DIP Report
Cartoon-ify Colour Images

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1 Problem Domain

An image in a cartoon art style has several distinct characteristics that separate them from a standard colour image:

1. Distinct edges on foreground objects
2. Vibrant, over-saturated colours
3. Reduced Colour palette

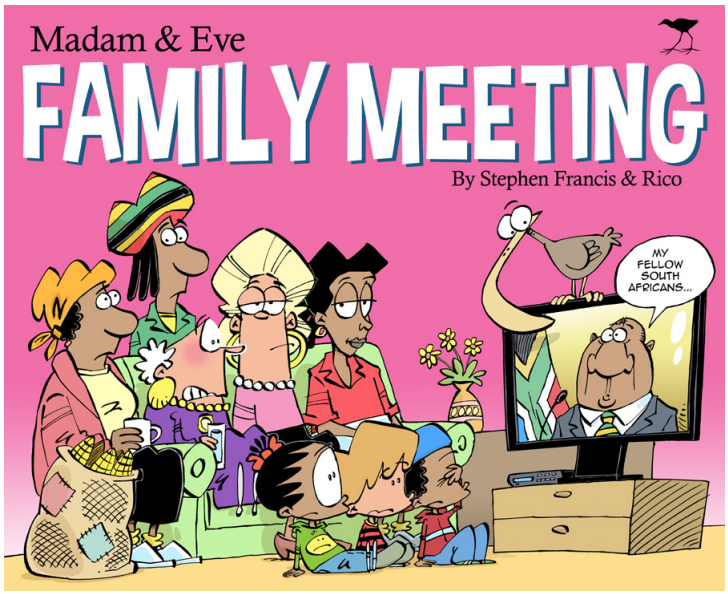

Figure 1: Popular South African Cartoon, Madam & Eve

As can be seen in Figure 1, which is the book cover for a collection of cartoons from the popular South African cartoon series Madam & Eve, all of the characters have been illustrated with a reduced colour palette, edges in the image are distinct, and colours are bright and saturated.

2 Dataset

I compiled my own data set of images using a collection of natural scenery stock images. These were collected from the website envato.com, with the appropriate rights obtained. See Figure 5 on page 5 for the collection of images used.

3 My Approach

3.1 Distinct Edges

The edges of in input image can be extracted using Canny edge detection. The image is first converted to gray-scale, and smoothed using a median filter. This smoothed, gray-scale image is then used to perform the Canny edge detection. In order to overlay the detected edges onto the image, and AND operation is performed between the colour image and itself, using the edges as a mask. See Figure 2 on page 2 for the algorithm in code form.

```
def apply_edges(image):
    image_gray = rgb_to_gray(image)
    image_smoothed = median_blur(image_gray)
    edges = canny(image_smoothed)
    imaged_edged = AND(image, image, mask=edges)
    return image_edged
```

Figure 2: The Apply Edges Algorithm

3.2 Vibrant Colours

In order to increase the saturation of the input image in a simple manner, the colour image format is converted from RGB to Hue Saturation Value. This allows the program to scale the saturation channel by a value > 1 in order to achieve an over saturated appearance. The image is then converted back to the RGB format for further processing. The conversion between RGB and HSV is discussed in the course. The program used a scaling factor of 1.5. See Figure 3 on page 3 for the algorithm in code form.

```
def apply_saturation(image):
    hsv_image = rgb_to_hsv(image)
    hsv_image[saturation] = hsv_image[saturation]*scaling_factor
    rgb_image = hsv_to_rgb(hsv_image)
    return rgb_image
```

Figure 3: The Increase Saturation Algorithm

3.3 Reduced Colour palette

In order to reduce the total amount of colours in the image, the programs performs K-means clustering on the image, with $K = 16$. This reduces the total amount of unique colours to 16, which achieves the goal of having a reduced colour palette in the image.

3.4 Final Pipeline

Each of the effects can be applied in different orders, which will result in different final results. For example, applying the apply_edges algorithm (Algorithm 2) before the k-means clustering algorithm will likely reduce the effect of a distinct edge on the image. Figure 4 shows the effect of this ordering. Each image has been passed through the same filters, with different orders. The order can be seen using the image caption, where the order of the names of the filters is the order which they were applied. Figure **??** shows the same process but with a different type of image. The best result appears to be image two, whose pipeline was Edge Detection, Increase Saturation, K-means clustering , and so this process was then applied to the whole data set.

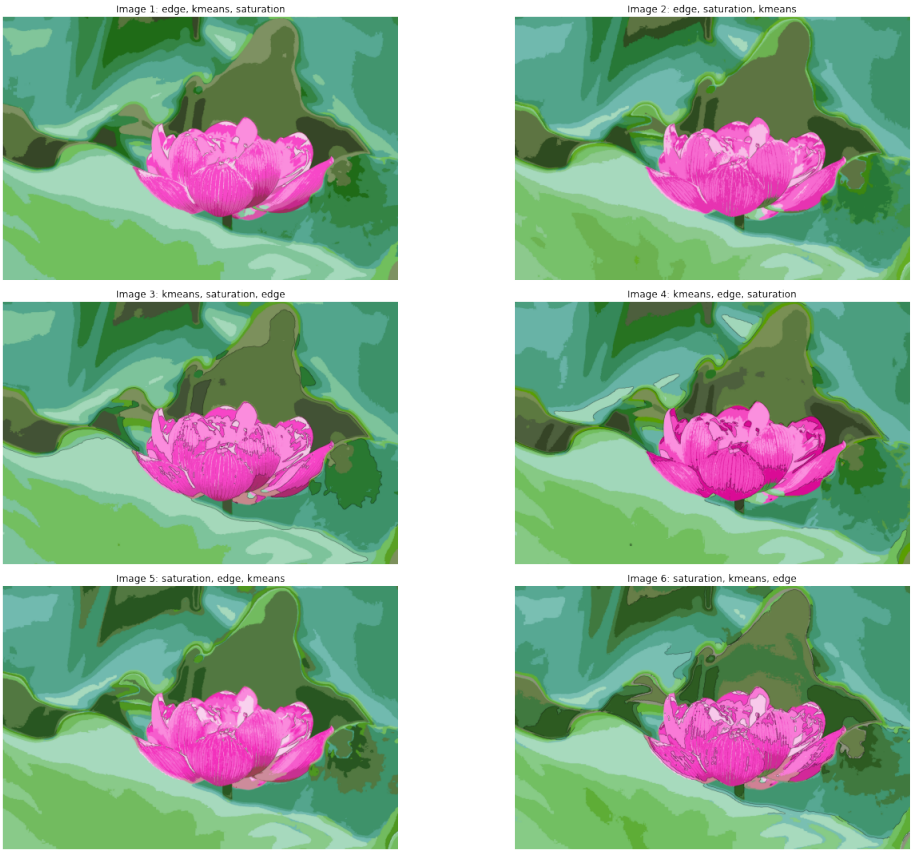

Figure 4: Caption

4 Results

Using the approach outline above, the entire data set was processed, the results can be found in Figure 5 on page 5. The approach seemed to be most effective with images that were brightly lit, with vibrant different colours between foreground and background. Images without too many initial colours also seem to perform better.

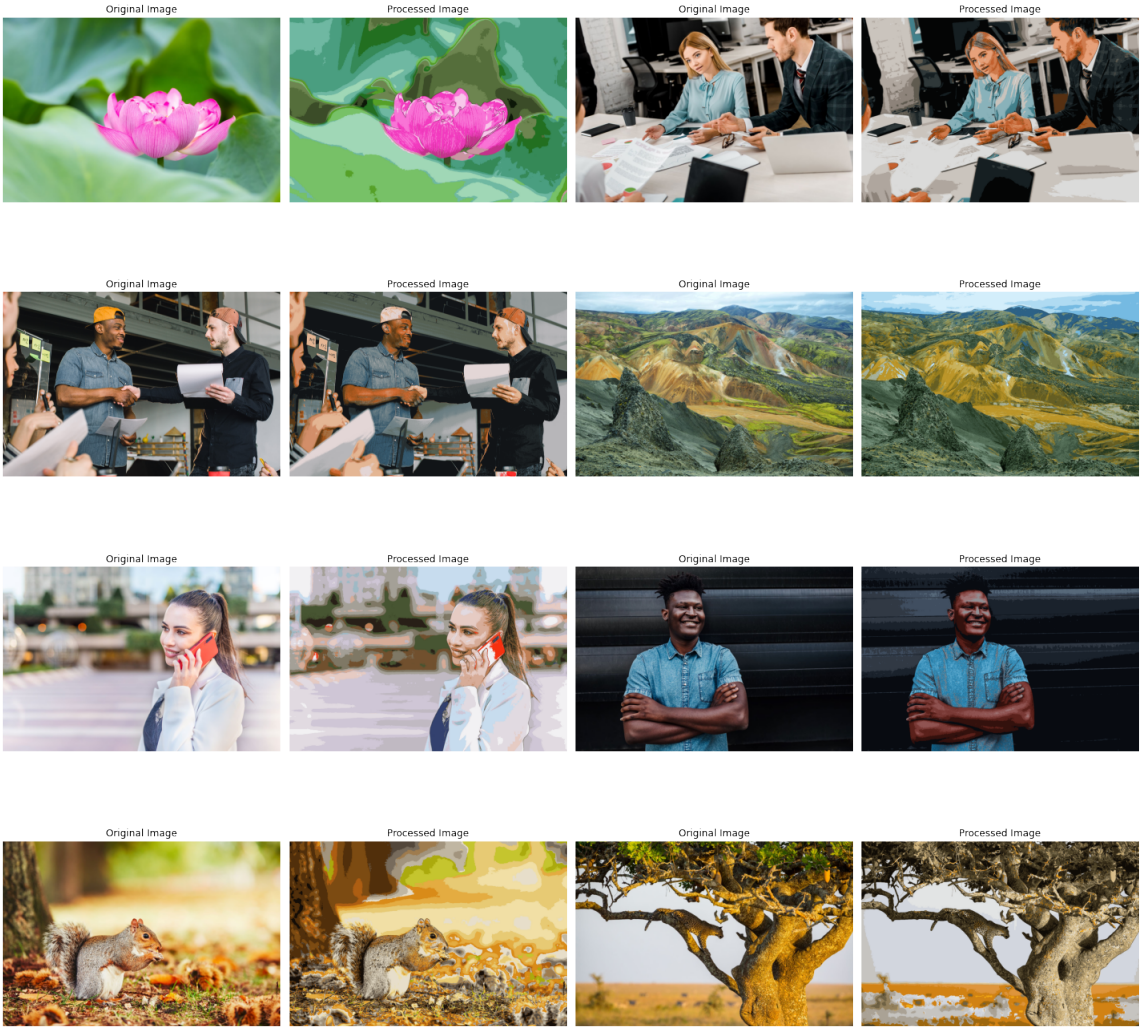

Figure 5: Full Data set

5 Image Sources

All data set images were purchased from https://elements.envato.com, whose license terms can be found at https://elements.envato.com/license-terms. Full list of image sources:
https://elements.envato.com/business-colleagues-discussing-work-during-meeting-UAX5KXC
https://elements.envato.com/creative-african-and-caucasian-young-men-shaking-h-5HNUMY6

https://elements.envato.com/female-person-smiling-while-talking-on-the-phone-H44P86U
https://elements.envato.com/simple-and-stylish-NBPH4YU
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https://elements.envato.com/leopard-rests-in-a-tree-after-meal-P7CPFUM
Madam and Eve Cover: http://www.madamandeve.co.za/