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# Objective Quality Assessment For Color-To-Gray Images Using FOM

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***Abstract-*** *Decolorization or grayscale conversion is the process to transform a color image to a grayscale one . it is widely used in many applications such as digital printing, stylized black and white photography, and in many single channel image processing applications. Here,in this paper we have proposed a method to compare the performance of C2G conversion algorithms. Subjective evaluation is reliable but it seems to be inconvenient and time consuming. Here we make some attempts to develop a subjective quality model that automatically predicts the quality of C2G converted images. Inspired by the philosophy of Figure of merit, we propose color to gray FOM (C2G- FOM) index ,which evaluates the luminance, contrast and the edge shift the reference image and color.*

**Keywords:** Decolorization, FOM,subjective quality.

## 1. INTRODUCTION

Grayscale is one of the widely used tool used in real world applications including black and white printing of color images, aesthetic digital black and white photography, and pre processing in image processing and machine vision system. Usually this type of conversion is a task of dimension reduction, which inevitably suffers from information loss. The main goal of C2G conversion is to preserve as much visually meaningful information about the reference color images as possible. Since color is a fundamentally a multi-dimensional phenomenon described by the perceptual attributes of luminance, hue and chroma, C2G image conversion ,which pursues a one dimensional representation of the color image, which causes some loss of information. As there are many C2G algorithms available, it is essential to decide which algorithm produces best result ie., loss of information should be low. The subjective analysis seems to be time consuming, expensive and cannot be incorporated into automated systems to monitor image quality and to optimize image processing image. So, objective quality assessment is highly desirable.The E-score method which combines color content fidelity ratio ,though provides good results ,it cannot make necessary quality predictions in C2G.

To solve the above problems, we go in for a technique to develop an objective IQA model that evaluates the quality of C2G image by comparing it with its reference image. Here we make one of the first attempts to develop a objective quality model that automatically predicts the perceive quality of C2G converted images through neural network base classification. Inspired by the philosophy of Figure Of Merit(FOM),which evaluates the luminance, contrast and edge shifts between the reference color image and the C2G converted image.

## 2 . RELATED WORKS

Presently , there are many works have been done to convert a coloured image into gray one. Depending on the scope of mapping, it may be classified into global mapping and local mapping. Local mapping methods are location based whereas global mapping methods apply the same decolorization mapping functions to all pixels. [2]Bala and Eschbach introduced high frequency chrominance information into the luminance channel so as to preserve distinctions between adjacent colors. By using predominant component analysis,[7] Grundland and Dodgson computed prevailing chromatic contrasts along the predominant chromatic axis and used them to compensate the luminance channel[5]. A coloroid system based C2G conversion algorithm , where color and luminance contrasts form a gradient field and enhancement are achieved by reducing the inconsistency of the field.

Most existing blind IQA models proposed in the past approaches extract distortion –specific features that relate to loss of visual quality, such as edge strength at block-boundaries. In the existing system, they developed an objective IQA model that evaluates the quality of a C2G image with C2G-SSIM. It consists of three components that measure luminance, contrast and structural similarities. The three components are then combined and an overall quality measure based on the type of content in the image.[1]

## 3. IMAGE ACQUISITION

The image acquisition is the first process in all image processing system. Inorder to do any operation such as decolorization, edge detection or comparison, it is essential to acquire the images and store in databases.

## 4. COLOR SPACE TRANSFORMATION

Whenever a color image is transformed into gray scale, there are more possibilities for quality loss. In order to prevent quality losses we desire to work in a color space of perceptual uniformity, where the Euclidean distance between two color points is proportional to the perceived colored difference. We have choosen CIELAB as our working color space. For a C2G image, its luminance value can also be transformed into achromatic axis in CIELAB space.[1]

## 5. SIMILARITY MEASUREMENT

Let x represent the spatial image coordinate ,f(x) and g(x) denote the color and C2G images respectively. Here we measure three distinct similarities such as luminance, contrast and FOM. Let the contrast measure be $C(x_c)$ indicates the local contrast similarity, $L(x_c)$ indicates the local luminance consistency between them, $S(x_c)$ evaluates the local FOM similar between them.

**FIG 1. INPUT COLOUR IMAGE**

**FIG 2. GRAYSCALE IMAGE**

1) LUMINANCE SIMILARITY:
   Luminance similarity can be computed by means of following formulae:

$$L(\mathrm{x}_c) = \frac{2u_f(\mathrm{x}_c)u_g(\mathrm{x}_c) + C_1}{u_f(\mathrm{x}_c)^2 + u_g(\mathrm{x}_c)^2 + C_1},$$

Where $u_f(x_c)$ denotes the weighted mean luminance of the color image and $u_g(x_c)$ denotes the weighted mean luminance of the gray scale image and $C_1$ is a small stabilizing constant.

2 ) CONTRAST SIMILARITY;

Inorder to evaluate the local color contrast, we compute its weighted mean color difference from its surroundings.

$$d_f(\mathrm{x}_c) = k_p^{-1}(\mathrm{x}_c) \int \phi(\|\mathrm{f}(\mathrm{x}) - \mathrm{f}(\mathrm{x}_c)\|) p(\mathrm{x}, \mathrm{x}_c) d\mathrm{x},$$

$$p(\mathrm{x}, \mathrm{x}_c) = \exp\left(-\frac{\|\mathrm{x} - \mathrm{x}_c\|^2}{2\sigma_p^2}\right),$$

we define the contrast measure as

$$C(\mathrm{x}_c) = \frac{2d_f(\mathrm{x}_c)d_g(\mathrm{x}_c) + C_2}{d_f(\mathrm{x}_c)^2 + d_g(\mathrm{x}_c)^2 + C_2},$$

Where $C_2$ is a small positive constant to avoid instability when the denominator is close to zero.

3) FOM COMPARISON:

The Pratt Figure of merit(PFOM) is used as a quantitative comparison between the edge detecting algorithms. An edge in an image is defined as a single pixel with local discontinuity in intensity. Edge detection is a process of identifying these local discontinuities in images using algorithm. Various factors are responsible for these discontinuities are light,shadow, illumination etc., There are many edge detection algorithms such as sobel edge detector, prewitt edge detector and canny edge detector. Here we have taken three edge detecting algorithms and compared them to find the best C2G algorithm. The prewitt and sobel are mainly dependent on masks.

Main steps in edge detection using masks:

(1) Smooth the input image ( $\hat{f}(x, y) = f(x, y) * G(x, y)$)
(2) $\hat{f}x = \hat{f}(x, y) * Mx(x, y)$
(3) $\hat{f}y = \hat{f}(x, y) * My(x, y)$
(4) $magn(x, y) = |\hat{f}x| + |\hat{f}y|$
(5) $dir(x, y) = \tan\text{-}1(\hat{f}y/\hat{f}x)$
(6) If $magn(x, y) > T$, then possible edge points. Ear edges can be detected by canny edge operator. The canny edge detection is an edge detection operator that uses a multistage algorithm to detect a wide range of edges in images. The algorithm runs in 5 separate steps. They are smoothing, finding gradients, non-maximum suppression, double thresholding and edge tracking by hysteresis.

```
BW1 = edge(bb,'prewitt');
BW2 = edge(bb,'canny');
BW3 = edge(bb,'sobel');


BW1 = edge(x1,'canny');

BW2 = edge(f,'canny');
figure, imshow(BW2)

F = pratt(BW1,BW2)
```

The results are as follows:

**FIG 3. EDGE DETECTED IMAGE**

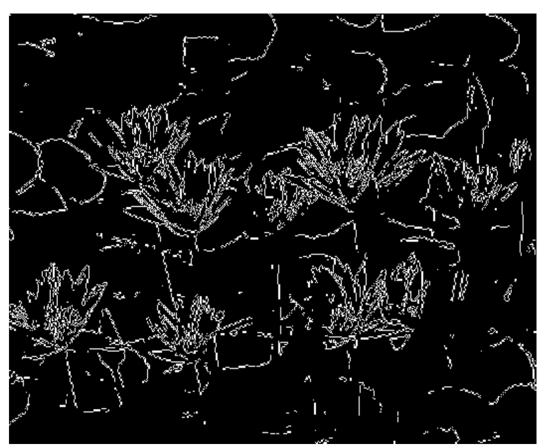

**FIG 4. EDGE DETECTED IMAGE**

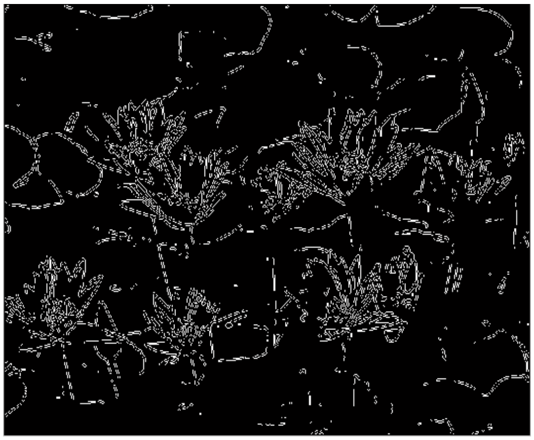

**FIG 5. EDGE DETECTED IMAGE**

4) OVERALL QUALITY MEASUREMENT:

The luminance measure $L(x_c)$, contrast measure $C(x_c)$ and FOM $S(x_c)$ describe three different aspects of the perceptual quality. The correlation is determined and the highest quality algorithm is determined.

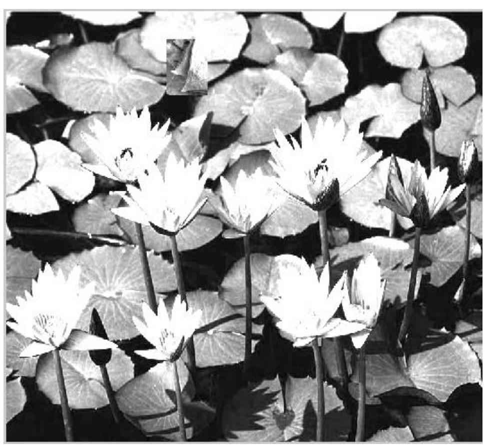

**FIG 6. OUTPUT**

## 6. CONCLUSION

In this paper, we develop an IQA model to determine the perceptual quality of C2G images using the original color as image. Image type dependent combination is then applied to yield an overall quality measure. The proposed system compares favorably against an average subject and significantky outperforms existing objective analysis of C2G conversion. In the future, we have planned to involve neural network, so that self intelligence is improved through proper training process.

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