Journal of AL-Qadisiyah for computer science and mathematics Vol.11 No.1 Year 2019
ISSN (Print): 2074 – 0204 ISSN (Online): 2521 – 3504

A Comparative Study of KMCG Segmentation Based on YCbCr, RGB, and HSV Color Spaces

Fatin Sadiq Alkinani **Abdul Monem Salih Rahma**

Department of Computer Sciences , University of Technology

fatin.alkinani@sc.uobaghdad.edu.iq **monem.rahma@yahoo.com**

Recived : 2\12\2018 **Revised : 12\12\2018** **Accepted : 26\12\2018**

Available online : 25 /1/2019

DOI: 10.29304/jqcm.2019.11.1.468

Abstract:

Kekre Median Codebook Generation (KMCG) is a vector quantization algorithm. It is used for several purposes like image compression and segmentation. It has been applied by several application and shows its efficiency. This paper presents a comparison study of applying KMCG with three color models: RGB, YCbCr, and HSV for image segmentation. The experiments applied on five images, three of them are benchmarks. Two numerical metrics are utilized: E measure and Peak Signal to Noise Ratio (PSNR), in addition to the visual results. The final results show that KMCG conducts better segments when it is applied with the RGB color model. It returns more homogenies segments than using KMCG with YCbCr or HSV.

Journal of AL-Qadisiyah for computer science and mathematics Vol.11 No.1 Year 2019
ISSN (Print): 2074 – 0204 ISSN (Online): 2521 – 3504

Introduction

Image segmentation is one of the most important steps in the analysis of processed image data. The main goal of segmentation is obtaining parts that have a strong correlation with objects areas of the real world in the image.

Segmentation accuracy is an important factor in determining the success or failure of computerized analysis procedures. For this reason, considerable care should be taken to improve the probability of accurate segmentation [1] [2]. Many methods of image segmentation have been proposed could be categorized generally as:

- **Edge**-based image segmentation like Active Contour
- **Region** base as Seed filling algorithm and clustering algorithms.
- **Thresholding** based image segmentation such as Otsu method.
- **Clustering** based image segmentation such as KMCG and K-mean
- **Combined** between the above category like watershed.

Literature Review

Generally, KMCG is a clustering algorithm found by Kekre in 2008 for data compression purpose. However; this algorithm enforces efficiency in several areas like segmentation and clustering. It summarized by the following steps [3]:

1. Distribute the data in equal size vectors.
2. Arrange vectors based on the first value.
3. Set the median of the array of vectors in the CB.
4. Repeat step 2 & 3 on the other vectors values until obtaining the desired codebook size as shown in Fig. (1).

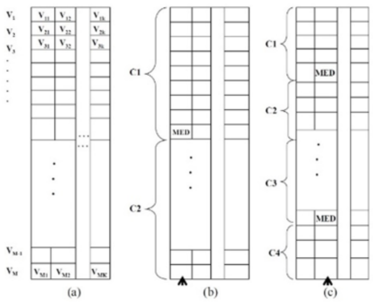

Figure 1: KMCG General Steps [5]

KMCG is applied to an image by dividing it's data to equal nonoverlapped windows. Each window color data is represented in a vector. As in gray level, the window size is four yields a vector length of 4 [4].

KMCG algorithm had been augmented, to decrease the required time in the clustering process of a gray image. In this method, vector size is increased to 6 columns, in which the last four columns are used to store original gray levels, which obtained from 2 x 2 blocks of the image. Further, averages of each of these blocks are done separately and stored in the second column in the respective vectors. The sequence number of the respective vectors has been stored in the first column [5].

KMCG used by different applications due to its homogeneity and efficiency of its segmentation. One of these applications is image cartooning. As in [6] shows that the consumed time of the cartoon production is less by using KMCG in comparison with other vector quantization methods. Also, it presents a better quality of segmentation of KMCG than the other methods.

Another application designed based on KMCG, which is fingerprint classification. It was observed that the method effectively improves the computation speed and provides high accuracy [7].

KMCG literature shows its importance and efficiency. Thus, this paper is to study and find the best color model to be applied with KMCG.

Journal of AL-Qadisiyah for computer science and mathematics Vol.11 No.1 Year 2019
ISSN (Print): 2074 – 0204 ISSN (Online): 2521 – 3504

Color Models

Color models in image processing provide valuable tools for objects recognition and extraction from the scene. It also enables the extension of the domain space compared with gray images. Color spaces are used for different applications such as; computer graphics, image processing, TV broadcasting, and computer vision. Several models had been introduced. YCbCr and HSV are two samples of them. All of the models are extracted from the original model of RGB. [8].

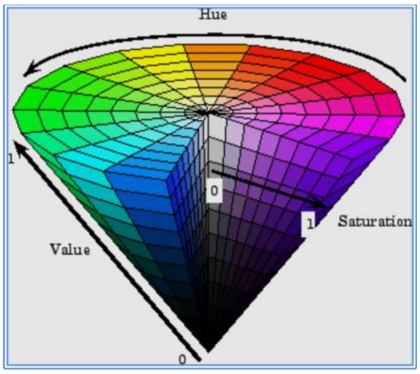

Figure 2: HSV color model single hex cone.

YCbCr Color model used for digital video. It defined in the ITU-R BT.601 standards of ITU (International Telecommunication Union) represents the encoding form of non-RGB signal. The transformation from RGB to YCbCr color model is given in the following equation [8]:

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.169 & -0.331 & 0.500 \\ 0.500 & -0.419 & -0.081 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

The **HSV** color model based on the idea of the human visual system. It belongs to the HSI family of color models uses cylindrical coordinates for the representation of RGB points as shown in Fig.2. Hue (H) and saturation (S) which are the chrominance components. V is the maximum value of RGB.

HSV is used mainly for computer vision, and image analysis of the segmentation process. The conversion from RGB to HSV is summarized by the following steps [8].

1. Find the maximum and minimum values as in the following equation:

$$M = \max(R, G, B), m = \min(R, G, B) \quad (2)$$

2. Normalized the RGB values to be in the range [0, 1].

$$r = \frac{M-R}{M-m}, g = \frac{M-G}{M-m}, and\ b = \frac{M-B}{M-m} \quad 2(3)$$

3. Find V value.

$$V = Max(R, G, B) \quad (4)$$

4. Calculate S value.

$$S = \frac{M-m}{M} \quad (5)$$

However, if $M = 0$ then $S = 0\ and\ H = 180$.

5. Calculate H value as in equation (2.26)

$$H = H - 360\ when\ H \geq 360, H = H + 360\ when\ H < 0 \quad (6)$$

6. Normalize H to be in the range [0,360[as in the following:

$$H = 60(b - g)\ when\ R = M,\ H = 60(2 + r - b) when\ G = M,\ or\ H = 60(4 + g - r)\ when\ B = M \quad (7)$$

7. Return HSV

KMCG Algorithm

The detailed steps of KMCG are demonstrated by algorithm 1. The window represents the data that needed to be clustered. For instance, if the vector is of RGB image data, and the window size is 4, then the length of the vector is 12. As shown in Fig. 3.

R1	G1	B1	R2	G2	B2	R3	G3	B3	R4	G4	B4

Figure 3 KMCG Vector Example

L is the length of the vector to be clustered. If the length is equal to 6, then the no. of clustering iterations is six, and the Codebook (CB) size is 64. Each iteration concludes sorting the vector of the whole image data based on one value of the vectors. For example: in the first iteration of the RGB image the vectors are sorted based on R1, which its position clarified by Fig. 3. Then after sorting the whole vectors, the data each cluster is separated into two clustered based on the median position of the vectors. Finally, the median vector is added into CB. This process is continued until the required length of the codebook is satisfied

Experiments and Results

The experiment is applied by testing KMCG with the three-color models: RGB, YCbCr, and HSV. Five samples of images that used. Three of them are standard images: Lena, Baboon, and the image of man is from a standard dataset called VidTIMIT [9].

The specification of the used computer and programming language is listed as the following:

- 12 G RAM, 512 SSD
- Intel ® Core™ i7_6500U CPU @ 2.50GHz
- System: Windows 10 64
- The programming language: C#

The size of the KMCG codebook which used by our experiment is 64.

Algorithm (1): Original KMCG

Input	A bitmap *Im* of size M*N, W (window size), L (required
Output	*CI* (Cartooned Image)
Begin	
Step1	**///Initialization** **Set** *lstVectors*← **FillVectors**(Im,W) **Set** *lstClusters* ←**InitializeClutsers**(*lstVectors*)
Step2	***///Clustering and Codebook Construction*** **for** *j* =1 **to** *L* **do** /* L is the required size of vectors values */ **foreach** *cluster* C in *lstClusters* **do** **SortAscending**(C,j) /* Sorting theCluster C based on value sequence j*/ **AddMediantoCB**(C) **SplitClusterAndAdd**(*lstTempClusters,C*) **end foreach** **Set** *lstClusters* ←*lstTempClusters* **end for**
Step3	***///Constructing Cartooned Image*** **foreach** *cluster* **in** *lstClusters* **do** **Set** *newRGB* ←**CalculateAverage(***cluster***)** **SetValueInImage(***C,newRGB,CI***)** **end foreach**
End	

Results

Table 1:PSNR of KMCG with RGB, YCbCr, and HSV

Image	KMCG RGB	KMCG YCbCr	KMCG HSV
Baboon	36.66	36.07	35.71
Lena	38.67	37.97	37.44
Man	42.85	39.21	40.18
Woman	42.02	38.33	38.08
Girl	42.76	38.39	38.8

Table 2: E measure of KMCG with RGB, YCbCr, and HSV

Image	**KMCG RGB**	**KMCG YCbCr**	**KMCG HSV**
Baboon	3.61	3.68	3.71
Lena	3.26	3.4	3.4
Man	2.8	2.9	2.94
Woman	2.95	3.15	3.14
Girl	2.92	3.2	3.2

Journal of AL-Qadisiyah for computer science and mathematics Vol.11 No.1 Year 2019
ISSN (Print): 2074 – 0204 ISSN (Online): 2521 – 3504

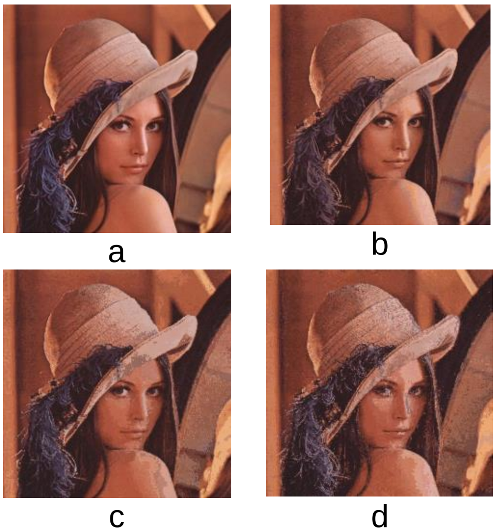

Figure 4: Lena a) Original b) RGB & KMCG c) YCbCr & KMCG d) HSV & KMCG

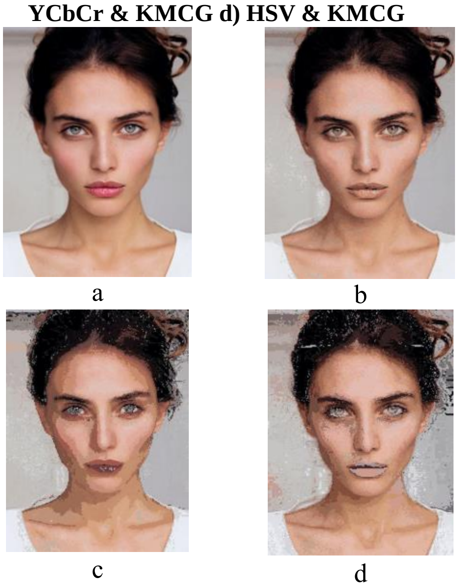

Figure 5: Woman a) Original b) RGB & KMCG c) YCbCr & KMCG d) HSV & KMCG

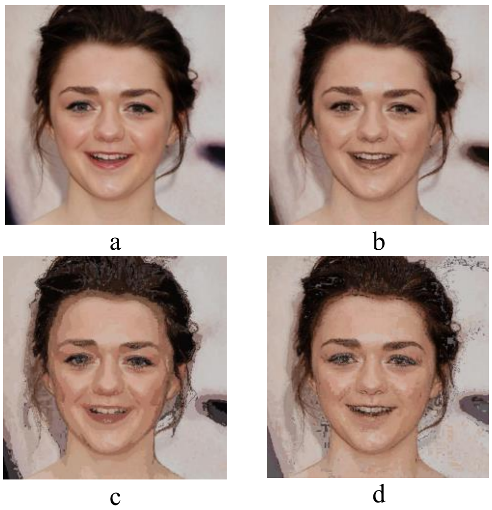

Figure 6: Girl a) Original b) RGB & KMCG c) YCbCr & KMCG d) HSV & KMCG

Discussion

The visual results are shown by Figs. 4,5,6. They reflect clearly that using KMCG with RGB color model conducts a better likeness and quality. While Applying KMCG with HSV shows the worst case. This remark is proved by utilizing the Peak Signal to Noise Ratio (PSNR) to evaluate and compare the precision of the KMCG with each color model as in Table 1.

PSNR is a good method to evaluate discrepancies between images. A high PSNR indicates an image of good quality. However, PSNR is not adequate for evaluating region homogeneity [10]. Thus, E measure is used to confirm PSNR results.

E is better at selecting images that agree with human evaluators. *E* balances region uniformity and the number of regions. A low *E* value indicates good internal uniformity of regions [11], [12]. Table 2 shows a functional impact of *E* measurement of the comparison between the three-color models. *E* indicates a good behavior balance of the KMCG with RGB. As shown by Table2 the E measure is the least in applying KMCG with RGB color model.

There is a slight difference between the results of using YCbCr and HSV. However, they don’t reach the quality of using RGB with KMCG.

Conclusion

The paper studied the best color model, which gives better segmentation results when it used with KMCG. The results show that KMCG gives a better visual and analytical results when it is used with RGB. We conclude that whatever the image is or the metrics used, using RGB with KMCG returns the best result. We recommend in the future work to compare KMCG with RGB segmentation with other clustering segmentation methods.

References

[1] R. C. Gonzalez and R. E. Woods, Digital Image Processing, 3rd Edition, Pearson Prentice Hall, 2008

.

[2] A. Er and K. R. Er, "Review of Image Segmentation Technique," *International Journal of Advanced Research in Computer Science,* 2017.

[3] H. B. Kekre and T. Sarode, "An Efficient Fast Algorithm to Generate Codebook for Vector Quantization," in *International Conference on Emerging Trends in Engineering and Technology, IEEE Computer Society*, 2008.

[4] P. A. K. A. K. Archana B. Patankar, "Image Cartoonization Methods Using LBG, KPE, KMCG quantization," in *International Conference on Computing Communication Control and automation (ICCUBEA)*, Pune, India , 2016.

[5] H. Kekre and P. Shrinath, "Segmentation of Ultrasound Breast Images using Vector Neighborhood with Vector Sequencing on KMCG and augmented KMCG algorithms," *International Journal of Advanced Computer Science and Applications,* vol. 4, no. 2, 2013.

[6] A. Patankar, P. Kubde and A. Kari, "Image Cartoonization Methods Using LBG, KPE, KMCG quantization," in *International Conference on Computing Communication Control and automation (ICCUBEA)*, Pune, India, 2016.

[7] W. G. Odongo, W. Mwangi and R. Rimiru, "Fingerprint Classification using KMCG Algorithm under Varying Window and Codebook Sizes," *International Journal of Computer Applications,* 2018.

[8] N. Ibraheem, M. Hasan, R. Khan and P. Mishra, "Understanding Color Models: A Review," *ARPN Journal of Science and Technology,* 2012.

[9] C. Sanderson and B. Lovell, "Multi-Region Probabilistic Histograms for Robust and Scalable Identity Inference," *Lecture Notes in Computer Science,* 2009.

[10] V. H. C. F. C. d. O. P. S. R. Fernando A. Fardo, "A Formal Evaluation of PSNR as Quality Measurement Parameter for Image Segmentation Algorithms," *Computer Vision and Pattern Recognition,* 2016.

[11] J. E. F. a. S. A. G. Hui Zhang, "An Entropy-based Objective Evaluation Method for Image Segmentation," *Proceedings of the SPIE,* vol. 5307, pp. 38-49, 2003.

[12] G. S. d. B. Giuliana Ramella, "Image Segmentation Based on Representative Colors Detection and Region," in *Mexican Conference on Pattern Recognition, Springer*, 2013.

[13] P. S. H.B.kekre, "Segmentation of Ultrasound Breast Images using Vector Neighborhood with Vector Sequencing on KMCG and augmented KMCG algorithms," *International Journal of Advanced Computer Science and Applications,* vol. 4, no. 2, 2013.

[14] T. K. S. H. B. Kekre, "An Efficient Fast Algorithm to Generate Codebook for Vector Quantization," in *International Conference on Emerging Trends in Engineering and Technology, IEEE Computer Society*, 2008.

Journal of AL-Qadisiyah for computer science and mathematics Vol.11 No.1 Year 2019
ISSN (Print): 2074 – 0204 ISSN (Online): 2521 – 3504

مقارنة تقسيم الصورة بواسطة خوارزمية الـ KMCG بالاعتماد على HSV وYcbCr،RGB

فاتن صادق خزعل عبد المنعم صالح رحمة
قسم علوم الحاسوب ، الجامعة التكنولوجية

ألمستخلص :

KMCG هي احد انواع خوارزميات الـ Vector Quantization المستخدمة لاغراض الضغط و تقسيم الصورة. استخدمت في العديد من التطبيقات و اثبتت كفاءتها و سرعتها. هذه الورقة البحثية تعرض مقارنة في تطبيق خوارومية الـ KMCG مع ثلاثة انواع من الـ Color Models و المتضمنة RGB، YCbCr، و HSV. تم تطبيق تجربة المقارنة على خمسة صور، ثلاثة منها هي صور معيارية (Standard). و عدد المقاييس المستخدمة اثنين: PSNR و E measure ، بالاضافة الى الصور الناتجة المرئية. جميع المقاييس اثبتت ان استخدام الـ RGBمع الـ KMCG يعطي نتائج افضل في تقسييم الصور