Image Enhancement

Introduction

Images contain a lot of information. However, due to the encoding an compression techniques, many details become unperceivable to the human eye. We use image enhancement techniques to make these details perceivable to the human eye.

Two techniques are explored in this notebook:

1. Whitening

2. Histogram Equalization

Whitening

Image whitening can be thought of as image normalization. This helps in increasing the overall brightness of the image. Thus, the image, which previously was spanning only a small interval of spectrum, now will span the entire spectrum.

$$Z = \frac{X - \mu}{\sigma}$$

```python
# get a new image for output
whiten_op = np.zeros(orig_image.shape, orig_image.dtype)

# perform whitening
mean_intensity = orig_image.mean()
std_dev_intensity = orig_image.std()
whiten_op = (orig_image - mean_intensity) / std_dev_intensity

# display image
plt.figure(figsize=FIG_SIZE)
plt.imshow(whiten_op, cmap="gray")
```

Histogram Equalization

Many times the intensities in an image are unevenly spread. Using this transformation, the intensities are equally distributed. Histogram equalization spreads the bright intensities in an image over a larger intensity range, and hence increases the contrast of the image.

$$h_k = \sum_{i=1}^{I}\sum_{j=1}^{J} \delta[p_{ij} - k], \qquad c_k = \frac{\sum_{l=1}^{k} h_l}{IJ} \qquad x_{ij} = Kc_{p_{ij}}$$

```python
# get a new image for output
hist_eq_op = np.zeros(orig_image.shape, orig_image.dtype)

# perform equalization
hist = cv2.calcHist([orig_image], [0], None, [256], [0, 256])
cumulative_prop = np.zeros(hist.shape, np.float32)
roll_sum = 0.0
for i in range(256):
    roll_sum += hist[i]
    cumulative_prop[i] = roll_sum / (orig_image.shape[0] *
orig_image.shape[1])

for i in range(orig_image.shape[0]):
    for j in range(orig_image.shape[1]):
        hist_eq_op[i][j] = 255 * cumulative_prop[orig_image[i][j]]

plt.figure(figsize=FIG_SIZE)
plt.imshow(hist_eq_op, cmap="gray")
```
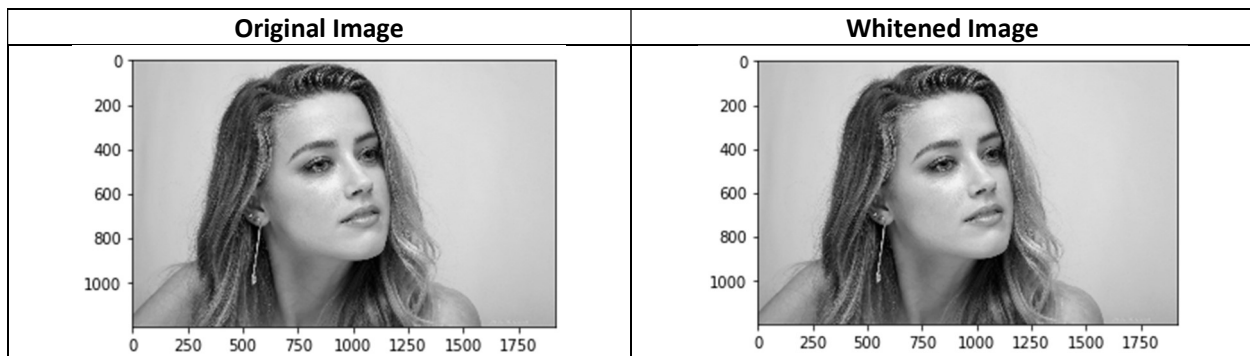
Results

Whitening

Original Image	Whitened Image

Histogram Equalization

Original Image	Original Histogram	Equalized Image	Equalized Histogram