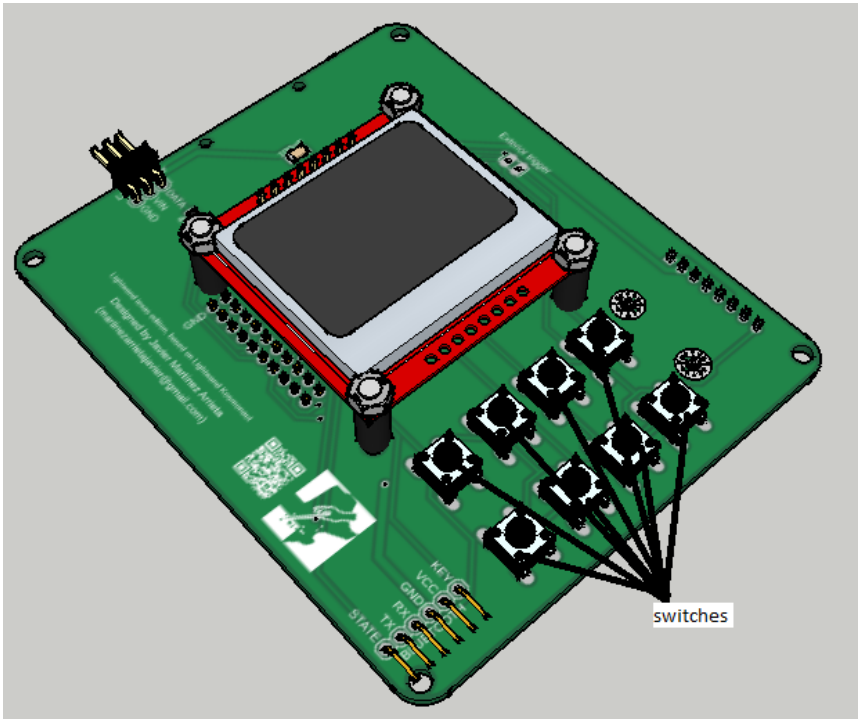

Figure 3: Buttons soldering

5.3. Solder the led strip connector:

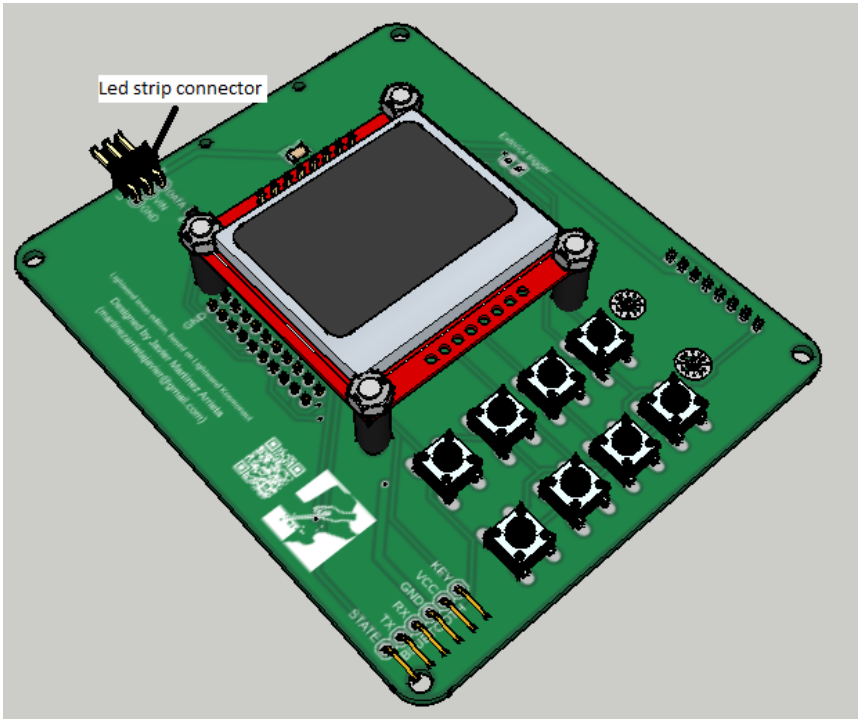

Figure 4: LED strip connector

5.4. Solder the bluetooth module (optional):

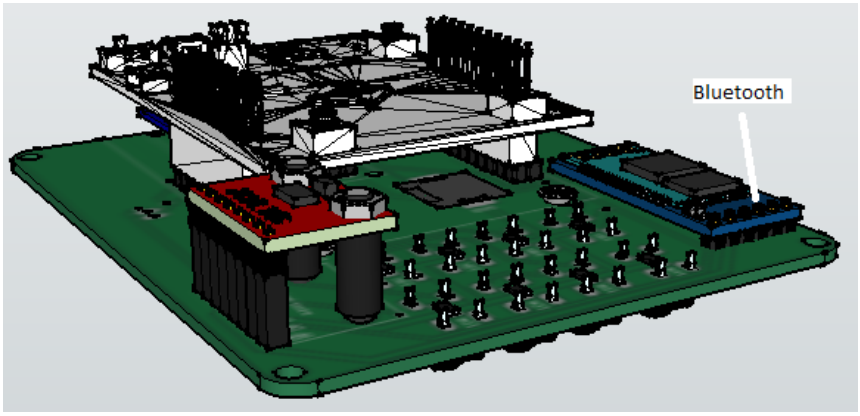

Figure 5: Bluetooth soldering

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

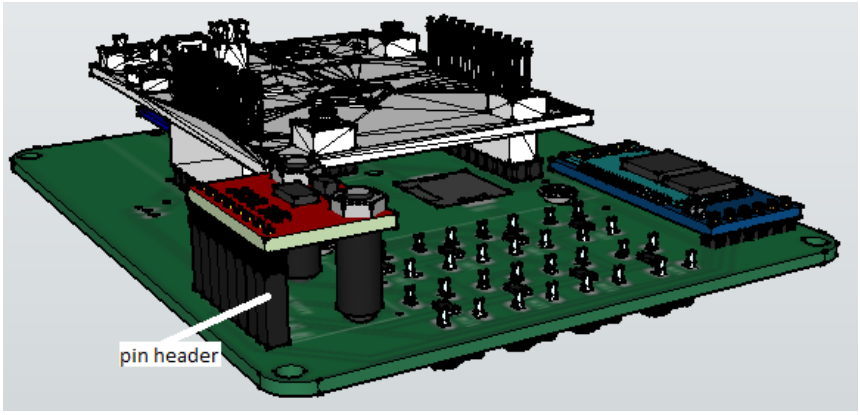

Figure 6: ADXL345 pin header

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

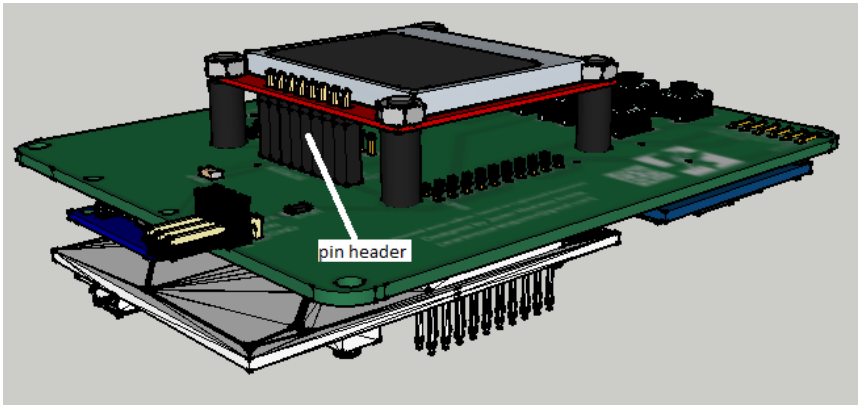

Figure 7: Screen pin header

5.7. Solder the SD card adapter:

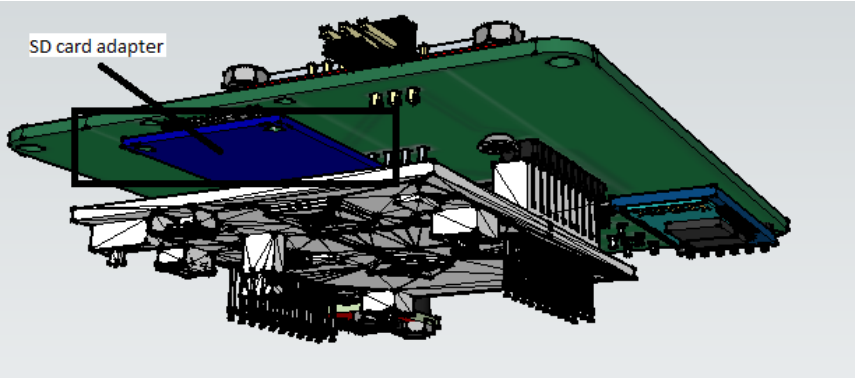

Figure 8: SD card adapter soldering

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

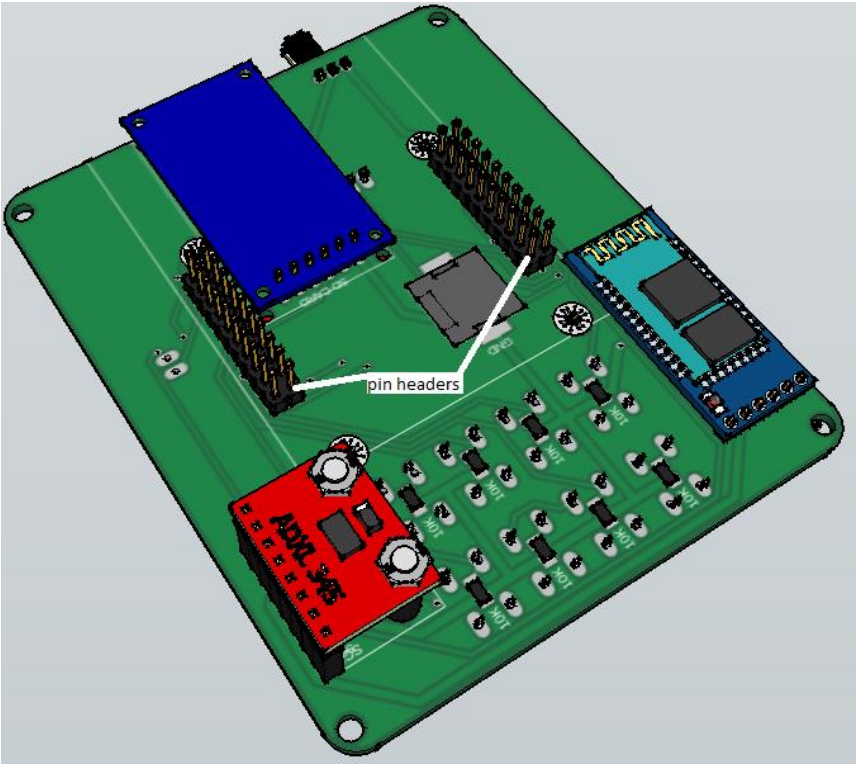

Figure 9: TM4C pin headers connectors

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:

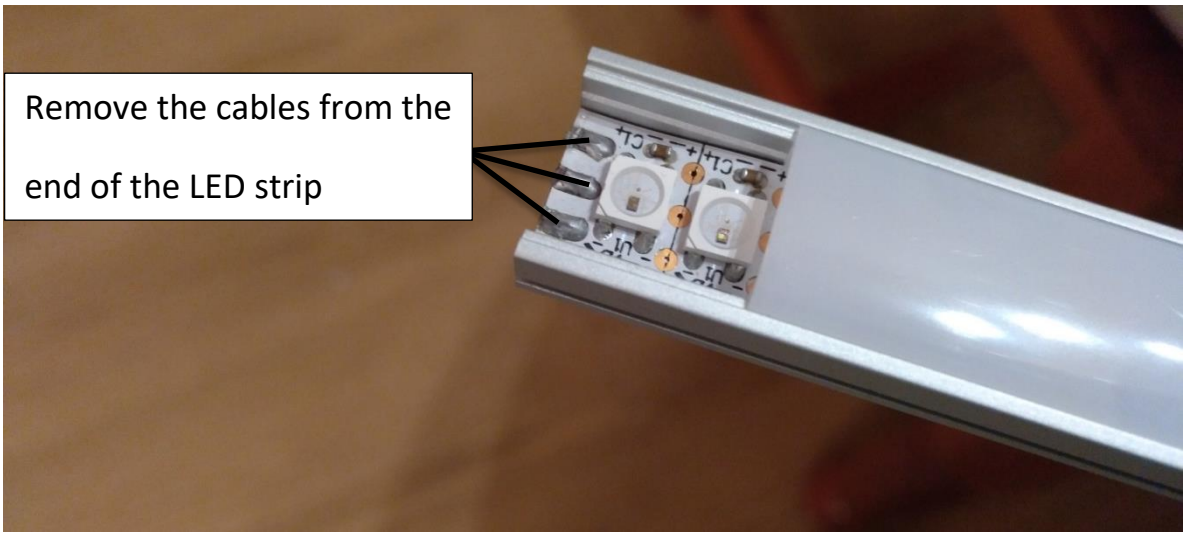

Figure 10: LED strip cable removal

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

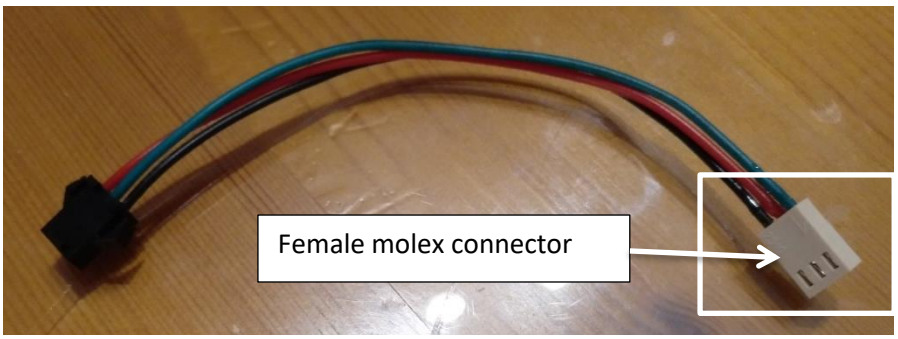

Figure 11: Female molex connector soldering

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

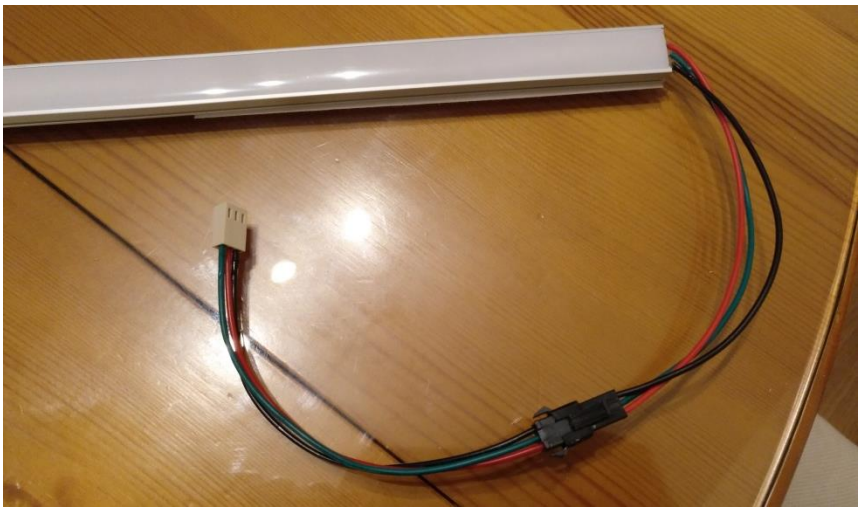

Figure 12: Extended cable connection

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

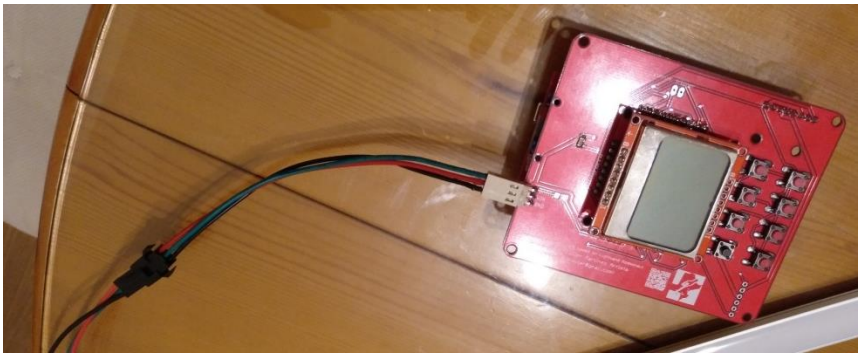

Figure 13: Connection between the LED strip and the board

6. 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.

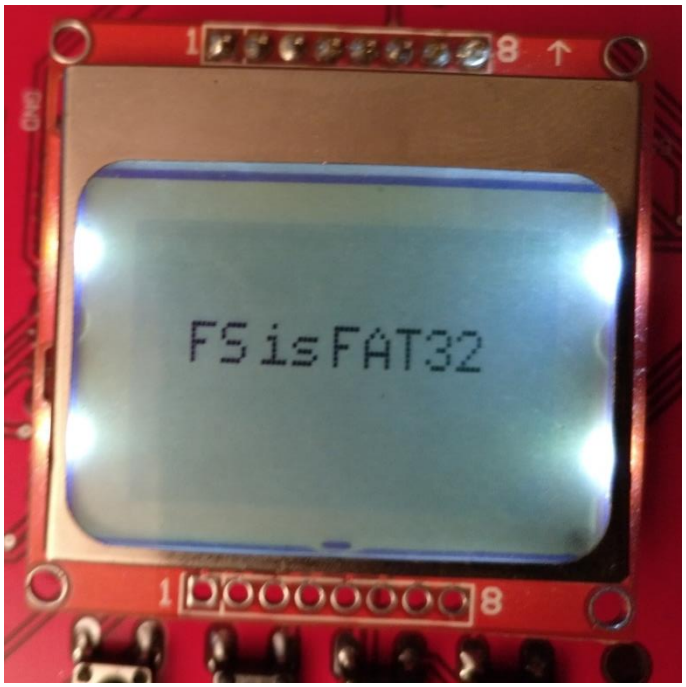

Figure 14: File system check

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

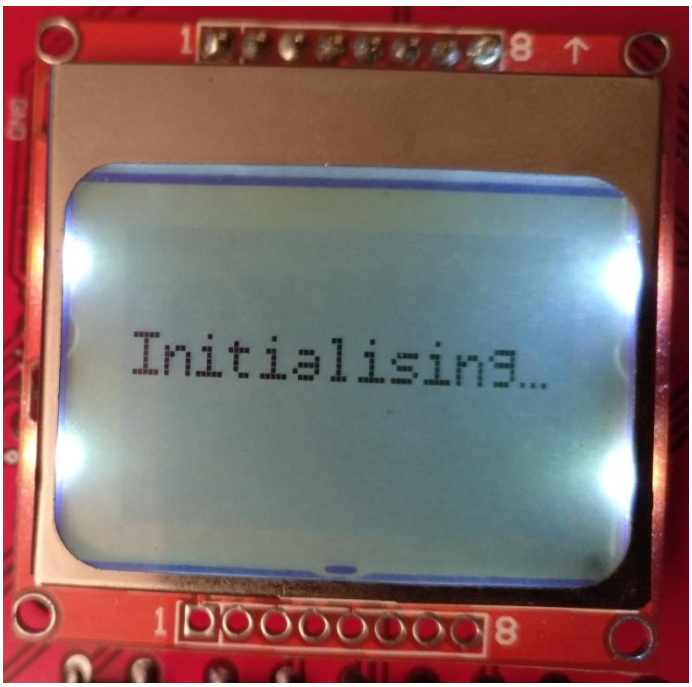

Figure 15: Initialisation

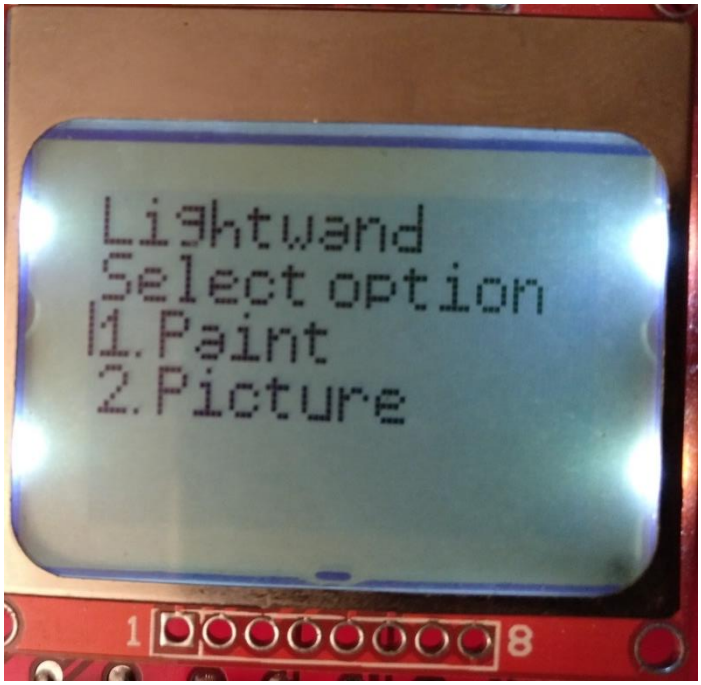

Figure 16: Main menu

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 17: 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 18: 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:

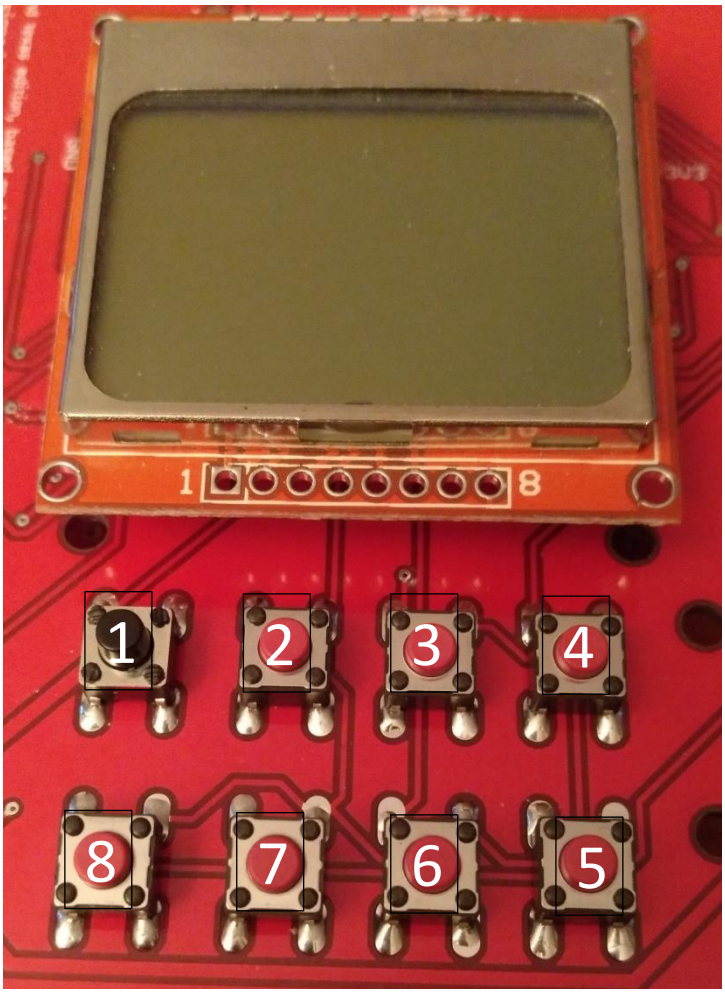

Figure 19: Options buttons

-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.

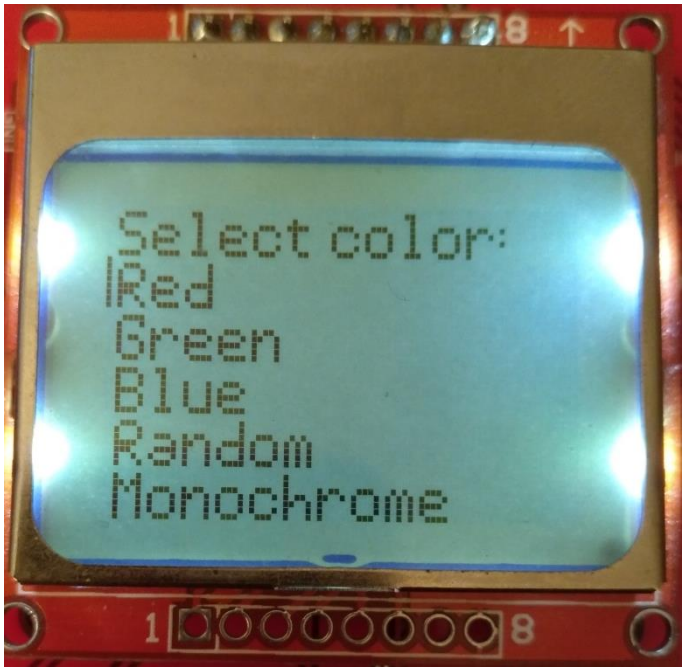

Figure 20: Paint colour menu

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.

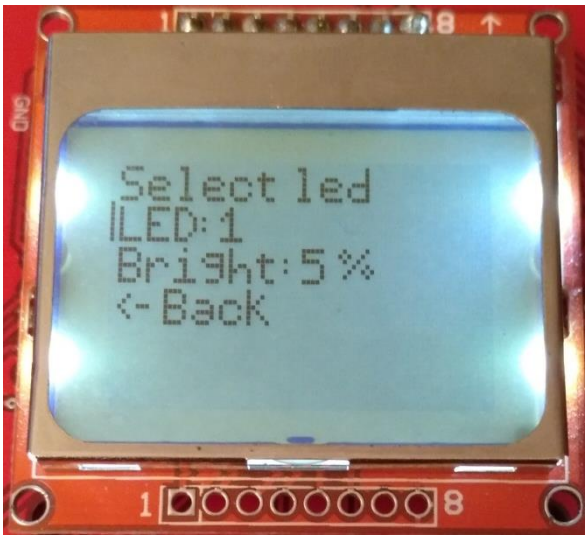

Figure 21: Paint menu, LED and brightness selection

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.

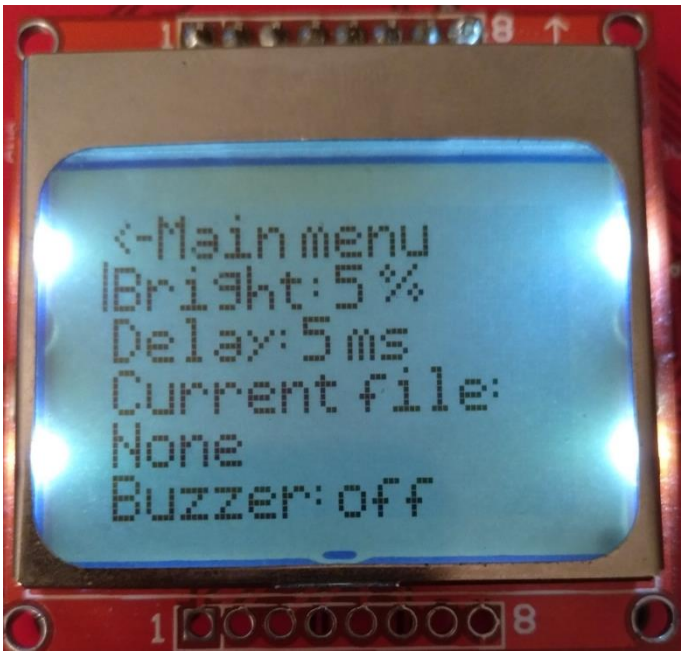

Figure 22: Picture menu

7. 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 23: 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*.

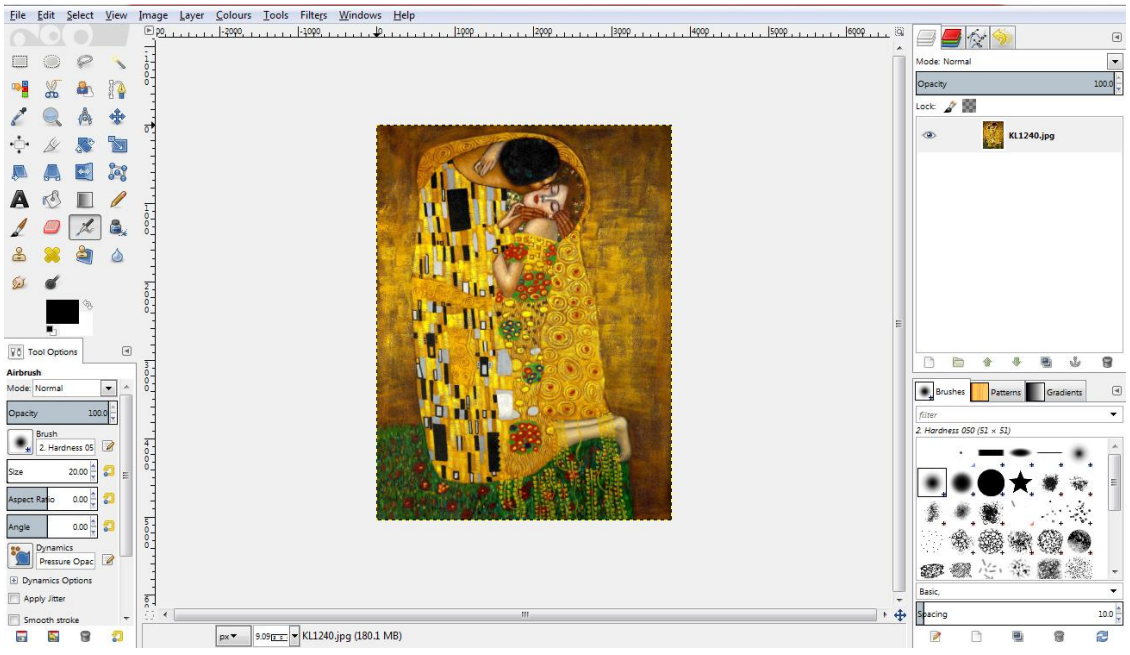

Figure 24: GIMP File Open

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*.

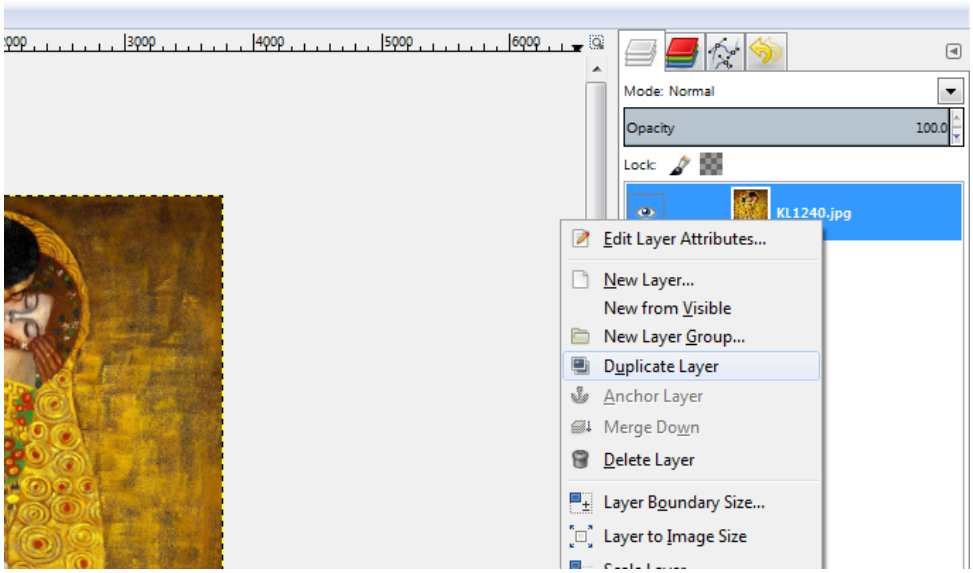

Figure 25: GIMP Duplicate Layer

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).

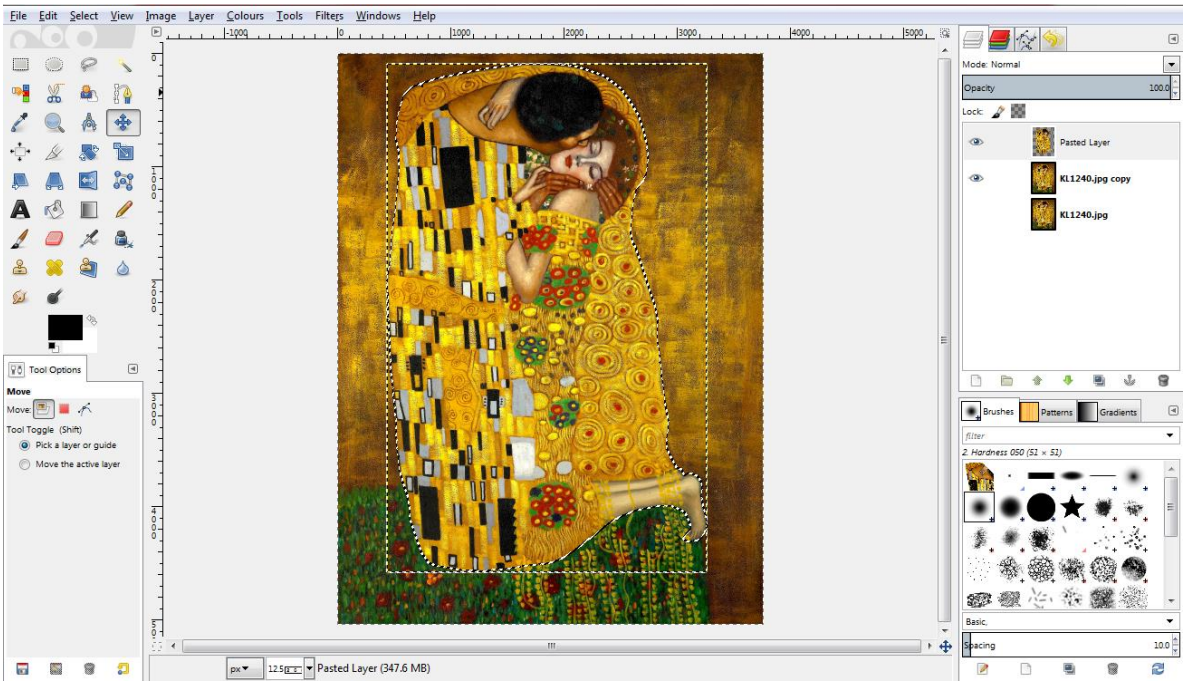

Figure 26: GIMP To New Layer

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

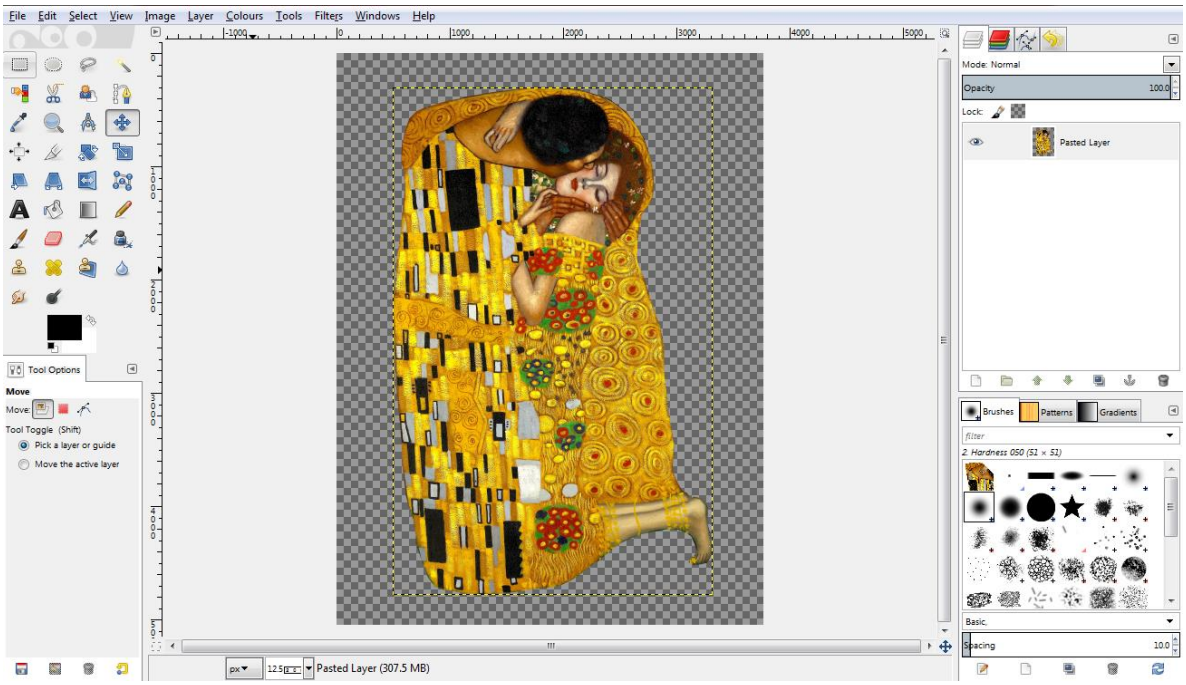

Figure 27: GIMP Main Figure

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*.

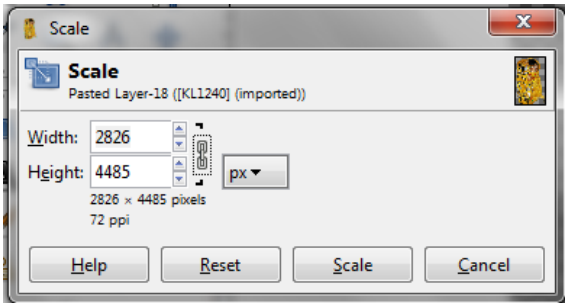

Figure 28: GIMP Scale Proportional

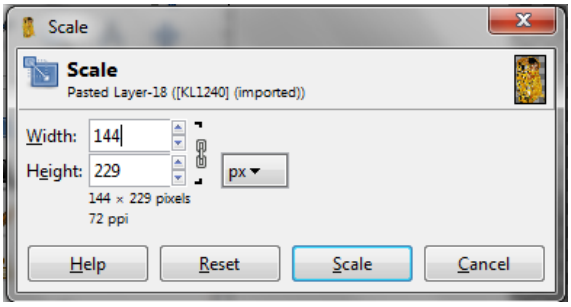

Figure 29: GIMP Scale Parameters

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.

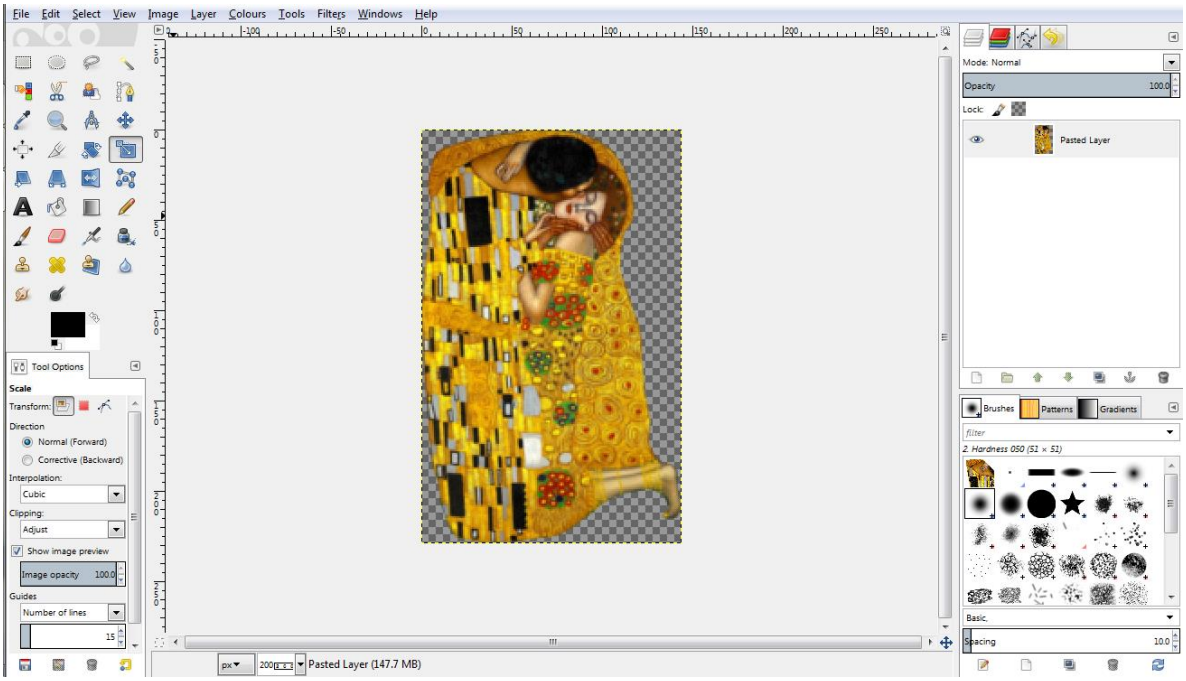

Figure 30: GIMP Resized Image Canvas

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.

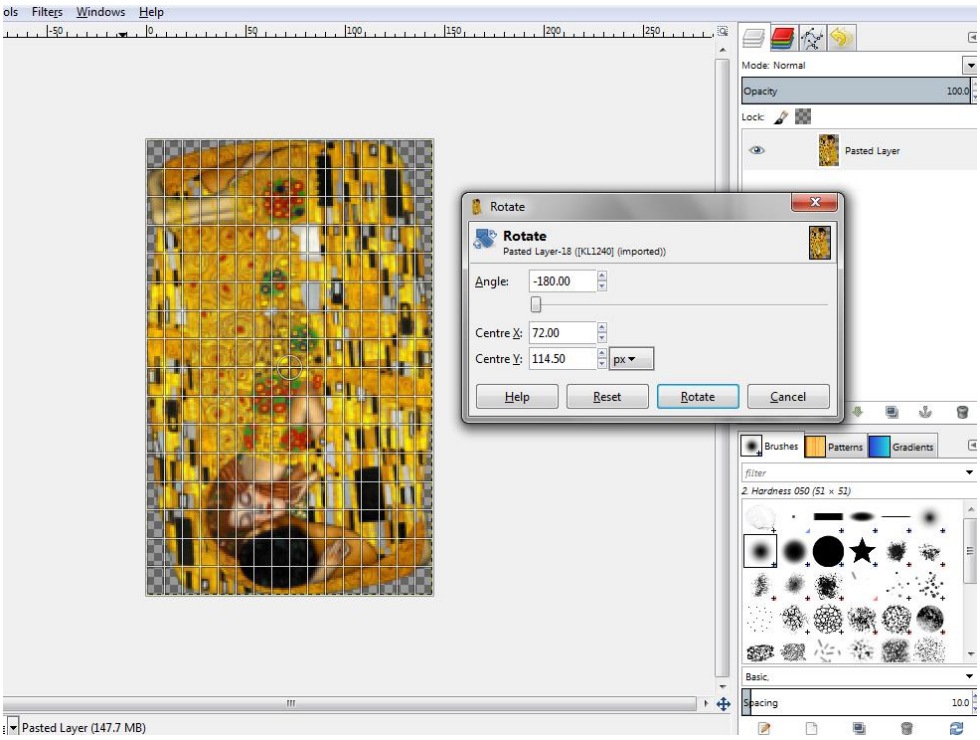

Figure 31: GIMP Image Rotation

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.

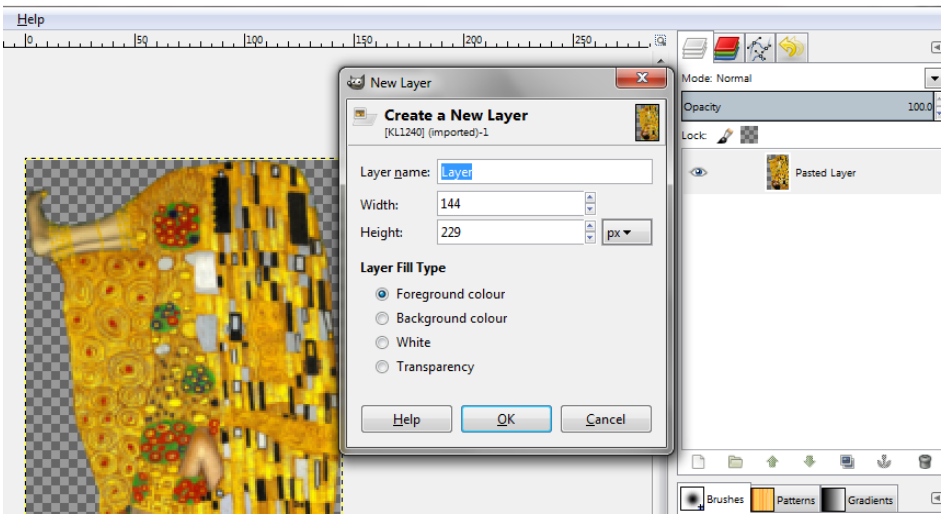

Figure 32: GIMP New Layer

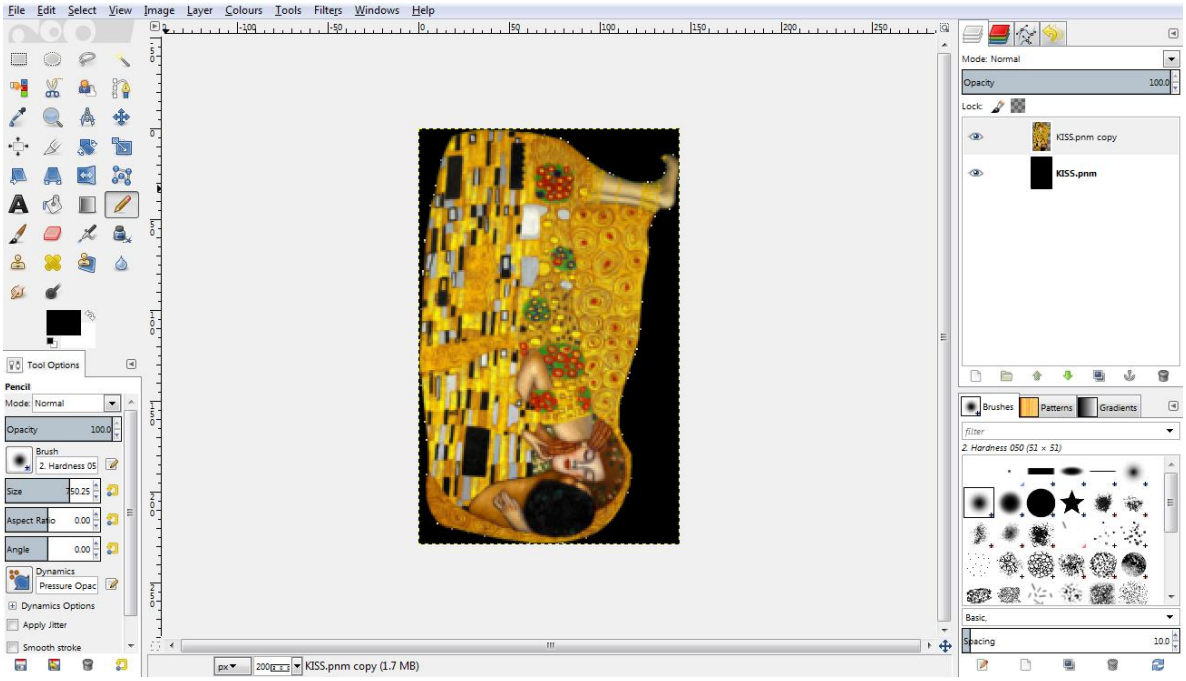

Figure 33: GIMP Black Background

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*.

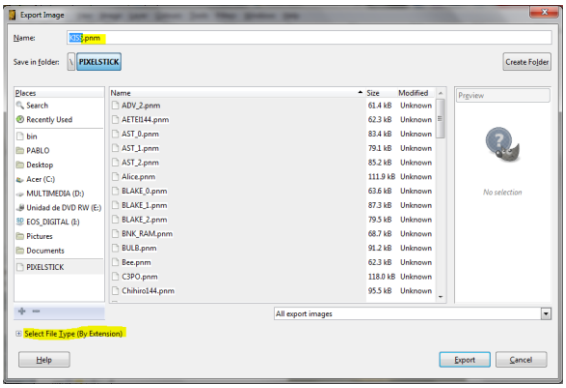

Figure 34: GIMP Export

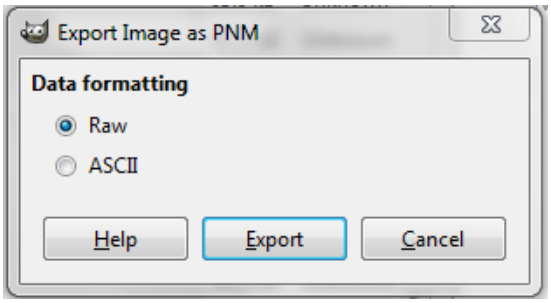

Figure 35: GIMP Raw .pnm Mode

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

8. 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.

9. 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.