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Robust Method for Noisy Image Segmentation

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***Abstract*— A major problem in noisy image processing is the effective segmentation of its components. In this paper, we are proposing a K - Medoid clustering algorithm for noisy image segmentation, which is able to segment all types of noisy images efficiently. As the presented clustering algorithm selects the centroids randomly hence it is less sensitive , to any type of noise as compare to other clustering algorithms. To prove this we will present experimental results on various images, effected by different noises, to demonstrate efficiency of the proposed method for segmentation of noisy image.**

Keywords— **Colour image segmentation, Image noise, PSNR, K - Medoids.**

I. Introduction

Image segmentation [1], [2] and [3] as an important research area in Digital Image Processing. Segmentation implies the division of an image into different objects or connected regions that do not overlap. On research paper [1] authors give a K – Medoids clustering algorithm for image segmentation. The result of this paper shows the effectiveness of algorithm on different types of images.

Noise is ubiquitous in real life and changes image acquisition and processing characteristics in an uncontrolled manner. Noise is the result of errors in the image acquisition process that results in pixel values that do not reflect the true intensities of the real scene.

The paper is organized as follows. In section II, details of various type of image noise is listed. In section III, a brief knowledge is given for PSNR. In section IV, we introduce our algorithm for segmentation. In section V, the results of our experiment are listed and the conclusion is covered in section VI.

II. Image noise

Image noise is the random variation of brightness or color information in images produced by the sensor and circuitry of a scanner or digital camera. Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector [4].Image noise is generally regarded as an undesirable by-product of image capture.

The types of Noise are following:-

- Amplifier noise (Gaussian noise)
- Salt-and-pepper noise
- Shot noise(Poisson noise)
- Speckle noise

A. Amplifier noise (Gaussian noise)

The standard model of amplifier noise [4]is additive, Gaussian, independent at each pixel and independent of the signal intensity.

B. Salt-and-pepper noise

An image containing salt-and-pepper noise [4] will have dark pixels in bright regions and bright pixels in dark regions. This type of noise can be caused by dead pixels, analog-to-digital converter errors, bit errors in transmission, etc.

C. Poisson noise

Poisson noise [4] or shot noise is a type of electronic noise that occurs when the finite number of particles that carry energy, such as electrons in an electronic circuit or photons in an optical device, is small enough to give rise to detectable statistical fluctuations in a measurement.

D. Speckle noise

Speckle noise [4] in conventional results from random fluctuations in the return signal from an object that is no bigger than a single image-processing element. It increases the mean grey level of a local area.

III. PSNR

Peak Signal – to – Noise-Ratio: Larger SNR and PSNR [5] indicate a smaller difference between the original (without noise) and reconstructed image. This is the most widely used objective image quality/ distortion measure. The main advantage of this measure is ease of computation but it does not reflect perceptual quality. An important property of PSNR is that a slight spatial shift of an image can cause a large numerical distortion but no visual distortion and conversely a small average distortion can result in a damaging visual artifact, if all the error is concentrated in a small important region. This metric neglects global and composite errors PSNR is calculated using Eq.

$$psnr = 20\log\left(\frac{N}{S}\right)DB$$

IV. K – Medoids Clustering

K-Medoids algorithm: The K-means algorithm [1] is sensitive to outliers since an object with an extremely large value may substantially distort the distribution of data. The basic strategy of K - Mediods [1] [6] clustering algorithms is to find k clusters in n objects by first arbitrarily finding a representative object (the Medoids) for each cluster. Each remaining object is clustered with the Medoid to which it is the most similar. K-Medoids method uses representative objects as reference points instead of taking the mean value of the objects in each cluster. The algorithm takes the input parameter k, the number of clusters to be partitioned among a set of n objects. A typical K-Mediods algorithm for partitioning based on Medoid or central objects is as follows:

Input:

K: The number of clusters

D: A data set containing n objects

Output:

A set of k clusters that minimizes the sum of the dissimilarities of all the objects to their nearest medoid. Method: Arbitrarily choose k objects in D as the initial representative objects;

Repeat:

Assign each remaining object to the cluster with the nearest medoid;

Randomly select a non medoid object Orandom;

Compute the total points S of swap point Oj with Orandom

if S < 0 then swap Oj with Orandom to form the new set of k medoid

Until no change;

The algorithm attempts to determine k partitions for n objects. After an initial random selection of k medoids, the algorithm repeatedly tries to make a better choice of medoids.

V. EXPERIMENTAL RESULT

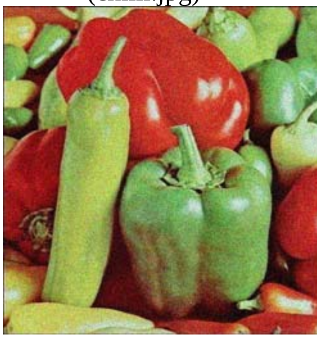
To verify the proposed segmentation method, experiments were performed on images collected from different sources, Test image 1 (Chilli.jpg) is a standard image from MATLAB, Test image 2 (Palace.jpg) is downloaded from internet and Test image 3 (Tumor.jpg) is a MRI scan, with different types of image noises. As examples, Figures gives five pairs of segmented color images with their different type of noise images. In the test images, figure 5.1.1, 5.2.1 and 5.3.1 are original images and 5.1.2, 5.2.2 and 5.3.2 are segmented output of original images. Figure 5.1.3 is with noise (Gaussian noise) ,5.1.4 is the segmented output of noisy image with Gaussian noise and respectively the other images and there corresponding segmented outputs are as below.

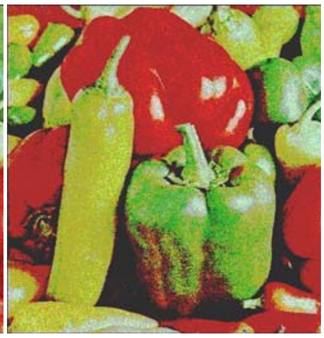
Table 5.1 shows the peak signal to noise ratio for segmented output with original image. First row of table shows the PSNR between original image and the segmented output of original image. Rows 2nd, 3rd,4th and 5th show the PSNR between the original image and the various segmented output of images with noise.

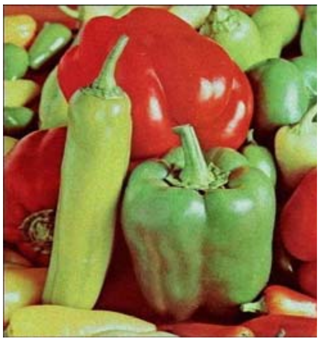
Table 5.2 shows the percentage of PSNR in respect of segmented output of original image and segmented output of noisy images. It shows the difference between the original segmented image and the various noisy segmented images.


5.1.1 Original picture (chilli.jpg)


5.1.2 Segmented image

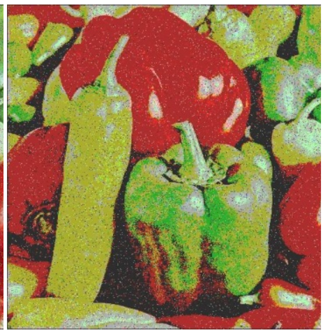

5.1.3 Image with Gaussian noise

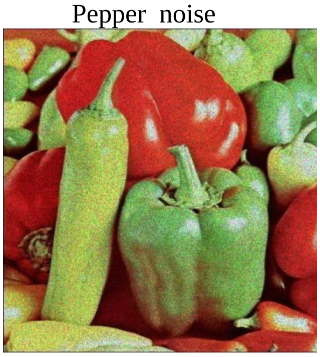

5.1.4 Segmented image


5.1.5 Image with Poisson noise


5.1.6 Segmented image


5.1.7 Image with Salt and Pepper noise

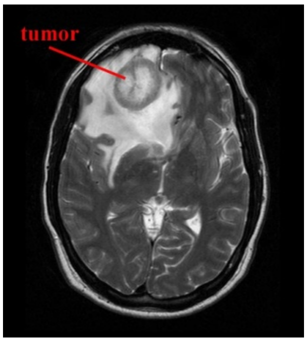

5.1.8 Segmented image


5.1.9 Image with Speckle noise


5.1.10 Segmented image

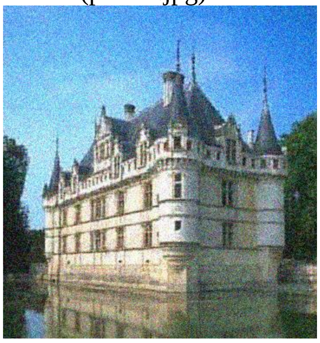
5.2.1 Original picture (palace.jpg)

5.2.2 Segmented image

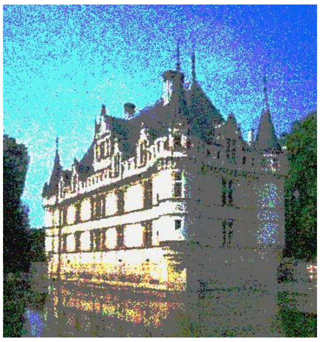


5.3.1 Original picture (tumor.jpg)

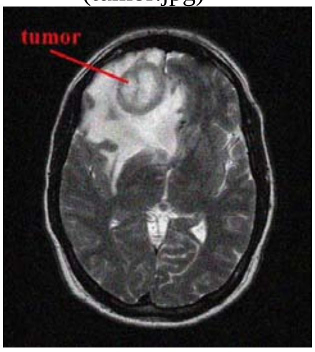
5.3.2 Segmented image



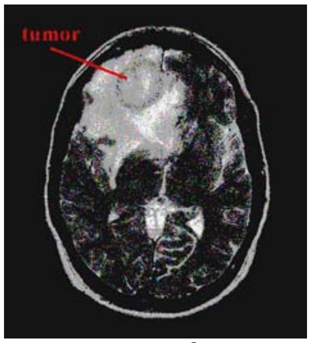
5.2.3 Image with Gaussian noise



5.2.4 Segmented image



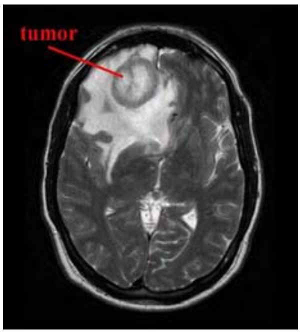
5.3.3 Image with Gaussian noise



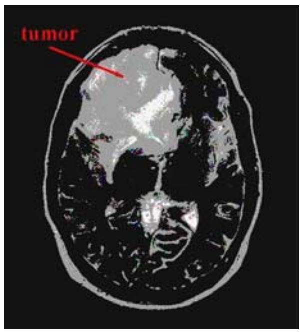
5.3.4 Segmented image

5.2.5 Image with Poisson noise

5.2.6 Segmented image

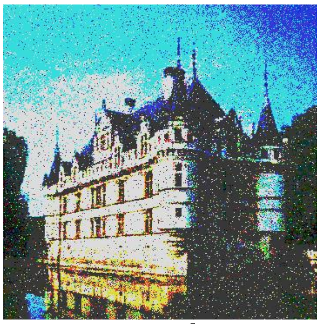


5.3.5 Image with Poisson noise

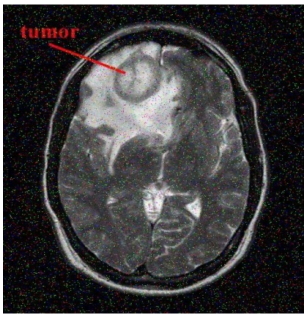


5.3.6 Segmented image

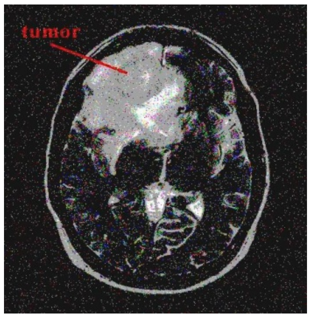
5.2.7 Image with Salt and Pepper noise



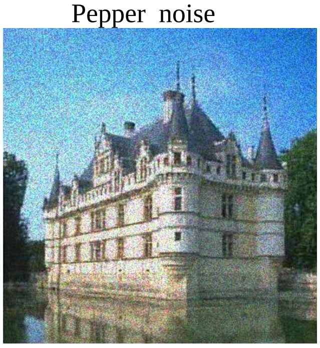
5.2.8 Segmented image



5.3.7 Image with Salt and Pepper noise

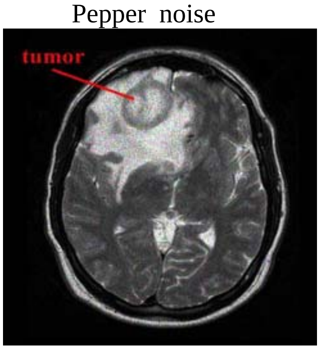


5.3.8 Segmented image

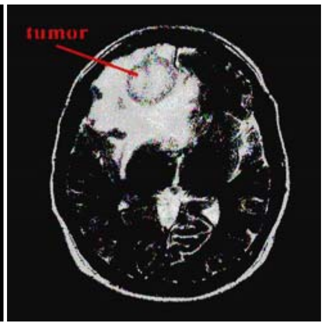


5.2.9 Image with Speckle noise

5.2.10 Segmented image



5.3.9 Image with Speckle noise



5.3.10 Segmented image

Table 5.1 for PSNR between original test image and various segmented images.

Segmented Output Images	Chilli .Jpg	Palace.Jpg	Tumor.Jpg
Original Image	23.8 db	24.06 db	21.26 db
Image With Gaussian Noise	19.01 db	20.44 db	18.74 db
Image With Poisson Noise	18.67 db	20.83 db	19.1 db
Image With Speckle Noise	19.65 db	20.7 db	19.26 db
Image With Salt & Pepper Noise	19.45 db	21.35 db	18.78 db

Table 5.2 Percentage of PSNR in respect of segmented output of original image and segmented output of noisy images.

Noise Component	Chilli .Jpg	Palace.Jpg	Tumor.Jpg
Gaussian Noise	79.87	84.95	88.15
Poisson Noise	78.45	86.58	89.84
Speckle Noise	82.56	86.04	90.59
Salt & Pepper Noise	81.72	88.74	88.34

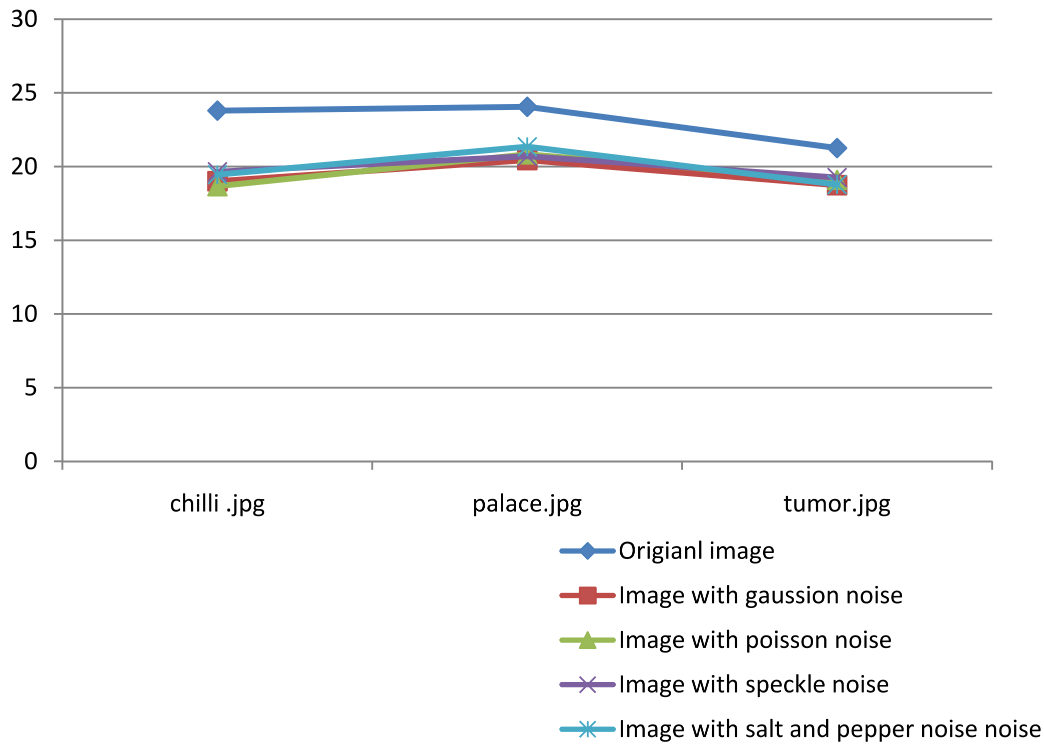


Figure 5.1 PSNR between original test image and various segmented images

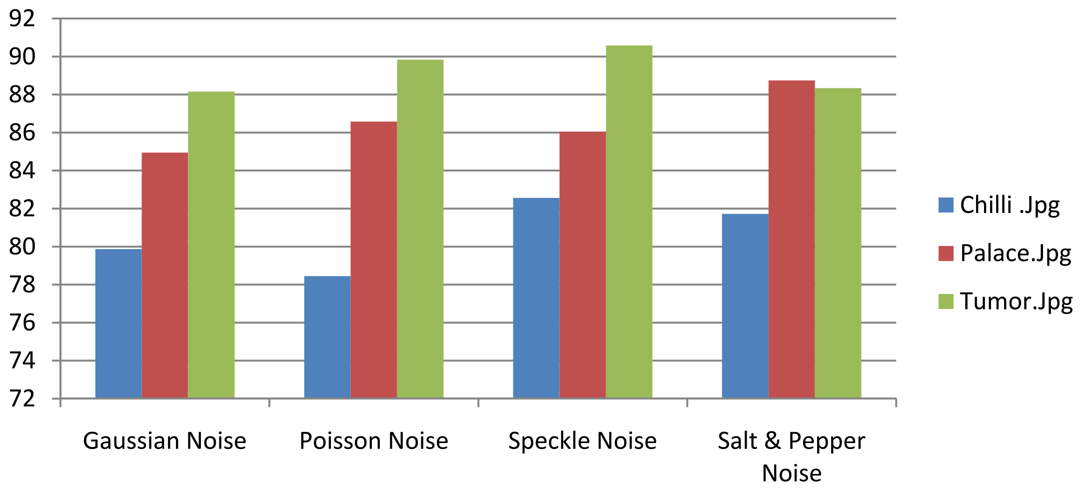


Figure 5.2 Percentage of PSNR in respect of segmented output of original image and segmented output of noisy images

VI. CONCLUSION AND FUTURE WORK

In this paper we use K – Medoids clustering technique to segment noisy images. Table 5.1 shows that the PSNR for all the three test images is high when the images are noise free. High PSNR value shows that the segmented output contains less dissimilarity with the original image. It also shows that the PSNR reduces when the image contains noise. Figure 5.1 shows that the algorithm works on different types of image noise, even though the PSNR for segmented output of the images with noise is not equal to the PSNR for segmented output without noise, Figure 5.1 shows that it is very near to that, also Figure 5.2 and Table 5.2 show that the efficiency of the proposed algorithm is more than 80%, it shows that the algorithm eliminate the overhead of de-noising process. Our future work incorporates to improve the efficiency of the algorithm.

VII. REFERENCES

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