Sgraffito Meets Posterization

Stephen M Campbell
stephen@smcampbell.eu

Vincent J. Matsko
vince.matsko@gmail.com

Abstract

Sgraffito is a technique for decoration where a surface is scratched away to reveal another underneath. This ancient technique can be extended by applying multiple layers of paint on fiberboard and using a variety of tools to scratch through the layers, resulting in richly textured pieces. Aspects of the sgraffito technique may be modeled digitally. In particular, images may be digitally processed using a small color palette to simulate the small palette used when applying the sgraffito technique using pigments. Post-processing involves smoothing out the digital images, since isolated pixels in a digital image are details too fine to be obtained using handheld tools.

NOTE: The first three sections concerning painting were written by the first author (SMC), and the fourth and fifth sections concerning programming were written by the second author (VJM).

History of Sgraffito

Sgraffito developed from one of the most basic forms of mark-making in human culture: scratching a line. The word sgraffito comes from *graffiare:* to scratch. As a result, this technique developed in some form in various cultures around the world. It is an easy way to deface property; you can see the names of Romans scratched into ruins in Ancient Egypt. Our modern word *graffiti* comes from the plural of sgraffito.

Sgraffito has been in constant use in ceramics since Ancient Greece. It was perfected as a plastering technique in Renaissance Italy before falling out of fashion. It was revived in the mid-19th Century in Germany and became very popular during the Art Nouveau movement, especially in Barcelona by architects such as Granell (see Figure 1). The Soviet Union introduced sgraffito to the curriculum of the monumental art department at the Leningrad Higher Institute of Industrial Art; from there, it spread across the Soviet Union, Central Europe, and South America. The limitations of the technique and materials – a constricted palette and primarily bold, clear borders – are elements prevalent throughout these periods of art history. For instance, painting in egg tempera or printing with silk screen have similar limitations. As new media such as oil painting were introduced, or the political climate moved away from Soviet realist propaganda, sgraffito fell out of fashion.

Like many others, my first experience with sgraffito was in junior school, scratching through black wax crayon to reveal a more colorful layer underneath. When I was in art school in Poland, I learned the architectural variation of coating a wall with cement, then painting dilute plaster over it, which was then scratched through using curved tools before the cement layer had hardened. Working with ceramicists Liz Scrine and Sally-Sarah Titterington in the United Kingdom, I learned the technique of painting a fired pot with a layer of differently colored slip (clay slurry) which, when dry, was scratched through and then the pot was fired again.

Figure 1 : *Catalan architect Jeroni Granell (1867-1931) (left), and ceramicist Sally-Sarah Titter-ington (right).*

The Sgraffito Technique

The term sgraffito is usually reserved for describing the technique when used for decorating pots, buildings (see [2]), and glassware: two-dimensional surfaces of three-dimensional objects (see Figure 1). We usually refer to a similar technique in 2D as an etching. When making an etching, we are also scratching through a layer to reveal another underneath in order to convey tone. In the etching process, the printmaker takes a plate of metal, coats the surface with wax, into which he scratches a design. The coated plate is then placed in a bath of acid, which eats away the exposed metal. The plate is taken from the acid and the wax is removed. Where the wax lay is now smooth, and the areas dissolved by the acid are now rough. The plate is then rubbed down with ink, which stays in the grooves that have been eaten by the acid, but not in the smooth portions protected by the wax. Prints can then be made from the plate.

The above techniques convey two tones in three dimensions. While the surface of the object being etched is two-dimensional, there is a third dimension corresponding to the color of the surface. This third dimension, though, is often binary – either the color of the object, or the color of the coating. Because the coating is usually opaque, made of large particles, and does not mix with the material on the surface of the object, gradients in tone are limited.

However, this limit is relative to the size of the larger design and the smallest possible mark to make. As in conventional drawing, gradations in tone can be made with hatching, cross hatching, stippling, aquatint in the case of etching, etc. In general, a sgraffito design will conventionally make the most of the contrast between the two layers and remain quite stark, whereas an etching is more likely to make the most of these gradation techniques. In my experience, I would say that this is due to the nature of the materials and tools: sgraffito using cement and plaster will have a habit of coming apart in clumps rather than lines, and a fine line will have less structural stability compared to a shape such as a circle. The appeal of sgraffito for me is that it differs from most mark-making techniques in how simple it is to draw a solid white line on a dark background.
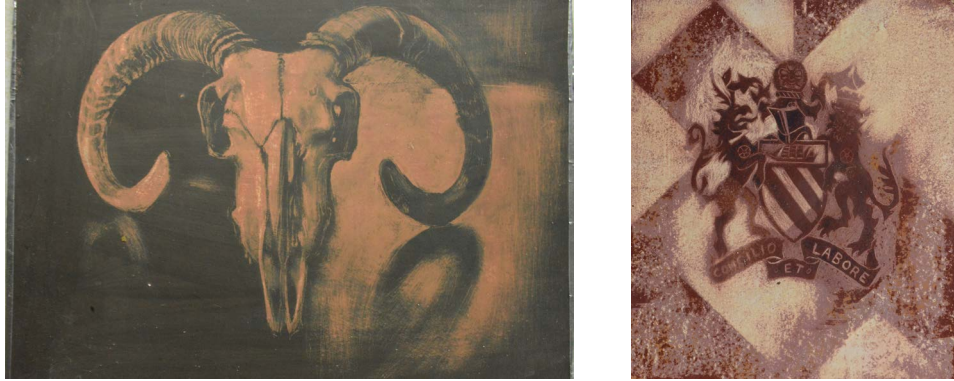
Figure 2 : *Two sgraffito examples: sheep (left) and coat of arms (right).*

Adaptation of the Technique

My own experiments with sgraffito (see Figure 2) began using silver point. Silver point was the precursor to the modern graphite pencil. One Renaissance painter who used this technique was Cennino Cennini; his instructions are to prepare a wooden panel with ground up, calcined bones, and saliva. Then taking a stylus made from silver, trace lines onto the support. The more the line is retraced, the darker the surface becomes.

I found that combining this technique with tempera (and substituting other materials for the spit and bone), not only could I draw darker lines, but if the ground layer beneath the tempera was a lighter color, I could create highlights by scratching the surface away. By experimenting with different types of paint: casein, oil, acrylic, distemper, tempera, and tempera grassa, I found a combination which could be scratched through one layer at a time. Here I must acknowledge the work of Nina Murdoch, who creates effects of dappled and reflected light by layering egg tempera, then removing and reapplying layers. The paint is sanded down to the gesso underneath, giving a luminosity created by the light refracting through the transparent calcium carbonate and the translucent thin layers of tempera.

The preparation that I found most effective was to begin by first sealing the support (a piece of medium density fiberboard) with size (glue), then several layers of gesso (calcium carbonate in glue). Next, layers of distemper (pigment in a water-based medium) are applied, followed by layers of tempera (an emulsion of pigment in water and egg yolk). Finally, layers of tempera grassa (an emulsion of pigment in water, egg yolk, and oil) are applied. The layers of gesso and distemper dry quickly by the evaporation of water. The layers of tempera and tempera grassa first dry by evaporation quickly, then cure by the oxidation of the oil over time. It takes between a month and three months for the paint to be completely dry. This means that the top layers will be softer than the lower layers and be easy to scratch into using a soft metal. The lower layers can be scratched using a harder metal to reveal the distemper or the gesso. Like the painting of Nina Murdoch, I prefer to use darker tones for the top layers and get lighter as more paint is scratched away.

So we take this as the basic structure, but variations in how the paint is applied will also affect the final outcome. Layers of paint can be applied with a paint brush, paint roller, or palette knife. A layer can be more than one color, or the paint can be sanded to a smooth finish between coats. Some examples of how these techniques affect the final outcome are shown in Figure 3.

Different marks and gradations may be made by using a variety of mark-making tools, such as a silver stylus, a steel stylus, a craft knife, wire wool, or sandpaper.

We could also change the support we begin with. A rigid panel is preferable as it is less likely to crack than stretched canvas. In many experiments I used earth colors simply because of cost, though using vivid pigments in the early layers is very effective because the white layers beneath will make the colors appear

Figure 3 : *How application of the paint changes the texture of the paint using a paint brush (top left), palette knife (bottom left), and paint roller (right).*

brighter than if they were used by themselves.

I try to keep notes of what the layers consist of on the back of the panel; once the panel is prepared, the colors underneath are not visible. An exciting aspect of this method is not knowing how the piece will turn out, as the behavior of the materials changes as the paint oxidizes. When the paint is fresh, the lines made can be finer than when the paint is old. Although the paint can be refreshed a little with a coat of walnut oil, it still behaves differently and mistakes cannot be easily erased.

This method of drawing is very messy, since so much of the paint is removed while mark-making. The paint comes off as a thick dust, but there will be a lot of airborne particles, so I would advise the following safety precautions: 1) keep the room well ventilated, 2) have a bowl of water beneath the support, and 3) wear a dust mask, as working with dusty materials can cause significant lung damage. It is also important to be wary of toxic pigments. I don't use flake white (lead white), cobalt blue, or cerulean blue. Be very careful about anything with cadmium, and always check the health restrictions about any new material.

The Algorithm

Since a sgraffito piece can be created from a photograph, it is natural to wonder whether this process can be approximated digitally using simple image processing techniques. We began with a four-color palette, since in addition to the colors painted on the board, it is possible to scratch away all the paint and expose the color of the wood.

When applying the technique, the dried pigments don't actually mix, but the effect of scraping away partial layers of paint is to produce color blends. From an algorithmic point of view, it is reasonable to assume that scraping away part of a layer of paint would produce a color on the segment in color space between the two colors of the adjacent layers.

So to set up the color space, we chose four colors. The order is significant, as the order of the colors corresponds to the order they are painted on the board. The segments joining these points in color space form the palette. For example, if c_1, c_2, c_3, and c_4 are the chosen colors, then the polygonal segment joining these points, consecutively, form the palette, as illustrated in Figure 4. For simplicity, we used a two-dimensional color space for the figures, although the algorithm described can be implemented in any number of dimensions. Also, the algorithm may be implemented with any number of colors; for example, three colors may be used if it is desired that the wood is never exposed.

Next, we imported an image into software which could handle image processing (we used the Processing platform, which is open source). At the first pass, we simply looked at the color of each pixel, and updated it with the closest color, relative to some metric, from the palette. We decided to use the usual Euclidean metric for our initial investigation. The same algorithm was also applied using the Manhattan metric, but no appreciable difference was found.
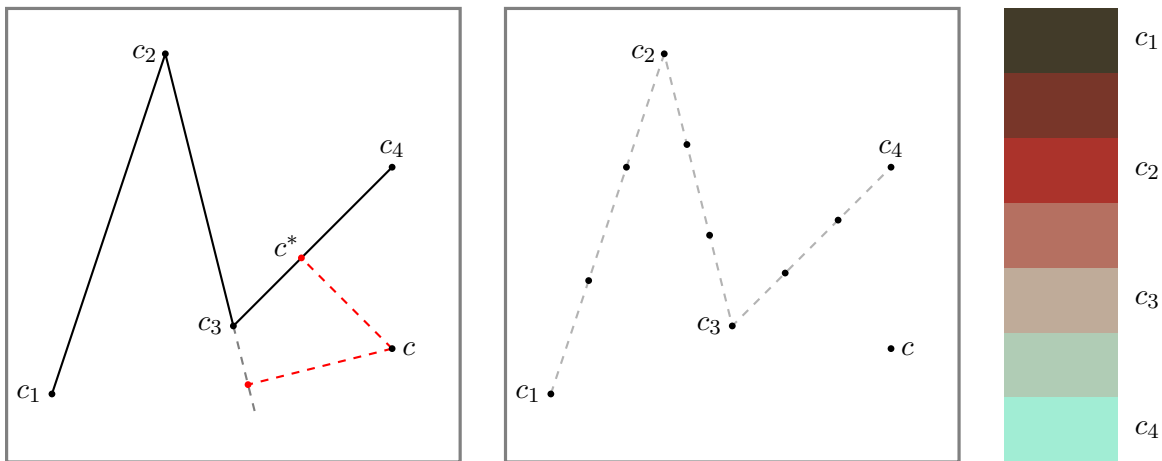
Figure 4 : *Continuous palette (left), discrete palette (middle), 7-color palette used in Figure 5.*

Ultimately, we wanted to use a discrete palette, like the one shown in the middle of Figure 4, since in practice it is not possible to produce color gradients with the sgraffito technique. In this example, two colors are interpolated between pairs of chosen colors, resulting in a palette of ten colors. Given a pixel with color c, simply update its color with the one closest in color space. A 7-color palette (used in Figure 5) is shown on the right of Figure 4. The process of significantly reducing the size of the color space used to render an image is sometimes referred to as *posterization,* used to convert images to produce screen-printed posters (see [3]).

However, we thought it interesting to look at a continuous palette as well, if only to compare the images produced by a discrete palette. (Of course, the usual 2^{24} RGB colors actually form a discrete palette, but we will consider it as a continuous palette as the eye cannot easily distinguish adjacent colors in this color space.)

So given a pixel with color c, we found the projections on the lines containing segments in the palette, and updated with the closest of these projections. It may happen, however, that the projection lies outside of the palette, as illustrated on the left of Figure 4. When c is projected on the line containing the segment joining c_3 and c_4, the result is in the interior of this segment, so the projection c^* is the closest color on this

segment. But when c is projected on the line containing the segment joining c_2 and c_3, the projection lies exterior to the segment, so we use the endpoint c_3 as the closest color on the segment in this case.

Figure 5 : *Original photo (upper left), continuous palette (upper right), 13-color palette (lower left), 7-color palette (lower right).*

Some examples are illustrated in Figure 5. On the upper left is the original image. On the upper right, a continuous palette based on four colors is used to update pixel colors. In this case, colors were chosen directly from the image (although this was not necessary). On the lower left is the posterized version with three colors interpolated between the endpoints of each segment of the palette, for a total of 13 colors. And finally, on the lower right, is the posterized version where one color is interpolated between the endpoints of each segment in the palette, giving seven colors (see Figure 4).

The posterization is clearly evident with the 7-color palette, although the original image is still easy to make out. However, this process produced many isolated pixels – that is, pixels whose immediate neighbors were different colors from the pixel itself. Given the tools used to scrape away paint using the sgraffito technique, it is virtually impossible to scrape an area of pigment so small. So an additional smoothing step was added. The color of each pixel was updated by looking at it and its neighbors, and choosing the color which occurred most frequently. This was done by sorting the counts of the colors in the box of pixels – a 2×2 box for corner pixels, a 2×3 box for interior edge pixels, and a 3×3 box for interior pixels – and then choosing the last in the list. The smoothed result is shown on the left in Figure 6, and the pixels that were actually changed are shown in black on the right of Figure 6. The color of approximately 5% of the pixels needed to be updated to create the smoothed version.

As mentioned earlier, it is not necessary to choose a color palette from the colors present in the original

Figure 6 : *Smoothed 7-color palette (left), pixels changed (right).*

image. Figure 7 shows an example where a bolder color palette is used, though the colors are not present in the original picture.

Figure 7 : *Posterization with colors not selected from the original photograph.*

A Comparison

We decided it would be interesting to compare the result of a computer-generated sgraffito image with a piece of artwork. In Figure 8, a picture of a crab is shown in the upper left. The upper right shows the crab rendered with the sgraffito technique described above, and the bottom images show the digital simulation of the sgraffito technique using a color palette taken from the image in the upper right (a continuous palette on the left, and a 7-color palette on the right).

While there are similarities, there are also marked differences. In the sgraffito piece, the eyes are darker, the head is smaller, and the jointedness of the legs is emphasized by using the dark background color to separate the segments of the legs. These are choices made by the artist in rendering the image of the crab, but are not evident in the digital rendering, as the digital image is simply mapped pixel-by-pixel from the photograph.

In addition, the scraping of the tools against the layers creates a texture in the sgraffito piece not visible in the digital rendering. So future work might include attempting to find heuristics for these artistic choices,

and incorporate them into the existing algorithm. The challenge lies with the fact that these choices involve analyzing larger portions of the original image, not just looking at the image pixel-by-pixel. The algorithms which would be needed are quite a bit more complex than those used to create the images in this paper.

Finally, we remark that while the posterization technique is not new, one of the goals was to simulate it in an open-source platform so it can be incorporated into future semesters of a mathematics and digital art course ([1]).

Figure 8 : *Original photo (upper left), sgraffito rendering (upper right), continuous palette (lower left), 7-color palette (lower right).*

References

[1] Matsko, Vincent J., *Mathematics and Digital Art, Fall 2017.* `http://vincematsko.com/Fall2017/MAT111/2017F_DigArt.html` (as of Apr. 12, 2020).

[2] *Monumental Almaty.* `http://www.monumentalalmaty.com/` (as of Apr. 12, 2020).

[3] Wikipedia: The Free Encyclopedia, *Posterization.* `https://en.wikipedia.org/wiki/Posterization` (as of Apr. 12, 2020).