Increase Efficiency of SURF using RGB Color Space

M. Wafy
Faculty of Computers and Information, Helwan University, Cairo, Egypt

A. M. M. Madbouly
Mathematics Department,
Faculty of Sciences, Helwan University,
Cairo, Egypt

***Abstract*—SURF is one of the most robust local invariant feature descriptors. SURF is implemented mainly for gray images. However, color presents important information in the object description and matching tasks as it clearly in the human vision system. Many objects can be unmatched if their color contents are ignored. To overcome this drawback this paper proposed a method CSURF (Color SURF) that combines features of Red, Green and blue layers to detect color objects. It edits matched process of SURF to be more efficient with color space. Experimental results show that CSURF is more precious than traditional SURF and CSURF invariant to RGB color space**

***Index Terms*—SURF; Features; Local Features; Color Space**

I. Introduction

Finding similarity between different images is representing a challenge problem in computer vision application. For instance, it uses in pattern recognition, object tracking, image retrieval, etc. Searching between images can be affected by three problems, scale, rotation and general transformations in gray image. SURF (Speeded Up Robust Features) algorithm was adopted by Bay et al. [1]. Firstly detects corner points under different conditions. Secondly, construct descriptor based on detecting corner points and its neighbors. The final match between descriptor using a distance function. SURF [1] is the most robust descriptor among the other local invariant feature descriptors. It is invariant to scale and rotation transformation with respect to different geometric changes. SURF has a main drawback it does not use color information. In fact, SURF has been constructed essentially for gray images, ignoring totally the information found in the color space as most of feature extractors. Neglecting color information leads to lose an important source of distinction between images as showed in following figure.

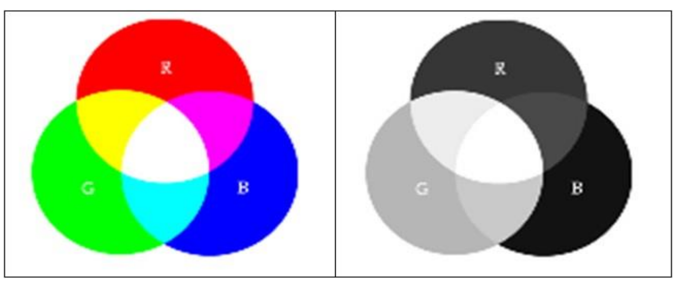

Fig. 1. Shows importance of color component

Figure 1 represents color and gray image of RGB and CMY the red and blue colors were converted to a same level of gray. The Figure 1 illustrates how studying color image cannot be done via converted it to the gray level.

This paper introduces a method that helps SURF to match color images with respect to its color in RGB space.

The rest of this paper is organized as follows: section two

Introduce survey of other color descriptors, section three represent methodology of the proposed color SURF (CSUR), section four represents experimental results, section five introduces conclusion.

II. Color Descriptors

Color information plays an important role in the computer vision application. As clear human vision system can distinctly many color values. There are several attempts that have been used for color information inside descriptor. For example, Abdel-Hakim and Farag [2], proposed a colored local invariant feature descriptor called CSIFT(Color SIFT). The new descriptor builds SIFT(Scale Invariant Feature Transform) on invariant color space. It involves three main steps: interest point detections, build descriptors and descriptor matching.

Firstly, selection of highly informative points as interest points. Secondly, descriptor of interest point is built to describe a local region around interest points. Thirdly, matching stage that decides if interest point belongs to object or not.

CSIFT is not efficient for photometrical variety of images. Ancuti and Bekaert[3] ,proposed SIFT-CCH(SIFT Color Co-occurrence Histograms) that merges the traditional SIFT with Color Co-occurrence Histograms computed from the Nrgb color space. Their method achieves as same as SIFT in the detection step, but establishes one dimension to the descriptor. Thus, features are illustrated by a two element vectors that merges the SIFT and the CCH descriptor vectors. The main limitation of such an approach is time of computation during feature matching due to the extra 128 elements added to the descriptor vector.

Cui et al.[4], proposed color descriptor called PC-SIFT (perception-based color SIFT) that invariant to illumination variation., this method builds SIFT based on new color space that formulated at [5], [6] to signify image as a replacement for using its gray scale values.

Ai et al.[7]proposed an adaptive Color Independent Component based on SIFT descriptor called (CIC-SIFT) for image classification problems. Their proposed algorithm can be summarized into three steps, firstly learning step, a transformation matrix is learned for each category by using Independent Component Analysis. Secondly color transformation step: original image components are transformed into three independent components by using the adaptive transformation matrix. Finally extraction of feature: the color independent components are used to compute CIC-SIFT descriptors.

Fan et al. [8] proposed color invariant descriptor based on SURF. It merges local kernel color histograms and Haar

Wavelet responses to build the feature vector. That means the descriptor is a two element vector. Matching process composed of two steps, firstly, SURF descriptor is matched, then unmatched points are calculated between their local kernel histograms using the distance function called Bhattacharyya. In this paper, we will introduce a novel a Color SURF descriptor called CSURF. It's based on RGB color space

III. COLOR SURF DESCRIPTOR

This section will illustrate our new Color SURF descriptor (CSURF). The method will divide into two main steps, firstly detect and extract features of entering the color image. Secondly, matching between two descriptor color images.

A. *Detect and extract feature*

CSURF firstly read color image and construct three images from it using RGB color space, where I1, I2 and I3 represent constructed images from Red, Green and Blue layers respectively. Secondly CSURF will find corner points of images I1, I2, I3 using traditional SURF to produce corner points P1, P2 and P3 of images I1, I2 and I3. Thirdly CSURF will extract features of constructing image using SURF descriptors that produce vpts1, vpts2 and vpts3 of images I1, I2 and I3 respectively.

Finally CSURF will merge the detected corner points in one vector P= [p1; p2; p3] and merge extracted features in one vector called vpts= [vpts1; vpts2; vpts3]. The previous procedure for extracting features using CSURF is summarized as figure 2.

B. *Matching features between images*

CSURF after extraction corner points and features of entering images will try to match between images with a simple strategy. It will match between extracted features using the traditional SURF descriptor and will divide the features into two classes matched features mf1, mf2 of image1 and image2 and unmatched feature uf1, uf2 of image1 and image2 respectively. CSURF will work on uf1 and uf2 as follows, firstly, it finds unmatched features that have nearly the same color and we will weight it with 0.3.

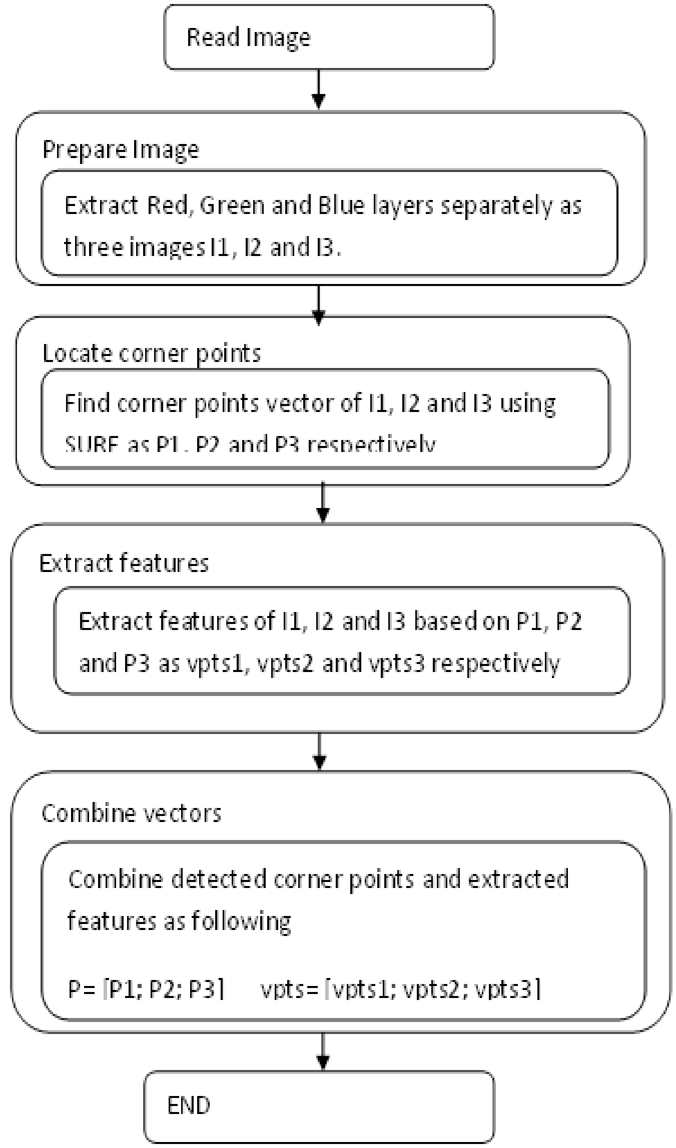

Fig. 2. Shows how CSUFR extract features

Secondly, our method will try to match unmatched features with lower threshold 0.5 (traditional SURF in this experiment use threshold =0.6) and we will weigh that with 0.7. Finally method will select unmatched features that pass both of the previous two steps and store them at umf1 and umf2. The method will combine features (matched and unmatched features) in one vector called cmatch1 = [mf1; umf1] and cmatch2 = [mf2; umf2].

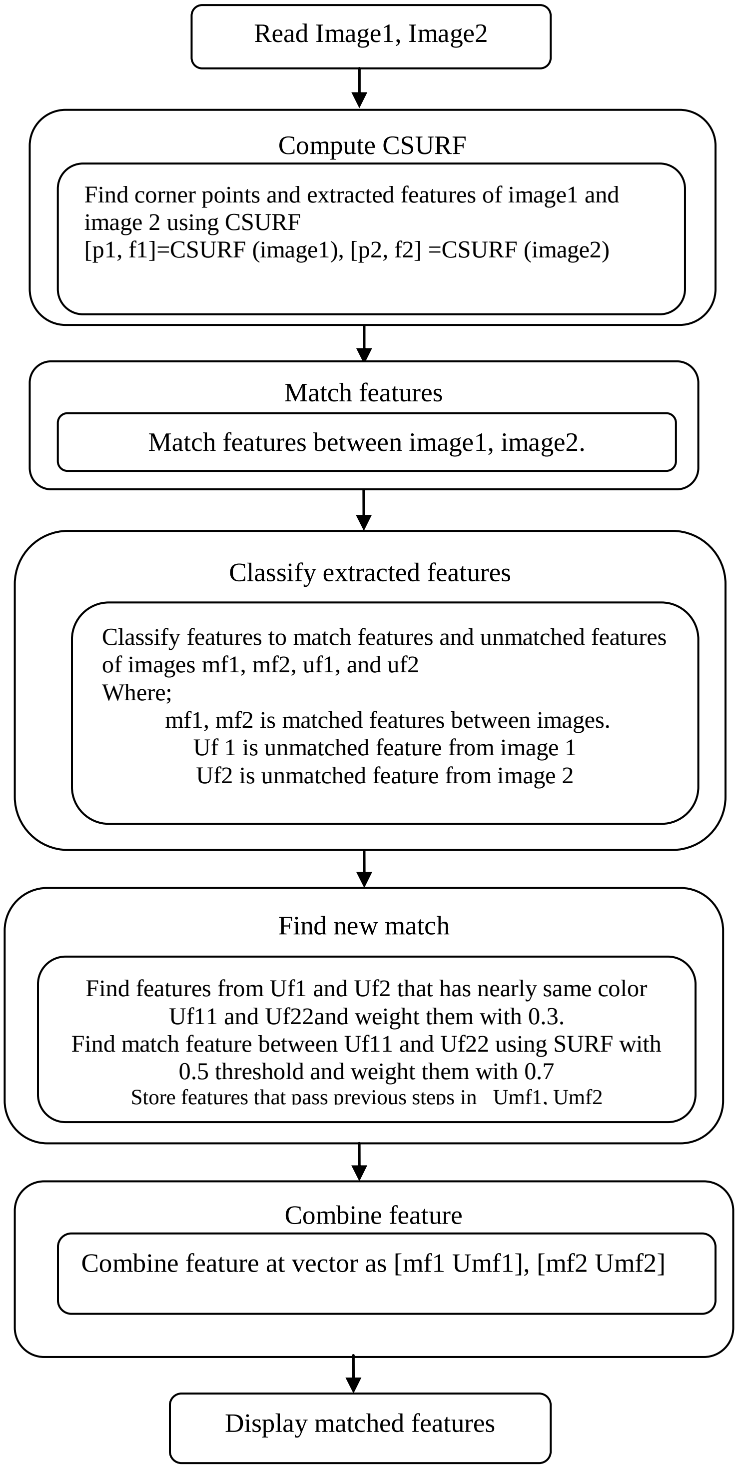

Fig. 3. The match between extracted features using CSURF

I. Experimental Results

In this experiment weuse the"Amsterdam Library of Object Images" (ALO))[9] that is a database of colored images. It contains a large number of images under different illumination directions, illumination colors, and viewing direction. The experiment will work on ten images at different levels of illumination directions, view direction and illumination colors where every image on illumination color have 12 different copies, images that at the illumination direction have 24 copies and every type of view direction have 72 different copies.

Figure 4 shows a sample of images under different illumination color, illumination direction and view direction.

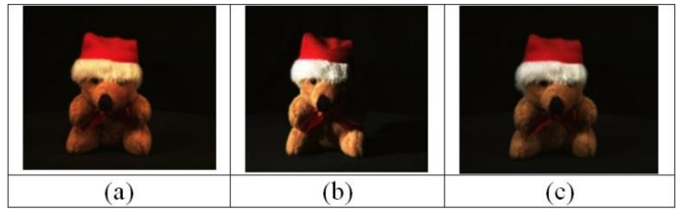

Fig. 4. Sample of ALOI color images at different illumination color, illumination direction and view direction

The method was performed on a laptop Lenovo 3000 C100 with the following configuration: Intel Pentium (R) M processor, (R) 1.73-GHz, 1.73-GHz and 2-GB RAM.

The experiment will work on three types of distortion illumination color, illumination direction and view direction. Due to importance of color component CSURF work on every layer of RGB color space separately. Figure 5 shows the difference of performance of traditional SURF and CSURF on illumination intensity distortion. Figure 5 image(a) and image(b) represent performance of traditional SURF and CSURF respectively.

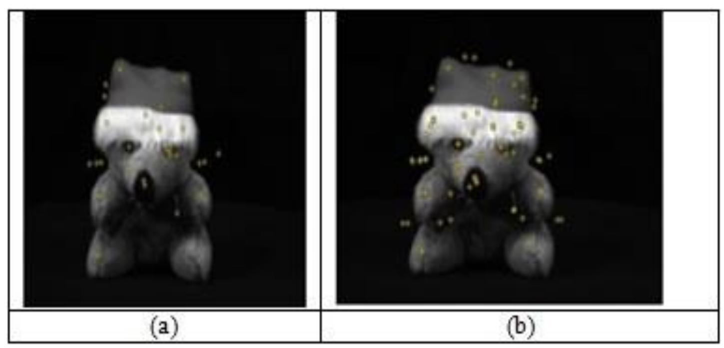

Fig. 5. Illustrate the difference in performance of match between traditional SURF and CSURF

Following figure shows how CSURF surpass traditional SURF in matching between images under illumination direction.

Figure 6 image (b) shows how CSURF matched important points that traditional SURF can't capture as shows in image(a) Important points noted that at points that helped to match a new object.

It is clear from following figure how CSURF results in image(b) have better performance than SURF result in image(a) that under different view of direction.

It is clear from figures 5, 6 and 7 that the performance of CSURF surpasses traditional SURF in number of matched points.

CUSRF detect the number of corner points more than SURF, as showed in figures 8.

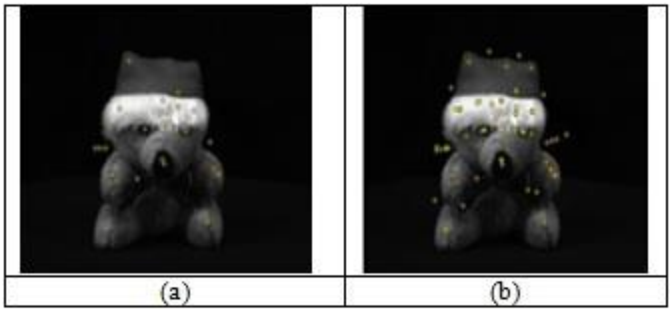

Fig. 6. Explain the difference in performance of match between traditional SURF and CSURF of images under different illumination direction

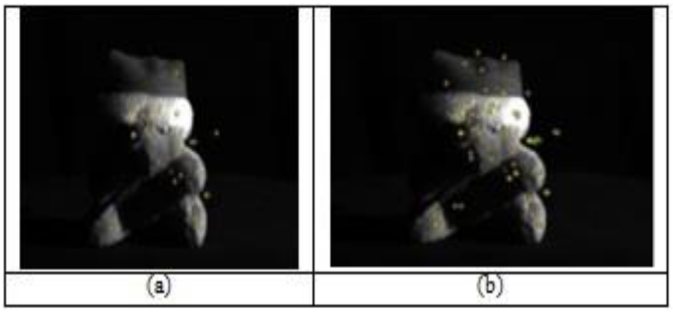

Fig. 7. Shows the difference in performance of match between traditional SURF and CSURF of images under different view direction

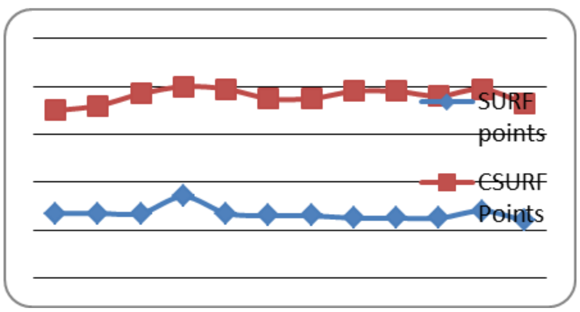

Fig. 8. Presents number of corner points detected by SURF and CSURF

Figure 8 represents the number of detected point using SURF and CSURF, where x-axis represents the level of color illumination of the image and y axis represents the number of detected points.

Most previous methods in color descriptors measure its progress by the number of detected or matched features. They show how their methods surpass traditional methods by numbers (no mentions if these numbers represent vital corner points or not. So experiment, test if CSURF detect interesting corner point tradition cannot detect it. So we will take three images on each distortion type (illumination directions, view direction and illumination colors) each image will have ten levels of its distortion. We will test the importance of the point (if point critical or not that mean it help to catch new object) and if detected by SURF or not using eye observer. The result will represent in following figure.

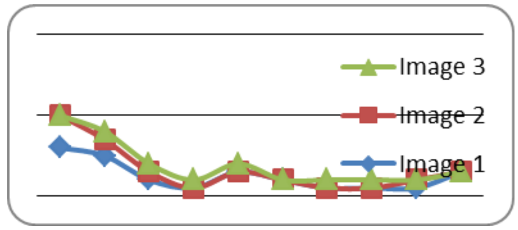

Fig. 9. Number of observed important corner points detected by CSURF at view direction distortion at different levels

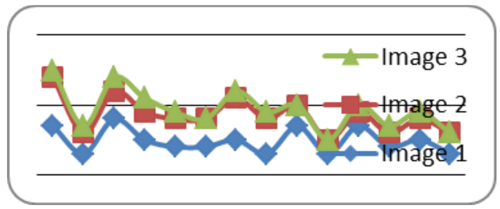

Fig. 10. Shows eye observed important corner point detected by CSURF at illumination direction distortion at different levels

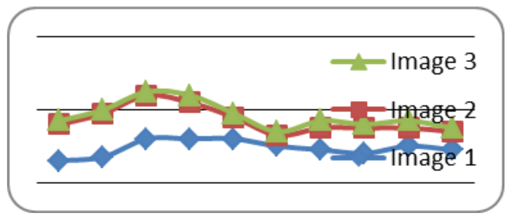

Fig. 11. Shows how CSURF detect d important corner point detected by CSURF at illumination color distortion at different levels

It is clear from the above figures (9,10 and 11), where x-axis represents the level of distortion (view direction, illumination direction and illumination color) and y axis represent the number of important detected points. CSURF can detect the important point that cannot be detected by traditional SURF because CSURF do not neglect color component as SURF did.

Proposed method will compare with [8] by matching two graffiti scene that used in [8]. Fan didn't mention the size of the image so we will compare his progress with SURF and proposed method. He mentions that traditional SURF match 43 features while his color SURF captured 51 features that mean progress 18.6%.

We will use graffiti sense similar in the sense that Fan[8] used. Traditional SURF matched 17 features while the proposed method captured 34 features that mean there is progress in number of matched as showed in figure 12.

(a) Matched SURF features (a) Matched CSURF features

Fig. 12. Comparison of SURF and Color-SURF

II. CONCLUSION

In this paper, we introduced CSURF (Color SURF) as color descriptor that works on RGB color space.

Contrary to many existing methods presented CSURF do not neglect color component due to its importance as it clearly in the human vision system. CSURF accomplished by two main steps, firstly it combined detected corner points and extracted features from Red, Green and Blue layers into two vectors, one for combined features and the other one for combined detected points. Secondly, it edits matched process of SURF to be more efficient with color space. Experimental results demonstrated the high performance of CSURF descriptor against traditional SURF.

REFERENCES

[1] H. Bay, T. Tuytelaars, and L. Van Gool, "SURF: Speeded up robust features," in Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 2006, vol. 3951 LNCS, pp. 404–417.

[2] A. E. Abdel-Hakim and A. A. Farag, "CSIFT: A SIFT descriptor with color invariant characteristics," in Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2006, vol. 2, pp. 1978–1983.

[3] C. Ancuti and P. Bekaert, "SIFT-CCH: Increasing the SIFT distinctness by color co-occurrence histograms," in ISPA 2007 - Proceedings of the 5th International Symposium on Image and Signal Processing and Analysis, 2007, pp. 130–135.

[4] Y. Cui, A. Pagani, and D. Stricker, "SIFT in perception-based color space," in Proceedings - International Conference on Image Processing, ICIP, 2010, pp. 3909–3912.

[5] H. Y. Chong, S. J. Gortler, and T. Zickler, "A perception-based color space for illumination-invariant image processing," ACM Transactions on Graphics, vol. 27, no. 3. p. 1, 2008.

[6] H. S. Fairman, M. H. Brill, and H. Hemmendinger, "How the CIE 1931 color-matching functions were derived from Wright-Guild data," Color Res. Appl., vol. 22, no. 1, pp. 11–23, 1997.

[7] D. Ai, X. Han, X. Ruan, and Y. W. Chen, "Adaptive color independent components based SIFT descriptors for image classification," in Proceedings - International Conference on Pattern Recognition, 2010, pp. 2436–2439.

[8] P. Fan, A. Men, M. Chen, and B. Yang, "Color-SURF: A surf descriptor with local kernel color histograms," in Proceedings of 2009 IEEE International Conference on Network Infrastructure and Digital Content, IEEE IC-NIDC2009, 2009, pp. 726–730.

[9] J. M. Geusebroek, G. J. Burghouts, and A. W. M. Smeulders, "The Amsterdam Library of Object Images," Int. J. Comput. Vis., vol. 61, no. 1, pp. 103–112, 2005.