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Color Edge Detection Based on the Fusion of Intensity and Chromatic Differences

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Abstract: ***Edge detection is the name for a set of mathematical methods which target at classifying points in an image at which the image intensity varies sharply or, has discontinuities. The paper tries to find the solution for detecting color edges based on color and intensity information of two new images H-image and T-image crafted on color space transformation, that will produce two-resulted edges derivates of H-image and T-image and are at last coalesced to obtain final edge.***

Keywords: ***Digital Image, Gaussian noise, Color Edge Detection.***

I. INTRODUCTION

Edge detection is the low-level image processing operations using the values of image pixels to modify individual pixels of an image, which are apportioned into one-to-one, neighborhood operation and many-to-one operations [1]. One-to-one operation rely on the conforming values of the pixels of the input image, and then similarity will be simple. On the other hand, the image produced by the Neighborhood operations relies on a cluster of neighboring pixels around the conforming pixel from the input image.

The low-level operations like sharpening, filtering, smoothing, edge detection and noise reduction are exceedingly important for image processing point of view for the color edge detection. Color edge detection plays very imperative roles for many applications of image processing like image analysis, segmentation and recognition, and the need of an hour is to pay more attention on the processing colored images.

The colored images (multi-spectral) encloses vast and meticulous amount of edge information as compared to colorless images where the edges commonly resemble to boundaries of object and the physical properties like reflectance or illumination also varies. Subsequently no edge will be perceived that is why it is not sufficient for certain applications of image processing.

According to psychological research on human visual system colour plays an important role in deciding object boundaries. So, the basic problem is to find the solution for detecting color edges based on color and fusion of intensity information of two new input images. In this paper, we are proposing a method which will use inter-component difference information for effectual color edge detection.

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For any multi-otherworldly picture F, a dark S-images is outlined as the rapacious contrasts between everything about two-shading modules, and elective dim E-images is then accomplished by weighting of S-images and the dim power images H. The last edges are resolved through combination of edges removed from R-images and G-images. Quantitative assessments under different degrees of Gaussian commotion are performed for additional correlations. Thorough outcomes from various test images have demonstrated that our methodology beats edges recognized from conventional shading spaces like RGB, YCbCr and HSV as far as adequacy and power.

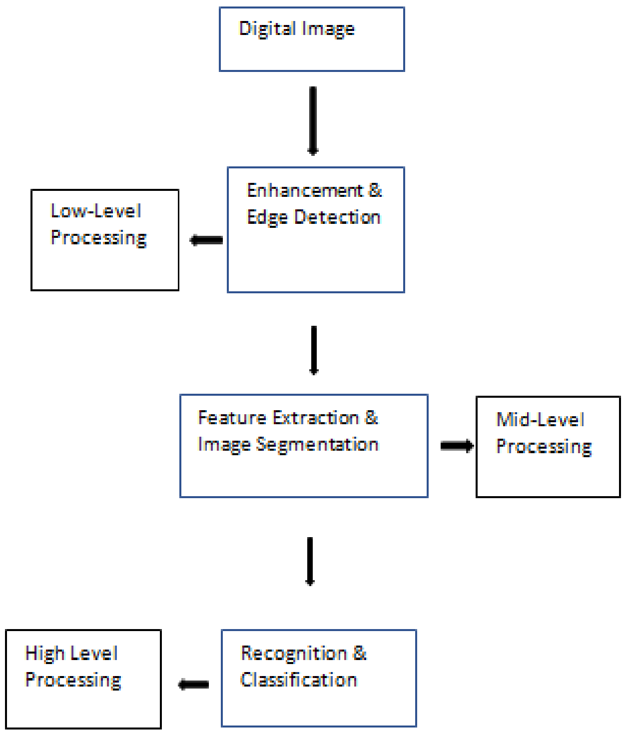

Fig. 1: Flowchart of Digital Image Processing

From Fig. 1, the main steps can be noticed in the digital image processing. In the other words, low level processing in image processing, includes:

1. Image data are not interpreted, i.e. semantic is not explored;
2. Signal processing methods, e.g., 2D Fourier transformation;
3. Same methods for a wide class of problems;

Still certain challenges of effective edge detection from color images will remain and one has to decide an optimal way to fuse chromatic components and illumination intensity for this purpose;

II. LITERATURE REVIEW

Since physical edges normally compare to obvious varieties in the brightening and hues, edge discovery is fitting and basic low-level application for giving fundamental visual data to highlight extraction, division and scene understanding [2].

Generally, there are three basic steps of edge detection image difference and gradient detection for edge pixel judgment, preprocessing or smoothing and continuous edge extraction. Gradient-based methods are almost the earliest edge detector which only uses convolution templates to obtain local difference for edge detection, and then Canny introduced a well-defined edge detector with good performance, high precision and unique response [2].

From convolution layouts to Canny edge locator, conventional edge recognition strategies are generally characterized on dim pictures, and a few enhancements or new techniques are vital for edge identification from shading images as indicated by human shading discernments. A straightforward thought is to change over (r, g, b) shading images to its luminance force image G, from which conventional edge identifiers are applied to extricate shading edges. As the transformation from shading to dim is various to one mapping, edges distinguished from G-images are less exact and ordinarily edge pixels with clear shading contrast yet less force variety are absent.

Although another way is to apply the edge detectors to all colored components, based on that the resultant edge will be pattern of edges from distinctive component images. The resultant edges may have more accuracy and detailed information then the edges from H-image, but the accuracy will not remain and may have missing edges since the inter-component information is ignored in the process of edge detection.

In order to obtain realistic and precise edges, a limited number of models have been recced [3, 4, 5], such as HLS HSV YUV, XYZ, YCbCr, etc. Edges are extracted from the pattern of new space during the conversion of colored images (r, g, b) to a specified color space. As a result, the resultant edges are mixture of edges, color and luminance information since the components are independent on each other. [1]

Then again, a couple of aggregate techniques have been anticipated for shading edge discovery, for example, morphological angle followed by exception dismissal [6], factual investigation of R-G and B-Y shading segments [7], bunching of pixels utilizing the negligible spreading over tree [8], self-arranging map (SOM), a dim scale edge indicator [9], and neighborhood hypergraph and approval of hyperedge [5].

Despite the fact that the joined edges have more precision and detail data than the edges from the force picture, they are as yet no exact enough for viable article recognition and picture division. In this way, choosing in that approach to incline toward another appropriate shading space is as yet a key undertaking, relies upon the situation upon the administrators or handling

III. METHODOLOGY AND RESULT

Edge discovery, is valuable and significant in some low-level vision applications as to give basic visual data to highlight extraction, division and scene understanding [2]. To obtain color edges most of the algorithms extract them using intensity of the images where some inter-component information is ignored or via fusing edges revealed from each color components. In this research, an improved method on color edge detection is proposed based on the inter-component difference information for effective color edge detection.

A. Color Space Transform

Comparing to texture and shape, color is the chief discrimination attribute in human visual system [7]. Although many color transforms and color space models have been developed, they can be converted between each other by mapping from and to RGB space.

Following is an example transform from RGB space to YUV space:

$$y = \omega_r r + \omega_g g + \omega_b b \qquad (1)$$

$$u = b - y,\ v = r - y \qquad (2)$$

In eq. (1) and (2), from RGB to YUV color space is a linear transform has been listed. In YUV space, illumination intensity is decided by weighting R, G and B values using weights ωr, ωg, ωb, where these weights are positive and less than and equal to 1.

The RGB to HSV transform can be defined as [4]:

$$V = \max(R, G, B)$$
$$P = V / V$$
$$V = V - M$$
$$M = \min(R, G, B)$$

YIQ and YCbCr have similar transforms like YUV above, and HSV and HLS spaces have more complex transform formulas [8].

Let L be the three-component original multi-spectral image, that states one component S-image as:

$$S(i, j) = \omega_1|m(i, j) - n(i, j)| + \omega_2|m(i, j) - p(i, j)| + \omega_3|p(i, j) - n(i, j)| \qquad (3)$$

where S-image gave us the over-all color differences between different color components.

For grey pixels in image L , they have unchanged values in all the three color channels, however, it is difficult to distinguish them from S-image; therefore, additional image T is acquired by weighting of S-image and luminance intensity image G as follows:

$$T(i, j) = k.\frac{\omega_d H(i,j) + \omega_g S(i,j)}{\omega_d + \omega_g} \qquad (4)$$

where ω_d and ω_g are the weights and determined in (5) and (6)

$$\omega_d = 1.5 \times Range(S) + \sigma(S) \qquad (5)$$

$$\omega_g = 1.5 \times Range(H) + \sigma(H) \qquad (6)$$

To check the difference of the maximum and the minimum intensity values within the image, and σ as the standard deviation, range function was used to determine the valid intensity range of an image.

For the most part, (4) is utilized to make the weighted qualities, $\omega_d H(i, j)$ and $\omega_g S(i, j)$, progressively similar to accomplish increasingly solid outcomes. Also, the utmost 1.5 is utilized observationally as it assists with yielding specific great outcomes than different qualities

Fig. 2: Orig. color Image (left) and Its Conforming 3 Sole Channel Images Comprising S-image, H-image and T-image.

For a given color image, its conforming S- image, H-image and T-image are all illustrated in Fig 4 for the similarities

Low-level Image Processing Approaches

The basic scheme on which our emphasis is, to detect improved color edges using the fusion scheme, standard edge detectors has been used for evaluation and consistent measurement. In order to achieve our goal, we are using well-known canny operators as for its relatively worthy performance.

The corresponding filters f(x) and the intervals [−w, w] impulses and band-width of canny operator should make formula (7) maximum:

$$\sum = \frac{\left|\int_{-\omega}^{0} f(x)dx\right|}{\sqrt{\int_{-\omega}^{\omega} f^2(x)dx}} \cdot \frac{|f'(0)|}{\sqrt{\int_{-\omega}^{\omega} f'^2(x)dx}} \qquad (7)$$

According to canny's theory [2], two parts are included in Eq. First for Canny detector, signal to noise ratio is achieved and localisation accuracy for second. By putting two together, the tradeoff can be reached for the edge detector. Canny Also proved that the product of the two parts in (7) would generate scale-invariant output, which was very important in edge detection. The important advantage for using Canny operator is it ensure the precision of detection as the edged detected are all local extrema. The normalized gradient image is obtained from the smoothed grey image smoothed by gauss function to determine possible edge pixels. In our experiments, the implementation of the Canny operator is adopted for edge detection. As seen, two threshold T_h and T_l being important limits will lead to quite different edge results. In Fig 2, for the H-image the detected edges use different thresholds are shown in Fig 3. Reduction in T_l for a given T_h can give us more detailed edges but may cause noise as shown in fig. 3, Therefore selection of thresholds parameters plays a key role and is also a basic problem for detecting edges of Canny operator

(a) $T_l = 95$ (b) $T_l = 50.$ (c) $T_l = 8$

Fig. 3: Extracted Edges with Th = 220 and Tl changes from 95, 50 to 8, Respectively

In our method T_h and T_l are automatically determined as follows:

$$T_h = \gamma + \max(\gamma/2, \sigma) \qquad (8)$$

$$T_l = |\gamma - \sigma|/2 \qquad (9)$$

where γ and σ are the mean and standard deviation of any grey image in this process.

For H-image in Fig. 3, $T_l = 50$ can be found, and the conforming edges is given in Fig 3(b), which is better than Fig 3(a) and Fig 3(c).

To separate the edges from the multi-phantom pictures the accompanying advances have been utilized:

1. The partner G-image and R-image are acquired dependent on same source picture;
2. By utilizing the Canny administrators with consequently decided parameters, edges are distinguished from these two images as E_G and E_R, individually;
3. The edges in the image for the shading picture E*final* are resolved as follows:

$$E_{final} = E_R \bigcup E_G \qquad (10)$$

Fig. 4 E_R (Left) and E_{final} (Right) of color Image in Fig 2

E_R and E_{final} in Fig. 4 have been detected for the color image in Fig. 2 and E_G in Fig. 3

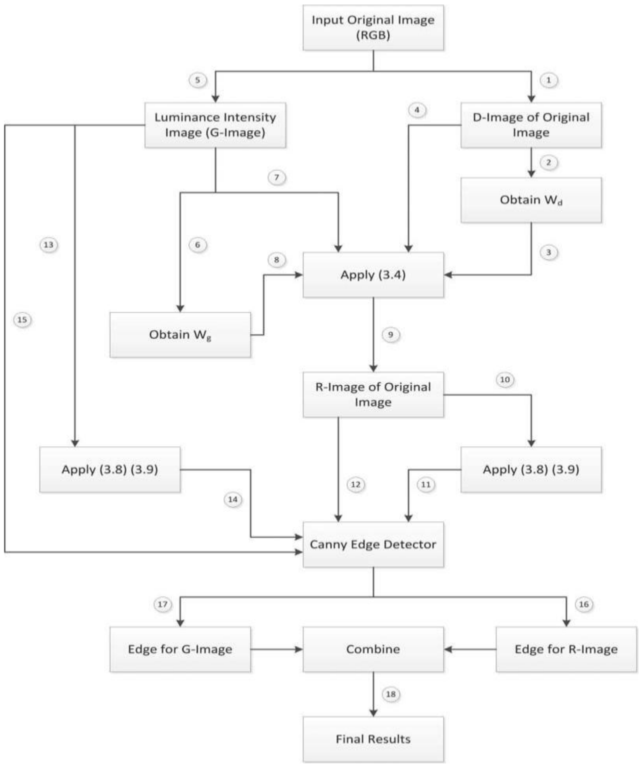

Fig. 5. Flowchart for Color Edge Detection

IV. CONCLUSION

For color edge detection, the imperative and very much precise component in multi-spectral images is inter-component information presented on color images, though these inter-component features have been ignored in many existing algorithms. However, fusion of intensity and chromatic differences discussed in this paper is found to be very beneficial in obtaining better color edges. The result obtained from various tests including gaussian noise on testing images verified both the effectiveness and robustness of our proposed approach.

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Mansoor Farooq, completed his Ph.D. in Computer Science and Engineering from Shri Venkateshwara University, MCA from Islamic University of Science and Technology and BCA from University of Kashmir, He has already published various research papers chapters and books. His core interest is image processing, Artificial Intelligence and IOT, besides that he is also a member of various professional computing societies like ACM New York, IAENG Hong Kong.