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# Comparison of Diffrent Thresholding Techniques for Image Segmentation

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**Abstract**— *Image segmentation is a prominent area of the research field. Several research works has been performed under this field but still there is a requirement of more improvements in the techniques used for this. Image segmentation is process which is implemented on an image in order to highlight those areas of the image which can be proved more meaningful and informative. Segmentation is the process of sectioning the digital image into number of regions which are called as pixels. Many algorithms have been developed which can be used for the purpose of image segmentation[4]. Some of the techniques are clustering based segmentation methods, compression based segmentation method, splits and merge technique, threshold based segmentation method, Histogram based segmentation etc. this paper focuses on the Thresholding based image segmentation techniques. There is a brief introduction to the various segmentation techniques and along with their procedures. This work can be beneficial for choosing the suitable segmentation technique according to the need of the environment.*

**Keywords— image segmentation, entropy, Thresholding**

## I. INTRODUCTION

Segmentation is the process of sectioning the digital image into number of regions which are called as pixels. The image obtain by the segmentation is more informative, clear and expressive that will easily depicts the information present in the pixel. The lines, boundaries, curves etc that are present in the image are detected by the image segmentation process. As the output of the image segmentation is the region that is segmented or is the set of the contour that are also taken from the image the pixels that are presented in the image are related to each other on the behalf of some properties[15]. The properties can be color, intensity or texture. Image segmentation plays important role in the medical imaging, Following is the list of other applications of image segmentation:

- Detect objects in satellite images like mountains, tracks, trees, etc.
- Face recognition
- Fingerprints recognition
- Automatic traffic controlling systems
- Machine vision

Only digital image is used for computation and processing. If there is analog image, it first gets converted into digital form so that it can be used for further computer purposes. Digital image is composed of discrete pixels of different brightness and color. Each pixel has its own numerical value. Moreover it has its own data number value which quantifies the radiance of the image at the particular spot. It basically represents the value between black and white which are typically the shades of gray.

## II. TECHNIQUES

Segmentation is a process which divides the image into small multiple parts of tiny sized and generally known as pixels.. The use of segmentation is to simplify the image and change the illustration which is more significant and easy to figure out. Image segmentation is a tool used to find out objects and boundaries. The outcome of image segmentation is a collection of regions which conjointly cover the thorough image, or a set of contours extracted from the image. Pixels in a region are similar in terms of characteristics or computed properties like color, intensity or texture features. Many algorithms have been developed which can be used for the purpose of image segmentation. These techniques are based on domain specific knowledge in order to solve the domain segmentation issues. The techniques are categorized as follows:

- Clustering Based Method
- Compression Based Method
- Histogram Based
- Split And Merge Technique
- Thresholding
    - Global Thresholding
    - Local Thresholding
    - Adaptive Thresholding
    - Shannon Entropy based Thresholding
    - Non-Shannon Entropy based Thresholding

### *A.* CLUSTERING BASED METHOD

This technique follows the idea of clustering. It divides the image into number of small k-clusters. The steps of this algorithm or technique are as follows:

1. Selection of k-cluster center either randomly or via some heuristic method.

2. In order to reduce the distance between pixels each pixel is allotted to the clusters or cluster centers.
3. After allocation of clusters, on the basis of average value cluster center is re-selected again.
4. Above 2 steps will repeat until the convergence is achieved.

In this method the distance refers to the difference between cluster centers and pixels. The difference is calculated on the basis of pixel intensity, color value of the pixel. The output or accuracy of the output relies on the value of k and set of clusters.

### *B.* COMPRESSION BASED METHOD

As the name suggest this technique is based on data compression. This is referred as the optimal technique for image segmentation. The reason behind its optimal nature is that it reduces the all the available segmentation and length of coded data. The logic behind this technique is that the segmentation is done by locating some matching patterns in the image and any regular data is used for compression. In this technique the segmentation is recognized by its consistency and outline that it follows. For available image segmentation, this technique bears that the large number of bits are needed to encode that the image is segmentation based. Then from various segmentation of the image the best segmentation is selected on the basis of reduced coding length.

### *C.* HISTOGRAM BASED

This method is most preferable as compare to other. The difference between this and other techniques is that in other technique at least one pass is required throughout the pixels of the image but in this technique a histogram is used for computation corresponding to all pixels. The peak and valley of histogram helps to locate the clusters in the image. An enhanced version of this technique is implemented on the clusters of the image for categorized them into various small clusters.

### *D.* SPLIT AND MERGE TECHNIQUE

The basic idea behind this technique is quad tree division of the image. Therefore another name is quad tree segmentation. The working of this technique is as follows: The process starts from the root here rot refers to the whole image. If the root is heterogeneous then it further divides it into four son-squares and so on. If the divided son-squares are homogeneous then they are merged as various linked sources. The nodes of the tree are segmented nodes. This procedure continues until no separation or merges are required.

### *E.* THRESHOLDING

It is the simplest method for image segmentation. The working of this technique is based on a threshold value defined by user. This technique is used to change an image from gray scale to binary image[13]. In this technique a threshold value is used which is pre-defined. The methods which are based on this technique are entropy methods, k-mean clustering technique etc.

**a.** Global Thresholding
**b.** Local Thresholding
**c.** Adaptive Thresholding
**d.** Entropy Based Thresholding

#### **a)** GLOBAL THRESHOLDING

Global Thresholding is also called single Thresholding. In case when there is a large difference between the intensity of foreground and background of the image then in such cases single threshold value is used to distinguish between foreground and background of the imag[13]e. Hence in this algorithm the value of threshold T depends upon the properties of the pixels and grey level value of the image. Example of Global threshold technique is Otsu method, entropy based Thresholding, etc. The steps included in the algorithm of global Thresholding are as follows:

1. First step is to select the value of threshold which is denoted by T.
2. Image segmentation is performed by using the following equation. The output of the equation will number of pixel which will be partitioned into two groups respectively $G_1$ and$G_2$. The first group will have all the pixels whose corresponding intensity values will be consisting > T, and $G_2$consists all the pixel value which has low intensity values as compare to the value of threshold T.

$$g(x,y) = f(x) = \begin{cases} 1. if\ f(x,y) > T \\ 0, if\ f(x,y) \le T \end{cases}$$

3. Next step is to compute the mean intensity of value of $G_1$ and $G_2$ which will be denoted as $m_1$and $m_2$ respectively.
4. In this step the threshold value is updated by using the equation: $T = \frac{1}{2}(m_1 + m_2)$
5. Step 2 and 3 will be repeated until the mean value do not vary successively.

This algorithm is suitable in case where there is a huge or big difference between nodes of histogram which relates to object and background.

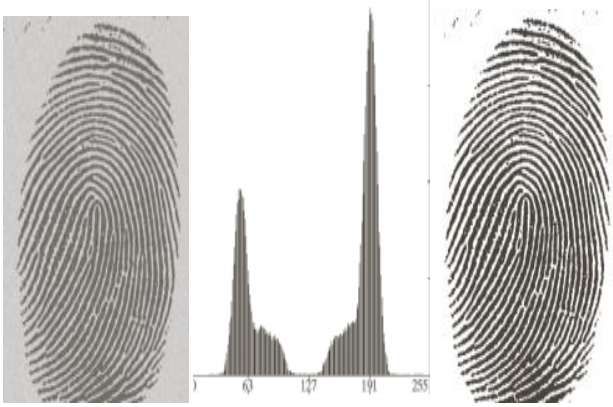


Figure 1 Example of Global Thresholding

**b)** LOCAL THRESHOLDING

Unlike single Thresholding technique, Local Thresholding firstly divides the whole image into segments and then select threshold values T corresponding to each segment individually. Hence in this technique threshold value T is selected on the basis of both f (x, y) and P (x, y). Example of local Thresholding technique is simple statistical Thresholding, 2-D entropy-based and histogram transformation Thresholding etc. In local Thresholding threshold value is calculated on the basis of local properties of the image as shown in following example:

$$T_{xy} = a\sigma_{xy} + bm_{xy} \qquad (1)$$

$$T_{xy} = a\sigma_{xy} + bm_G \qquad (2).$$

In order to perform image segmentation the following equation is used and this predicate value is denoted by $Q_{xy}$:

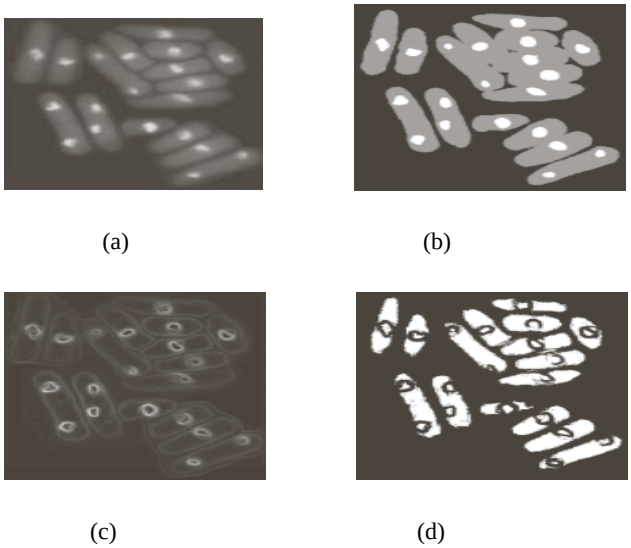
$$g(x,y) = \begin{cases} 1, if\ Q_{xy} \\ 0, otherwise \end{cases} \qquad (3)$$

Here $Q_{xy}$ defines the instance for:

$$f(x,y) > T_{xy} \qquad (4)$$

$$f(x,y) > a\sigma_{xy}\ AND\ f(x,y) > bm_{xy} \qquad (5)$$

This technique is a comprehensive method for multiple thresholds segmentation.



(a) (b)

(c) (d)

Figure 2 Example of local Thresholding (a) Original image (b) segmentation of original image with double threshold (c) local standard deviation (d) segmentation with local Thresholding

**c)** ADAPTIVE THRESHOLDING

Adaptive Thresholding is a technique which processes the color image or grayscale image and converts it into binary image as the result of image segmentation. The threshold calculation in this is different from others since it calculates the threshold value corresponding to each and every pixel of the image. If the value of the pixel is lesser than the threshold value then it is treated as background value but if the value of the pixel is greater than the value of the threshold then it is treated as foreground value. In this technique following approaches are used for calculating the value of the threshold:

- Chow and kaneko
- Local Thresholding

The basic criteria for both of the approaches is that the regions of the image which covers the smaller area are likely to be more even elucidation, hence it makes it more suitable for Thresholding.

**d)** ENTROPY BASED THRESHOLDING

Entropy is a term which is used to measure the variations or arbitrariness in an image. If the variations are small or few then it is termed as minimum entropy and if the variations are large then it is termed as maximum entropy[14]. There are many entropy measurement techniques such as Shannon, Tsallis and Renyi etc**.**

- **SHANNON ENTROPY**

There are various theories of entropy among which Shannon is considered the classic method which is considered to be the basis for other entropy based methods. Basic Shannon entropy has been used which is given as[27],

$$SE = -\sum_{i=0}^{n} p_i log_2 p_i \qquad (6)$$

Multi levels were obtained on the basis of the three values computed from the three entropy based methods.

- **NON-SHANNON ENTROPY**

Non-Shannon entropy is more preferable technique as compare to Shannon entropy. The advantage of non Shannon entropy is that it has many parameters as compare to other techniques. The list of parameters varies as shown below:

**e)** Renyi Entropy: It is defined as[23]

$$R = \frac{1}{1-\alpha} log_2 \left( \sum_{i=0}^{N_g - 1} H_i^{\alpha} \right) \qquad (7)$$

$$\alpha \neq \alpha > 0$$

**f)** Havrda and Charvat defined as

$$HC = \frac{1}{1-\alpha} log_2 \left( \sum_{i=0}^{N_g-1} H_i^{\alpha} - 1 \right) \qquad (8)$$

$$\alpha \neq \alpha > 0$$

**g)** Kapur entropy defined as

$$K_{\alpha,\beta} = \frac{1}{\beta-\alpha} log_2 \frac{\sum_{i=0}^{N_g-1} H_i^{\alpha}}{\sum_{i=0}^{N_g-1} H_i^{\beta}} \qquad (9)$$

$$\alpha \neq \beta, \alpha > 0, \beta > 0$$

### *F.* EVALUATION PARAMETERS*:*

The evaluation is necessary to take decision for selecting appropriate Thresholding technique. Some of the parameters are given as:

a. Random index
b. Global consistency error
c. Mean square error
d. Peak signal to noise ratio
e. Variation of information

**a. RAND INDEX:** Rand index counts the fraction of pixels who's labeling are consistent between the computed segmentation. It is measure of similarity between two data clusters[16]. Given a set of n elements and two partitions of S to compare, following are defined as (a) the number of pair of elements in S that are in same class in same clusters. (b) the number of pair of elements that are in different class in different clusters. (c) the number of pair of objects that are in same class and in different clusters. (d) the number of pair of objects that are in different class in same clusters.

$$\text{Rand index} = \frac{a+b}{a+b+c+d}$$

**b. GLOBAL CONSISTENCY ERROR:** In global consistency (GCE) error segments which are related are considered as consistent, since they could represent the same image segmented at different pixels[16]. If segment is proper subset of other then pixels lies in the area of refinement then error should be zero. If there is no subset relationship then two regions overlaps in an inconsistent manner.

$$\text{GCE} = \frac{1}{n}\min\{\sum_i (S_1 S_2 P_i) \sum_i E(S_2 S_1 P_i)\}$$

Where, segmentation error measure take $S_1$ and $S_2$ as input and produces a real valued output in range [0:: 1] where zero signifies no error. For a given $p_i$ consider the segments in $S_1$ and $S_2$ that contain that pixel.

**c. VARIATION OF INFORMATION**: Variation of information (VOI) is a distance metric derived from the mutual information. It is information or entropy which is not shared between two random variables[16]. It measures amount of randomness in one segmentation which cannot be explained by the other. Suppose we have two clusterings (a divison of a set into several subsets) X and Y where is:

$$X = \{ X_1, X_2, X_3, \ldots\ldots\ldots X_k \}$$

Then variation of information between two clustering is:

$$VI(X:Y) = H(X)+H(Y)-2I(X,Y)$$

I(X,Y) is mutual information between X and Y The mutual. Where H(X) and H(Y) are entropies of X and Y. Information of two clustering is the loss of uncertainty of one clustering if the other is given. Thus, mutual information is positive and bounded by:

$$\{ H(X), H(Y) \} = \text{Log}_2(n)$$

**d. MEAN SQUARE ERROR:** Mean square error (MSE) indicates the average difference of the pixels throughout the image[34]. A higher MSE indicates a greater difference between the original and processed image. Nevertheless, it is necessary to be very careful with the edges. The equation gives formula for calculating the MSE.

$$\text{MSE} = \frac{1}{N} \sum_i \sum_j \left[ E_{ij} - O_{ij} \right]^2$$

Where N is the size of the image, E is the edge image, and O is the original image.

**e. PSNR:** The PSNR computes the peak signal to noise ratio between two images in decibels[34]. It is used as quality measurement between original and resultant image. The higher the PSNR the better is the quality of image. The compute the PSNR mean square error calculated is used. The PSNR can be calculated as:

$$\text{PSNR} = 20 \text{ Log}_{10}[\frac{(255)^2}{\text{MSE}}]$$

## III. RELATED WORK

I. **Fari Mohammad Abubakar[1]** image segmentation is a process which is used for making an image more informative and qualitative. It is used to distinguish between foreground and background of an image. In this paper the main focus is on the concept of using the image segmentation along with thresholding methods in order to remove noise from an image. The simulation is performing under the software MATLAB 7.12. The paper also highlights the performance of the proposed work.

II. **Sheema Shuja khattak[2],** the work shows the importance of image segmentation in medical field. Hence most appropriate methods should be used for image segmentation hence best decisions can be taken in future. In this paper the segmentation is performed by using thresholding techniques to calculate the maximum entropy such Shannon, Renyi,

Tsallis. This research work is based on the concept of detecting disease form the body such as lesions etc.

III. **Varshika Pandey[3**], The main aim of this work is to represent and improve the use of image segmentation in the field of medical science in order to diagnose the tumor in the MRI images of a patient. MRI is a process which diagnose the human brain and detect the tumor from the scanned image. Hence the techniques used for image segmentation should be quite efficient because the decision related to the disease depends upon the analysis of the scanned image. The proposed work is based upon the Shannon, Renyi, Harvard, Charvat, kapur and vajda entropy methods.

IV. **Piska irenda vasthi[4],**In this work the author studies the concept of object segmentation along with the process of image analysis. The procedure of object analysis is widely used in the field of fruit image analysis. There are many techniques which are used for the purpose of object segmentation but the mostly suitable and reliable technique is OHTA. In this an enhanced OHTA technique is proposed to solve the problems of traditional OHTA. The threshold value is used for more efficiency. It is set to be 50. The threshold value is used to resolve the problem of over segmentation and under segmentation. The results are analyzed and it is observed that the proposed system has more accuracy for various kinds of images such as apple, banana and tomato.

V. **Yim and Foran.[5]** proposed the segmentation of CT images with watershed and active contour method and proposed standard value of parameters which give better segmentation results. It compares both methods. The watershed technique was not so effective because it gives the segmentation error on the maximum number of slices and no improvement in the reproducibility was seen although the contouring was done manually. The size of the tumor is the basic measure of the seriousness of deadly disease cancer and the watershed algorithm as well as active contour methods is initialized by tracing it manually. The outcomes of these algorithms are taken by comparing manual tracing results and their reproducibility terms.

VI. **Lijun Yin et al. [6]**gave another method for detecting the region of interest (abnormal area) which is considered as important part for the surgeries. The exact width and area of the tumor part can help the surgeons to assess the tumor before and after the treatment. Various methods have been proposed for the exact segmentation of the image but due to some drawbacks they are not considered as best. Some of them did not tackle noise. So in this paper mesh based active contour method is discussed which helps in finding the exact location and area of the object in the starting stage. Firstly, the mesh distributes itself over the whole region of the image and it tells the region of interest. Secondly, the final region of interest is selected from all the possible options. Thirdly, meh energy is used to control the active contour to extract the appropriate contour of the region of interest.

VII. **Nilanjan Ray et al [7]** In this author introduces an technique for tracking rolling leukocytes observed in video microscopy. Traditional active contour models monitor the direction of leukocyte movement. Whereas the technique GVF is not workable or suitable in case when the leukocytes movements are fast or speedily performed. But the technique MGVF is suitable for tracking both leukocytes with slow and fast motions. MGVF is well dynamic to both fast and slow rolling. MGVF works a t the time when the resolution of the leukocytes rolling sequence is decreased. Hence it is used to enhance the throughput of the system.

**Savelonas et al.[8]** In this paper author introduces an active contour method and named as Variable Background Active Contour Model. It has main applicable in field of medical science in order to detect the thyroid in images of ultrasound. This technique have various advantages such as there is no requirement for smoothing the image and have no need to detect the boundaries. This technique is much efficient as compare to the traditional active contour without edge model technique. This technique decreases the image homogeneity by using a background variable. The output images of this technique consist of perturbation and speckle noise which uses the concept of Raleigh distribution To detect the thyroid module of infected objects in such kind of images infringe which uses segmentation which inherent the properties of noise automatically. Active contour models have not been employed for the effective detection of thyroid nodules in ultrasound images

## IV. EXPERIMENTAL RESULTS:

Various Thresholding techniques such as Local Thresholding, Global Thresholding, Adaptive Thresholding, Shannon Entropy based Thresholding and Non Shannon based Thresholding are applied on different images. The experimental results showing the visual outcomes of segmented images as shown in below figures:


Image1


Local


Global

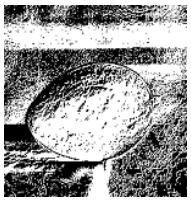

Adaptive


Shannon Entropy


Non Shannon Entropy


Image2


Global


Local


Adaptive


Shannon Entropy

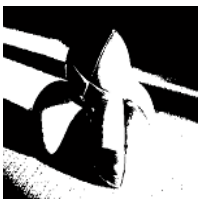

Non Shannon Entropy

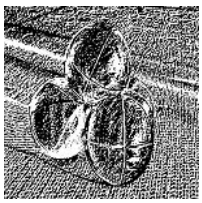

Adaptive

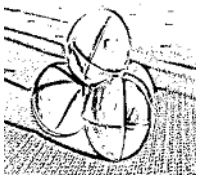

Shannon Entropy


Non Shannon Entropy


Image3


Global


Local

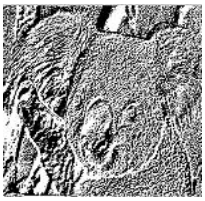

Adaptive


Shannon Entropy


Non Shannon Entropy


Image4


Global


Local


Adaptive


Shannon Entropy


Non Shannon Entropy


Image5


Global


Local

**PARAMETERS EVALUATION APPLYING VARIOUS THRESHOLDING TECHNIQUES**

| Evaluation Parameters | Global | Local | Adapt-ive | Shannon Entropy | Non Shannon Entropy |
|---|---|---|---|---|---|
| RAND INDEX | 0.4686 | 0.4945 | 0.3187 | 0.4572 | 0.4611 |
| GCE | 0.1350 | 0.6076 | 0.3942 | 0.1350 | 0.1350 |
| MSE | 1.0941 | 1.0914 | 1.0859 | 1.0885 | 1.0885 |
| PSNR | 47.7404 | 47.7508 | 47.7728 | 47.7627 | 47.7623 |
| VOI | 6.2752 | 8.1215 | 7.6552 | 6.2923 | 6.2863 |

Table1: Parameter Evaluation of Image1

| Evaluation Parameters | Global | Local | Adapt-ive | Shannon Entropy | Non Shannon Entropy |
|---|---|---|---|---|---|
| RAND INDEX | 0.5042 | 0.4995 | 0.2732 | 0.4269 | 0.4359 |
| GCE | 0.1350 | 0.6103 | 0.3775 | 0.1350 | 0.1350 |
| MSE | 1.6141 | 1.6162 | 1.6078 | 1.6096 | 1.6098 |
| PSNR | 46.0514 | 46.0458 | 46.0684 | 46.0636 | 46.0361 |
| VOI | 6.6539 | 8.2715 | 7.8217 | 6.4719 | 6.4581 |

Table2: Parameter Evaluation of Image2

| Evaluation Parameters | Global | Local | Adapt-ive | Shannon Entropy | Non Shannon Entropy |
|---|---|---|---|---|---|
| RAND INDEX | 0.4519 | 0.4928 | 0.0765 | 0.4062 | 0.4063 |
| GCE | 0.1350 | 0.5776 | 0.2030 | 0.1350 | 0.1350 |
| MSE | 6.7052 | 8.4635 | 7.8016 | 6.6254 | 6.6052 |
| PSNR | 46.6598 | 46.6569 | 46.6807 | 46.6704 | 46.6603 |
| VOI | 1.4031 | 1.4041 | 1.3964 | 1.3997 | 1.3991 |

Table3: Parameter Evaluation of Image3

| Evaluation Parameters | Global | Local | Adapt-ive | Shannon Entropy | Non Shannon Entropy |
|---|---|---|---|---|---|
| RAND INDEX | 0.4908 | 0.4936 | 0.4272 | 0.3967 | 0.4002 |
| GCE | 0.1350 | 0.6097 | 0.5021 | 0.1350 | 0.1350 |
| MSE | 6.8178 | 8.7345 | 8.4767 | 6.9684 | 6.8031 |
| PSNR | 45.8577 | 45.8931 | 45.8837 | 45.8735 | 45.8733 |

| | | | | | |
|---|---|---|---|---|---|
| **VOI** | **1.6878** | **1.6818** | **1.6777** | **1.6816** | **1.6717** |

Table4: Parameter Evaluation of Image4

| **Evaluation Parameters** | **Global** | **Local** | **Adapt-ive** | **Shannon Entropy** | **Non Shannon Entropy** |
|---|---|---|---|---|---|
| **RAND INDEX** | **0.3984** | **0.4914** | **0.4617** | **0.4641** | **0.4355** |
| **GCE** | **0.1350** | **0.6043** | **0.4611** | **0.1350** | **0.1350** |
| **MSE** | **6.8302** | **8.5868** | **8.1374** | **6.6717** | **6.6697** |
| **PSNR** | **47.1925** | **47.2076** | **47.2183** | **47.2099** | **47.2090** |
| **VOI** | **1.2412** | **1.2369** | **1.2338** | **1.2362** | **1.2365** |

Table5: Parameter Evaluation of Image5

| **Techniques** | **Image1** | **Image2** | **Image3** | **Image4** | **Image5** |
|---|---|---|---|---|---|
| **GLOBAL** | **3.2735** | **2.8604** | **2.7477** | **2.8802** | **2.7354** |
| **LOCAL** | **2.7714** | **2.7021** | **3.4817** | **3.6753** | **3.4761** |
| **ADAPTIV E** | **3.2851** | **3.2690** | **3.1136** | **3.5521** | **2.7896** |
| **SHANNON** | **2.5052** | **2.7388** | **2.7201** | **2.9283** | **2.6899** |
| **NON SHANNON** | **2.5032** | **2.7343** | **2.7131** | **2.9265** | **2.6804** |

Table6: Calculation of mean value based on GCE, MSE, VOI Parameters of 1 to 5 images.

| **Techniques** | **Image6** | **Image7** | **Image8** | **Image9** | **Image10** |
|---|---|---|---|---|---|
| **GLOBAL** | **3.2337** | **2.3227** | **2.5483** | **2.1252** | **3.1751** |
| **LOCAL** | **3.9721** | **3.1138** | **3.2898** | **2.7423** | **3.4554** |
| **ADAPTIVE** | **3.6197** | **2.8947** | **3.1493** | **2.4805** | **3.2858** |
| **SHANNON** | **3.2323** | **2.3070** | **2.4991** | **2.0819** | **2.6821** |
| **NON-SHHA SHANNON** | **3.2304** | **2.3035** | **2.4694** | **2.0657** | **2.6760** |

Table7: Calculation of mean value based on GCE, MSE, VOI Parameters of 6 to 5 images.

| **Techniques** | **Image1** | **Image2** | **Image3** | **Image4** | **Image5** |
|---|---|---|---|---|---|
| **GLOBAL** | **24.1045** | **23.2628** | **23.5558** | **23.1742** | **23.7954** |
| **LOCAL** | **24.1226** | **23.2726** | **23.5748** | **23.1938** | **23.8495** |
| **ADAPTIVE** | **24.0457** | **23.1708** | **23.3786** | **23.1554** | **23.8401** |
| **SHANNON** | **24.1099** | **23.2452** | **23.5383** | **23.1351** | **23.8370** |
| **NON SHANNON** | **24.1117** | **23.2650** | **23.5233** | **23.1367** | **23.8222** |

Table8: Calculation of mean value based on PSNR and RAND INDEX Parameters of 1 to 5 images.

| **Techniques** | **Image6** | **Image7** | **Image8** | **Image9** | **Image10** |
|---|---|---|---|---|---|
| **GLOBAL** | **22.1731** | **24.7472** | **24.5710** | **26.0469** | **23.6816** |
| **LOCAL** | **22.2075** | **24.7638** | **24.6452** | **26.1920** | **23.7434** |
| **ADAPTIVE** | **22.1183** | **24.7473** | **24.5757** | **26.0537** | **23.7087** |
| **SHANNON** | **22.1470** | **24.7483** | **24.6231** | **26.0865** | **23.7233** |
| **NON SHANNON** | **22.1456** | **24.7622** | **24.6135** | **26.0706** | **23.7289** |

Table9: Calculation of mean value based on PSNR and RAND INDEX Parameters of 6 to 10 images.

Table 1 to 5 shows the RAND INDEX, GCE, MSE, PSNR and VOI parameters that are calculated for each image segmented after applying Local, Global, Adaptive, Shannon Entropy and Non Shannon Entropy based Thresholding Techniques.

Table 6,7 shows mean calculation of MSE, VOI and GCE parameters it shows that mean of Non Shannon Entropy is lower as compare to other techniques.Table 8,9 shows mean calculation of RAND INDEX and PSNR parameters it shows that mean of Local Thresholding based on these parameters is higher as compared to other techniques.

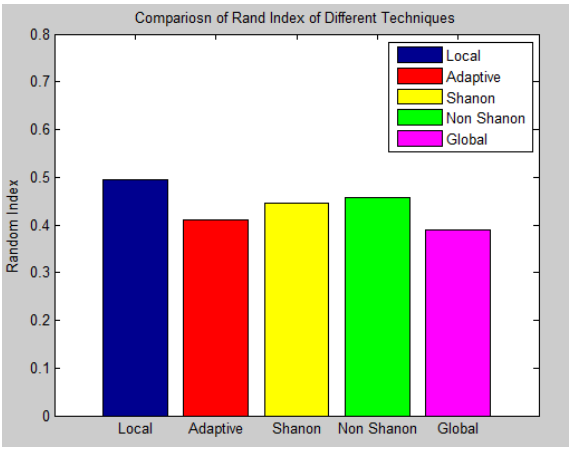



Figure3: Comparison of Rand Index of Different techniques

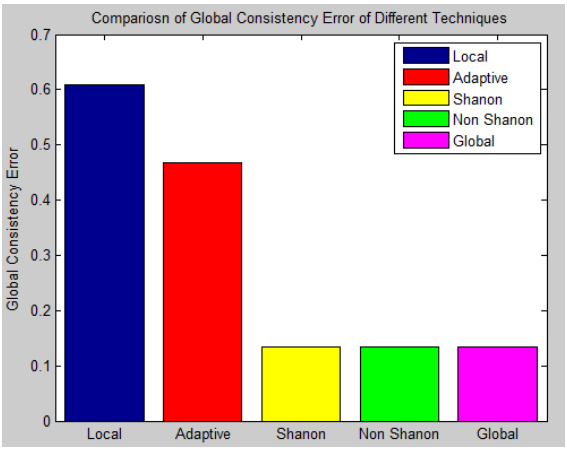



Figure4: Comparison of Global consistency Error of Different techniques

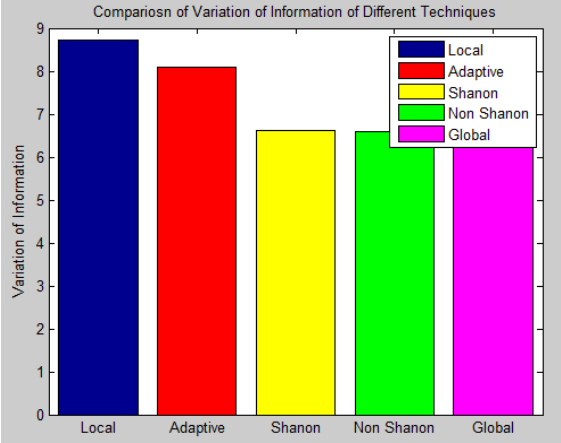


Figure5: Comparison of Variation of Information of Different techniques

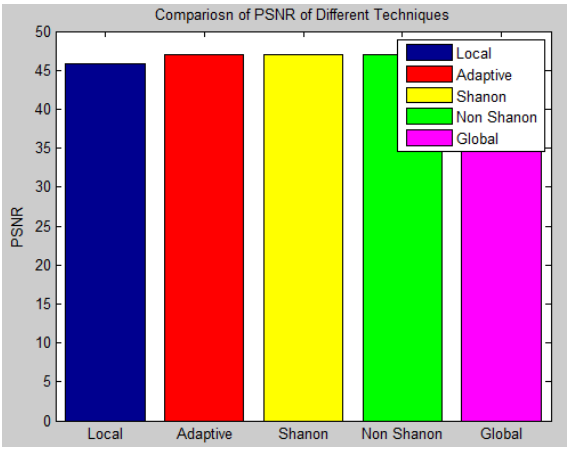


Figure6: Comparison of PSNR of Different techniques

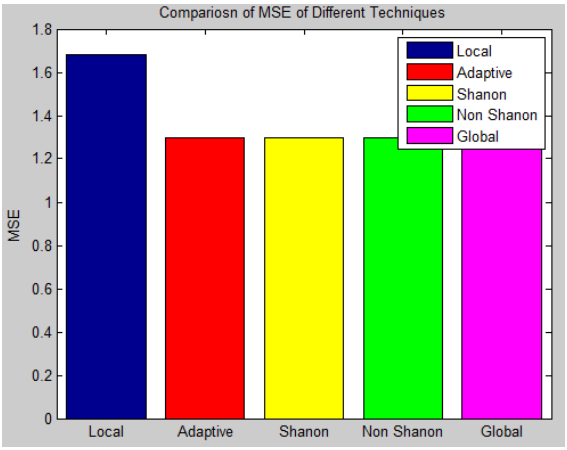


Figure7: Comparison of MSE of Different techniques

## III. CONCLUSION

Digital image segmentation is crucial for medical imaging. Now segmented images have been used in various applications including tissue volume quantification, diagnosis, study of anatomical structure. Image segmentation is a hard task for the researchers because of variation of object shapes and image quality. Image segmentation is a process which divides the image into small segments or parts in order to extract information from it. It is a part of image analysis process. There are many techniques which are used for segmentation. In this paper the focus is on the thresholding based image segmentation techniques. This paper concludes the various thresholding based techniques such as non-Shannon, Shannon, local thresholding and global thresholding techniques. This paper provides an overview to multiple thresholding techniques for image segmentation.. The performance of these techniques have been evaluated in terms of GCE, MSE, VOI, PSNR and RAND INDEX. Ten images have taken for experimentation. Various Thresholding techniques applied on these images fo segmentation. After segmentation parameters have been evaluated. Mean have been calculated separately for MSE, VOI, GCE and PSNR, RAND INDEX. For better segmentation results mean value of MSE, VOI, GCE should be min and mean value of PSNR, RAND INDEX should be minimum. From above results it is clear that mean value of MSE, VOI, GCE is minimum for Non Shannon Entropy based Thresholding hence this technique is best as compare to other techniques on basis of minimum error value. Also mean value of PSNR and RAND INDEX should be maximum. Local thresholding techniques shows maximum value hence this technique is best as compare to other techniques on basis of maximum value of similarity index.

In future traditional techniques can be enhanced by introducing more parameters so that the techniques can become more efficient and generate accurate results.

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