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IMPACT OF IMAGE SEGMENTATION APPROACHES ON NOISY AND BLURRED IMAGES

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ABSTRACT

In today's world, many applications are used for image processing. Segmentation is one of the main steps used for image processing. Segmentation is used to identify objects in an image. It divides an image into multiple segmentations. There are hundreds of techniques present that are used to segment an image. Clustering is one of the techniques. K nearest neighbor and K-mean techniques are two clustering techniques of segmentation. The main principle of clustering technique is to make cluster of pixels on the basis of distance between pixels and centroids. This paper gives details about KNN and K-mean techniques and their efficiency. In past, these images are applied a lot on smooth images. In this paper, the efforts have been done to analyze the impact of these techniques on various non-efficient images. The functions used to make the images degraded are noise and blur in the image. It has been observed that depending on various parameters both the algorithms performs in similar manner except some differences which are highlighted in this paper.

KEYWORDS: Image, K nearest neighbor, K-mean, Noise, Segmentation.

INTRODUCTION

Computer vision tries to understand scene with the help of image processing and machine learning. Image processing is a subfield of signals and systems but the main focus is on images. The centre of attention for digital image processing is to make a digital system with the help of efficient algorithm and techniques which is capable of processing an image. In digital image processing, many algorithms or techniques are applied on the digital image to achieve required output (Gonzalez & Woods, 2009). Image processing consists of steps such as image enhancement, image restoration, image compression, and morphological operation, representation, and description, object identification (Aly, Deris, & Zaki, 2011). Image processing is a study that accepts an image as input and gives back an image as output. It also includes various tasks such as image display and printing, image editing and manipulation, image enhancement, feature detection and image compression etc (Introduction, 2012) (Tutorials Point, 2016). Image processing has mainly three steps. First is image acquiring, in which image is captured using camera or any digital equipment, second step is analysis and manipulation of image, in which image processing is done which includes steps like image enhancement, image compression etc., and third step is output, which is the last step and result of image processing. The main purposes of image processing are: a) Visualization – detect objects that is not visible, b) Image sharpening and restoration - for a better image, c) Image retrieval - Seek for the image of interest, d) Measurement of pattern – measures different objects in an image, e) Image Recognition – differentiate objects in an image (Introduction to Image Processing, 2012). Segmentation is one of the steps which is used to manipulate an image. Segmentation is a process to divide an image into multiple parts or segments to identify different objects in an image. Segmentation technique has many applications such as to identify an object in a still scene for object based

measurement for e.g. - shape and size, identify objects in a moving scene for object based video compression and identifies objects that are at different distance from a sensor using depth measurement. Segmentation is used for image compression, image editing processing, object recognition etc (Aly, Deris, & Zaki, 2011). Image segmentation is mid-level processing techniques which is used for manipulate an image and also used to classify pixels into different classes, on the basis of homogeneity characteristics of pixels that is texture, color or intensity etc. (Khan & S., 2013). Image segmentation is used to extract useful information and to select region of interest (ROI) from an image. Image segmentation has many techniques. Segmentation techniques are basically divided into two categories, which are (Das, Priyanka, & Devi, 2012):

- Detecting discontinuities: In detecting discontinuities, partition of an image is based on sudden changes in intensity. Edge detection is an example of detecting discontinuities.
- Detecting similarities: In detecting similarities, partition of an image is based on similarity depending on a predefined criterion. Some techniques which are based on similarities are thresholding, region growing, and region splitting, and merging.

Some application of image segmentation are medical applications (Locate tumors and other pathologies, Measure tissue volumes, Computer guided surgery, Diagnosis, Treatment planning, study of anatomical structure), remove noise, Locate objects in satellite images (roads, forests, etc.), Face Recognition, Finger print Recognition, MPEG-4 video object (VO) segmentation, airport security system, criminal investigation, computer graphics etc. In digital image processing, there are different types of images such as light intensity (gray scale), color, thermal (infrared), sonar, X ray (radiographic), nuclear magnetic resonance images (MRI), and so on. The decision to select an appropriate segmentation technique and level of segmentation depends on kind of image and characteristics of the problem that is considered to be solved (Das, Priyanka, & Devi, 2012) (Kumar, M. Jogender, Kumar, & Raj, 2014) (Saraha & Kaur, 2013) (Image Segmentation, 2016). K-nearest neighbour and K-mean techniques are discussed in this paper. K-nearest neighbour technique mainly based on nearest neighbour classification technique. K-mean technique decides a number of the cluster to segment an image.

PROBLEM FORMULATION

Image segmentation is a process to divide an image into multiple segments which are further used for analysis of image. It changes the representation of an image into simple, and more meaningful. Image segmentation provides a label to each and every pixel in an image. The pixels of same label have same characteristics. Image segmentation has many techniques to implement but generally, these techniques are divided into two categories: detecting similarity and detecting dissimilarity, as discussed above (Saini & Arora, 2014). Segmentation is gap filler between mid-level processing and high-level processing. It is used for object recognition, identification, and measurement in an image. The success or failure of these tasks depends on the result of segmentation (DIP, 2016). Edge based, region based, thresholding, matching, fuzzy based, k-nearest neighbour and k-mean techniques etc. are some techniques which are used by segmentation. Clustering technique is one of techniques, used for image segmentation. Clustering technique is unsupervised technique. The basic principle of clustering is minimization intra class similarity and maximization interclass similarity. In the clustering technique, grouping of pixels falls into cluster or classes (Palus & Bogdaski, 2003). A group of pixels which are similar within the class and dissimilar with other classes is called cluster. It is a main task of inspect data mining, and a popular method for statistical data analysis is used in different areas including, image analysis, insurance, pattern recognition, marketing, machine learning, information retrieval with bioinformatics. The main component of clustering is to calculate distance between two pixels (A Tutorial on Clustering Algorithms, 2016) (Sathiyasekar & Karthick, 2014). K-mean and KNN techniques are types of clustering technique. K-mean technique is simplest unsupervised learning algorithm which solves well known problems.

K-mean is simple and computationally faster than hierarchical technique. It also works for large number of variables. The main concept of K-mean is to choose centroids randomly for each cluster and initially, grouping of pixels are based on these centroids. Then, calculate distance between pixel data point and centroids. ??Again, grouping of pixels falls into different clusters based on nearest neighbour centroid using this calculated distance. It is an iterative method (K-Means Clustering, 2016). The most popular matrices used for distance calculation are: City block metric and Euclidean distance. The main idea of change centroids is that distance between pixels and centroid is too much. So, changes happened to reduce distance between them and changes of centroid is repeated until difference between new

and old place is too small. The only disadvantage is that it requires k number of centroids to initialize it but it is also a fastest method used for clustering (Palus & Bogdaski, 2003).

K-Nearest Neighbour (KNN) is a supervised learning and a classification algorithm (Xu, 2014). The idea of KNN is to discover closest matched data with a region. KNN is firstly introduced by E. Fix and J. Hodges researchers in their paper Discriminatory Analysis: Nonparametric Discrimination: Consistency Properties, in 1951 (Mower, 2016). The principle of the nearest neighbour method is to discover cluster-pair and discovered pair combined in the path. This path will terminates when all the nearest pixels are merged in the path (Nearest Neighbour Chain Algorithm, 2015). Using distance matrix, all possible pairs of points (x, y) made a distance matrix and using this matrix all the data points are identified (Mower, 2016).

In this paper, K-mean and KNN techniques are implemented. The efficiency of these techniques is analysis with the help of two parameter noise and blurriness. The Peak Signal-to Noise Ratio (PSNR) is also calculated. PSNR is used to measure the quality between original image and compressed/noise image. The PSNR is measured in. To calculate PSNR, first compute Mean Squared Error (MSE) (MathWorks, 2016). That is:

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

where m and n is number of rows and columns, I(i, j) is original image or signal and K(i, j) is other image than original image. PSNR is

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

where MAXI is maximum possible values of pixels.
Noise is an unwanted value of pixels in an image. It is erratic modification of color information or brightness and usually it is electronic noise. This noise is added to image during image acquisition, image transmission, image processing, conversion, or storing etc. When noise is added to image, it degrades the quality of image. Recovery of original image from degraded image is possible with the help of filters. In DIP, many types of noise are used such as gaussian, periodic, salt & pepper, speckle, shot noise etc (Image Noise, 2016) (Noise (Signal Processing), 2015). Blurring, also known as smoothing, is often used operation in image processing (Smoothing Image, 2016). When a filter is used to remove noise, blurring operation is applied. When blurriness of image is increased after a peak level then effect on image is also increased and output image looks like a noisy image. So, level of blurriness in removal of noise is important.

RELATED WORK

Segmentation is a process to subdivide an image into multiple parts. The segment can be a pixel or set of pixels which are homogeneous in characteristics such as texture, color, intensity etc. Many different techniques are developed till now. Some techniques addressed below:

Threshold method: Threshold technique is a powerful technique for images which has light objects on a dark background (Kumar, M. Jogender, Kumar, & Raj, 2014). An appropriate threshold value T is select to segment an image. The value of a pixel is lower than T, it is from the background (0). The value of a pixel is greater than T, it is from the region of interest (1) (Kumar, M. Jogender, Kumar, & Raj, 2014).

Edge-based: Edge-based technique is used to identify pixels between various objects in image and to connect these pixels as a closed boundary. Edge is a symbol of discontinuity and ending of object in an image. A discontinuity occurs in features of image like gray level, texture, color etc (Das, Priyanka, & Devi, 2012). Some operators which are used to edge detection: laplacian operator, sobel operator, prewitt operator etc (Saini & Arora, 2014).

Region based: In the region based, segmentation is based on the similarity between the regions using predefined criteria (Das, Priyanka, & Devi, 2012). In edge based technique, first find the boundary of an object and then detect the object automatically by filling boundaries but the region based technique used opposite approach to edge based

(Singh, Chadha, & Singh, 2013). Region splitting and merging method are used in this technique (Saini & Arora, 2014).

Segmentation Based on PDE (Partial Differential Equation): Partial differential equations and its numerical schemes are used for segmentation of an image. This method is firstly introduced by Kass et al. in 1987, to find known object in the presence of noise (Shah, Patel, & Jivani, 2013). PDE performs segmentation using active contour and snakes (Das, Priyanka, & Devi, 2012).

Fuzzy based segmentation: Fuzzy-based segmentation technique is able to integrate expert knowledge. This technique is less computationally expensive compared to fuzzy c-mean clustering (Das, Priyanka, & Devi, 2012).
Artificial neural network (ANN): ANN system is a software or hardware system which tries to make a similar structure as a human brain (Reyes-Aldasoro, Constantino Carlos, & Laura, 2016). One of the biggest advantages of ANN is that it can take decisions based on noisy and complex data (Chandhok, 2012). In ANN, first image is mapped into a neural network. Every neuron is referred to as a pixel (Das, Priyanka, & Devi, 2012).

Featured based: Featured based segmentation technique is based on the feature of an image means the technique is based on the difference in color, intensity etc. of the image (Yogamangalam & Karthikeyan, 2013).

RESULTS & DISCUSSIONS

K-Mean and KNN technique are implemented using 4 image dataset in previous paper "Clustering Techniques for Image Segmentation". In this paper, efficiency of these both algorithms is examined. Matlab toolbox is used for implementation. Two parameters are used to compare efficiency of both algorithms: noise and blurriness. Noise is unwanted signal which is added into image at the time of image acquisition. Blurriness is a smoothing of an image, but it degrades image when it is too high. In implementation, noise is added to original image. Image converted to l*a*b* colormodel from rgb colormodel. KNN takes sample region from users to cluster an image. K-mean requires k number of centroid to initialize algorithm. K-mean does not require any sample region from users. To implement these algorithms, Euclidean distance is used to calculate distance between data point and centroid. In the presence of noise, KNN technique gives better result as compared to K-Mean technique. Gaussian noise, salt & pepper noise and speckle noise are used for implementation to examine efficiency of both algorithms. Experiment is also done with blurred image. KNN technique gives better result. Segment region in KNN technique is good and better for further analysis or processing. In case of K-mean technique, some clusters are messy that is not good for segmentation. Implementation of both algorithms, different image set is used. Different images which are used to experiment and result of both algorithms and different types of noise, is shown as below:

Figure 1

(a) ***(b)*** ***(c)*** ***(d)***

Different 4 images used for implementation

Figure 2

(a) ***(b)*** ***(c)***

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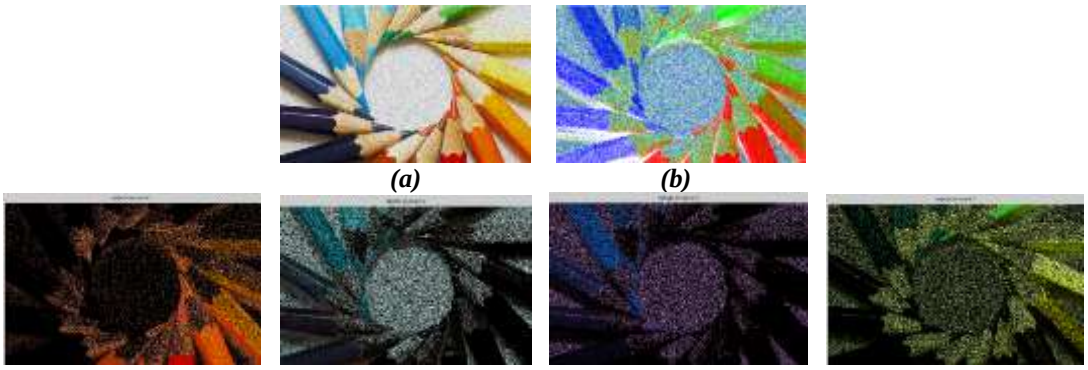
(d) *(e)* *(f)* *(g)*

(a) Original image, (b noisy image with gaussian noise, (c) result of segmentation of KNN technique, (d) (e) (f) (g) show result of K-Mean technique in different clusters.

Gaussian noise is also called amplifier noise. In gaussian noise model, value of pixel is sum of true value pixel and a random gaussian noise value (Verma & Ali, 2013).

Figure 3



(a) *(b)*

(c) *(d)* *(e)* *(f)*

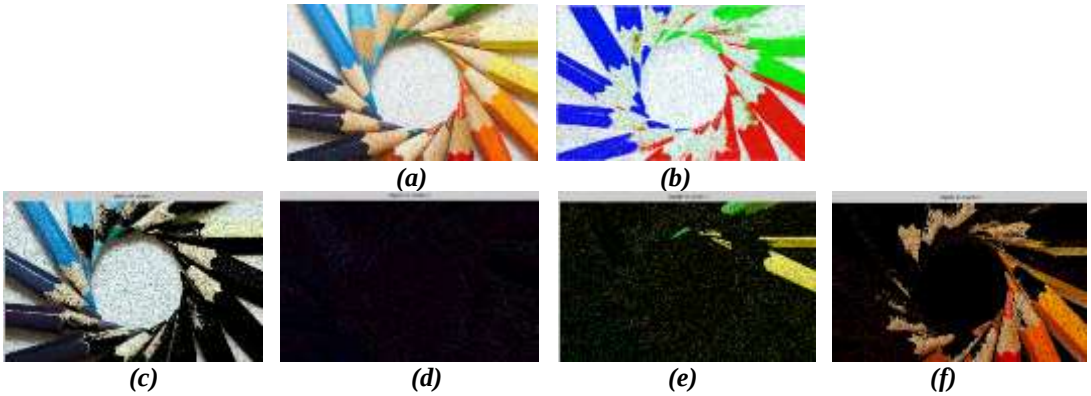
(a) noisy image with speckle noise, (b) result using KNN technique,(c) (d) (e) (f) different segmented clusters as result of K-Mean technique

In this noisy image, Speckle noise is present. In speckle noise, random speckle noise value is multiplied by value of true pixel. It is expressed as

J=I + n*I

where J is speckle noise distribution image, I is input image, and n is uniform noise with mean o and variance v. This type of noise is appears in image because of coherent processing of back scattered signals from multiple distributed points (Verma & Ali, 2013).

Figure 4



(a) *(b)*

(c) *(d)* *(e)* *(f)*

(a) noisy image with salt & pepper noise, (b) result using KNN technique,(c) (d) (e) (f) different clusters of an image that is result of segmentation using K-mean technique.

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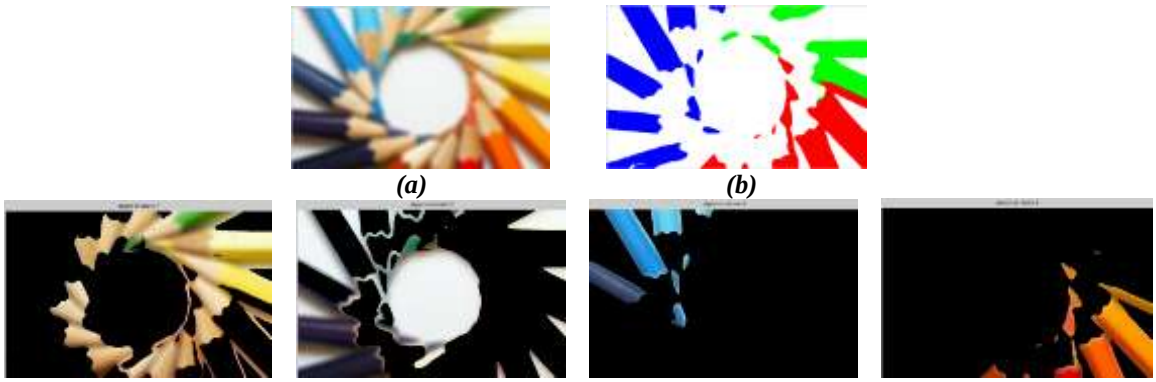
When black and white dots are present in image, it is salt & pepper noise. Salt & pepper also called impulse noise, random noise, and spike noise. When sudden and sharp changes appears in image signal, impulse noise is arises in image (Verma & Ali, 2013) After analyze all the images, result of KNN technique is better as compared to K-mean technique in the presence of different noises. In result of segmentation using K-mean technique, different clusters come out and in some clusters segmentation of regions are not clear. It is not good for segmentation.

Figure 5



(a) blurred image, (b) result using KNN technique, (c) (d) (e) (f) result of K-Mean clustering.

After analyze images, KNN technique gives better result in blurriness of image. In experiment, imfilter is used to blurring an image.

Table 1 Comparison table for value of PSNR in presence of noise at different level

Type of Noise	Variance of Noise	Value of PSNR(db)	
		In K-Mean Technique	In KNN Technique
Gaussian	0.1	34.329	35.116
	0.5	34.546	35.232
	0.9	34.696	35.954
Salt & Pepper	0.1	35.533	39.412
	0.5	34.979	36.218
	0.9	35.944	35.880
Speckle	0.1	34.142	36.475
	0.5	34.582	35.864
	0.9	34.846	36.729

Table 2 Comparison table for value of PSNR in blurriness of image

Type of Technique	PSNR(db)
KNN Technique	40.371
K-mean Technique	35.981

In this paper, efficiency of both techniques, KNN and K-Mean, has been measured on various degraded images. In implementation, different noises are added to image and their results are shown as above with different level of noise. The PSNR is calculated for both techniques at different level of different noise with same image set. Table 1 show that KNN and K-mean techniques have nearest similar values of PSNR values. K-mean technique has values of PSNR in range of nearest 34-35 db and KNN technique has 35-36 db. In case of salt & pepper noise, KNN has high value of

PSNR as compare to K-Mean at 0.1 variance of noise. Table 2 shows PSNR values of blurred image. In case of blurriness of image, KNN technique has high value of PSNR as compared to K-mean technique.

CONCLUSION

The role of image processing is increasing day by day. Hundreds of applications are used for image processing and many more are growing. Image segmentation is one of the methods which are used to segment an image. Image segmentation has many techniques to apply on images such as edge based, region based, thresholding etc. The choice of appropriate segmentation technique depends on the image in hand. K-mean and KNN techniques are based on clustering. In this paper, efficiency of K-mean and KNN algorithms is analyzed. Matlab tool is used for implementation. The image for this experiment is degraded with various types of noises and blur. This degraded image is used to compare the techniques for their respective efficiency. Results in this experiment shows that both algorithms behaves better on degraded image. Segmented images and tables with respected PSNR values have been provided. From these tables, it can be concluded that KNN results better than K-means in some settled parameter values.

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