|| Volume 1 ||Issue 1 ||April 2016||ISSN (Online) 2456-0774

INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH AND ENGINEERING TRENDS

A Fuzzy Rule Based Clustering

Sachin Ashok Shinde[1], Asst.Prof.Y.R.Nagargoje[2]

Student, Computer Science & Engineering Department, Everest College of Engineering, Aurangabad, India [1]

Asst.Prof, Computer Science & Engineering Department, Everest College of Engineering, Aurangabad, India[2]

***Abstract*:- This paper presents a detailed study of different clustering based image clustering algorithm. A cluster is collection or group of data objects that are similar to each other with the same cluster object and not similar with other cluster object. Also it is study on different fuzzy rule based clustering algorithm. To overcome the limitations of conventional FCM its need to study Kernel fuzzy c-means (KFCM) algorithm in detail. Basic K-means algorithm is sensitive to noise and outliers so, and changes of K-means called as Fuzzy c- means (FCM) are developed .FCM allows data points to belong to number of cluster where each data point has own degree of membership of belonging to each cluster. The KFCM uses a unique function and gives better performance than FCM in case of noise corrupted images. So it is nothing but grouping of set of physical data objects into the classes of similar or matching objects. The fuzzy rule clustering is the crisp clustering at the boundaries among the cluster are vague and ambiguous. Up to yet the cluster never can be identified by the human directly but which was possible for the machines or system to identify cluster easily as per the requirements of dataset or system. The cluster which is fuzzy in nature is quite difficult to understand. The most drawback of fuzzy and crisp clustering algorithm is there nature of sensitivity to number of potential cluster and their initial position. The image clustering is not easy to understand for human up to yet. This is concept behind of this fuzzy clustering to make it possible to understand for human, And also to make the crisp and boundaries easy for the image cluster. The accuracy of the finding image cluster should be to maintain with respective rate. This will be another attempt to make it possible by using different types of algorithm.**

Keywords:-*Clustering, Fuzzy, Boundaries, Initial, Crisp, Fuzzy Clustering, FCM, KFCM, NMKFCM.*

I INTRODUCTION

Now a day**,** fuzzy rules clustering is going to used widely because they are having the capability of to work with each data for to handle different nonlinear problems and acquired knowledge with these models is more interpretable than the other models.[2] The constructing of rule based fuzzy model is very challenging problem. It is acceptable that the rule base covers every part of the system and at the same time. There are number of attempt have been proposed to construct the fuzzy rule based from numerical data. This technique includes different approaches like Fuzzy algorithm, neuro-fuzzy techniques, clustering are methods etc.[3] Many attempts have been proposed that use clustering techniques for learning fuzzy classification rules from the image types of data, below of this mentioned some of it. Fuzzy clustering, i.e., the synthesis between every clustering and fuzzy set theory, is suitable to solve problems with vague boundaries of clusters [1]. In fuzzy clustering, the requirement that each and every data is assigned to only one cluster is relaxed to lose requirement in which the object can belong to all of available clusters with a certain degree of membership [6]. Moreover, the memberships may help us to discover more soft relations between a given object and the disclosed clusters [7]. It can also provide a basis for the construction of a Fuzzy rule model that is human readable and performs well for nonlinear -Problems. In this clustering there are four types of input data sets are used, that is Medical images, real images, synthetic images and noisy images.[8] For this all image datasets three types of algorithm used to apply on datasets for to form the cluster. The algorithms are FCM, KFCM, and NMKFCM. By using this algorithm image cluster can be form with in multiple number in some iteration within quick time and best CAR Values. [9]

The Yager and filev developed and discovered the simple method based on fuzzy clustering for generation of fuzzy rules.[4] The one developer has added new developed concepts regarding the fuzzy neural network base on Takagi-Surgeons model propose by Han et althea. Another one Zhao et al proposed a two stage approach to extract cluster compact takagi-sugeno fuzzy models using subtractive clustering and particle swarm optimization for numerical data.[11] Another techniques invented by scientist Eftekhari and katebi proposed a hybrid approach for the getting optimal fuzzy model from data for nonlinear and unscented filter.[12] Then another new technique developed about using the FCM to generate fuzzy rules from data to agreement with the object classification problem. Hossen et al proposed a novel changed adaptive fuzzy inference system.[10] There are number of techniques are going to be developed on fuzzy rule based clustering algorithm related with cluster. But it wasn't able to understand and learn to human clearly. [2] It was only machine readable or system understandable cluster was developed. First time these are going to implement such types of algorithm which will be readable for human and improvement on cluster with fuzzy rule based techniques.

II LITERATURE SURVEY

Today different types of technology are growing fast so in this clustering is also one of the important tasks**.** Fuzzy set theory and Fuzzy logic concepts are ideally suited to deal with some kind of uncertainties. Fuzzy sets were introduced in 1265 by scientist LoftiZadeh [1] with a view to result reconcile mathematical concept and human understandable knowledge in the engineering, sciences. Medical images are also included for in this research. The Fuzzy C- means (FCM) [5] algorithm, developed by Bezdek, is the most widely used algorithm in image clustering and segmentation because it has powerful

characteristics for ambiguity and it can regain much more information than clustering methods. FCM has been successfully implement for to feature of analysis, clustering, and classifier rule designs in fields such as e.g. astronomy, geology, medical images, target recognition, and image segmentation. An image can be represented in various features and the FCM algorithm divides the image by grouping similar data points in the attributes space into clusters. In case the image is noisy (impure) or distorted then FCM technique wrongly classifies noisy or impure pixels because of its abnormal feature data which is the major drawback of FCM. Various approaches are proposed by researchers to compensate this drawback of FCM .Even though there is an increasing interest in the use of clustering techniques in pattern matching & recognition technology [Anderbergs 1973]. Image processing [Jain and Flynn 1996] and information retrieval [Rasmussen 1992, Salton 1991], clustering has a long history in other disciplines [Jain and Dubes 1988] such as biology, psychiatry, psychology, recognition, archaeology, geology, geography, and marketing. The K-means method is considered as one of the most popular and quality clustering methods. The goal of cluster is to partition (group) a given dataset such that data points in a same cluster are similar or matching and the data points in different clusters are dissimilar (unmatching). The clustering algorithm which satisfies the requirements is classified as crisp clustering algorithms. On the other hand, algorithms that allow every data point or object to be assigned to more than one or number of cluster are classified as fuzzy clustering methods. Fuzzy c-means method is developed by Dunn (1973) and improved in Bezdek (1981), is a fuzzy clustering method that is analogous to the K-means method. The K-means techniques and fuzzy c-means techniques can be Varied or improved by being applied with different choices of distance measures by Mao and Jain (1996).

III SYSTEM DEVELOPMENT

A. Fuzzy Clustering

The fuzzy clustering is nothing but set of theory and is suitable to handle problems with the vague and boundaries of the clusters. In the fuzzy clustering every object or data is assigned to belong to handle all of the clusters with some degree of membership. The fuzzy clustering is easy to crisp clustering when the boundaries among the cluster are vague and ambiguous. For to maintain the drawback of both fuzzy and crisp clustering algorithms is about the total number of sensitivity of cluster.[2] The fuzzy clustering is synthesis medium between clustering and fuzzy set theory. Our proposed approach attempts to resemble to unsupervised issues of partial supervised clustering. To extract each cluster the FRBC used all the unlabeled data patterns of problems as main data have to convert labeled to that data. The Cluster membership is a matter of degree for the relevant cluster. The part one shows proposed algorithms to represents the data for get cluster.

Figure 1, shown for the representation for to form the clustering in this input is given from different types of image datasets. Datasets can be synthetic image, real image, medical image and noisy image. Then algorithm will apply on image datasets for to form cluster with good accuracy and potential cluster

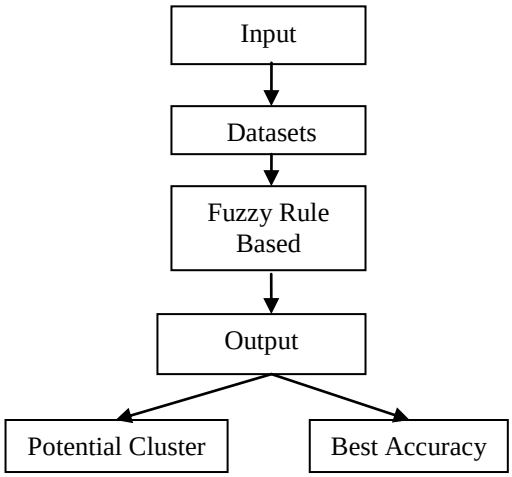


Figure 1 System Development for Fuzzy rule clustering.

B. Fuzzy C-Means Algorithm

Fuzzy c-means (FCM) is a method of clustering which allows every piece or part of data to belong to two or more clusters. This method developed by Dunn in 1973 and improved by the Bezdek in 1981 is frequently used in pattern recognition to study of the cluster. The most well-known fuzzy clustering algorithm is FCM (Fuzzy c-means), which is modified by Bezdek, an improvement of the original crisp or k-means clustering algorithm. Fuzzy c-means allows data points to be assigned into more multiple cluster each data object has an own degree of membership (or probability) of belonging to each cluster. Fuzzy c-means has been a very important tool used for image processing in clustering objects in an image. The conventional clustering algorithms are the partitioning algorithms where each data object belongs to only single cluster. So, the clusters in k-means are said to be disjointed. Fuzzy Clustering (Hoppner, 2005) extends this notion and suggests a soft clustering schema. Here, the pattern is represented by the membership function given to each cluster. The assignment of the pattern to each cluster larger data membership values gives better performance. In a fuzzy clustering when the threshold of this membership values are obtained a hard clustering can be retrieved.

In the below Figure 2 we can see working of FCM algorithm input will be in the form of image which will be selected by using fuzzy logic tool box and used to form cluster. Then for each data point membership grade is assigned. Then iterative update will come under work and it form center and membership grade and after that output will be cluster. The algorithm used to form cluster is as below.

Algorithmic steps for Fuzzy c-means clustering:

It can be obtain through an iterative process, which is carried as follows-

INPUT

Step 1. $X=\{X_1, X_2....X_n\}$, Data set.

Step 2. C, $2 \leq C \leq n$, n is number of cluster.

Step 3. Set value of $\mathcal{E}$, it is stopping criteria parameter.

Step 4. Initialize membership function using data set and cluster.

Step 5. Calculate initial cluster center $W_0 = (w_{01}, w_{02} \ldots w_{0c})$

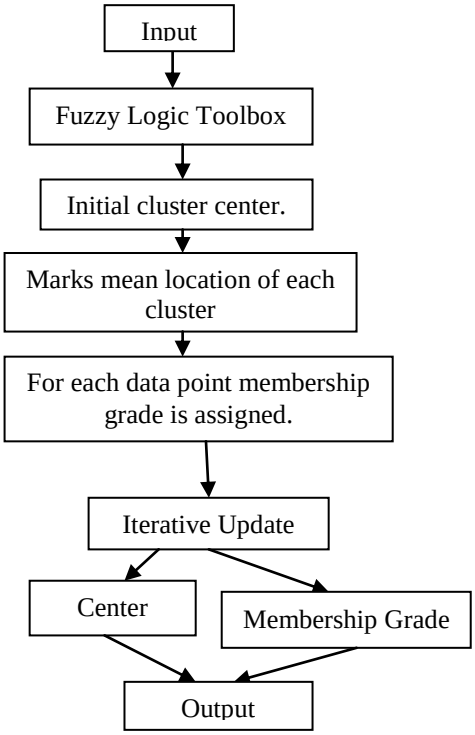


Figure 2 working of FCM Algorithm.

Minimize Objective Function:

$$Jm(U,W) = \sum_{j=1}^{c}\sum_{i=1}^{N} U^{m}_{i,j} d^{2}_{i,j} \ldots\ldots\ldots\ldots 1$$

Where N: The number of patterns in *X*.

C: The number of clusters.

U_{ij}: The degree of membership x_i of in the j^{th} cluster.

W_j: The prototype of the center of cluster *j*.

d_{ij}: Distance measure between object X_i and cluster center W_j.

m: The weighting exponent on each fuzzy membership.

C. Kernel fuzzy C-means clustering (KFCM)

The FCM is the soft extension of the traditional hard c-means clustering. Each cluster was considered as fuzzy set and the membership function measures the possibility that each training vector related with cluster. so, the vectors may assigned to multiple clusters. Thus, it overcomes some drawbacks of hard clustering but it is effective only when the data is non-overlapping. So, we use the Kernel-based fuzzy C-means algorithm (KFCM).KFCM can improve accuracy compared with FCM algorithms. Data points are measured into a high dimensional space in which they are more clearly separable. In FCM if the image is noisy or distorted then it wrongly classifies noisy pixels. The basic idea of KFCM is to first map the input data into a feature space with higher dimension via a nonlinear transform.

The Figure 3 shows the flow of Kernel fuzzy c means clustering (KFCM).in this input will be given in the form of image and then it assume the initial cluster. After that the cluster uses kernel function to make separating with each other.

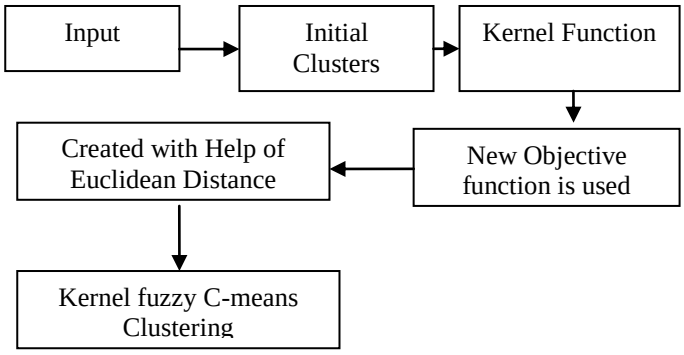


Figure 3 Working of KFCM Algorithm.

Then new objective function is used with the help of Euclidean distance and after that cluster will form. KFCM, the data and the cluster centres are mapped from the original space to a new space by Φ so, the objective function is given as Follows:

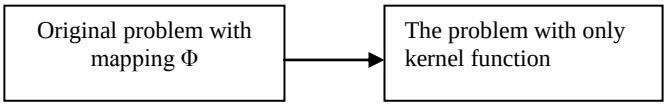
$$\mathbf{Q = \sum_{i=1}^{c}\sum_{j=1}^{n} u_{ij}^{m} |ø\,(X_j) - ø\,(o_j)^2|}$$

And $\mathbf{| ø\,(Xj) - ø\,(O\,i)^2| = Ø\,(Xj).\,Ø\,(Xj) + Ø\,(Oi).\,Ø\,(oi)}$

$= K(X_j, Xj) + K(X_i, Xi) - 2k(X_j, Oi)$

We reformulate the objective function as,

$$Q = \sum_{i=1}^{c}\sum_{j=1}^{n} u_{ij}^{m} (K(Xj, Xj) + K(Xi, Xi) - 2K(Xj, Oi))$$



Cannot be solved "Kernel trick" solve this problem

Figure 4 Kernel Fuzzy c-means with mapping.

The Kernel fuzzy C-means (KFCM) Algorithm is as follows:

Step 1.Fix c, tmax, m>1 and ϵ>0 for some positive constant.
Step 2. Initialize the memberships U^0_{ij} , C, m.
Step 3. For t=1, 2,…….., tmax do.

D. Novel on Multiple Kernel Fuzzy C-means clustering (NMKFCM).

The FCM is work well on noise free image and KFCM having good performance on noisy image using Kernel.Still KFCM having drawback that is it is very sensitive to noise and does not consider any information about neighborhood term. Propose NMKFCM algorithm which incorporates local information into its objective function and the effect of neighbor pixel information. NMKFCM improved the clustering accuracy of an image. NMKFCM method is more efficient and better image segmentation than the FCM algorithm and KFCM algorithm.

Algorithm:

Let X = {x1, x2, x3 ..., xn} be the set of data points and V = {v1, v2, v3 ..., vc} be the set of centres.
Step 1. Randomly select 'c'cluster centres.
Step 2. Calculate the fuzzy membership 'μij'
Step 3. Compute the fuzzy centers 'vj'
Step 4. Repeat step 2) and 3) until the minimum 'J' value is achieved or ||U (k+1) - U (k) || < ε.
Where's the iteration step.'ε. 'Is the termination criterion between [0, 1].

The iteration steps lies in between values of 0 and 1 and count total number of iteration for to display results. On that mathematical Euclidean distance formula is apply for to form cluster and below Figure 5 shows the working of NMKFCM algorithm for to form cluster. In NMKFCM algorithm images datasets will provide inputs then that image will find and grouped that into center. After that sorting technique will apply for append images to increment after that Euclidean distance will apply with NMKFCM Algorithm then cluster will formed.

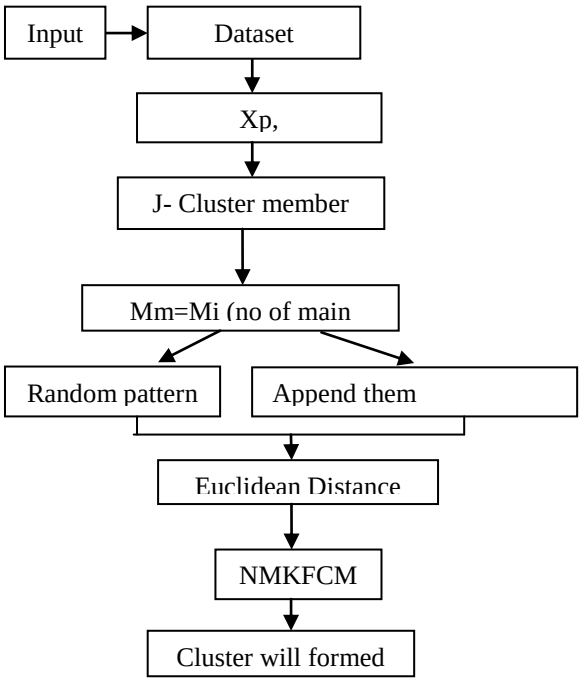
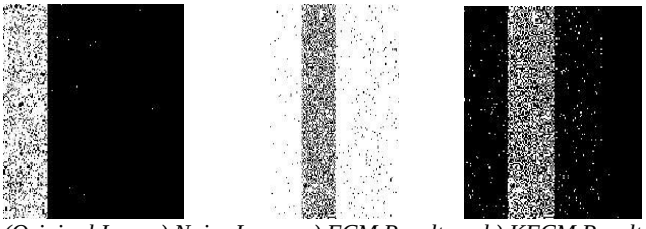


Figure 5 Working for NMKFCM algorithm.

IV EXPERIMENTAL RESULTS

The original image is taken which is the image of a synthetic image. It is corrupted with salt and pepper noise and the results of datasets are used e.g. medical images, real image, and synthetic image and used. The clustering results of the different clustering algorithms are shown in below Figure 6.FCM, KFCM and NMKFCM are compared by taking two images Synthetic test image and medical image by applying these algorithm total number of six Clustering results are shown in Figure with high accuracy rate (CAR values).

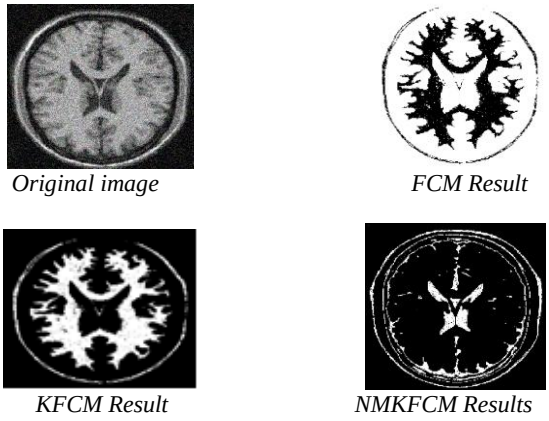


(Original Image) Noisy Image a) FCM Results b) KFCM Results

c) KFCM Result d) NMKFCM Results e) NMKFCM results

Figure 6 Clustering Results with Algorithm

In this way, there are different types of algorithm can be used to Form clustering with high accuracy rate. The average accuracy Rate (CAR Values) can be obtained 80.65% for this entire algorithm.



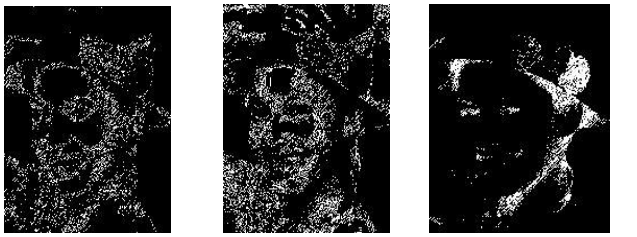
Original image *FCM Result*

KFCM Result *NMKFCM Results*

Figure7 The above Figure shows results of Different algorithm on medical image.

Let's see another e.g. of real image which shows cluster output results by implementing all FCM, KFCM and NMKFCM algorithm. This also shows CAR values for results of real image.

Original Image (Real) *FCM Result* *FCM Result*



KFCM Result *KFCM Result* *NMKFCM Result*

Figure 7 Clustering Results for Real Image.

The above Figure shows different clustering results for real image. With accuracy rate (CAR) of 82.34. So it's beneficial for all types of fuzzy algorithm for to get image cluster.

So the conclusion from this entire FCM algorithm provides good and fast results for all image but sensitive for noisy image. Then KFCM used kernel tricks to solve problem is having good performance over sensitive image. Last algorithm NMKFCM is used for to get improvement on excellent performance and results on image clustering. it is good for neighborhood clustering and can be used for image segmentation.

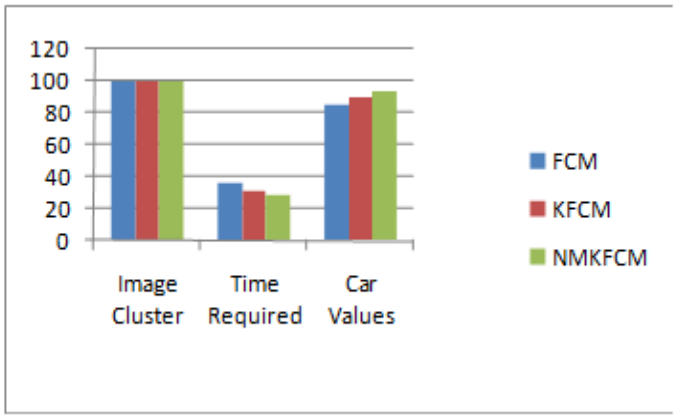
Performance Table for Algorithm-

TABLE I PERFORMANCE OF ALGORITHM

Parameter	**FCM**	**KFCM**	**NMKFCM**
Image	100 cluster form	100 cluster form	100 cluster form
Time required	35.64 sec.	31.41 sec	29.23sec
CAR values	85.43	89.67	93.87
Performance	Good (sensitive for noisy images)	Good	Better (Cluster Accuracy)

The above table shows results from all used algorithm with image cluster. This table represents results with different types of parameter used in this Paper.

In the above shown graph, all mentioned algorithms are representing its CAR Value with cluster. The FCM looks sensitive for noisy image but fast as compare with KFCM and NMKFCM. The KFCM algorithm looks good for noisy NMKFCM is having higher image With good performance. Then last algorithm Performance on different type of image. These results defiantly will make Impact on clustering technology as well as image identification process. Image Clustering will be helpful for medical diseases identification and scientifically Research.



Graph 1 Performance of algorithm with CAR values

V CONCLUSION

FCM provides fast results but sensitive for noisy image. KFCM provides better results for image regarding CAR Values and Average speed for to form cluster. NMKFCM Provides Best Results with high speed on noisy image with good CAR values.

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