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ACO Based Color Edge Detection on the Fusion of HUA and PCA Components

Kavita Sharma, Vinay Chopra
Deptt. of CSE DAVIET
Jalandhar, Punjab, India

Abstract— This paper proposed a novel technique of edge detection in which ACO Edge detection is performed on fusion of Hue and PCA component. Edge detection is the vital step in numerous critical vision applications. Edge detection produces a black and white binary image where each object is distinguished by lines. Edges are the region in the image where sharp variations exist. Matlab tool is used for its implementation. Total ten natural images are taken for the experimental purposes. Pratt's figure of merit parameter is used for comparison purposes and the results shows that the proposed technique outperforms over available techniques.

Keywords— Edge detection, Hue, PCA, Fusion Based Fuzzy, Fusion based ACO

I. INTRODUCTION

Edges can be defined as the boundaries between regions in an image that helps with segmentation and object recognition. Edge detection is an important area in the field of Computer Vision [9].Edge detection [11] is the method of identifying and locating sharp discontinuities within an image. The discontinuities are abrupt variations in pixel intensity which describe boundaries of objects in a scene [10]. As contrast to the grey-scale images, the color and multispectral images enclose extra information. The benefit of color edge detection schemes over grey-scale approaches is that those edges that exist at the boundary between regions of different colors cannot be detected in grey-scale images if there is no variation in intensity [12].

ACS is an iterative algorithm [16]. At every iteration, it carries outs a loop containing two fundamental operations:

Route construction [17]**: F**irstly, the travelling ants construct a route arbitrarily on their way to food. However, the successive ants chase a probability-based route construction method.

Pheromone update: This phase includes two vital stages. Firstly, a special chemical "pheromone" is dropped on the route traversed by the individual ants. Secondly, this dropped pheromone is an expose to evaporation. The amount of pheromone updated on an individual route is a cumulative consequence of these two stages [18].

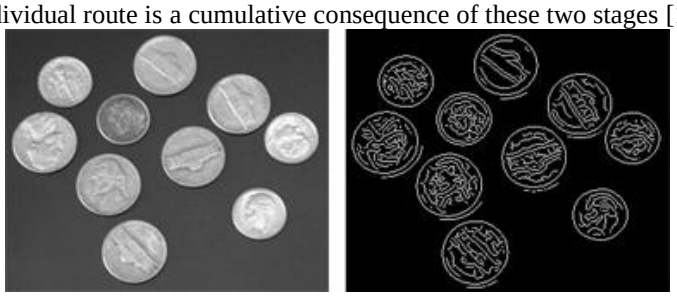

Fig. 1.Edge detection [13]

II. RELATED WORK

Di Zenzo 1985[1] first proposed the vector solution through the introduction of vector gradient into colour edge detection. **Evans et al. 2006** [2] proposed a new color edge detector based on vector differences. To enhance the performance in the existence of noise **Dikbas,et al. 2007** [3]proposed a color edge preserving grayscale conversion algorithm that helps to detect color edges using just the luminance component. **Paskaleva et al. 2010** [4] developed an algorithm for joint spatio-spectral (JSS) feature selection termed Spectral Ratio Contrast (SRC) edge-detection algorithm. **Ren et al. 2010** [5] proposed an improved method on colour edge detection in which the significant advantage was the use of inter-component difference information for effective colour edge detection. **Dinh et al 2011** [6] proposed SEDMI, a method that aims to overcome the problem of finding edges in multispectral images by thinking the salient properties of edges in an image. **Lau et al. 2011** [7] Proposed a cluster-based approach for optimizing the transformation for individual images in a way that preserves as much of the information as possible from the source space while staying as faithful as possible to the natural mapping. **Chu et al. 2013** [8] proposed an edge and corner detection method based on colour invariants, which can achieve true target features because of its lower sensitivity to shadow, shading and highlight. Many advantages and disadvantages of these papers are shown in Table 1.

Table.1: Evaluation of Existing Literature

Ref no.	Advantages	Disadvantages
[1]	1) Improve the edge detection results of colour image. 2) Obtain more accurate edges 3) Widely used in colour and multispectral image processing,	Lose some edges caused by hue changes.
[2]	Improved the performance of the classical morphological gradient operators using a novel pair-wise outlier rejection scheme.	1) Lose some edges caused by hue changes 2) Complex
[3]	Detect colour edges only using the luminance component in low-computational complexity.	Don't consider edges caused by saturation and hue component
[4]	This method can obtain more detail edges generated by luminance and saturation changes.	1) Complex approach 2) Miss the edges caused by hue Changes
[5]	1) Well suited to detection of weak edges. 2) Produces good image map. 3) Mask is independent of image plane.	Hue component is not considered.
[6]	1) Applied to color transformation problems .2) Image optimization-on for color deficient viewers.	1) Omit role of hue component 2) Computational complexity
[7]	1) Good for multispectral data sets. 2) Detect objects in background clutter or appearing in a few bands. 3) More robust to severe noise	1) Omit hue component 2) more computation Cost 3) Edges were not continuous
[8]	1) Lower sensitivity to photometric variations 2) Effective and stable 3) Better result for repeatability	Pseudo edges created.

III. IMPROVED COLOR EDGE DETECTION USING ACO ON FUSION OF HUE AND PCA

We have proposed a new technique in which on the fusion of Hue component and PCA component Ant colony optimization edge detection technique is used to find the edges of a digital image. The procedure to find the edges is given below:-

1. Firstly input image is taken.
2. Then on this image RGB to HSV transformations are applied, HSv color space uses color characteristics of a direct sense of the three quantities: the brightness or lightness (I), hue (H), saturation (S) to describe the color. This method is more in line with the human eye habits to the description of the color, but the expressed colors are incomplete visual perceived color. When we get the hue image on it Color Image gradients are applied which are used to locate sharp variations in intensity values as gradients will give more value where edges exist. After applying Image gradients ACO is applied to detect the edges of that image. This image will be fused at 5^{th} step.
3. Now applying RGB to PCA conversion of the input image.PCA image will make edge detection very easy and reduces computational complexity. On this PCA image Color Gradients are applied to locate sharp variations which will be useful for final edge detection. On this Gradient image ACO is applied to detect edges of image. This image will also be used for fusion at 5^{th} step.
4. Now RGB image converted to Gray scale image because gray images contain also useful information .On it Gradient is applied to find areas where edges may exist .this information is very useful at final edge detection by ACO. On this gradient image ACO technique is applied to detect edges of the image. This image will also be used for fusion at 5^{th} step.
5. Now edge images obtained from 2^{nd}, 3^{rd} and 4^{th} step are fused. This will give better result.
6. Now final edge detected image is obtained.

IV. EXPERIMENTAL SETUP AND RESULTS

Different edge detectors like Hue, PCA, Fusion of Hue and PCA, Fuzzy on the fusion of Hue and PCA and the proposed technique (ACO based edge detector on the fusion of Hue and PCA) has been designed and implemented with MATLAB tool. Ten distinct natural images are taken for experimental purposes and the results have shown that the proposed technique has more efficient and effective results over the existing techniques. Following section encloses the result existing and proposed techniques.

Fig.2. Input image

Fig.2 has shown the input image.

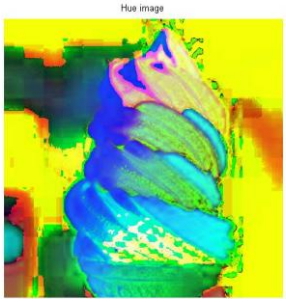

Fig.3. Hue image

Fig.3 shows the Hue image of the input image shown in the Fig.2.

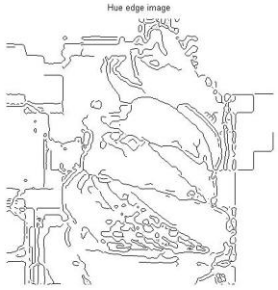

Fig.4. Hue edge detected image

Fig.4 shows the Hue edge detected image of the hue image shown in the Fig.3.

Fig.5. PCA image

Fig.5 shows the PCA image of the input image shown in the Fig.2.

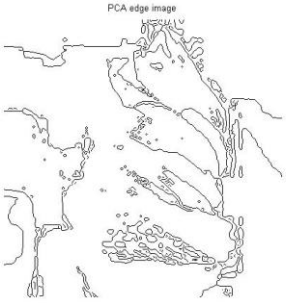

Fig.6. PCA edge detected image

Fig.6 shows the PCA edge detected image of the PCA image shown in the Fig.5.

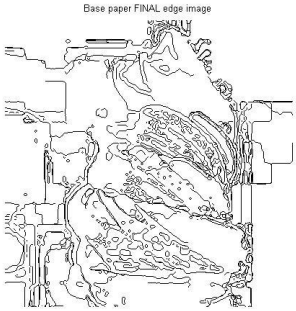

Fig.7. Fusion based edge detected image

Fig.7 shows the Fusion based edge detected image of the input image shown in the Fig.2.

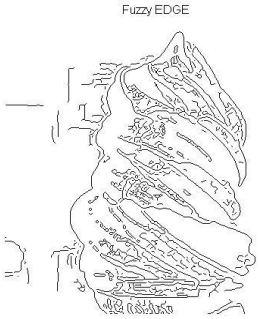

Fig.8. Fuzzy edge detected image

Fig.8 shows the Fuzzy based edge detected image of the input image shown in the Fig.2.

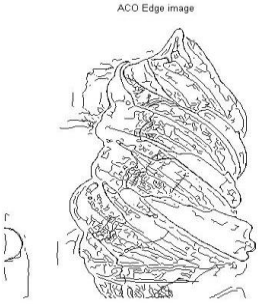

Fig.9.ACO based edge detection

Fig.9 shows the ACO based edge detected image of the input image shown in the Fig.2.

The outcomes have shown that proposed method is more efficient than other methods because of having highest edges. The outcomes has exposed that the each techniques has pretty efficient outcomes above each other but the outcome of fuzzy based edge detectors are pretty more efficient because of having maximum edges. But the result of the ACO based edge detectors are much more useful as well as clear than other techniques.

V. PERFORMANCE EVALUATION

Numeral researchers have considered the problem of measuring the performance of edge detector. In fact, it is difficult as we don't really know what the underlying features are that we desire to detect. However, if we suppose that there are step edges corrupted with Gaussian noise, then some criteria can be set for calculating performance. Such criteria are generally the following:

- The probability of false edges and missing edges.
- An error to approximate the edge angle.
- Edge' mean square distance is estimated from the true edge.
- Algorithm's tolerance to deformed edges and additional features similar to corners and junctions.

The first criterion relate to edge detection, the subsequently two to edge localization, also the very last to tolerance to exits from the ideal edge model. Pratt created function FOM for computed quantitatively the performance of distinct edge detectors. The measure is

$$FOM = \frac{1}{max(I_d, I_I)} \sum_{i=1}^{I_d} \frac{1}{1+\beta (d_i)^2} \quad (1)$$

where I_d, I_I, and d_i are respectively the detected edges, the ideal edges, the edge variation from i[th] detected edge pixel and $\beta > 0$ is a design constant which used to penalise displaced edges. The value of FOM lie among 0 and 1 i.e. 0<FOM≤ 1, value 1 illustrates the ideal match among detected and ideal edge points [14].

Table.2. Pratt's Figure of Merit Analysis for Existing and Proposed Techniques

Pratt's Figure of Merit					
Image No.	Hue	PCA	Fusion	Fuzzy	ACO
1	0.0989	0.0946	0.5391	0.6952	0.7326
2	0.0693	0.0692	0.6511	0.8415	0.9462
3	0.1053	0.1090	0.4122	0.8067	0.9115
4	0.0794	0.0787	0.6575	0.8431	0.9834
5	0.0860	0.0820	0.5908	0.7123	0.8698
6	0.0745	0.0731	0.4264	0.5064	0.8656

7	0.0864	0.0843	0.4883	0.5218	0.8908
8	0.0713	0.0702	0.5896	0.6512	0.7127
9	0.0722	0.0721	0.4391	0.5278	0.8369
10	0.0909	0.0929	0.4020	0.6952	0.8809

Table 2 has shown the outcome of PFOM of the hue only, PCA only, Fusion (Hue and PCA), Fuzzy technique and ACO edge detection on the fusion of Hue and PCA. It has been clearly shown that the PFOM of the proposed technique is better in every case. Therefore the proposed algorithm has shown important improvement over the available techniques.

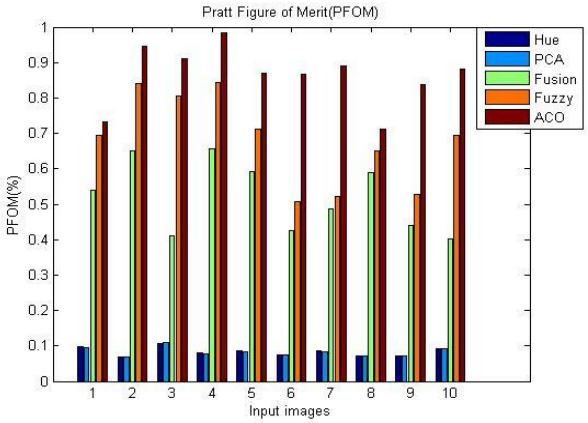

Fig.10. Pratt's Figure of Merit Analysis for Existing and Proposed Technique

Fig.10 shows the result of PFOM of the Hue only, PCA only and Fusion (Hue and PCA), CF (Color Fuzzy) technique and Hybrid technique (combination of Hue, PCA and Color Fuzzy). It shows that the PFOM of the Hybrid technique is improved in every case. Therefore the Hybrid algorithm shows significant improvement over the existing techniques.

VI. CONCLUSION

ACO on the fusion based edge detection is an efficient way for edge detection which considers the hue changes as well as is of low computational complexity, whereas existing methods don't consider the hue changed in an image due to which in this methods results of edge detection are better than before. This research has evaluated the performance of PCA, HUE and Fusion of PCA and HUE, Fuzzy on the fusion of PCA and Hue component and ACO based edge detection on the fusion of Hue and PCA techniques. The most of the existing techniques has neglected the use of colors while detecting the edges but in many applications a region can be categorized based upon the color. The results of the ACO based edge detectors have shown the effectiveness of the ACO based edge detection on fusion of Hue and PCA. It outperforms over the available techniques. In this work only PFOM is considered for experimental purposes which show the good results for this project.

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