Research Journal of Applied Sciences, Engineering and Technology 14(8): 276-280, 2017
DOI:10.19026/rjaset.14.4951
ISSN: 2040-7459; e-ISSN: 2040-7467

Submitted: March 20, 2016 Accepted: May 25, 2017 Published: August 15, 2017

Research Article

An Efficient Static Filters for Sky Detection

[1]Irfan Ullah, [1]Yang Fan, [1]Gao Bing, [2]RehanUllah Khan, [3]Farhan Ullah and [1]Kai Liu
[1]State Key Laboratory of Power Transmission Equipment & System Security and New Technology, School of Electrical Engineering, Chongqing University, Chongqing 400044, China
[2]Department of Information Technology, Qassim University, Al-Qassim, KSA
[3]Lab of Service Computing, Shanghai University, Shanghai, China

Abstract: For colour based detection, the benefit of the static filter is the simplicity of the detection rules. Sky colour can be estimated in a precise cluster in any colour space if the conditions for the images remain constant (illumination controlled environment). A static sky filter clearly defines the boundaries that the sky has in a colour space. One or numerous varieties of threshold values for each colour space segments are shaped and the sky pixel values within these ranges for all the selected colour segments are defined as sky pixels. In this article, we have investigated and evaluate static sky filters for sky detection in complex scenarios. As a contribution, three new static sky filters for the RGB, nRGB and HSV colour spaces developed in this article. The highest performance (F-measure) depicted by the HSV colour space which is 0.56 while the lowest performance reported by the RGB colour space having an F-measure of 0.43. The three new static filters RGB, nRGB and HSV colour spaces are evaluated on the dataset (of 1000 complex images) by F-Measure elevation. Experimental results show that the viability of the developed static sky filters. It has also found that since the static filters use static boundaries, any shift of sky colour ranges from the defined boundaries affect the over-all performance.

Keywords: nRGB, RGB, HSV, sky color detection, static filter

INTRODUCTION

In Computer Vision, the sky colour detection has a number of applications. It includes but not limited to lighting correction, image enhancement, horizon alignment and others. Most of pictures/videos contain sky colour in the area of blue tone, half white and somewhere, other components are also present. The challenges for sky detection algorithms are the different clouds, airplanes, trees, seas and other confused sky-like backgrounds. The sky colour can be detected from the image pixel values and due to this unique property; processing speed of the pixel based algorithm is fast as compare to the region based detection techniques. Generally, colour based detection is independent of image size, angle of pixel and orientation (Khan *et al*., 2012). Pixel based sky detection is significantly dependent on the lightning conditions, due to this reason its strength is limited in uncontrolled environments.

The colour spaces for sky detection mostly consist of RBG, YCbCr, nRGB, HSV, HIS and Lab. RGB colour space values are written in normalized form as:

$$nr = \frac{cR}{cR + cG + cB} \quad (1)$$

$$ng = \frac{cG}{cR + cG + cB} \quad (2)$$

$$nb = \frac{cB}{cR + cG + cB} \quad (3)$$

Where, cR, cG and cB are the three colour RGB color components. The resultant is an nRGB color space which is more stable as compared to the RGB color space. This stability property mostly used in matte surfaces. nRGB shows good performance is situations where light variation effects the performance of the RGB color space. (Quach *et al*., 2007) Use the YUV colour model, in which, the Y represents the luminance where V and U are two different chrominance factors. Concerning color image processing (Jalali *et al*., 2013) use YIQ colour model for various applications in colour based imaging and conclude that the usage of colour information is not sufficient to harvest a good

Corresponding Author: Irfan Ullah, State Key Laboratory of Power Transmission Equipment and System Security and New Technology, School of Electrical Engineering, Chongqing University, Chongqing 400044, China

performance and that it is specifically our new approach to colour that results in significant improvement.

Dev *et al*. (2014) Presents a systematic approach for the selection of colour spaces and components for optimal segmentation of sky/cloud images. Using mainly principal component analysis (PCA) and fuzzy clustering for evaluation, the authors identify the most suitable colour components for this task. De Croon *et al*. (2011) developed an efficient technique for sky detection in colour images. After converting the original image to YCbCr, the authors separate sky from non-sky.

In this study, we base our sky detection approach on the static filters. As such, we develop, investigate and evaluate the static sky filters for sky detection. As a contribution, three new static sky filters for the RGB, nRGB and HSV colour spaces developed.

STATIC SKY FILTERS

A static sky filter clearly defines the boundaries that the sky has in a particular colour space. One or numerous varieties of threshold values for each colour space segments developed and the sky pixel values within these ranges for all the selected colour segments defined as sky pixels. For colour based detection, the benefit of static filter is the simplicity of the detection rules. Sky colour can be estimated in a precise cluster in any colour space if the conditions for the images remain constant (illumination controlled environment).

The dataset from (Russell *et al*., 2008) used for the evaluation of the proposed algorithm for sky detection. The selected sky images contain (1000) complex images with cloudy and partial cloudy sky images. We include images containing different objects too to test the performance of the algorithm for separating the sky portion from the other complex objects in pictures. The images are annotated precisely per pixel basis. The dataset represented as the dataset DS.

RGB Static Filter : RGB colour space is the most widely used in computer graphics. Red, Green and Blue colours are the three dimensions of RGB space (Fig. 1). The diagonal of a cube with equal RGB values indicates grayscale from black to white.

RGB is composed of three colours values i.e. red, blue and green and all the remaining colours are the result of the mixture (Fig. 2) of these three colours values.

RGB static filter was create on a set of sky images. RGB final static sky filter is a rule based filter as follow:

RGB Static Filter
(R>min_R && R<max_R-20 && G>min_G && G<max_G-20 && B>min_B && B<max_B-10)

Whereas;
min_R=14 and max_R=255 and min_G=77 and max_G=255 and min_B=90 and max_B=135

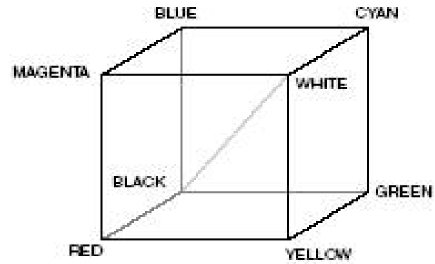

Fig. 1: RGB cube (Rasras *et al*., 2007)

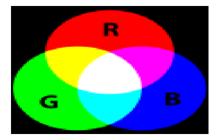

Fig. 2: RGB color space model (Abdelrahman, 2013)

Fig. 3: Effect of RGB static filter on dataset DS. First rwo: Original images, Second row: result of applying the RGB static filter. The black pixels show the pixels reported as the non-sky pixels by the algorithm

For visual analysis, we show the effect of applying this filter in Fig. 3. The first row shows the original images in Fig. 3. The second row illustrates the effect of RGB static filer. The black pixels show the pixels reported as the non-sky pixels by the algorithm. As can be seen from the result, the RGB static filter is not precisely detecting the sky pixels.

Figure 4 shows the experimental evaluation using an F-measure for the proposed RGB static filter on the dataset DS.

As can be seen in Fig. 4, the accuracy of RGB static filter is 0.58, precision is 0.31, recall is 0.68 and F-measure is 0.43. As RGB static filter is not precise, the decreased F-measure of 0.43 was obtained. On the contrary, a good recall rate was obtained.

Normalized RGB (nRGB) Static filter:
Normalized RGB (nRGB) is normalization of three colours i.e., red, blue and green.
The sum of normalized RGB colour space is 1 (nr + ng + nb = 1).

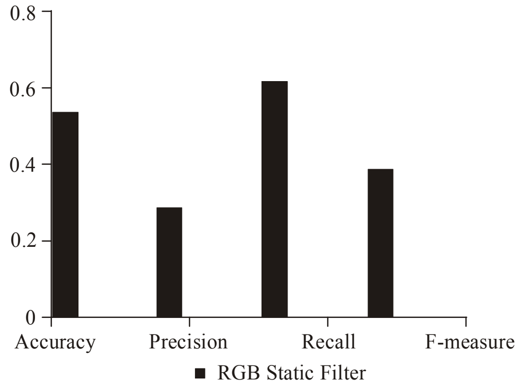

Fig. 4: Evaluation result of RGB static filter on the dataset DS

Fig. 5: Effect of normalized RGB static filter on dataset DS

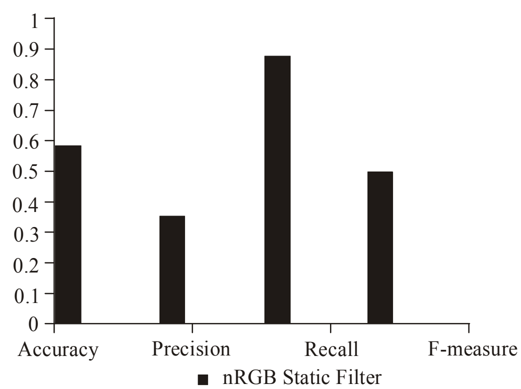

Fig. 6: Evaluation result (using F-measure) of nRGB static filter on the dataset DS

Normalized RGB Static Filter
nRGB static filter was created on a set of sky pixels. nRGB static filter is a rule based filter as follow:
(nR>min_nR && nR<max_nR && nG>min_nG && nG<max_nG && nB>min_nB && nB<max_nB)
Whereas;
min_nR=0.05 and max_nR=0.38 and min_nG=0.37 and max_nG=0.55 and min_nB=0.99 and max_nB=0.99

The effect of applying this filter as shown in Fig. 5 from dataset DS. The first row shows the original images in Fig. 5. The second row illustrates the effect of nRGB static filer. The black pixels show the pixels reported as the non-sky pixels by the algorithm. As can be seen from the results, the nRGB static filter is not as precise as expected in detecting the sky pixels.

Figure 6 shows the experimental evaluation of the nRGB static filter on the dataset DS.

As can be seen in Fig. 6, the accuracy of the nRGB static filter is 0.61; precision is 0.36, recall is 0.91 and F-measure is 0.52. Because the nRGB static filter is not precise, the decreased F-measure of 0.52 was obtained, but the F-measure was 9% higher compared to the RGB colour space. For nRGB, a good recall rate was also obtained.

Fig. 7: Effect of HSV static filter on images. The black pixels show the pixels reported as the non-sky pixels by the algorithm

HSV Static filter : We created HSV static filter in the HSV colour space on a set of sky pixels. Our HSV static filter is a rule based filter as follow:

(H>min_H+0.1 && H<max_H-0.1 && S>min_S+0.1 && S<max_S-0.1 && V>min_V && V<max_V)
Whereas;
min_H=0 and max_H=.9833 and min_S=0 and max_S=0.9125 and min_V=0.3529 and max_V=1

The effect of applying this filter on images as shown in the Fig. 7 from dataset DS. The first row shows the original images in Fig. 8. The second row illustrates the effect of HSV static filer. The black pixels show the pixels reported as the non-sky pixels by the algorithm.

Figure 8 shows the F-measure for the evaluation of the HSV static filter on the dataset DS. As can be seen in Fig. 8, the Accuracy of HSV static filter is 0.74; Precision is 0.46, Recall is 0.71 and F-measure 0.56. Compared to the RGB and nRGB color spaces, the HSV color space depicts good over-all performance.

COMPARATIVE ANALYSIS AND DISCUSSION

From the experimentation setup on dataset DS, we have the following results in summarized (Fig. 9).

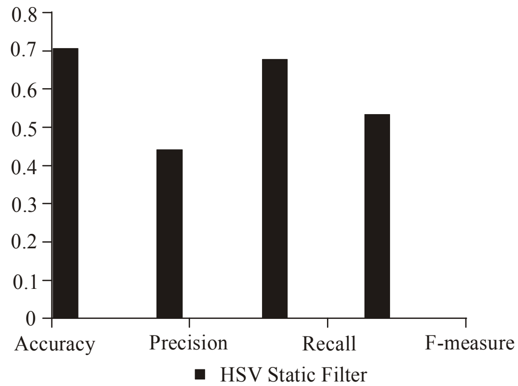

Fig. 8: Evaluation result of HSV static filter on the dataset DS

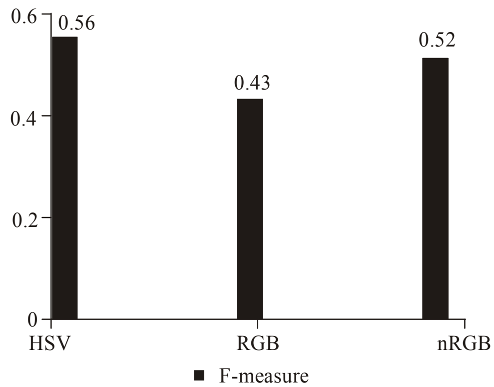

Fig. 9: F-Measure evaluation results of three static filters on dataset DS

Figure 9 shows the F-measure of all three the static filters. From the Fig. 9, we can see the highest F-measure of 0.56 achieved by the static filter of the HSV colour space. F-Measure of HSV colour space is 4% greater than the F-measure of the nRGB colour space (F-measure 0.52). F-Measure of HSV is 12% greater than the F-measure of the RGB colour space.

For visualization purposes, some of the other images from the dataset DS and the result of applying the three static filters as shown in Fig. 10.

CONCLUSION

The static sky filters have been investigated and evaluated for sky detection. As a contribution, three new static sky filters have been developed for the RGB, nRGB and HSV colour spaces. The highest performance (F-measure) depicted by the HSV colour space is 0.56, while the lowest performance reported by the RGB colour space has the F-measure of 0.43. Experimental results show the feasibility of HSV static sky filter in complex scenarios.

ACKNOWLEDGMENT

I am thankful to Engr. Dr. Adnan Daud Khan for supporting during my research experiments and for valuable suggestions.

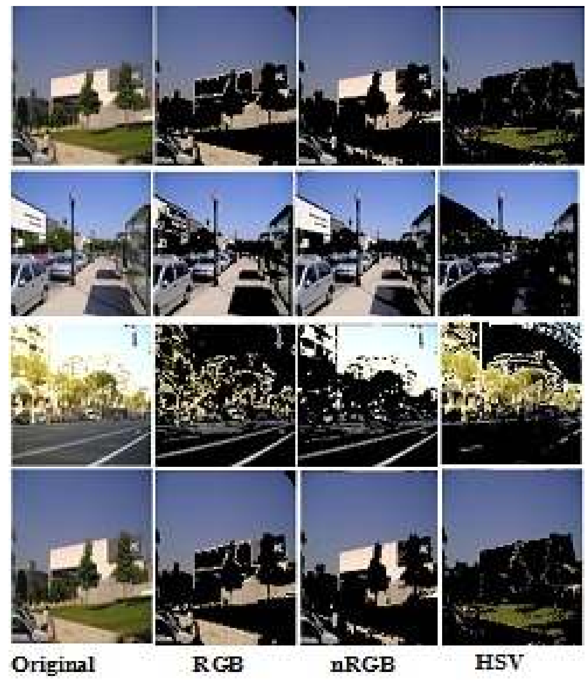

Fig. 10: Visualization effect of all the three static filters. Firs column: Original images, Second Column: RGB static filter, Third Column: nRGB static Filter, Fourth Column: HSV static filter

Funding information: This study was supported by the National Natural Science Foundation of China (grant numbers 51477013).

REFERENCES

Abdelrahman, A., 2013. Detection and extraction of sky regions in digital images based on color classification. B.Sc. Thesis, Department of Industrial Development, IT and Land Management, Faculty of Engineering and Sustainable Development, University of Gävle, pp: 17.

De Croon, G.C.H.E., B.D.W. Remes, C. De Wagter and R. Ruijsink, 2011. Sky segmentation approach to obstacle avoidance. IEEEAC, pp: 4244-7351. Retrieved from: http://www.delfly.nl/publications/Sky%20Segmentation%20Approach%20to%20Obstacle%20Avoidance(Draft).pdf.

Dev, S., Y.H. Lee and S. Winkler, 2014. Systematic study of color spaces and components for the segmentation of sky/cloud images. Proceeding of the IEEE International Conference on Image Processing (ICIP), pp: 5102-5106.

Jalali, S., C. Tan, J.H. Lim, J.Y. Tham, S.H. Ong, P. Seekings and E. Taylor, 2013. Visual recognition using a combination of shape and color features. Proceeding of the Annual Meeting of the Cognitive Science Society (CogSci), pp: 2638-2643.

Khan, R., A. Hanbury, J. Stöttinger and A. Bais, 2012. Color based skin classification. Pattern Recogn. Lett., 33(2): 157-163.

Quach, N.T., B. Zafarifar and G.N. Gaydadjiev, 2007. Real-time FPGA-implementation for blue-sky detection. Proceeding of the IEEE International Conference on Application-Specific Systems, Architectures and Processors, pp: 76-82.

Rasras, R.J., I.M.M. El Emary and D.E. Skopin, 2007. Developing a new color model for image analysis and processing. Comput. Sci. Inform. Syst., 4(1): 43-56.

Russell, B.C., A. Torralba, K.P. Murphy and W.T. Freeman, 2008. LabelMe: A database and web-based tool for image annotation. Int. J. Comput. Vision, 77(1-3): 157-173.