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Amelia Carolina Sparavigna

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## **GIMP Retinex filter applied to arts: Gerrit van Honthorst and his Chiaroscuro**

**Amelia Carolina Sparavigna**  
Politecnico di Torino

**Abstract:** Here we apply the Retinex tool of GIMP software for filtering the digital images of the masterpieces of an artist that used the Chiaroscuro, a strong tonal contrast between light and dark, in his painting technique. In particular, we use the GIMP Retinex for some works of Gerrit van Honthorst, known in Italy as Gherardo delle Notti. The filter allows the vision of significant details in the shadows of the images.

**Keywords:** Image processing, Retinex filtering, GIMP, Chiaroscuro, Arts

It is true that only a direct vision makes us appreciate the masterpieces of artists. However, when for several reasons this is impossible to achieve, we can use the resources that the web is giving us through its huge gallery of images, to see and study the works of artists.

Among painters, many used the technique of Chiaroscuro, characterized by a strong tonal contrast between light and dark, and able to give a dramatic effect to the scenes depicted in their works [1]. Great masters of Chiaroscuro are Leonardo da Vinci, Caravaggio, and Rembrandt. In fact, Caravaggio was the crucial artist for a further development of this painting technique. In his works, he used a very pronounced Chiaroscuro, characterized by spotlight effects [2]: it is the Tenebrism technique, which was popular during the Baroque period [3].

Sometimes, the digital images of masterpieces made in a very pronounced Chiaroscuro are not able to give us all the beauty of the original works. Moreover, it is hard to appreciate all the contents that the artist had included in the painting, contents that can have some symbolic intent too. For appreciate the details in the digital images, we can try to filter them by some tools of image processing. Here we show the use of the Retinex filter; the reason for this choice is in the specificity of the Retinex approach.

Retinex filters - among them we have that provided by GIMP, the GNU Image Manipulation Program - had been developed to reproduce the mechanisms of the human vision, according to experimental observations. In fact, experiments are showing that it is easy to find discrepancies between an image recorded by a camera and the directly observed scene. The reason is that humans are able to see details both in the shadows and in the nearby illuminated areas, whereas a photograph of the same scene is showing either the shadows as too dark or the bright areas as overexposed [4]. Actually, the human vision possesses peculiar features concerning colors, brightness and contrast, which are quite different from those of recording devices [5,6]. Retinex filters are therefore used to adjust the digital images to mimic a direct observation of a scene.

The first Retinex algorithms for image processing had been proposed by Edwin H. Land, an American scientist and inventor best known as co-founder of Polaroid Corporation [7-11]. Through the years, Land evolved several models until his last one proposed in 1986 [4]. Even the term "retinex" was coined by Land himself, combining the words "retina" and "cortex", to indicate that the human vision is involving processes ranging from the retina to the cerebral cortex. Today, different Retinex approaches exist [6,12]: the single-scale Retinex (SSR), the multiscale Retinex (MSR), and, for color images, the MultiScale Retinex with Color Restoration (MSRCR).

Among the MSRCR filters we find the GIMP Retinex, a freely available tool developed by Fabien Pelissou [13]. This tool is easy to use. The resulting image can be adjusted selecting different levels, scales and dynamics. The "levels" are three: "uniform", which tends to treat both low and high intensity areas fairly, "low" that "flares up" the lower intensity areas on the image, and "high" that tends to "bury" the lower intensity areas in favor of a better rendering of the clearer areas of the image. The "scale" determines the depth of the Retinex scale. Minimum value is 16, a value providing gross, unrefined filtering. Maximum value is 250. Optimal and default value is 240. A "scale division" determines the number of iterations in the multiscale

Retinex filter. The minimum required and recommended value is three. The “dynamic” slider allows to adjust the color saturation contamination around the new average colour (default value is 1,2). In some previous papers, we have proposed the use of GIMP Retinex for several applications and evaluated it by means of the image entropy [14-20].

In the following examples we will filter some Chiaroscuro masterpieces using uniform level, scale 240, scale division five and dynamic slider on 1,2. The artist whose works we use is Gerrit van Honthorst.

Gerrit van Honthorst was a Dutch Golden Age painter, who became especially noted for his depiction of artificially lit scenes. He received the nickname Gherardo delle Notti in Italy [21]. Early in his career he visited Rome, where he had great success painting in a style influenced by Caravaggio. He was much employed by the prince Giustiniani, for whom he painted one of his finest works: St. Peter delivered from prison and Christ before the High Priest. Honthorst visited England, soon after his return from Italy. On leaving England he settled at the Hague, and was taken into the employment of the Prince of Orange [21].

The first proposed example of the use of Retinex is exactly the “St. Peter Being Freed from Prison”, 1616-1618, Berlin State Museums. In the Figure 1, we see the original image on the left (it is that we find in Wikipedia, [https://en.wikipedia.org/wiki/Gerard\\_van\\_Honthorst](https://en.wikipedia.org/wiki/Gerard_van_Honthorst) on January 18, 2017). On the right, we see the image processed by the GIMP Retinex filter, with the values of the parameters chosen as previously told. In the Figure 2, we see the result we can obtain by combining the original image and the filtered image of the Figure 1.



**Figure 1:** “St. Peter Being Freed from Prison”. Original image on the left; on the right, the output of the GIMP Retinex filter.



**Figure 2:** The result of the superposition of the two previous images. Note the chains on the wall behind St. Peter.

As we can see in the Figure 1, the Retinex filter allows seeing the details in the shadows of the image. In fact, a direct vision of this painting can show them, but the digital reproduction needs an adjustment to mimic the direct vision. In order to have a more natural reproduction, the best seems to be the use of the original image and of the filtered image as two layers combined into a single image. This is what is shown in the Figure 2. In it, such as in the filtered image, we can see the chains on the wall behind St. Peter. Let us stress that the subject of the painting is the liberation of St. Peter, an event described in the Acts of the Apostles, in which the Saint is rescued from prison by an angel. "Acts 12:3-19 says that Peter was put into prison by King Herod, but the night before his trial an angel appeared to him, and told him to leave. Peter's chains fell off, and he followed the angel out of prison, thinking it was a vision (verse 9)" [22]. Then, the chains are a significant element in the work painted by Gerritt van Honthorst.

Here some other examples. In the following figures (Figs. 3-6), we see, on the left, the original digital image that we find in Wikipedia and, on the right, the image we obtain combining the original and the filtered image (as in the example shown in the Figure 2).



**Figure 3:** Adoration of the Child. On the left the Wikipedia image and, on the right, the image we obtain combining it with the output of the Retinex filter. Note the wings of the angels.

The Adoration of the Child is a 1619-1621 oil on canvas. It is in the collection of the Uffizi in Florence. The painting shows Mary laying the Child in white clothes. Joseph is looking over her shoulder and two angels are leaning over the crib. In the image, we see that the Child is the light source, as shown by the faces of the characters. The same happens in the Figure 4.



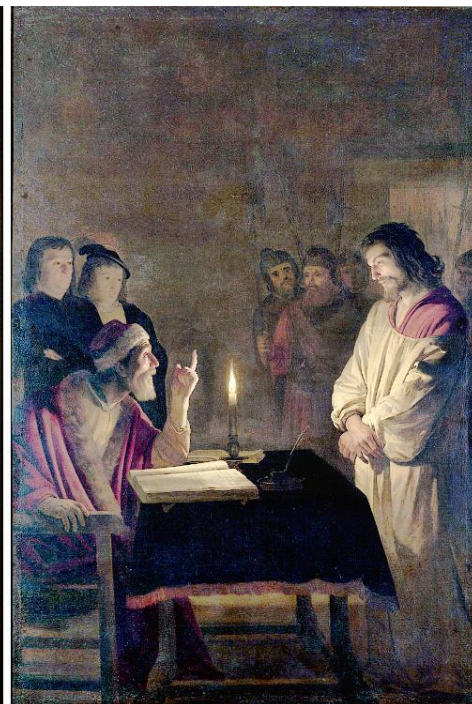
**Figure 4:** Adoration of the Shepherds, 1622, Wallraf-Richartz-Museum. On the left the original image and, on the right, the combined image. Note the presence of the animals.



**Figure 5:** The Denial of Saint Peter, c. 1620. On the left the Wikipedia image and, on the right, the combined image. Two light sources are present in this work, creating two scenes in the same painting.



**Figure 6:** Merry Company, 1623, Staatsgalerie, Schleissheim.



**Figure 7:** Christ before the High Priest, 1617, National Gallery, London. Note the soldiers in the background.



**Figure 8:** Mocking of Christ.

Let us conclude showing two other examples, where the artist represented two moments of the passion of Jesus Christ. The first shows Christ before the High Priest (Figure 7), and the second shows the Mocking of Christ (Figure 8).

In this last example, the painter represented Christ mocked by soldiers. One of them is pushing a crown of thorns on his head; another one has a fork or fire iron that he is pushing into Jesus' right hand as a scepter. As told in [23], the Chiaroscuro "illuminates Christ and casts the mockers in shadow; one soldier throws up his hand to hide the light of the flame from his face, bringing Jesus' words in John 3 to mind". That is, John 3:19, Light has come into the world, but people loved darkness instead of light because their deeds were evil. [23] continues telling that "the most mesmerizing moment in the painting is the contrast in the behaviors and expressions of the central Roman soldier and Christ", the soldier whose laughing face is illuminated by the torch.

In the examples we have here proposed, the original images are very good examples of the Chiaroscuro technique, but do not allow the vision of all the characters and details that the artist collected in his work. A Retinex filtered image, combined with the original one, shows us the true scene that the artist had depicted. This helps us in understanding the subject of the work and the symbolism the artist used in it.

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