

A NEW APPROACH FOR IMAGE FEATURE VECTOR CLASSIFICATION USING UNSUPERVISED CLUSTERING METHOD

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ABSTRACT

In this paper, we introduce a new approach for image feature vector classification using unsupervised clustering technique. The proposed approach is aimed to partition the trained image feature vector set into highly relative clusters. The proposed approach consists of two stages viz. (1) Image preprocessing stage (2) Classification stage. The image preprocessing stage aims to train the limited image feature vector set from the set of gray scale images through the feature extraction and feature selection. In the feature extraction stage, applied three spatial statistical operators such that mean, standard deviation and variance over the each individual block in the digital image and extracted three features from each block respectively. In the feature selection stage, the size of the image feature vector set is limited. In the classification stage, the trained image feature vector set is partitioned into 'm' highly relative clusters through the k-means technique. The experimental result shows that the proposed approach is very suitable for partitioning the image feature vector set into highly relative clusters.

Keywords: Statistical Operators Supervised Clustering, Unsupervised Clustering.

I INTRODUCTION

Classification of images can be done in supervised and unsupervised way. Supervised classification starts by specifying an information class on the image. An algorithm is then used to summarize multispectral information from the specified areas on the image to form class signatures. This process is called supervised training. For the unsupervised classification, however an algorithm is first applied to the image and some spectral classes (also called clusters) are formed. The image analyst then tries to assign a spectral class to the desirable information class. An efficient method to identify and classify the exudates as hard and soft exudates was introduced in [1]. Candidate exudates were detected using k-means clustering technique in this system.

A hybrid clustering which is combination of k-means and PSO clustering was introduced by [2] for classification of multispectral images. Here k-means clustering was done initially and the result was used to see the initial swarm. In [3], proposed a new unsupervised classification approach for automatic analysis of polarimetric synthetic aperture radar (SAR) image. Here the classification of multidimensional SAR data space by dynamic clustering was addressed as an optimization problem. A different approach was proposed by [4], they used supervised features in the context of image classification and retrieval yielding excellent results and demonstrated how these supervised features can be effectively used for unsupervised image categorization that

is for grouping semantically similar images. In [5], they have proposed a new multistage method for unsupervised image classification using hierarchical clustering. In the first phase, the multistage method performs segmentation using a hierarchical clustering procedure which confines merging to spatially adjacent clusters and generates an image partition. In the second phase, the segments resulting from the first stage are classified into a small number of distinct states by a sequential merging operation.

In [6], have proposed a New Fuzzy Cluster Centroid (NFCC) for unsupervised classification algorithm to improve the traditional FCM and fuzzy weighted c means (FWCM) algorithm. They reported that the inclusion of the fuzzy centroid for each cluster has increased the stability of the algorithm and the inclusion of the new term reduces the number of iterations for image classification. Frank Y. Shih et.al. [7] Have proposed a new two-pass unsupervised clustering algorithm incorporated the fuzzy theory for classification of land sat remote sensing images. In the first pass they derived the mean vectors of different land cover types representing their geographic attributes and in the second pass the membership grade of a pixel belonging to different land cover types is computed based on the distance between its gray-value vector and the mean vector of each type. Beaulieu J.M. et.al.[8] have proposed a method which includes segmentation and classification of image. They applied clustering over segment mean values and considered only large segments. They reported the method was very efficient in simplifying the image. In [9] have proposed unsupervised image classification algorithms using a hierarchical model. In this approach the only parameter supposed to be known is the number of regions, all the other parameters are estimated. The algorithms they presented was implemented on a Connection Machine CM200. They reported comparative tests were done on noisy synthetic and real images (remote sensing). Another approach was proposed in [10], they derived an EM algorithm on the hybrid structure which mixes an exact EM algorithm on each subtree and a low cost Gibbs EM algorithm on the coarse spatial grid. Experiments on a synthetic image and multispectral satellite images are reported.

In this paper we have focused on a new approach for image feature vector classification using unsupervised k-means clustering. Proposed approach partitions the trained image feature vector into highly relative 'm' clusters. The major goal of the proposed technique is to partition and classify image feature vector with good accuracy.

II THE PROPOSED SYSTEM

In this section, the detail of the proposed system is presented. The proposed system consists of two stages viz. 1) Image preprocessing stage, and 2) Classification stage. Image enhancement can be done in two approaches, Spatial and frequency domain. In the spatial domain method, the pixel composing of image details are considered and the various procedures are directly applied on these pixels. The spatial technique methods are simple and easy to implement and also the speed of operation is high.

Fig 1 shows that the steps involving in the proposed system. The above two stages are described in the below subsection.

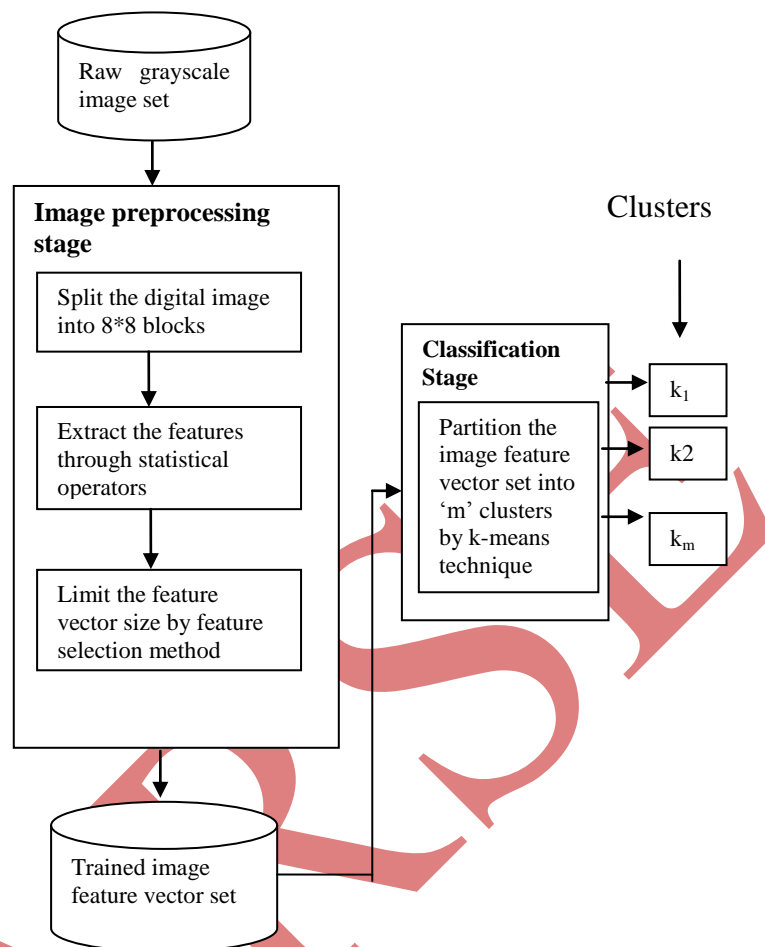


Fig 1.Functional Diagram of the Proposed System

2.1 Image Preprocessing Stage

In the image preprocessing stage, we train the image feature vector set from the set of grayscale images through the spatial statistical operators. It consists of two steps: feature extraction and feature selection. In the feature extraction step, the input image is divided into (8*8) blocks of smaller size. On each block, applied three spatial statistical operators and extracted three features from each individual blocks such that mean, standard deviation and variance. For example each input image of 200*200 size shown in Fig 2. Each image is divided into 625 blocks of size 8*8 and respectively three features such as mean, standard deviation and variance are extracted from each individual blocks. Mean (\bar{X}_k) is defined by,

$$\bar{X}_k = \left\{ \frac{\sum_{k=0}^N \sum_{i=0}^R \sum_{j=0}^C I_{kij}}{R \times C} \forall I_{kij} \in I_k \text{ and } \forall I_k \in I \right\} \quad (1)$$

where I_{kij} is denoting the i^{th} row and j^{th} column pixel value that belongs to the k^{th} block in the image

I for $k=0,1,...,N$, I_k represents the k^{th} block in the image I , R and C are denoting the row and column size respectively, and N is the number of blocks in the image. Next, the standard deviation (SD_k) is defined

$$\text{as: } SD_k = \left[\frac{\sum_{k=0}^N \sum_{i=0}^R \sum_{j=0}^C (I_{kij} - \bar{X}_k)^2}{R \times C} \right]^{\frac{1}{2}} \quad (2)$$

where \bar{X}_k is representing the mean value of k^{th} block in the image I for $k=0,1,...,N$ and finally the Variance (V_k) is defined as:

$$V_k = \left[\left[\sum_{k=0}^N \sum_{i=0}^R \sum_{j=0}^C (I_{kij} - \bar{X}_k)^2 \right]^{\frac{1}{2}} \right]^{\frac{1}{2}} \quad (3)$$

where \bar{X}_k represents the mean of k^{th} block that belong to image and I_{kij} is denoting the i^{th} row and j^{th} column pixel value that belongs to the k^{th} block in the image I for $k=0,1,...,N$. Next, the feature selection step, the feature vector size is limited. Among all the features only means values of all input images are taken. The classification stage is described in the below subsection.

2.2. Classification Stage

In the classification stage, the trained image feature vector set is partitioned into 'm' highly relative clusters through the k-means technique. K-means is explained as follows: First randomly select $K = \{K_1, K_2, ..., K_m\}$ where $K_1, K_2, ..., K_m$ are the candidate representative representing initial cluster center values that belongs to the actual feature vector set and here 'm' denotes the number of clusters or partitions. In the second step, measure the similarity between the feature vector set and the cluster centers using Euclidean distance measure and is defined as,

$$d(\bar{X}_i, K_j) = \left[\sum_{i=1}^n \sum_{j=1}^m (\bar{X}_i - K_j)^2 \right]^{\frac{1}{2}} \quad (4)$$

where \bar{X}_i denotes trained image feature vector set, i.e mean of all the images I and n denotes the number of input images. K_j denotes the initial cluster centers for $j=1,2,..., m$ and $d(\bar{X}_i, K_j)$ denotes the distance between data in \bar{X}_i and all the cluster centers values in K .

At last, when all the feature vector set data are included in some clusters an initial grouping is done. New clusters centers $C = \{C_1, C_2, ..., C_m\}$ are then calculated by taking average of feature data in the present cluster using average mean function and is defined as,

$$C = \frac{1}{N} \sum_{q=0}^N S_q \quad (5)$$

where $\sum_{q=0}^N S_q$ is the sum of all the values in the cluster whose center is K_j for $j=1,2,.. m$ and N is the number of values in that cluster.

This cluster updating is done because inclusion of new feature data may lead to changes in the existing cluster centers. This process of center updation is iterated until a situation where centers do not update anymore or criterion function becomes minimums. Square error criterion is used for this purpose and is defined as,

$$E = \sum_{i=1}^n \sum_{j=1}^m |\bar{X}_i - C_j| \quad \text{and } \bar{X}_i \in C_j \quad (6)$$

where \bar{X}_i denotes trained image feature vector set, i.e mean of all the images I , C_j is the center for cluster whose initial center was K_j .

Algorithm

Input: Trained Image feature vector set of n images \bar{X}_i ($i=1$ to n)

Number of clusters 'm'

Output: 'n' images clustered into 'm' Clusters.

Begin

1. Randomly select $K = \{K_1, K_2 \dots K_m\}$ from image feature vector set \bar{X} as candidate representative representing initial clusters.
2. Repeat
3. Calculate the distance between \bar{X}_i ($i=1$ to n) and all 'm' cluster centers K_j ($j=1$ to m) using Euclidean distance Eq.(4) and assign \bar{X}_i to nearest cluster.
4. For each cluster, recalculate the cluster center using average mean function using Eq(5).
5. Until no changing of cluster centers or criterion function becomes minimum using Eq.(5).

End

III EXPERIMENTS AND RESULTS

In this section, we tested the proposed system over 20 sample images that are shown in Fig 2 obtained from [11]. These sample images are grayscale images of size 200*200. Each pixel in the image corresponds to some characteristic at that point in space, for example protein density in MRI or X-ray absorption in CT scans. These images stack together to form a solid representation of the head.

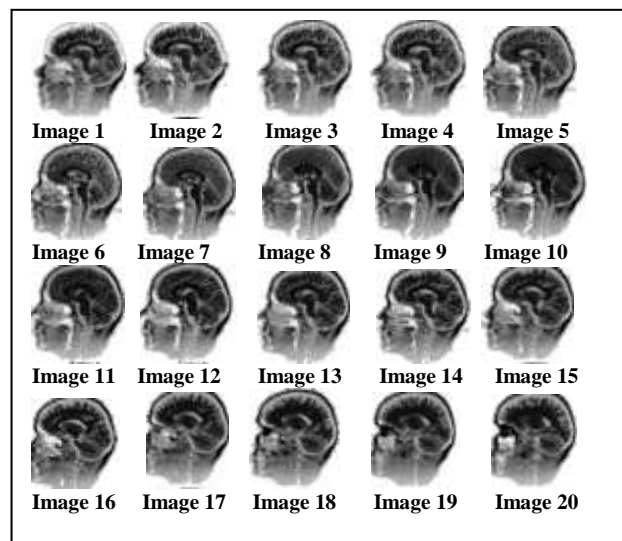


Fig 2. Input Images for the Proposed System.

It is clearly noticed from the Fig 3, the input image is divided into 625 blocks of 8×8 size and pixel values of all blocks are obtained.

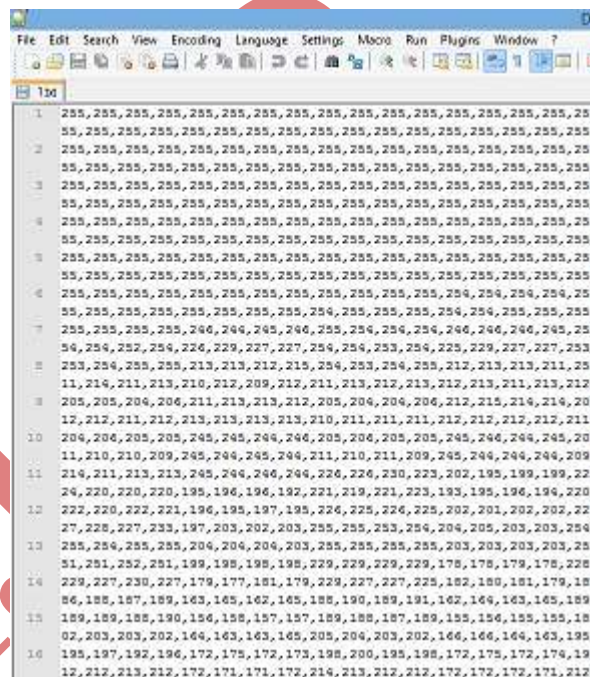
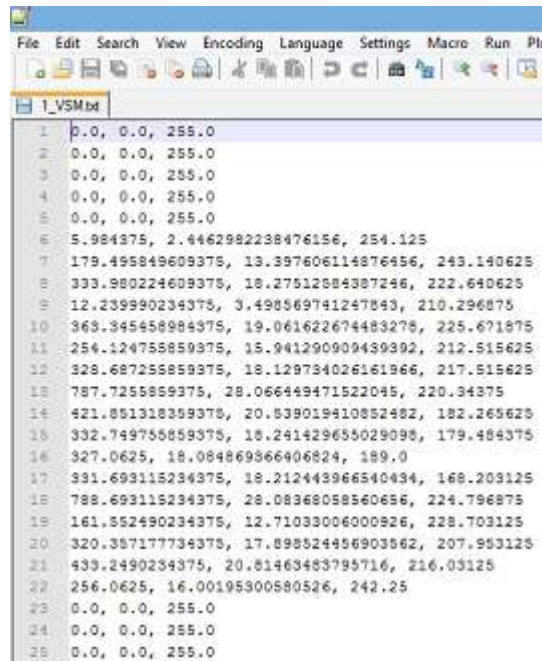


Fig 3. Result of sample digital image is divided into 625 blocks of size is (8×8) that the sample images in Fig 2

It feature extraction stage, applied statistical operators and features such as mean, standard deviation and variance are obtained from all the 625 blocks as shown in Fig 4.



Sample	Set 1	Set 2	Set 3	Set 4	Set 5
1	0.0	0.0	255.0		
2	0.0	0.0	255.0		
3	0.0	0.0	255.0		
4	0.0	0.0	255.0		
5	0.0	0.0	255.0		
6	5.984375	2.4462982238476156	254.125		
7	179.495849609375	13.397606114876456	243.140625		
8	333.980224609375	18.27512884387246	222.640625		
9	12.239990234375	3.498569741247843	210.296875		
10	363.345458984375	19.061622674483278	225.671875		
11	254.124755859375	15.941290909439392	212.515625		
12	328.687255859375	18.129734026161966	217.515625		
13	787.7255859375	28.066449471522045	220.34375		
14	421.851318359375	20.839019410852482	182.265625		
15	332.749755859375	18.241429655029098	179.484375		
16	327.0625	18.084869366406824	189.0		
17	331.693115234375	18.212443966540434	168.203125		
18	788.693115234375	28.08368058560656	224.796875		
19	161.852490234375	12.71033006000926	228.703125		
20	320.387177734375	17.898524456903562	207.953125		
21	433.2490234375	20.81463483795716	216.03125		
22	256.0625	16.00195300580526	242.25		
23	0.0	0.0	255.0		
24	0.0	0.0	255.0		
25	0.0	0.0	255.0		

Fig 4.Result of feature extraction method that tested over the 20 sample images in the Fig 1

During feature selection, the image feature vector set size is limited and only mean feature of all the blocks are obtained as shown in Fig 5.

1	255.0	255.0	255.0	255.0	255.0	254.125	243.140625	222.640625	210.296875	225.671875	212.515625	217.515625	220.34375	182.265625	179.484375	189.0	168.203125	224.796875	228.703125	207.953125	242.25	255.0	255.0	255.0	255.0	
2	179.484375	189.0	168.203125	224.796875	228.703125	207.953125	242.25	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	255.0	
3	245.140625	222.703125	229.90625	233.296875	197.15625	158.546875	206.6875	212.28125	209.0625	250.34375	255.0	140.140625	76.46875	66.953125	56.296875	42.90625	48.953125	217.046875	252.953125	255.0	255.0	255.0	255.0	255.0	255.0	
4	68.84375	53.734375	71.234375	37.515625	42.21875	89.0625	237.265625	215.921875	178.609375	84.5	28.9375	24.296875	89.609375	99.53125	58.75	72.453125	110.421875	197.484375	43.671875	63.0	40.53125	26.0	40.828125	65.515625	72.7	
5	165.46875	219.5	248.25	255.0	255.0	255.0	231.125	20	102.953125	107.921875	109.390625	42.8125	33.984375	66.5	255.0	220.046875	204.90625	136.25	44.234375	22.734375	62.65625	20.203125	34.46875	40.21875	68.1875	73.234375
6	116.734375	68.125	64.0	65.734375	78.03125	66.828125	57.71875	41.734375	70.046875	170.015625	228.03125	255.0	118.859375	108.125	126.0	126.34375	60.234375	29.328125	64.828125	149.0625	220.6875	254.6875	252.015625	214.25	98.234375	
7	98.234375	123.890625	90.34375	37.828125	99.125	100.015625	247.28125	197.90625	86.3125	53.921875	124.265625	133.446875	93.203125	30.96875	61.8125	64.03125	57.875	78.3125	86.4625	62.8125	119.3125	119.328125	135.984375	154.015625	47.703125	
8	114.015625	125.609375	142.515625	142.078125	134.15625	64.3125	61.859375	69.734375	87.0	134.984375	152.78125															

Fig 5.Result of statistical mean are extracted from each individual block that belongs to the each image in the Fig 2

Finally the trained image feature vector set consisting of average mean value of all the input images obtained in Fig 6 are given as an input to k-means technique and highly relative '3' clusters K_1, K_2, K_3 are obtained as shown in Fig 7 and Fig 8.

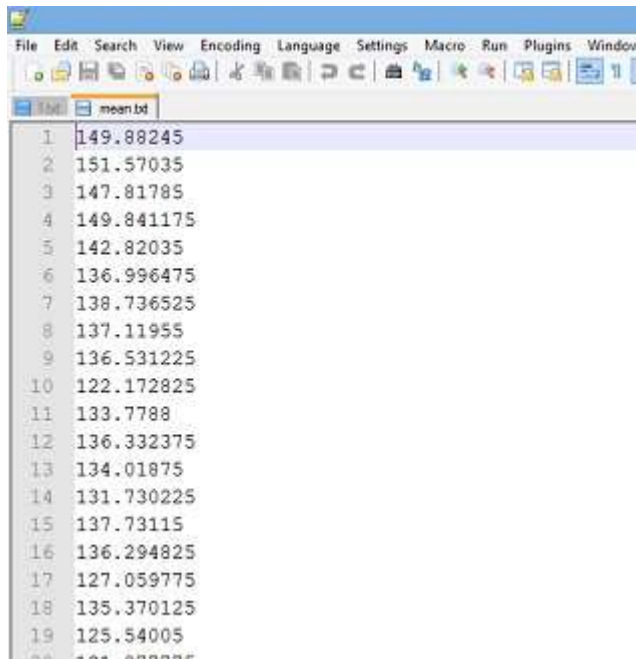


Fig 6.Result of feature selection method that tested over the result of feature extraction in the Fig 2

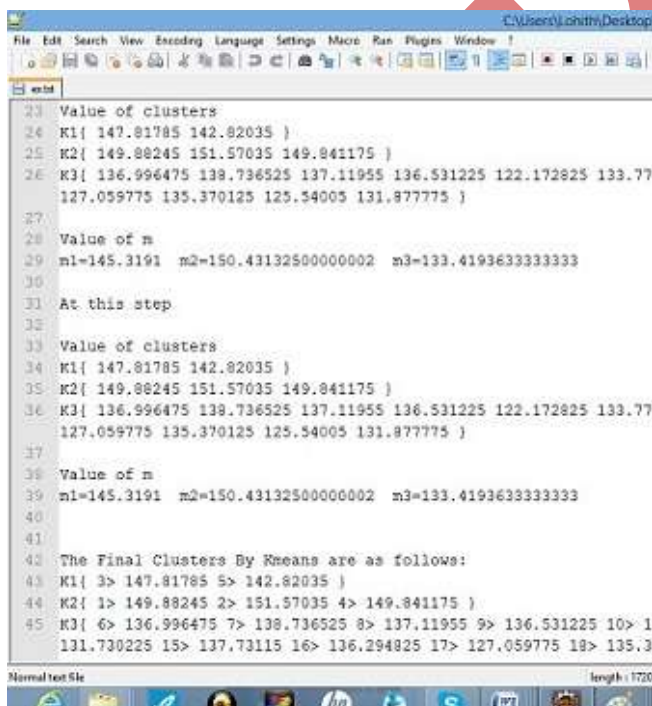
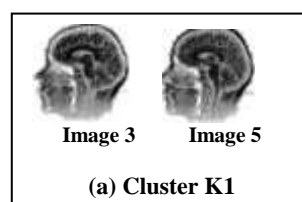


Fig 7.Clusters of Mean Values as a Final Output.



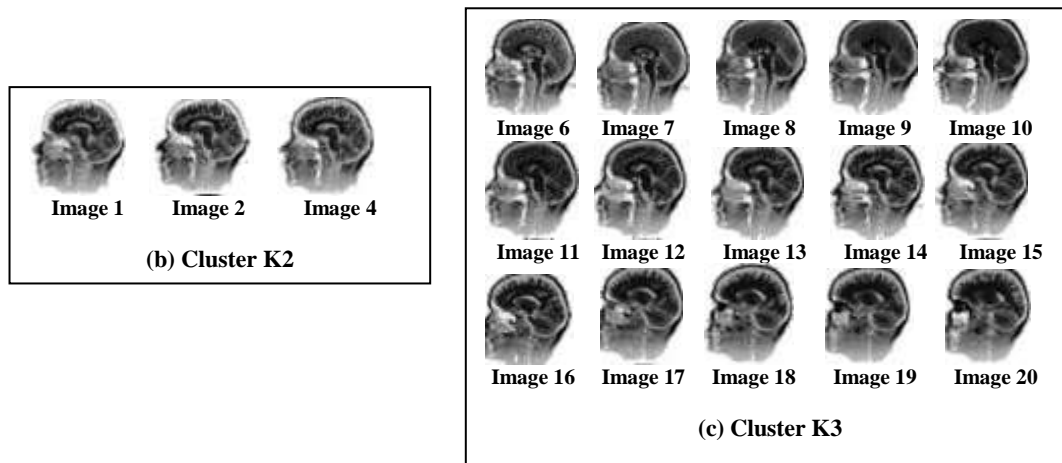


Fig 8.Clusters of images.(a) Cluster k1(b) Cluster k2 (c) Cluster k3.

IV CONCLUSION AND FUTURE WORK

In this paper, we introduced a new approach for image feature vector set classification using unsupervised clustering technique. The proposed approach is aimed to partition the trained image feature vector set into highly relative clusters. The proposed approach consists of two stages viz. (1) Image preprocessing stage (2) Classification stage. The image preprocessing stage aims to train the limited image feature vector set from the set of gray scale images through the feature extraction and feature selection. In the feature extraction stage, applied three spatial statistical operators such that mean, standard deviation and variance over the each individual block in the digital image and extracted three features from each block respectively. In the feature selection stage, the size of the image feature vector set is limited.

In the classification stage, the trained image feature vector set is partitioned into 'm' highly relative clusters through the k-means technique. We tested our proposed system over the 20 sample medical images and partitioned into three highly relative clusters or classes with high accuracy. According to the experiment results, our proposed system is better suitable for partitioned the images into highly relative classes for the image classification. In the future work we will improve our system for classifying the new sample images that belong to which class or cluster in the existing classes.

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