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Segmentation of Region of Interest in Ultrasound Images Using Fuzzy Logic Clustering Method

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Abstract

Ultrasound image analysis is desirable for diagnosis of presence stone, cyst and other abnormalities, whereas the presence of speckle noise in ultrasound images may degrade visual quality and also hinder the diagnosis procedure. The present study is aimed to detect stone region in the image. It is important to suppression speckle noise to enhance the visual quality. Moreover, noise suppression is prerequisite condition for object segmentation in ultrasound images. To find the region of interest, it is important to segment the object from the background. The fuzzy logic clustering method has been used to represent region of interest and background. It is flexible clustering method which allows the elements in different clusters to be members of different groups simultaneously. It helps to justify the members of group which lie on the edge of two groups. As stone region has the similar feature characteristic as of non-stone region due to presence of speck noise everywhere. Such case fuzzy clustering method has shown better results.

Keywords:*Kidney stone detection, segmentation, region of interest detection, fuzzy logic method*

1. INTRODUCTION:

The problem of kidney stone is a major health concern and need immediate attention. The early detection is considered as one of the best solution of the problem. The ultrasound procedure is most popular option to detect stone and locate the position. Various efforts have been made in past to automate the detection system and present research work is also an attempt to provide such system. The main objective of the present study is to develop an application to find the presence of the kidney stone in the ultrasound images. The segmentation has its important role in finding region of interest.

The segmentation technique divides the image region into differ regions in order to separate region of interest. The meaningful region may be a complete object or a part of the object for which segmentation process is carried out [9]. Ultrasound image segmentation is a complicated task as the speckle noise gets intermixed with fine detail and makes it difficult to detect edges. It degrades information which helps to distinguish border and area between regions [2]. There exists no generalized segmentation technique, which suits all type of segmentation problems. The segmentation algorithms are derived using some suitable heuristic knowledge of the features of the image [3].

According to present research work, the research design is based on the determination region of interest in the US images. The main objective of the present study is to detect region of interest i.e. area having stone in ultrasound image. As, presence of speckle noise in ultrasound images are inherited in nature which degrades the visual quality. It is not possible to perform any areas segmentation and detection method on such noised images. The study considered, denoising as the pre-processing phase which deals with denoise the ultrasound images. The goal of any denoising technique is to preserve as possible significant characteristics like contrast, brightness, edges and background while suppressing the noise in the images. The selection of an appropriate method plays a major role in getting the desired images. The denoising techniques are problems specific in

nature. In the first phase, the denoising algorithm is developed to meet the present requirements. In the second phase, the ultrasound image is segmented into various parts, which are further proceeding for testing for presence of stone. The segmentation of image for detection of region of interest is based on observation [5]. The expected region of interests are segmented from the ultrasound images manually. The image is divided into various segments where each segment is processed for recognition. The recognition of stone area is done into two phases: features extraction and classification[4].

2. REGION OF INTEREST IN KIDNEY STONE IMAGES:

Clustering is a technique which is a classification of objects in different groups based on some common characteristics[8][11]. A cluster refers a group which contains elements within group having similar characteristics. Clustering defines the ways organizing objects into differs group[1]s. There is need to find the criteria which can divide the various elements into well-established groups.

The clustering technique can be of two types i.e. hierarchical and partition. The hierarchical algorithms look for successive clusters by using information of previously defined clusters in different phases[7][12]. The partition clustering divides clusters in single phase.

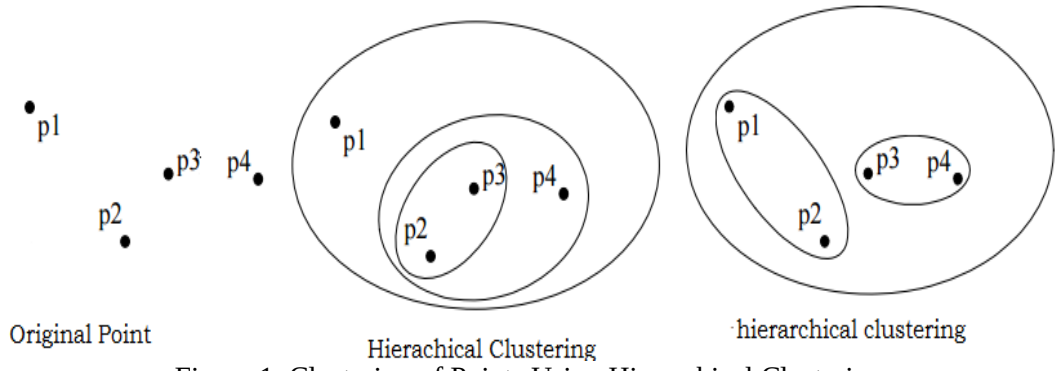


Figure 1: Clustering of Points Using Hierarchical Clustering

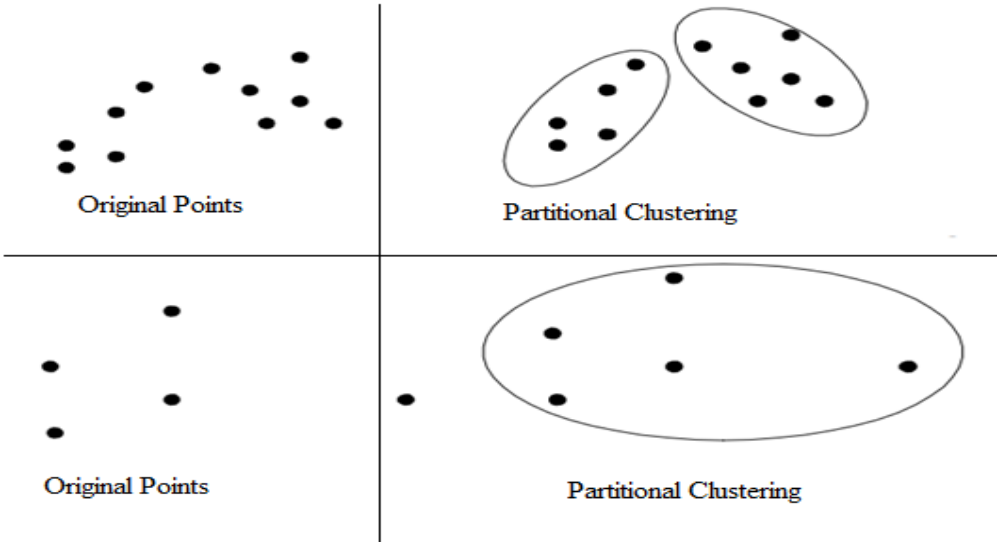


Figure 2: Clustering of Points using PartitionalClustering

K-Mean Clustering: K-Mean Clustering is based on partitional clustering approach. The algorithm assigns each point to the cluster whose center is nearest to centroid. The centroid is computed from the average of all the points in the cluster [6][9].

Algorithm of K-Mean Clustering

1. Initialize value of K which represents object points in space that are being clustered
K points into the space represented by the objects that are being clustered. Select value of K point as starting centroids.
2. Repeat
3. Assign points around centroid of the cluster with reference to K
4. Compute centroid for each cluster
5. Continue above steps till thecentroidsdon't change.

Fuzzy Clustering Methods:

It is flexible clustering method which allows the elements in different clusters to be members of different groups simultaneously. It helps to justify the members of group which lie on the edge of two groups. The fuzzy algorithm doesn't fore such elements to be member of one group[10[13]. The elements on edge assigned degree of membership i.e. 0 or 1.The FCM algorithm consist of the following steps:

Algorithm

1. Assume points be clustered is N with M-dimensional. That can be represented by following equation
X_i (i = 1, 2. . . N)
2. Consider C represents number of clusters to be made and it must satisfied the following equality,
$2 \leq C \leq N$
3. Consider value of cluster Fuzziness such that f > 1.
4. Let us suppose there is matrix U with the N × C ×M, where the sized membership matrixis U, at random, such that U_{ijm}€[0,1].
5. Fine out the centre of the cluster at j^{th} cluster and its m^{th} dimension as

$$Centre = \frac{\sum_{i=1}^{N} U_{ijm}^{f} x_{im}}{\sum_{i=1}^{N} \sum_{i}^{f} jm}$$

6. Compute the Euclidean distance for i^{th} data point and j^{th}cluster center by considering m^{th} dimension like the following:

$$Distance = [\![x_{im} - Centre]\!]$$

7. Now make changes in U as fuzzy membership matrix as per change in according to Distance at i,j and m.
If $Distance_{ij}$> 0, then

$$U_{ijm} = \frac{1}{\sum_{c=1}^{C} \frac{Distance_{ijm}}{Distance_{icm}}^{\frac{2}{f-1}}}$$

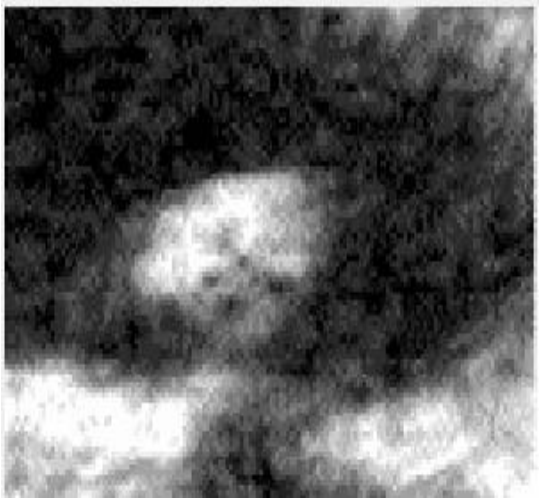
8. If $Distance_{jm}$= 0, which implies that data point is coincided with the corresponding data point of j^{th} cluster at center $Distance_{jm}$ and it should have Uijm = 1.0. i.e. full membership
9. Iterate from Step 5 to Step 7 until there is change in fuzzy membership matrix and satisfied U≤€, where € is a pre-specified termination criterion.

3. ANALYSIS AND RESULT:

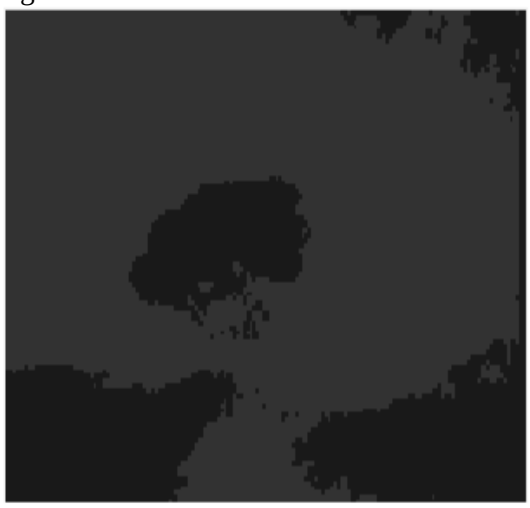
It has been observed that in literature different measures are being used to evaluate algorithm performance for the classification.As per the study, the performance of the recognition system is measured using following parameters:

- Accuracy (AC)
- Matthews correlation coefficient (MCC)
- Sensitivity and Specificity

The classification results are evaluated using the above statistical parameters. The accuracy is computed based on the results obtained from confusion matrix. Matthews correlation coefficient (MCC) is used in quality measurement tool which values lines between (-1 to 1). Sensitivity tells about ability of a classifier's that correctly identifies stone region images. The specificity defines ability to correctly identify the region of interest [14].The following are the various results of segmentation:

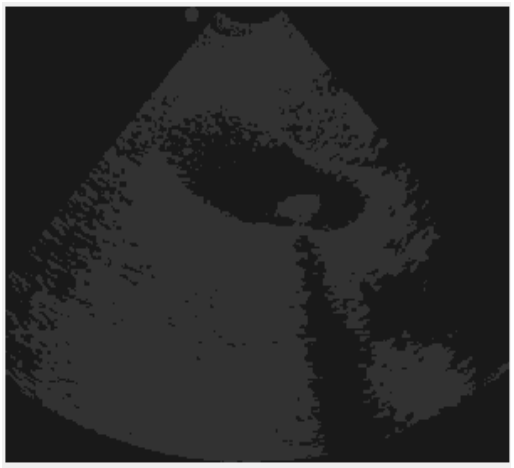


a) BeforeprocessingImage

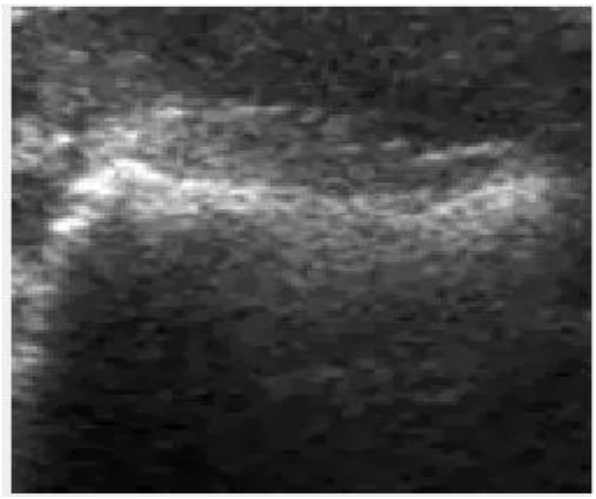


b) After Fuzzy Clustering

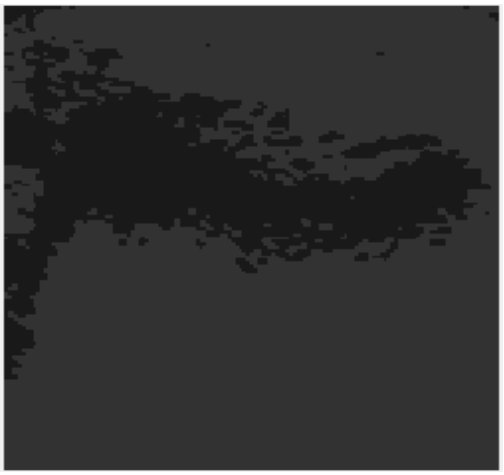
c) Beforeprocessing Image



d) After Fuzzy Clustering



e) Beforeprocessing Image



f) After Fuzzy Clustering

Figure3 shows various results of segmentation procedure. On left side of the figures original input images have been shown and results of fuzzy clustering are shown on the left side. The fuzzy clustering method find the regions where majority of pixels on sharing based are in majority and have similar gray scale value with reference to centroids of the region

4. CONCLUSION:

There are various methods and approaches available in literature for segmentation of region of interest but most the methods found specific to the problem under taken. It means that it is method is heavily depend features with reference to neighbouring regions in the image.To meet the current requirements for detection of kidney stone region in the images, the present research come up with fuzzy logic and hybrid binarisation method. It is based on the theme that region around pixel along with neighbouring pixel has strong relationship with each other and we do considered pixel lies within both region near border but do not strongly lies in the any of the region. The fuzzy logic segmentation has shown better result in recognition of stone in the images.

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