Review on Perceptual Object Tagging Techniques

M. J. Patil
VPCOE,Baramati
Pune, India

ABSTRACT
Human observer can understand the contents of image and can do object based enhancement manually based on their perceptual understanding. Existing photo applications use low level description for performing similar tasks. However, there is gap between the output of operations by application and same task performed by human being. To bridge this gap, objects must be identified by photo applications before enhancement. This is achieved by breaking the image into significant segments and finding important perceptual objects. In this paper we describe different methods for detecting and tagging specific objects such as sky, skin and foliage in image.

General Terms
Image Processing, object detection

Keywords
Image Segmentation, perceptual tagging, sky detection, skin detection, foliage detection.

1. INTRODUCTION
Photo applications that exist today, contains mature algorithms for image denoising, image sharpening, contrast enhancement, color correction etc which depends on local features. Some applications depend on some level of content understanding. For eg. Red eye removal. Algorithms that are listed here treat specific objects in the image, so that each object appears most pleasing, for example, bluer sky, greener grass, sharper foliage, skin with a healthy glow[1]. In our algorithm, a segmented image is tagged to identify specific object categories. To identify any object and tagging those objects require segmented image. Here we present some existing segmentation techniques and previous object detection approaches for detecting sky, skin and foliage.

2. SEGMENTATION
Segmentation is a process of partitioning the image into some non-intersecting regions. This section attempts to review some of existing segmentation techniques for color image.

2.1 Novel algorithm using Dynamic Color Gradient Thresholding (DCGT) operator
This technique uses region growing approach for image segmentation. Algorithm described in [2] is useful in unsupervised color image segmentation using dynamic color gradient thresholding scheme. In this method, color gradient map is obtained by using vector based color gradient. Gradient map is converted into Enhanced gradient map, GE by mapping gradient values of each pixel between range 0 to 1. Weighted color gradient map, GW is calculated using GE. Low gradient regions in weighted color gradient map can form initial seed. 4-neighborhood connected pixels with intensities <0.1T0 (T0 is automatic optimal threshold calculated by Ostu's method) are assigned initial seed labels. After generating seeds, remaining pixels of gradient map are input for next level of thresholding. Difference between initial thresholding and current thresholding is that, initial thresholding was computed by Ostu's method on entire pixel set and next thresholding is done by applying Ostu's method on unclassified pixels only. This is dynamic color gradient threshold. Iterations continues till new threshold and old threshold shows nearly same values. This means that only edges remains unclassified. Region growing approach is followed by region merging. Algorithm achieves a high level of accuracy in defining region boundaries and guarantees that the edges are not submerged, avoiding under-segmentation issues. Execution time for algorithm is approximately 40 secs to 4 mins. Performance of algorithm is affected for images with varying performance.

2.2 Gradient SEGmentation Algorithm (GSEG)
GSEG algorithm described in [3],consists of three modules for unsupervised color image segmentation in CIE L*a*b* color space as shown in fig 1. In first module, edge map is produced using edge detection algorithm. Adaptive gradient threshold is generated using edge map which dynamically

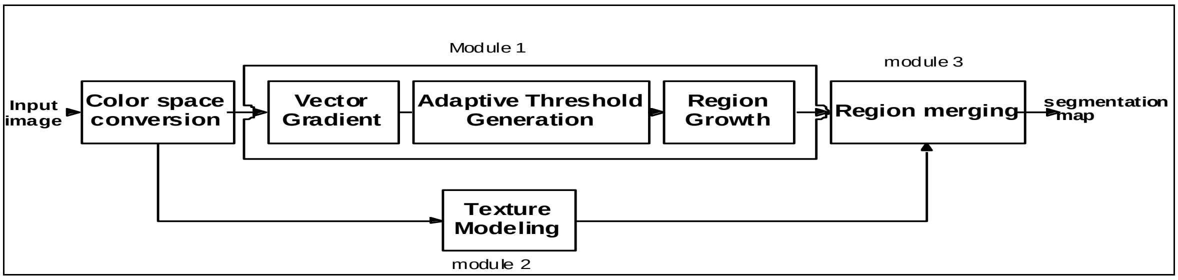

Fig 1.GSEG Algorithm

selects region of contiguous pixels which produces initial segmentation map. Second module creates a texture characterization channel by first quantizing the input image, followed by entropy based filtering of the quantized colors of the image. Last module generates final segmentation map by using initial segmentation map and texture channel.

GSEG accurately segments complex images, images with different textures and varying illumination. It takes 24 secs for execution.

3. SKY DETECTION

Sky is most important object in outdoor images. It occupies upper large region of image with light blue or gray color. Sky detection aims to find all the pixels in an image which satisfies characteristics of sky.

In [4], Luo and Etz proposed an physical model based algorithm for detecting blue sky which is based on concept of Rayleigh scattering. Small molecules in the atmosphere scatter light short wavelengths (blue) more than light with long wavelengths. Red light and green light have similar distribution across the sky, and their distribution differs from that of the blue light. Due to this phenomenon the sky appears blue[1]. This method consists of three steps. In first step is color classification is done by using multilayer backpropogation neural network. This neural network has two hidden layers containing 3 and 2 neurons with single output neuron. Output of this network is belief map. Next step is region extraction, which determines global threshold for belief map and extracts connected components. Last step is signature validation. It extracts 1-D traces within region and computes sky belief based on physics-based sky trace model. Overall flow of algorithm is shown in figure 2

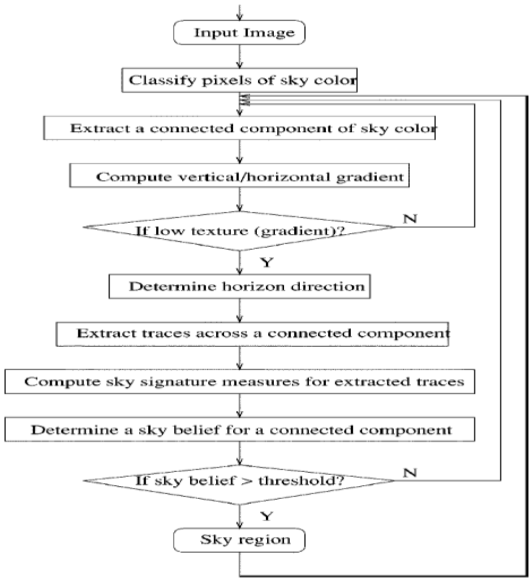

Fig.2 Sky Detection Algorithm

As concept of Rayleigh scattering is used for detecting blue sky, it can accurately find sky within all blue objects. But this method is not useful for detecting gray sky or sky covered by clouds. Detection rate is 96% with a false positive rate of 2%.

In [5], object detection and annotation is done based on color characteristic. Probability density function(pdf) is used to model color distribution within specific classes, where mean vectors and covariance matrices are computed from appropriate training sets. This serves to define a mapping from a 2-D chrominance space to a scalar statistic λ. A succession of binary hypothesis tests are then utilized to decide whether a particular pixel belongs to any of the classes, where adaptive thresholds are computed as a function of both the histograms of the statistics λ for each class and the universal thresholds determined from ROC curves for a set of training images. The MAP rule is then employed for those pixels belonging to more than one class to resolve the ambiguity.

In[1], sky detection is done by considering color ,texture & gradient. Region in image which covers large space at the top is considered. It must satisfy the characteristics of image such as blue or gray color with low texture and high luminance. Color model for sky in image is extracted from this region by using multivariarte Gaussian function in LCH or L*a*b* color space. This model is applied to other pixels to compute average. Similarly, texture and correlation of gradients is computed. Overall likelihood for sky segment is obtained by combining likelihood of the color, texture &gradient correlation. Overall image sky color is probable sky color for all sky segments in image. This algorithm detects both blue and gray sky in image. Blue sky tagging rate is 85% with false alarm of 10%. Gray sky tagging rate is 63% with false alarm of 22%.

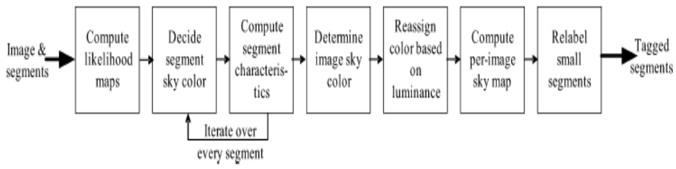

Fig.3 Sky Detection Algorithm

4. Skin Detection

In [6], Jones and Rehg constructed color models for skin and non-skin classes from dataset of nearly 1 billion labeled pixels. These color models are then used for designing two skin pixel classifier i.e. histogram model and mixture model. Histogram model is superior in accuracy and computational cost. Larger dataset gives good performance. Color distributions for skin and non-skin pixel classes learned from web images can be used to design accurate pixel-wise skin detector with detection rate of 80% with 8.5% false positive. This method completely based on color characteristic of pixel.

In[7],algorithm for dynamically defining Region Of Interest(ROI) videophone application is described. It first generates human skin color model based on nonparametric histogram color model. It considers hue component of HSV color space and Cr component of YCbCr color space. Then skin-color segmentation algorithm is applied to color image sequences. This algorithm consists of 3 steps : color segmentation, background elimination, post processing and object tracking. This method applies morphological closing operation as a post processing, which removes false detection. Flow of algorithm is shown in figure 4. It gives detection rate 93.79% with false alarm rate of 6.82% for news videophone sequence. This model completely based on color characteristic of pixels in image.

In [1], skin detection is done by combining face detection, segmentation and global skin color model. It detects face using multiview face detector and tags face segment. Algorithm then computes body skin map by examining each face in order and refines skin color model repeatedly. First refinement uses most probable skin pixels by considering

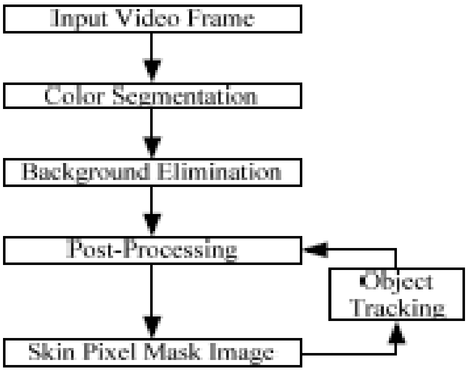

Fig 4. Videophone skin color algorithm

color feature weight obtained by using information gain(IG). In next step, skin probability is computed by applying color model and feature weights to face box. Then it finds face segment by matching this map to each segment..Segment skin color model is then estimated from pixels in face segment. This model is applied to entire image to find body skin associated with each face and tags body skin segment. Flow of algorithm is shown in fig. 5. Segmentation along with feature tagging is stronger than that of segmentation alone. This method tags skin segments 80% correctly with false rate of 21%.

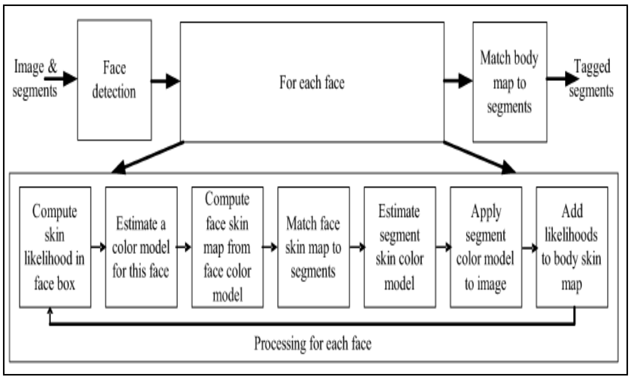

Fig 5. Skin Detection Algorithm

5. FOLIAGE DETECTION

[8] Addresses issue of detecting sky and vegetation in outdoor images based on color and texture features of image. Image is divided into sub-blocks of 16× 16 and color, texture, position features of each sub-block is extracted. Class conditional densities of these features are estimated from codebook vectors, which are then used for Bayesian methodology. Sky and vegetation detectors are trained over 400 color image database. It gives classification accuracy over 94%. But it mis-detects some green objects as foliage.

[9] uses hyperspectral imaging for detecting foliage and calculates LAI(Leaf Area Index, the area of leaf over given area of ground) of coniferous forest using optical scanners of satellite resolution. 18 subplots are selected for this research and LAI for each subplot is calculated by summing up the individual leaf area and dividing by ground area of subplot. Range of LAI values is 0.6 to 15.9 m2/ m2.

In [1], the foliage tagging algorithm considers three color models for computing likelihood maps: general foliage model, shaded foliage(forest) model and ground color model. It also computes likelihoods due to texture characteristic using standard deviation and local direction of gradients as a feature. Order statistics and natural statistics for each of likelihood map for segment are computed and used in heuristic decision function. First decision function accepts only segments which are more likely as foliage and tag as a foliage. Next decision function accepts segments which have high likelihood of foliage color, moderate luminance, high texture and high natural statistic value. Last decision function detects shaded forest segment which have little texture and low luminance value. Use of texture characteristic along with color improves detection rate up to 92% but also has false detection rate of 45% as it mis–detects water segments with reflection of foliage as foliage.

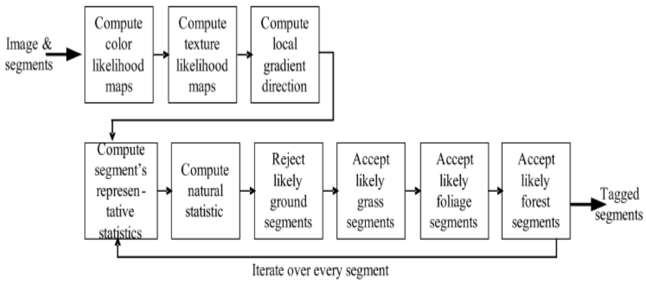

Fig 6. Foliage Detection Algorithm

6. SUMMERY

Table 1 shows summery of all algorithms described above. We can compare each algorithm for segmentation, sky detection, skin detection and foliage detection by considering advantage, disadvantage and performance. It is observed from TABLE 1 that GSEG can perform better than DCGT as it considers texture and varying illuminance along with color characteristic. Sky detection algorithm by Bergman and Nachlieli can perform better as it can find gray sky as well. But its performance limits when image contains more brighter snow. Skin and foliage detection algorithm by Bergman and Nachlieli gives better detection as it considers color, texture and gradient direction for detecting objects.

Table 1.Summery

	Methods	Advantage	Disadvantage	Performance
Segmentation	1] DCGT	Region segmentation with well-defined edges and segmentation of low resolution objects	Performance degrades for images with varying illumination	Execution time is 40 sec to 4min
	2]GSEG	Accurately segments images with different texture &varying illuminance	-	Execution time is 24 sec
Sky Detection	1]Algorithm by Luo & Etz	Can detect blue sky correctly within all blue objects as Rayleigh scattering is used	Cannot detect gray sky or sky covered by cloud	Detection rate is 96% with 2% of false positive rate
	2]Algorithm by Saber	Threshold adaption scheme reduces number of misclassified pixels	Algorithm is based only on color Characteristic of image	Adaptive threshold Improves perform-ance over universal threshold
	3]Algorithm by Bergman &Nachlieli	Can detect blue as well as gray sky	Mis-detects snow as gray sky	Detection rate is 85% with false alarm of 10%
Skin Detection	1]Algorithm by John& Rehg	Used large dataset which improves performance of detector	Algorithm totally depends upon Color characteristic of image	Detection rate is 80% with 10% false positive rate
	2]Algorithm by T. Sawangsri	Uses properties of human skin which detects human skin correctly and morphological operations removes false detection	Depends only on color characteristic of image	Detection rate 93.79% with false alarm rate of 6.82%
	3] Algorithm by Bergman &Nachlieli	Detection based on color, texture & Gradient direction which improves Performance	Performance of face detection limits overall performance	Detection rate 80% with false alarm rate of21%

7. CONCLUSION

This paper presents algorithms for automatic detection of some objects, such as sky, skin and foliage. Methods that use region growing approach for segmentation are described, in which GSEG gives better result. Some object detection algorithms use simple characteristic of color image i.e. color and some algorithms use color as well as texture and gradient direction. Object detection algorithms based on color, texture and gradient direction features of image can find object more correctly than algorithms based on simply on color characteristic.

8. REFERENCES

[1] R.Bergman, H.Nachlieli "Perceptual Segmentation: Combining Image Segmentation With Object Tagging" IEEE Trans. on Image Processing, Vol. 20, No. 6, June 2011

[2] G. P. Balasubramanian, E. Saber, V. Misic, E. Peskin, and M. Shaw, "Unsupervised color image segmentation using a dynamic color gradient thresholding algorithm," in Proc. SPIE/IS&T: Electron. Imag. Symp., B. E. Rogowitz and T. N. Pappas, Eds., Vol. 6806,Jan. 2008

[3] L.Garcia, E. Saber, V. Amuso, M. Shaw, and R. Bhaskar, "Automatic image segmentation by dynamic region growth and multiresolution merging," in Proc. IEEE Int. Conf. Acoust., Speech Signal Process., pp. 961–964, Mar. 2008.

[4] J. Luo and S. P. Etz, "A physical model-based approach to detecting sky in photographic images," IEEE Trans. Image Process., Vol. 11, No.3, pp. 201–212, Mar. 2002

[5] E. Saber, A. M. Tekalp, R. Eschbach, and K. Knox, "Automatic image annotation using adaptive color classification," Graph. Models Image Process., Vol. 58, pp. 115–126, Mar. 1996.

[6] M. J. Jones and J. M. Rehg, "Statistical color models with application to skin detection," in Proc. IEEE Conf. Comput. Vis. Pattern Recognit., Vol. 1, pp. 274–280, 1999.

[7] T. Sawangsri, V. Patanavijit, and S. Jitapunkul, "Face segmentation based on hue-cr components and morphological technique," in Proc. IEEE Int. Symp. Circuits Syst., Vol. 6, pp. 5401–5404 May 2005.

[8] A. Vailaya and A. Jain, "Detecting sky and vegetation in outdoor images," in Proc. IS&E/SPIE Conf. Storage Retrieval Media Databases, pp. 411–420, Jan. 2000.

[9] A. Vailaya and A. Jain, "*Detecting sky and vegetation in outdoor images*," in Proc. IS&E/SPIE Conf. Storage Retrieval Media Databases, pp. 411–420, Jan. 2000.