Analysis on *Shot Marilyns* by Andy Warhol

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Abstract

This report presents a comprehensive analysis of the color composition in Andy Warhol's Shot Marilyns series. Utilizing image processing and clustering techniques, the study dissects the color structure of these iconic artworks. The report also explores the segmentation of the face, hair, and background of the portraits, and demonstrates how these elements can be modified. The study concludes with an interpretation of Warhol's potential original ideas on colors, providing insights into the emotional resonance and visual impact of the artwork.

I. Introduction

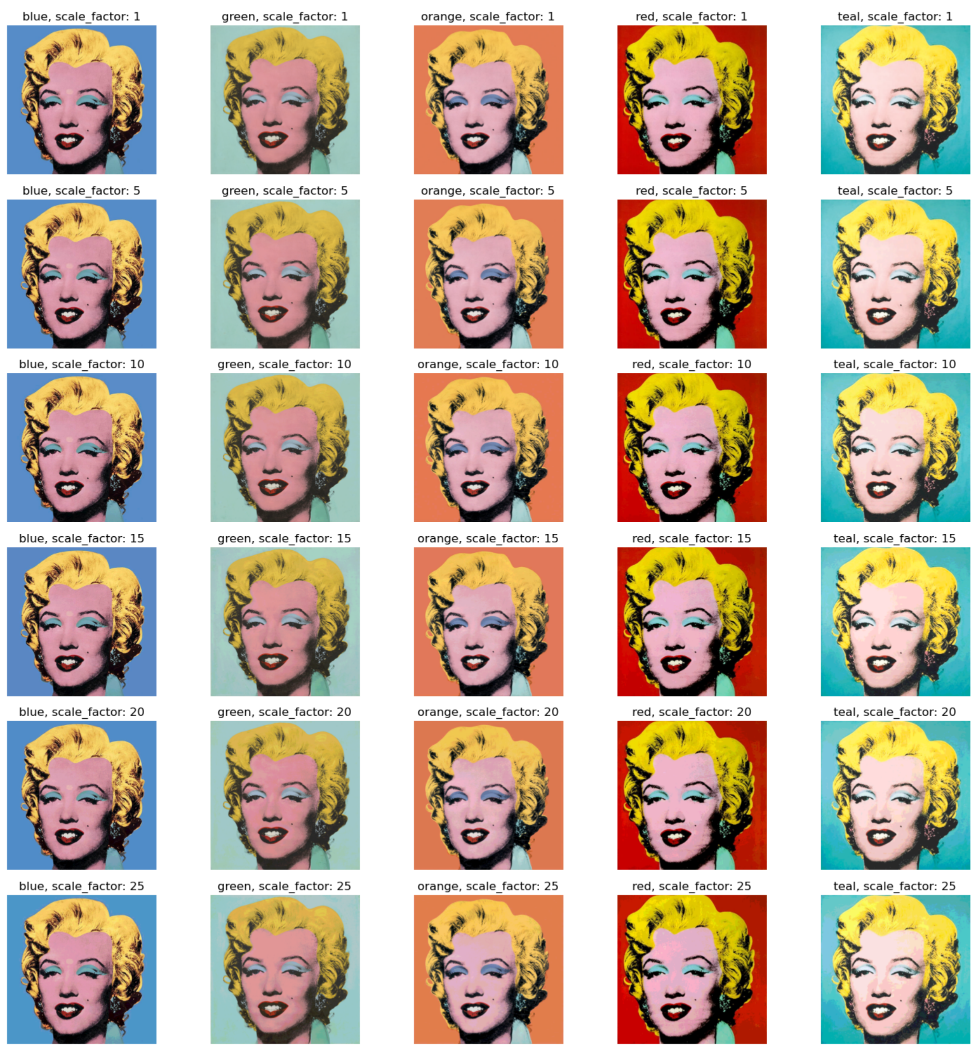
In this report, we delve into the color composition of Andy Warhol's renowned Shot Marilyns series. We employ a variety of image processing and clustering techniques to dissect the color structure of these artworks. The study also explores the segmentation of the face, hair, and background of the portraits using Numpy and OpenCV packages, demonstrating how these elements can be individually manipulated. We further discuss the application of alpha blending to ensure a natural integration of the modified colors. Finally, we interpret Warhol's potential original ideas on colors, providing insights into the emotional resonance and visual impact of the artwork.

II. Result & Methods

Color Composition Analysis

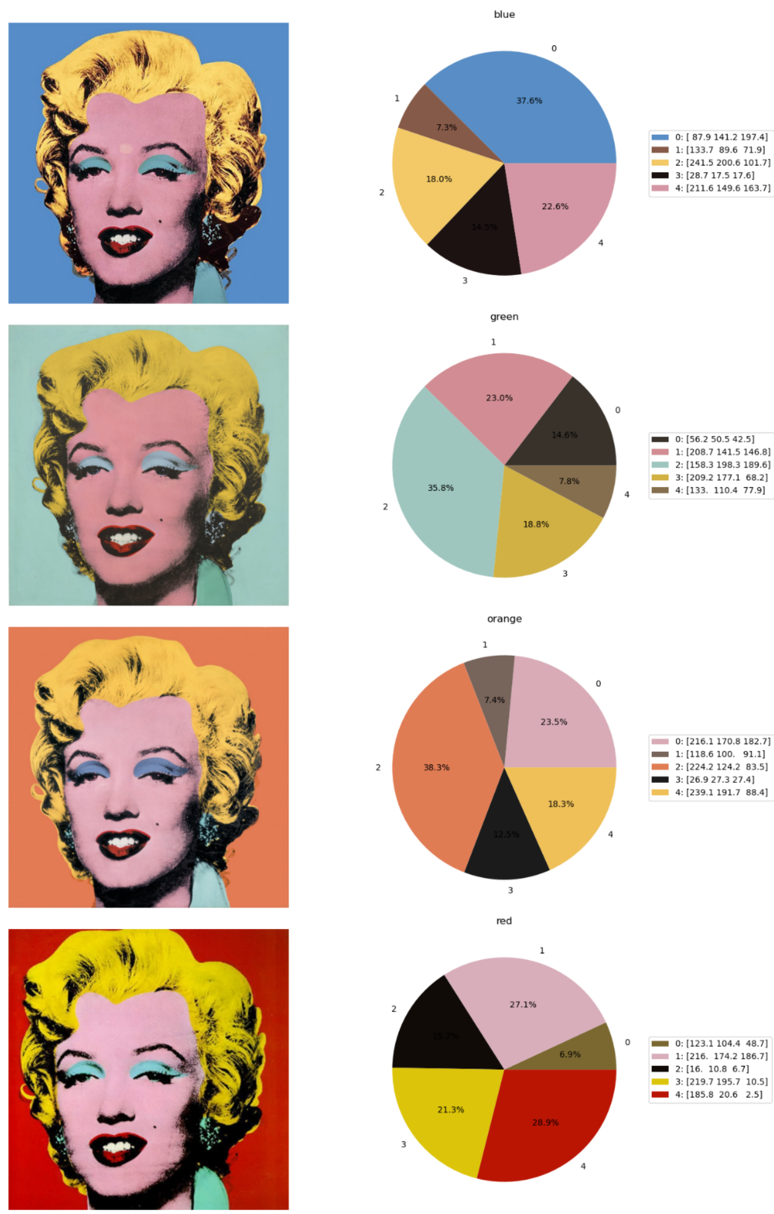
In this color composition analysis, we conducted an in-depth exploration of the color composition in a series of renowned paintings featuring Andy Warhol's *Shot Marilyns*. The study employed a variety of image processing and clustering techniques to dissect the color structure of these artworks. The steps of the analysis are outlined below:

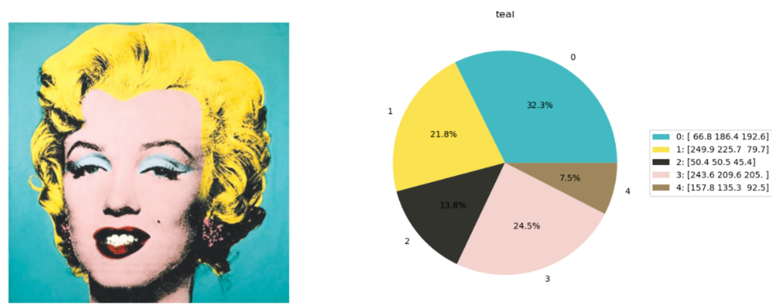
- **Color Depth Reduction**: The initial phase of the analysis involved the reduction of color depth in the images. Color depth reduction is a form of quantization that minimizes the number of distinct colors utilized in an image. We developed a function, `reduce_color_depth`, which accepts a DataFrame containing RGB values and a scale factor. This function operates by dividing each RGB value by the scale factor, rounding to the nearest integer, multiplying by the scale factor again, and constraining the result within the range [0, 255]. The application of this function effectively diminished the color depth of the images. We applied this function to the images using a variety of scale factors and visualized the outcomes.



Color Depth Reduction with Different Scale Factors Visualizations

- **Major Color Analysis via K-Means Clustering**: The K-means algorithm, a widely used clustering method, was employed to identify the most prevalent colors in each image. Each color was represented as a 3D point in RGB color space, and the five most common colors were identified by executing the K-means algorithm with K set to 5. The results were visualized as pie charts, demonstrating the frequency of each color.





KMeans Major color visualizations

- **Attempted Hierarchical Clustering**: Hierarchical clustering, another clustering algorithm that constructs a hierarchy of clusters, was attempted on the images. However, a memory issue was encountered, likely due to the requirement of hierarchical clustering for a distance matrix of a size quadratic to the number of points, which can be substantial for an image.

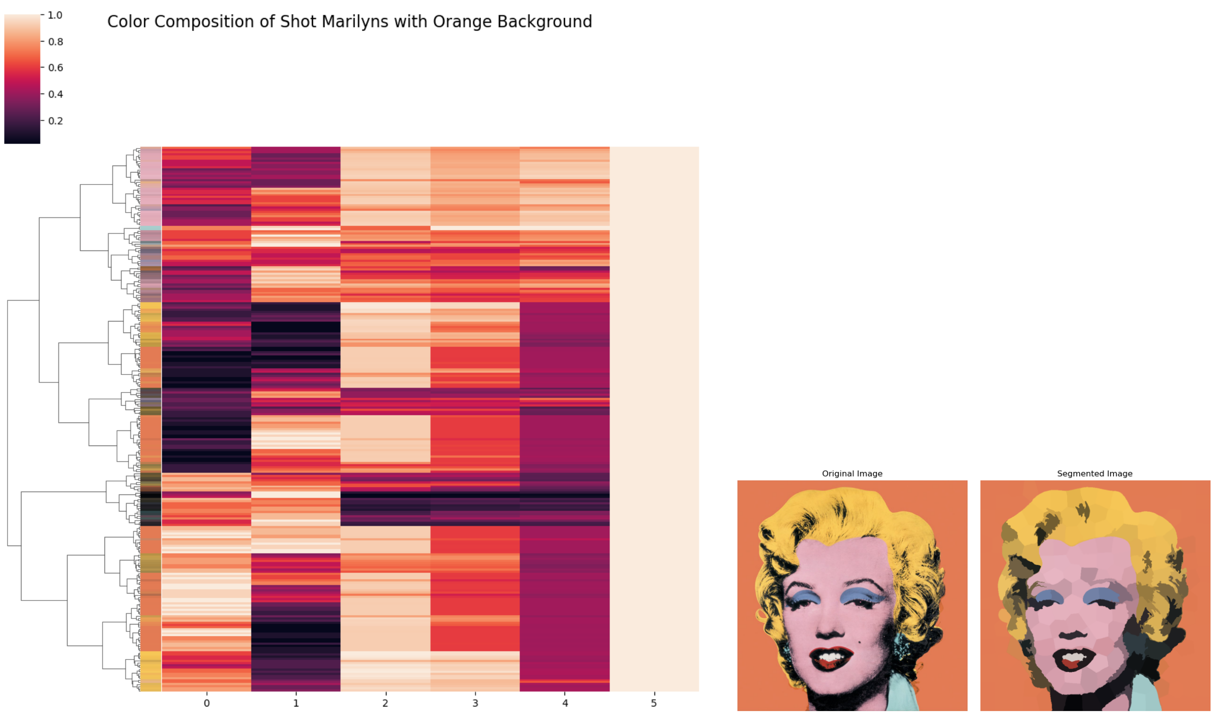
- **SLIC Superpixels and Parameter Testing**: To circumvent the memory issue, we employed the Simple Linear Iterative Clustering (SLIC) algorithm, which segments an image into "superpixels". Superpixels are clusters of pixels in the image space that share similar attributes. The SLIC algorithm was applied to the images with varying parameter values, and the results were visualized.

- **Hierarchical Clustering with Superpixels**: To address the memory issue associated with hierarchical clustering, we first applied the SLIC algorithm to create superpixels, then performed hierarchical clustering on these superpixels rather than the individual pixels. This significantly reduced the number of points to be clustered, thus avoiding the memory issue. Each superpixel was represented by a 5D feature vector, comprising the x and y coordinates of the superpixel's centroid and the average RGB color of the superpixel. After normalizing the features, we performed hierarchical clustering and visualized the results as a dendrogram.


Color Composition of Shot Marilyns with Blue Background
1.0
0.8
0.6
0.4
0.2
0
1
2
3
4
Original Image
Segmented Image


Color Composition of Shot Marilyns with Green Background
1.0
0.8
0.6
0.4
0.2
0
1
2
3
4
5
Original Image
Segmented Image


Color Composition of Shot Marilyns with Teal Background
1.0
0.8
0.6
0.4
0.2
0
1
2
3
4
5
Original Image
Segmented Image


Color Composition of Shot Marilyns with Orange Background
1.0
0.8
0.6
0.4
0.2
0
1
2
3
4
5
Original Image
Segmented Image

Dendrogram with Heatmap and Superpixel derived from SLIC

In conclusion, this analysis provided a comprehensive examination of the color composition of the Marilyn Monroe painting series. By reducing the color depth of the images, identifying the major colors using K-means clustering, and performing hierarchical clustering on superpixels derived from the SLIC algorithm, we were able to gain significant insights into the color structure of these artworks.

Segmentation of face, hair, and background

To better manipulate our data, we used various Numpy and OpenCV packages to segment the face, hair, and background of all 5 portraits of *Shot Marilyns.* The following are the details of the separation process:

- **RGB to HSV Color Space:** HSV stands for Hue, Saturation, and Value, and it's a popular color model used in image processing. It's particularly useful when color detection is needed. Hue represents the type of color (such as red, green, or blue) or the dominant wavelength. Saturation refers to the intensity of the color. A saturation of 0 will be a shade of grey, and the color becomes more vibrant as saturation increases. Value indicates the brightness of the color. A value of 0 makes the color completely black, and increasing the value makes the color lighter. The RGB color model represents colors as a combination of red, green, and blue. However, it's often easier to work with colors in the HSV space when processing images, as it closely aligns with the way humans perceive color.

- **Gaussian Blur and InRange(color thresholding) Function:** Gaussian Blur is used to reduce image noise and detail. The image is convolved with a Gaussian filter, which reduces the sharpness and detail of the image, effectively blurring it. This can help with contour detection by eliminating small, unnecessary details. The cv2.inRange function is used to filter out colors that lie within the given HSV range from the image. Pixels falling within this range are given the value 255, creating a binary mask where the 'white' pixels represent areas of the original image that fall within the specified color range.

- **Contour Detection Method:** The method used for contour detection is the findContours function provided by OpenCV. This function uses a variation of the Suzuki-Abe algorithm, which operates based on the principles of border following or chain code. Given a binary image, findContours effectively traces the boundaries of objects in the image. In this case, the "objects" are regions of the image that match the desired color.The cv2.RETR_EXTERNAL flag is used as an argument to findContours, meaning that only the outermost contours (or "parents") are detected and nested contours (or "children") are ignored. The cv2.CHAIN_APPROX_SIMPLE method is also used, which removes all redundant points and compresses the contour, thereby saving memory.

Segmentation of face,hair, and background

As we can see from the images above, we were able to successfully separate the hair, face, and background of each portrait using the techniques. However, one can easily identify that the shape of the hair, face and background of each portrait are slightly different. This is due to the fact that color thresholding is very sensitive to the tolerance that we choose. For example, on the portrait with the orange background, our segmentation scheme doesn't perform very well because the orange background and the yellow hair are very close to each other on the HSV diagram, thus we have to carefully choose our tolerance for hue, saturation, and value to extract the hair from the background.

Change Color

With the prior techniques in hand, we are able to modify each portraits to our liking:

Original portrait(left) and modified portrait(right)

To make the color fit in more nicely, we used another technique Alpha Blending. Alpha blending is a technique for combining or blending two images together. It works by taking the weighted average of the pixel values of the two images. It's named after the alpha component of the RGBA color model, which defines the transparency of colors. The transparency level or the "alpha" is used as the weight. The addWeighted function of OpenCV performs alpha blending in the code. The parameters for this function are the two source images and two alpha values (one for each image), and an optional scalar added to each sum. In our code, the original image and the copy with the highlighted contours are blended together. The result is an image where the highlighted contours are semi-transparent, allowing the underlying original image to be visible.

Insights on Potential Original Andy Warhol’s Ideas on Colors

Analyzing the color choices in Andy Warhol's "Shot Marilyns" necessitates an understanding of color theory and the visual implications of these choices. Warhol's deployment of bold, vibrant colors generates a striking visual impact, immediately capturing the viewer's attention and infusing the artwork with energy and dynamism. The use of contrast, especially between Marilyn Monroe's brightly colored face and the darker background, heightens the visual prominence of the subject and adds depth to the composition. This application of contrast is a fundamental principle of color theory, skillfully utilized by Warhol to create a visually compelling piece.

Moreover, Warhol's color choices contribute to the emotional resonance of the artwork. Different colors can evoke varied emotional responses according to color theory. The bright reds and pinks in Monroe's face could be interpreted as conveying passion, intensity, and vitality. Conversely, the darker colors used in the background might create a sense of melancholy or foreboding, providing a stark contrast to the vibrancy of the subject.

Warhol's use of repetition with color variation also plays a significant role in the interpretation of the "Shot Marilyns." Each repetition of Monroe's face is rendered in different colors, creating a sense of variation within the uniformity. This could be seen as a reflection of the multifaceted nature of Monroe's public image, with each color variation representing a different aspect or interpretation of her persona. Through his effective use of color theory principles, Warhol creates a work that is not only visually striking but also rich in meaning and emotional resonance.

III. Conclusion

In conclusion, this report provides a detailed and insightful analysis of the color composition in Andy Warhol's Shot Marilyns series. The use of various image processing and clustering techniques has allowed us to gain a deep understanding of the color structure of these artworks. The segmentation of the face, hair, and background, and the subsequent color modifications, demonstrate the flexibility and potential for further manipulation of these images.

The interpretation of Warhol's potential original ideas on colors highlights how his color choices and the principle of contrast contribute to the visual impact and emotional resonance of the artwork. This study not only offers a technical dissection of the artworks but also delves into the potential meanings and emotional implications of Warhol's color choices.

References:

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