Analysis of Color Image Segmentation Using Cluster Based Self-Organizing Map (SOM) Algorithm

Thida Soe
University of Computer Studies, Hinthada

***Abstract*:** Image segmentation is an important role in digital image processing and it could be solved by many clustering method. Segmentation of an image entails the division or separation of an image into regions of similar attribute. In this proposed system, initially natural images are taken from the Berkley Image Segmentation Database (BSD). Various color space of images such as RGB, HSV and L* A* B* are used as input images for the segmentation process. In order to get the same size of image images with different color space, Image J software is used to in this system. Because color conversion function may reduce the input images size is not flexible for this system. This system uses the different color images and the resultant is analyzed with subjective and objective measures. Then the cluster based segmentation techniques SOM unsupervised clustering techniques is applied. A self-organizing map (SOM) is a type of artificial neural network (ANN) that is trained using unsupervised learning to produce a low-dimensional input space of the training samples. This developed method takes into account the color similarity and spatial relationship of objects within an image. According to the features of color similarity, an image is first segmented into cluster regions. The resulting regions are further treated by computing the spatial distance between any two cluster regions, and SOM with a labeling process is applied. The experimental results show that the proposed system is feasible and that the segmented object regions are similar to those perceived by human vision.

***Keywords*- Color Image Segmentation, SOM Algorithm, Image Processing, Color Space Model, ANN**

1. INTRDUCTION

Color image segmentation is the challenging task in image processing and contains two critical issues, firstly which color model to be used and secondly, which segmentation technique should be applied. A color space is a method by which we can specify, create and visualize colors. Several color representations, such as RGB, HSI, CMY, CMYK, YIQ, CIE L∗a∗b∗,etc., are employed for color segmentation, but none of them can dominate the others for all kinds of colors images. Image segmentation is the process of partitioning a digital image into multiple segments. Each segment will represent some kind of information to user in the form of color, intensity or texture.

The goal of segmentation is to simplify or change the representation of an image into that is more meaningful and easier to analyze. Image segmentation is a useful tool in many real system including industry, health care, astronomy and remote sensing, biomedical imaging, change detection, object detection and recognition. Clustering methods provide with a different view of the image segmentation by using different color spaces with same size of input images. SOM studies each inputs component and then classifies the input into the corresponding class. The K-Means clustering technique is a well-known approach that has been applied to solve low-level image segmentation tasks. A successful segmentation depends on the good selections of similarity measure, feature description of an image, evaluation of the segmentation and prior knowledge available. This clustering algorithm is convergent and its aim is to optimize the partitioning decisions based on a user-defined initial set of clusters that is updated after each iteration. This work was motivated from the fact that the accuracy in segmentation of a color image depends not only on the algorithm but also on the color space selected.

K means clustering algorithm which involves mapping the image pixel to the RGB color space and HSV color space [1]. HSV color space will be more compatible for conduct with segmentation of rough color images. RGB color space is also called additive color space, which can be described well based on the RGB color model. In [2], three different cluster based segmentation techniques performed on 3 different color images .But in K-means technique we can get various segments according to cluster size. K-Means provided better results than the other two techniques using subjective (visualization and execution time) measure for RGB, HSV and LAB color spaces.

In [3] , K-Means, Fuzzy C-Means and Density Based clustering techniques are compared for their performance in segmentation of color images. K-Means algorithm is convergent and its aim is to optimize the partitioning decisions based on a user-defined initial set of clusters. Fuzzy C-means (FCM) is a method of clustering which allows one pixel to belong to two or more clusters. Image segmentation based on density-based clustering; will integrate the spatial connectivity and the color similarity simultaneously in the segmentation process. Using these three techniques, the performance for different images were evaluated by calculating their accuracy. Self-Organizing Map (SOM) is an unsupervised artificial neural network technique that is used to produce a low dimensional representation of the input space [4]. SOM operates in two modes, Training and Mapping. Training builds the map from the input and Mapping classifies a new input vector. Self-organizing maps are capable of maintaining spatial information of the image and are therefore preferred whenever preserving the topological features is a priority in this paper. It is show that the proposed K-Means algorithm, gets better segmentation results with less time needed and no need to set any parameters in advance.

2. COLOR IMAGE SEGMENTATION

Clustering is the task of partitioning the data points into homogeneous classes or clusters so that items in the same class are as similar as possible and items in different classes are as dissimilar as possible. Clustering can also be thought of as a form of data compression, where a large number of samples are converted into a small number of representative prototypes or clusters. Depending on the data and the application, different types of similarity measures may be used to identify classes, where the similarity measures controls how the clusters are formed. As a kind of unsupervised learning method, clustering is divided to be a hierarchical and partition.

2.1 Clustering Based Segmentation

Clustering is the task of partitioning the data points into homogeneous classes or clusters so that items in the same class are as similar as possible and items in different classes are as dissimilar as possible. Clustering can also be thought of as a form of data compression, where a large number of samples are converted into a small number of representative prototypes or clusters. Depending on the data and the application, different types of similarity measures may be used to identify classes, where the similarity measures controls how the clusters are formed. As a kind of unsupervised learning method, clustering is divided to be a hierarchical and partition.

SOM differ from other artificial neural networks as they apply competitive learning as opposed to error-correction learning and they use as a neighborhood function to preserve the topological properties of the input space. Being a typical partitioned clustering method, K-Means method assign each points to the cluster with the nearest center.

2.2 Color Space Model

A color space is a useful method for user to understand the color capabilities of a particular digital device or file. An RGB color space can be simply interpreted as "all possible colors" which can be made from three colors for red, green and blue. The HSV color space is used when selecting colors for paint or ink because HSV better represents how people relate to colors than does the RGB color space. Selecting an HSV color begins with picking one of the available hues, which adjusting the shade and brightness value.

LAB color is designed to approximate human vision. L component closely matches human perception of lightness. It can be used to make accurate color balance corrections by modifying output in a and b components, or to adjust the lightness contrast using the L component. The system use Image J tools combine with color conversion plugin for color space conversion like that RGB to HSV and RGB to LAB.

This tool designed with an open architecture that provides extensibility via Java plugins. User-written plugins make it possible to solve almost any image processing or analysis problem. It supports standard image processing functions such as contrast manipulation, sharpening, smoothing, edge detection and median filtering. It can display, edit, analyze, process, save and print 8-bit, 16-bit and 32-bit images. It can read many image formats including TIFF, GIF, JPEG, PNG, DICOM, BMP, PGM, FITS and so on.

3. Proposed System Architecture

This proposed system is to simplify and change the representation of an image into something that is more meaningful and easier to analyze. Self-Organizing Map (SOM) for color clustering which is applies in color image segmentation process. Learning SOM algorithm for training with neural network structure and feature of prototype vector for color image segmentation. In this experiment, the effectiveness of low clustering methods involving RGB, HSV, L*a*b color spaces for a variety of real color image is obtained.

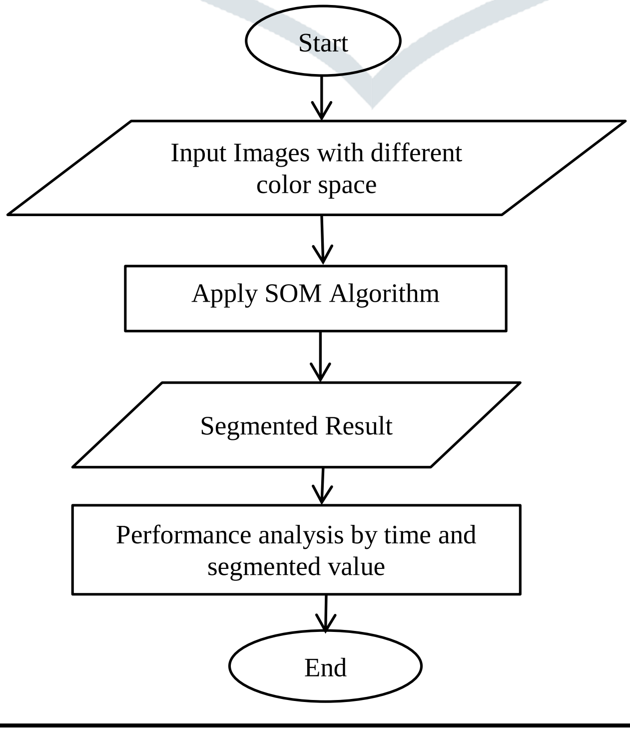


Figure 1. Flowchart of the proposed system

Self-Organizing Maps (SOM) are special classes of artificial neural networks, which are based on competitive learning. Use the SOM for clustering data without knowing the class memberships of the input data. Based on the unsupervised learning, which means that there is no human intervention is needed during the learning and those little needs to be known about the characteristics of the input data. In competitive learning the output neurons of the network compete among themselves to be activated or fired, with the result that only one output neuron, or one neuron per group, is on at any one time.

The neuron that wins the competitive is called a winning neuron. The winner neuron determines the spatial location of the topological neighborhood. The excited neurons, i.e. the neighboring nodes of the winner neuron decrease the value of their individual discriminates function according to the input pattern through suitable adjustments associated with the connection weights. The weight adjustment corresponding to the smallest learning progress criterion is the result of the SOM learning process. Only the weight vectors of winner and its neighbor units are update.

3.1 SOM Learning Algorithm Steps

The following steps are running in SOM learning algorithm.

Step 1: Randomly position weight vector in the data space.
Step 2: Select one data point, either randomly cycling through the dataset in order
Step 3: Find the neuron that is closest to the chosen data point. This neuron is called the Best Matching Unit (BMU).
Step 4: Move the BMU closer to that data point. The distance moved by the BMU is determined by a learning rate, which decreases after each iteration.
Step 5: Move the BMU's neighbors closer to that data point as well, with farther away neighbors moving less. Neighbors are identified using a radius around the BMU, and the value for this radius decreases after each iteration.
Step 6: Update the learning rate and BMU radius, before repeating Steps 2 to 5. Iterate these steps until position of neurons have been stabilized.

3.2 Self Organization Map Algorithm

$\boldsymbol{m}$ is the dimension of the input space,

$x = \{ \boldsymbol{x}_1, \boldsymbol{x}_2, \ldots, \boldsymbol{x}_m \}^T$,

Updating the weight vector of neurons

$$\boldsymbol{w\_i}(t+1) = \boldsymbol{w\_i}(t) + \alpha(t)\, \boldsymbol{h\_(c,i)}(t)\, [\, \boldsymbol{x(t)} - \boldsymbol{w\_i}(t)\,]$$

Where $\boldsymbol{h\_(c,i)}(t)$ is neighborhood function

$$h_{c,i}(t) = \alpha(t)\, .\, \exp\left(\frac{||r_c - r_i||}{2\sigma^2(t)} \right)$$

Where $\alpha(t)$ is the learning rate

$$\alpha(t) = \alpha_0 \left(1 - \frac{Iteration\_number}{total\_number\_of\_iteration}\right)$$

Where,

-$\boldsymbol{r}$ is the coordinate position of the neuron on the map
-$\boldsymbol{\alpha(t)}$ is the learning rate due to iteration process
-(t) is the width of neighborhood radius at time t
-$\boldsymbol{t}$ is the iteration length

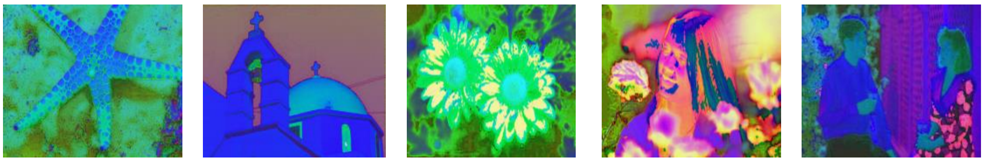
4. Experiment Result

Analysis in this system uses images from the Berkeley Segmentation Dataset (BSDS). There are 5 test images with RGB color space, which are shown as below in Figure 2.

101.jpg 102.jpg 103.jpg 104.jpg 105.jpg

Figure 2. Original image of test images

There are 5 test images with HSB color space, which are shown as below in Figure 3.



101.jpg 102.jpg 103.jpg 104.jpg 105.jpg

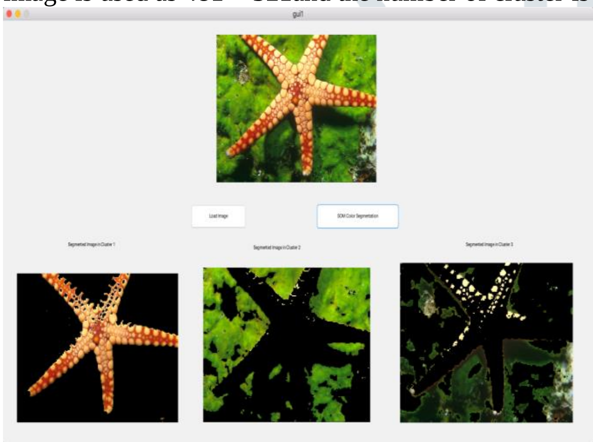
Figure 3. Test images with HSB color space

There are 5 test images with LAB color space, which are shown as below in Figure 4.

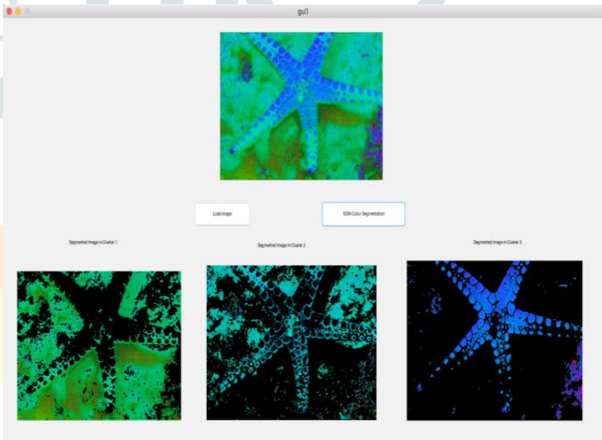
101.jpg 102.jpg 103.jpg 104.jpg 105.jpg

Figure 4. Test image with LAB color space

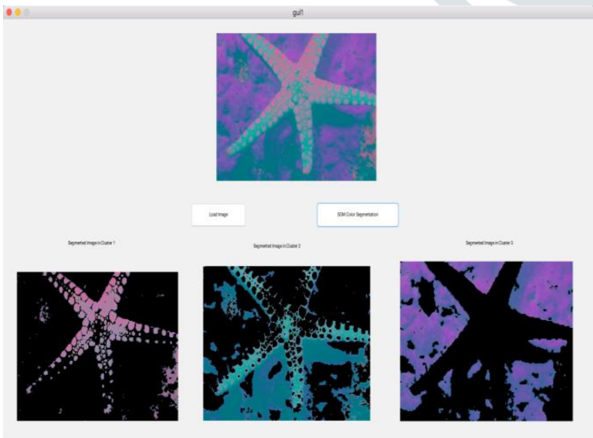
In this proposed system three type of input data images are used for implementation process. The same size of input image is used as 481 × 321and the number of cluster is 3.



101RGB.JPG



101HSV.JPG



101LAB.JPG

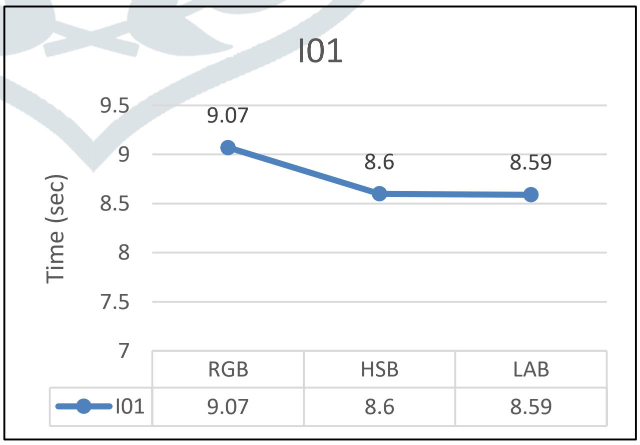
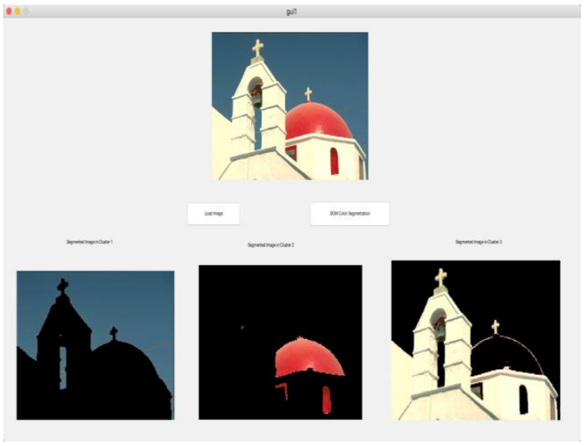
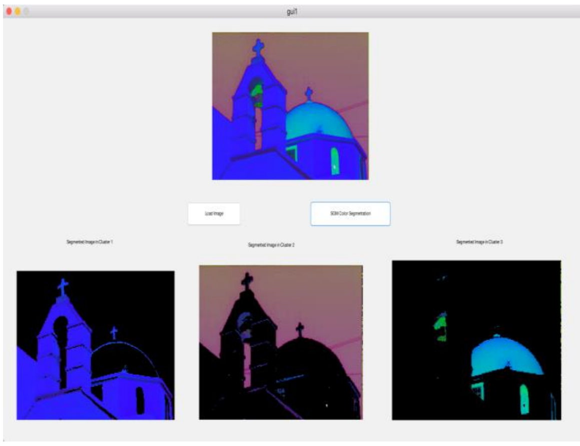


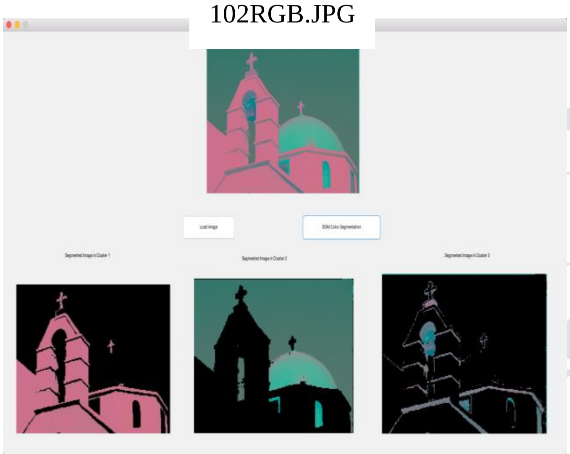
Figure 5. Experimental result for 101.jpg images with SOM algorithm



102RGB.JPG



102HSV.JPG



102LAB.JPG

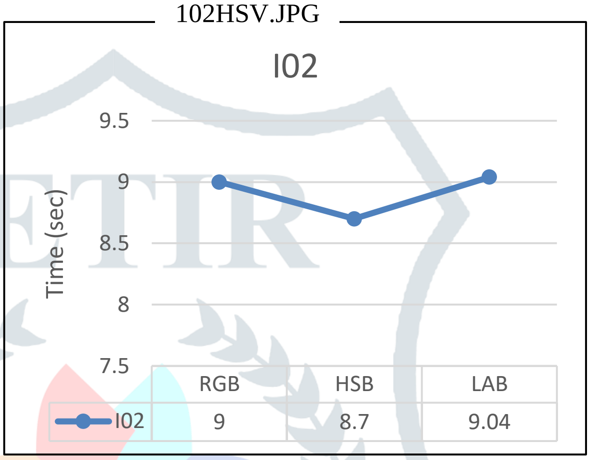
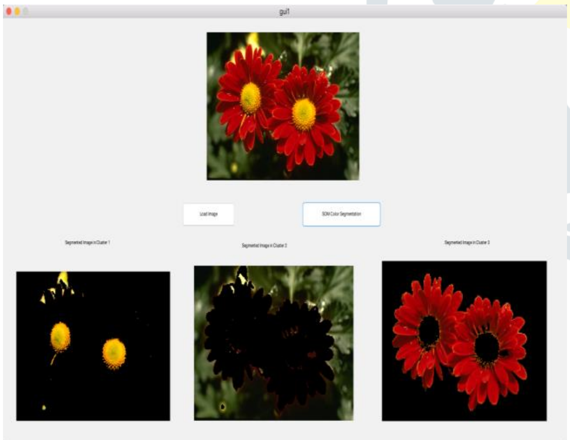
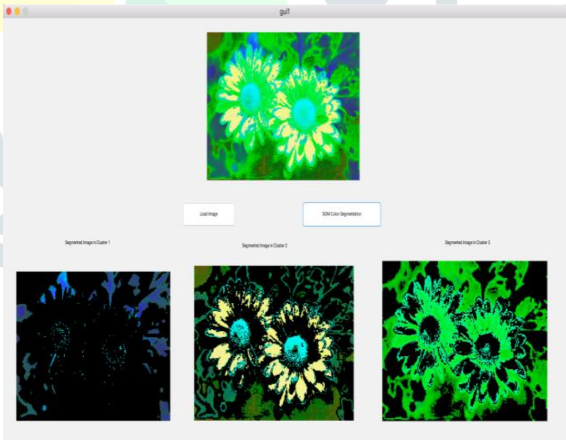


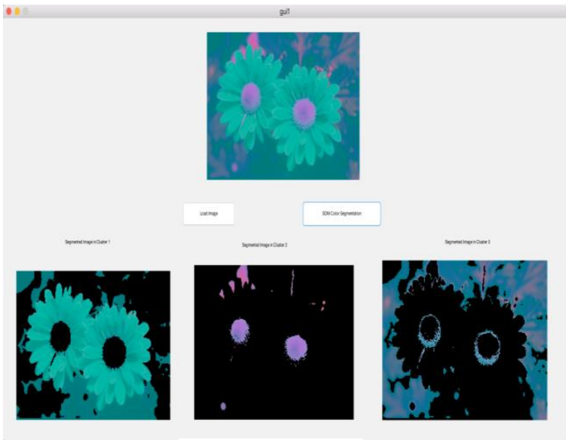
Figure 6. Experimental result for 102.jpg images with SOM algorithm



103RGB.JPG



103HSV.JPG



103LAB.JPG

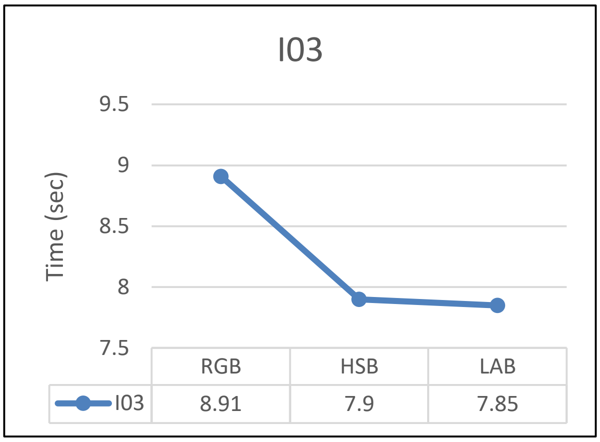
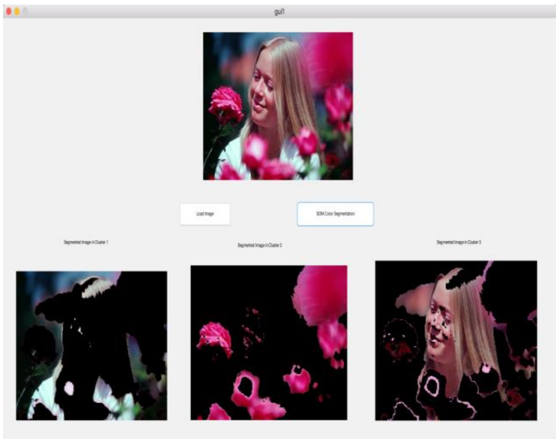
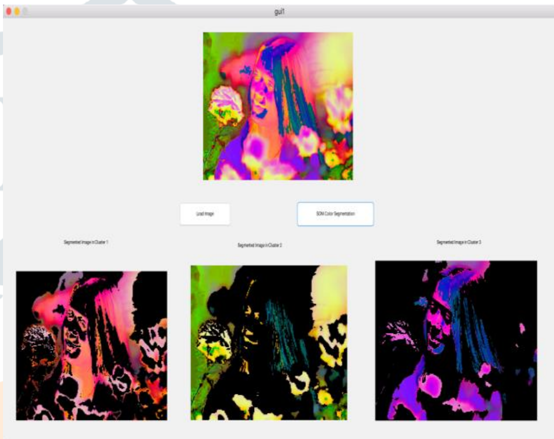


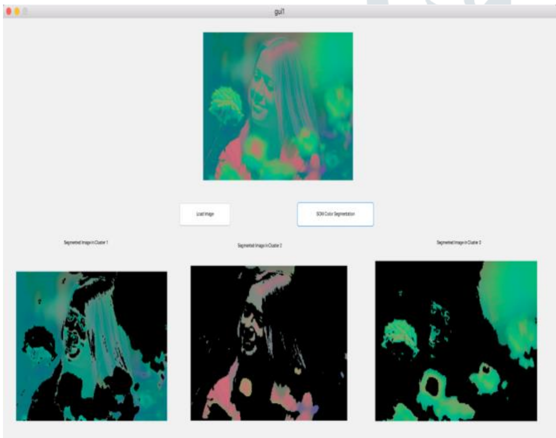
Figure 7. Experimental result for 103.jpg images with SOM algorithm



104RGB.JPG



104HSV.JPG



104LAB.JPG

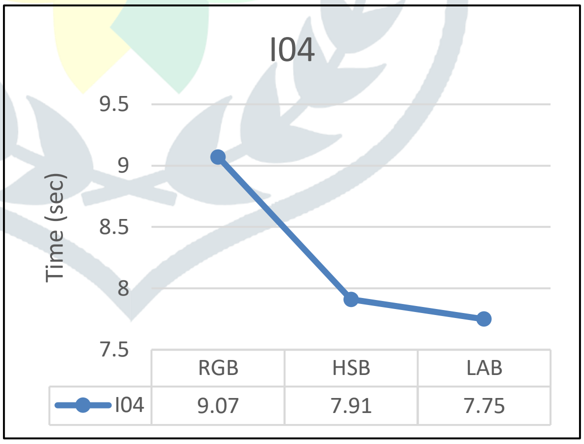
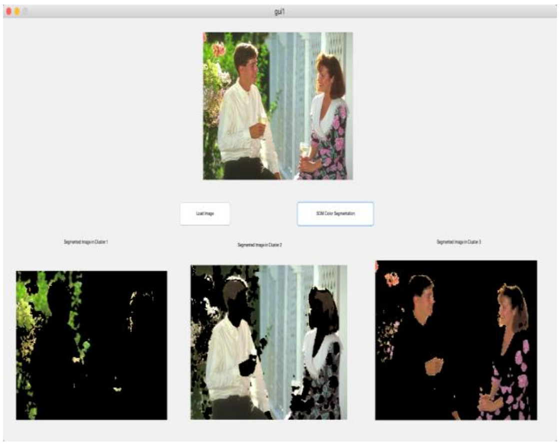
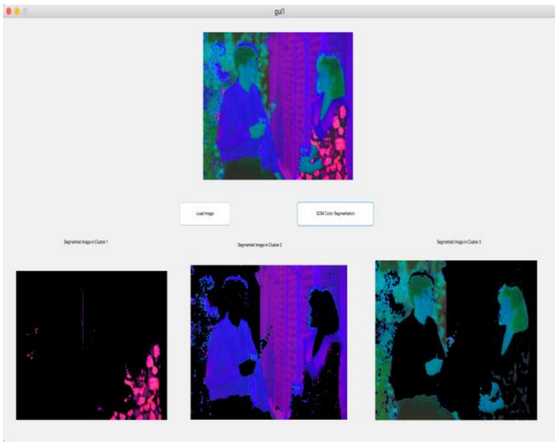


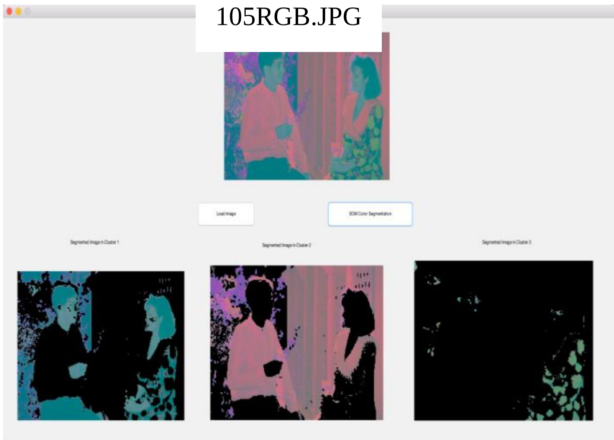
Figure 8. Experimental result for 103.jpg images with SOM algorithm

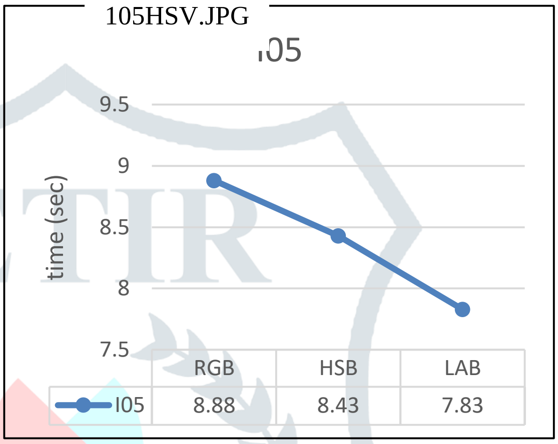




105RGB.JPG

105HSV.JPG

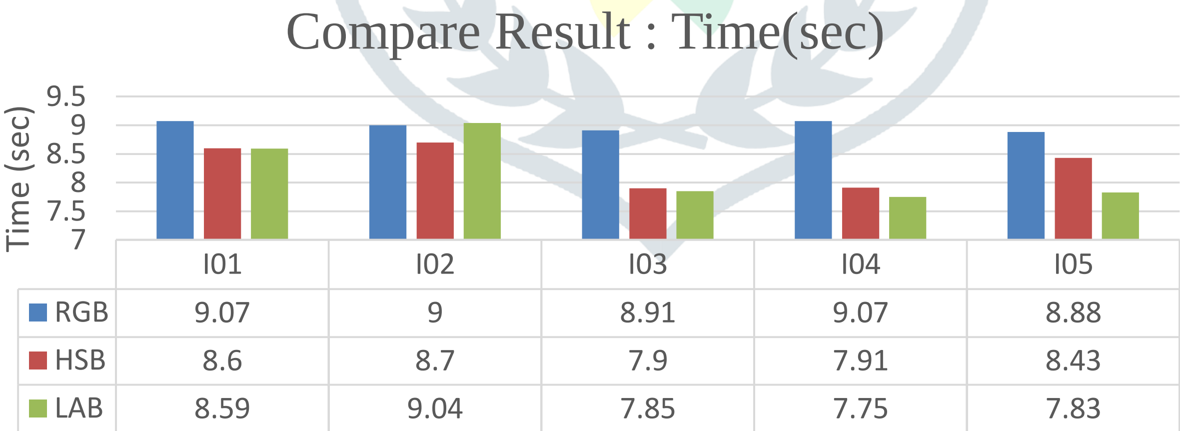




105LAB.JPG

Figure 9. Testing result for 105.jpg with SOM Algorithm

The following graph shows the execution time measure, where x-axis represents the different color images and y-axis indicated the corresponding value derived from the specific measure for SOM segmentation technique.



	I01	I02	I03	I04	I05
RGB	9.07	9	8.91	9.07	8.88
HSB	8.6	8.7	7.9	7.91	8.43
LAB	8.59	9.04	7.85	7.75	7.83

Figure 10. Compare results for various images

The time taken for the image segmentation results for all three color spaces for a similar number of iterations and same size is applied in this proposed system. The experimental result show that the proposed system is feasible and that the segmented object regions are similar to those perceived by human vision. In this system, three cluster provide a feasible new solution for image segmentation which may be helpful in image retrieval. The number of iteration of SOM algorithm also affect the result and convergence time of the neural network. In this experiment the number of iteration in SOM is assigned to 90 and that can give better clustering result.

5. Conclusion

Color image segmentation that is based on the color feature of image pixels assumes that homogeneous colors in the image correspond to separate clusters and hence meaningful objects in the image. SOM and K-Means being an unsupervised methods, can achieve better segmentation results with less computational load and no human intervention. K-Means produces relatively high quantity clusters with considering the low level of computation required. A self-organizing map (SOM) is a grid of neurons which adapt to the topological shape of a dataset, allowing us to visualize large datasets and identify potential clusters.

An SOM learns the shape of a dataset by repeatedly moving its neurons closer to the data points. Distinct groups of neurons may thus reflect underlying clusters in the data. SOMs are best for datasets with continuous variables, and it should be repeated to check for consistency. Resulting clusters should also be validated. In the system show the evaluation of segmentation of color images is tested with different classical color spaces RGB, HSV and LAB to select the best color space for the considered kind of images based on different methods. The segmentation results depend on not only color space bout also using algorithm, there is no single color space that can provide acceptable results for all kinds of images. This system is to compare the performance of different segmentation techniques for various color space with color images.

References

[1] R.Hassan, R.R.Ema, "Color Image Segmentation using Automated K-Means Clustering with RGB and HSV Color Spaces", Global Journal of Computer Science and Technology: Graphic and Vision Volume 17Issue 2Version 1.0 Year2017.

[2] Amrita Mohanty, S Rajkumar, Zameer Muzaffar Mir, Puja Bardhan "Analysis of Color Images using Cluster based Segmentation Techniques ", International Journal of Computer Applications (0975 – 8887),Volume 79 – No.2, October 2013

[3] Preeti , "Color Image Segmentation Using K-Means, Fuzzy C-Means and Density Based Clustering", international journal for research i n applied science and engineering technology (IJRASET), Vol. 2 Issue VI, June 2014.

[4] S.Sengupta, S.Verma, S.M.S.Paul, "Comparative Study of Image Segmentation using Variants of Self Organizing Maps (SOM)", international journal for research in emerging science and technology, volume-2, issue-5, may-2015