

# A Novel Scheme for Image Ordering based on ‘Perception Values’

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**Abstract**—Since the advent of the internet, more and more visual information is encountered in the form of arrays of images. In most cases, the arrangement of images ignores human perception, making it stressful for the eyes and the brain to process this information over extended periods. This paper presents a novel method of arranging a set of images based on the relative luminance of the images which takes into consideration the human perception of color and intensity. The proposed concept revolves around calculating the overall “Perception Value” of an image based on photometric luminosity. The results clearly illustrate that images arranged using our proposed method give a more pleasant experience to the user.

**Keywords**—Image Ordering, Image sorting, Perception, luminosity.

## I. INTRODUCTION

VISUAL perception is the interpretation of information contained in visible light that reaches the eyes after being reflected from a set of objects. The human eye responds differently to light of different colors. There are associated brightness and chrominance components to any color system. The brightness component tells about the intensity of the pixels, whereas the chrominance components convey the color information. The human eye is much more sensitive to the fine brightness (luminosity) details than to the fine color details. It is no surprise, therefore, that in video transmissions, the two components are separately transmitted with the bandwidth of chrominance relatively suppressed.

Photometric luminance or relative luminosity is calculated using the coefficients based on the CIE color matching functions. The ITU Rec. 709 [5] has defined the relative luminance based on the Red, Green and Blue components of a pixel. The relative luminosity (relative intensity) is in the range 0 to 255. White color has the highest intensity of 255 while black has the lowest of 0.

The human visual system has an extremely high dynamic range, considerably larger than that photographic media. This high dynamic range is due to the ability of the eye to adjust with the intensity of light. However, frequent large changes in intensity lead to viewing discomfort. Hence, viewing images is a more comfortable experience when images are arranged to mitigate sudden variations of intensity.

The remainder of the paper is organized as follows. In

Section II, the proposed algorithm is described. Section III discusses the proposed implementation module. Section IV contains the details of the experiments and results. Section V discusses the ideas for future work and Section VI contains the conclusions.

## II. PROPOSED ALGORITHM

Here are two important points to consider:

- The higher the relative luminosity of a pixel more would be the visual perception produced by it. Human eye is sensitive to the brightness of a pixel and higher brightness would be addressed better than a lower brightness value.
- Continuous region of a high brightness color would produce more visual perception than when the high brightness regions are distributed over the same area. This is because human eye finds it perceptually better when the intensity variations are small as compared to the case where the intensity variations are high.

Based on the above considerations, we propose an algorithm that arranges a set of images in an order that best suits the eye. Following this order of arrangement of images, the eye would not need to adjust to sudden changes in intensities and hence the user will have a comfortable and pleasant experience while viewing them. The algorithm for suitably arranging the images consists of the following steps:

Step 1: Calculate the Perception Value of each image in the set.

Step 2: Sort the Perception Values and present the images in the increasing order of Perception Values.

For the implementation, a set of images is chosen. For each image  $I$  in the set, the Perception Value ( $V_I$ ) is calculated. The images are arranged in the increasing order of these Perception Values calculated and presented to the user. This type of arrangement (sorting) can be integrated easily to any image viewing application.

### A. Calculation of Perception Values

For each image  $I$ ,

$$V_I = S_I + A_I \text{ where}$$

$V_I$  is the Perception Value of the image  $I$

$S_I$  is the Intensity Contribution

$A_I$  is the Adjacent Contribution

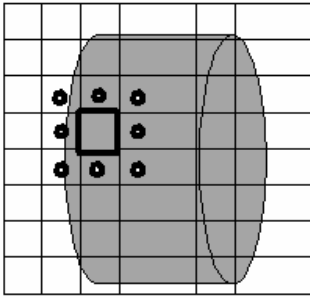


Fig. 1 A sample image divided into a grid

The Image is divided into a grid of N cells (8 X 8 = 64, in this case).

The darkened cell is the cell being considered and the cells marked with dots are the neighboring cells. So, there can be a maximum of 8 and a minimum of 3 neighboring cells.

For calculating the Intensity Contribution ( $S_j$ ) and Adjacent Contribution ( $A_j$ ) of an image, the image is divided into a grid of cells.

Then for a given cell  $j$ , Let,

$H_j$  be the height of each cell (in pixels)

$W_j$  be the width of each cell (in pixels)

So, the number of cells along the

$$X \text{ axis of the Image, } m = \frac{\text{(Width of the Image)}}{W_j}$$

$$Y \text{ axis of the Image, } n = \frac{\text{(Height of the Image)}}{H_j}$$

### B. Intensity Contribution

The Intensity Contribution ( $S_j$ ) of a cell  $j$  = Normalized mean of relative intensities of all the pixels in that cell.

$$S_j^r = \left[ \frac{\sum(Y_k)}{K} \right]$$

where

$\sum(Y_k)$  is the sum of relative intensities of all the pixels in the cell. Dividing this sum by  $K$  (the number of pixels in the cell) gives the mean relative intensity of the cell. We normalize  $S_j^r$  by dividing it by 255 (the maximum of relative intensity).

So,

$$S_j = \frac{S_j^r}{255}$$

### C. Adjacency Contribution

The Adjacency Contribution ( $A_j$ ) for a cell  $j$  = The Sum of Adjacency Contributions due to the cells surrounding the cell  $j$

$$A_j \propto \frac{1}{(S_j - S_k)}$$

$$\propto S_j$$

$$\propto \frac{1}{N}$$

where,

$S_j$  is the Intensity Contribution of cell  $j$

$S_k$  is the Intensity Contribution of a neighboring cell  $k$ .

$N$  is the number of cells

$$A_j = \rho \left( \sum \left( \frac{1}{(S_j - S_k)} \right) \right) \times S_j \times \left( \frac{1}{N} \right)$$

(Where  $k$  ranges from 1 to 8)

So, the Perception Value,  $V_i$  of image  $I$ , is

$$V_i = \sum (S_j + A_j)$$

(Where  $j$  ranges from 1 to  $N$ )

### III. PROPOSED IMPLEMENTATION MODEL

The proposed model consists of a database that stores the [Perception Value, File Location] pairs in a sorted List. Addition or deletion of image files should be handled with appropriate updates. The sorted list should be updated as images are inserted, deleted or modified from the list. Maintaining such a list would avoid the heavy calculations needed during the actual display of images.

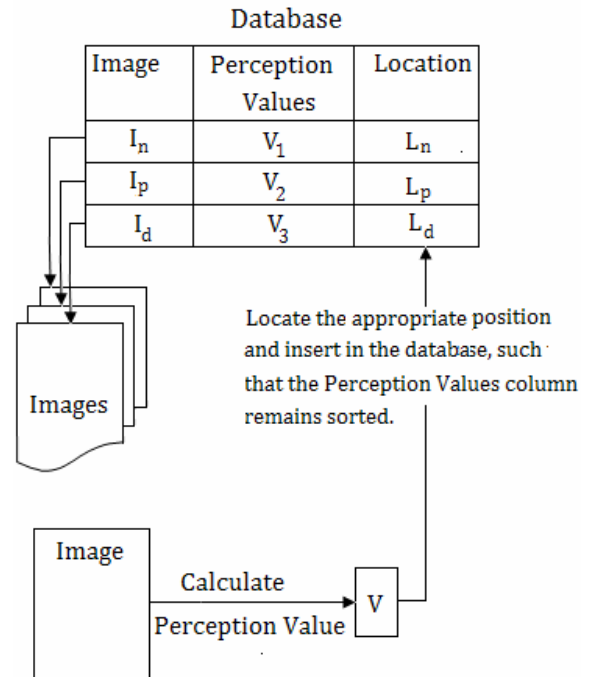


Fig. 2 The model for simulation

### IV. EXPERIMENTS AND RESULTS

For the purpose of experiments,  $\rho$  has been chosen as 1 and the dimensions of each cell (corresponding to the grid into which an image is to be divided) have been kept constant.

#### A. Arrangement of Images in the order of their Perception Values

Figure 3 below shows the sample set chosen for the experiments.



Fig. 3 Sample Set

Figure 4 graphs the Perception Values of the images in the chosen sample set.

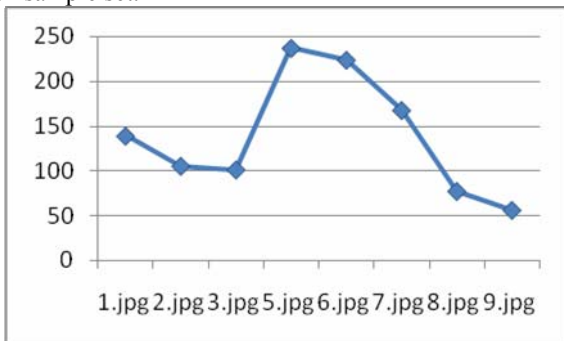


Fig. 4 Perception Values of the images in the chosen sample set.

Figure 5 below displays the images sorted in increasing order of their Perception Values.

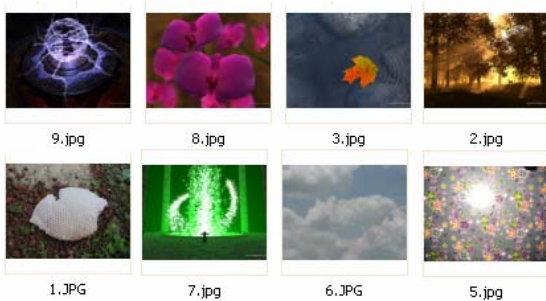


Fig. 5 The sorted images

Since the resultant sorted images are arranged in the increasing order of Perception Values, they create a more comfortable user experience while viewing the complete set of images.

*B. The influence of Adjacency Effect*

The sample set in Figure 6 will be used to demonstrate the effect of adjacency values on the total Perception Value of an image.

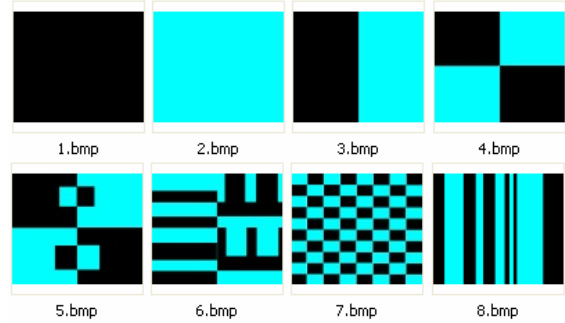


Fig. 6 Sample set for demonstrating the Adjacency Effect

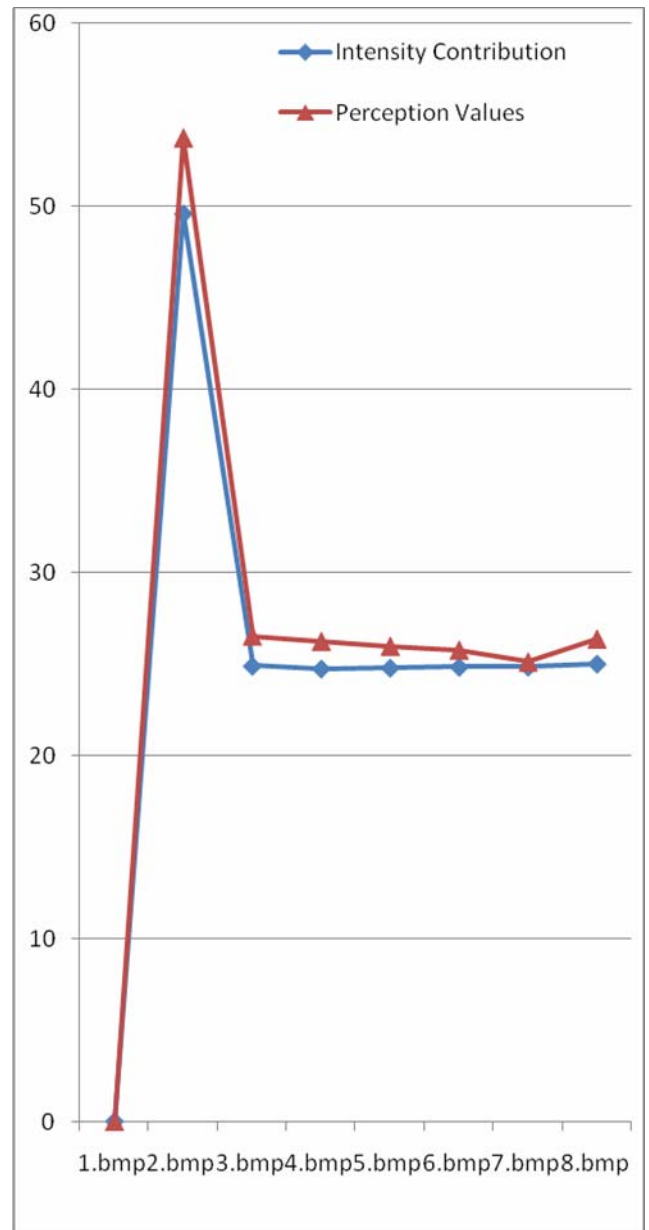


Fig. 7 Graph showing the effect of Adjacency Contribution in Perception Values. Even though the areas of black and white regions is almost same for images 3 to 8 (Intensity Contribution is almost same), the Perception Values are different and hence sorting the images in the order of Perception Values, presents a more comfortable user experience

Figure 8 below displays the images sorted in increasing order of their Perception Values.

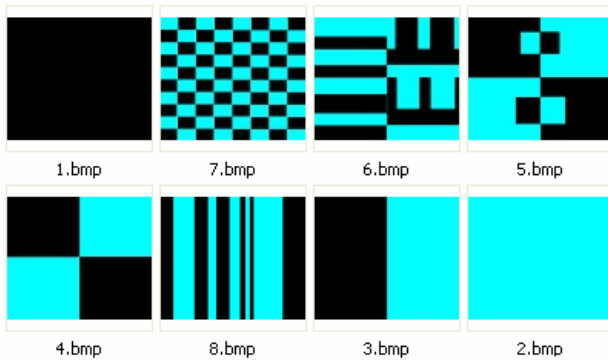


Fig. 8 The sorted images

## V. FUTURE WORK

For the adjacency calculations, only the immediate adjacent neighboring cells have been considered. A different approach can also be taken wherein instead of just considering the immediate adjacent cells, a larger surrounding area of a particular cell can be considered to compute the adjacency effect. If  $X$  is the cell being considered and  $Y$  is any other cell within the defined neighborhood, then the contribution due to  $Y$  on  $X$  would depend on the proximity of  $Y$  from  $X$ . More the distance of  $Y$  from  $X$ , less would its effect of adjacency on  $X$ . Outside the boundary of the decided neighborhood, this effect can be defined as zero.

## VI. CONCLUSIONS

In this paper, a novel way of arranging the images has been presented which takes the comfort of user experience while looking at them is taken into consideration.

By considering the intensity values of the pixels constituting the image and considering the adjacent effect, we were able to define and visualize the Perception Value of an image. Arranging a group of images based on Perception Value, presented a more comfortable viewing experience.

## REFERENCES

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