An Adaptive Image Enhancement using Wiener Filtering with Compression and Segmentation

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ABSTRACT
Today information technology plays an eminent role in every fields of human survival. Due to the rapid development in the information processing system, and the huge data base become a challenging tasks. Due to the various issues in the text processing, image processing has been emerged to provide a solution to such issues using various stages viz., image acquisition, image enhancement and image retrieval. In this paper a method for preprocessing of images and compression of filtered images with lossy and lossless compression is and segmentation is presented. Finally, this paper shows a compact image processing and the result of compared to evaluate the performance of the methods.

Keywords
PSNR, MSE, Compression ratio (CR), Gaussian filters.

1. INTRODUCTION
Digital image processing is of emerging field in the area of Information Technology. It consists of various stages such as Image acquisition, Enhancement, Segmentation and recognition etc. Among them image segmentation is an important and the most difficult task. In this paper two methods are used and compared with the existing methods [1]. This work proposes a method of image segmentation and noise removal techniques with wiener filter, also known as edge preserving linear filter.

Preprocessing is the first stage and a gray scale image is given as input for noise removal [2]. Preprocessing of images commonly involves removal of noises, normalizing the intensity of the individual contents of images and enhancing the images prior to computational processing. Generally, noises will occur due to malfunctioned pixels in camera sensors, faulty memory location in hardware or error in data transmission. Hence, the wiener filter is used to preprocess the image.

The next step is to compress the filtered image using wavelets. The wavelet based image compression used a threshold technique to eliminate all the insignificant values, and transmit the significant coefficients. The haar wavelet transform method is also used for image compression. The Wavelet compression suppresses the redundant attribute of an image.

Finally, the marker controlled watershed algorithm is applied for edge detection and control over segmentation in gradient image. Using wiener filter provides the accuracy of segmentation high. The method is experimented with Berkley Segmentation Dataset and provides better results. The results show that the proposed method effectively reduce the over segmentation effect and achieve more accurate segmentation results than the existing method.

The implementation activities take part in this paper “An Adaptive Image Enhancement Using Wiener Filter with Compression and Segmentation”

- Pre-processing
- Compression
- Segmentation

2. PREPROCESSING
Preprocessing of images commonly involves in removing low frequency background noise, normalizing the intensity of the individual particles images, removing of enhancing data images prior to computational processing.

Generally noise will occur due to malfunctioning pixels in camera sensors, faulty memory location in hardware or error in data transmission.

2.1. Types of Noises
- Salt and pepper noise

This kind of noise occurs due to sharp, sudden disturbances in the image signal, it is randomly scattered white or black (or both) pixels. It can be modeled by random values added to an image [3].

- Gaussian Noise

Gaussian noise is an idealized form of white noise, which occurs by random fluctuations in the signal [2].

2.2. Wiener Filter
The wiener function is derived from the Wiener filter techniques which is also been a type of linear filter. Appling the wiener filters in an image adaptively, tailoring itself to the local image variance. It smoothen the image at low variance. Similarly, it also smoothen the image more when the variance high. This filter provides better results compared to the linear filter. It performs well when the noise is constant-power "white" additive noise, such as Gaussian noise [4].

2.3 Mean Square Error (MSE)
MSE refers to a sort of average or sum of squares of the error between two images.

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(x(i,j) - y(i,j))^2 \qquad \dots (1)$$

Where, x - Original image

y - Segmented image

i - i^{th} row pixel

j - j^{th} column pixel

M - Number of pixels in row

N - Number of pixels in column

2.4 Peak Signal to Noise Ratio (PSNR)

Peak signal to Noise Ratio is the ratio between signal variance and reconstruction error variance. PSNR is usually expressed in Decibel scale. PSNR is used as an approximation to human perception of segmentation quality. PSNR has been accepted as a widely used quality measurement in the field of image segmentation

$$PSNR = 10log_{10}\frac{R^2}{\sqrt{MSE}} \qquad \ldots (2)$$

Where, R - Maximum fluctuation in the input image data type.

The table 1.1 shows the performance measure of PSNR and MSE value to filtering process for the experimented images.

3. FILTERED IMAGE COMPRESSION

Storage of image data occupies huge storage space and also the data transformation requires a wide channel capacity. The method of reducing the amount of data required to represent an image is called image compression. The pre processed image is compressed using wavelet. The basic idea of wavelet based image compression is to use a threshold to eliminate all the insignificant values, and only transmit the significant coefficients. There are two steps involved in image compression are listed below,

1. Compression
2. Decompression (Reconstruction)

Compressing an image is the process by which a large image size is converted to a smaller image size, such as a 10 KB image converted to a 1 KB image. Decompressing an image is the process by which a compressed image is converted back to its actual size, such as 1 KB image were converted back to a 10 KB image. Image compression can be classified as follows.

Image compression is divided into two types,

- Lossy Compression
- Lossless Compression

3.1. Lossy Compression

Lossy compression results in losing of data and the quality of an image from its original representation. It is typically associated with image files, such as JPEG, MP3 files etc. The "lossyness" of an image file may show up as jagged edges or pixilated areas. Lossy compression removes data from the original file; the resulting file occupies less disk space than the original.

3.2 Lossless Compression

Lossless compression [5] reduces a file's size without loss of the image quality. This seems to be an efficient technique of reducing file sizes and it can be applied to both image and audio files. Lossless compression basically rewrites the data of the original file in a more efficient way. In this method, the resulting files are typically much larger than image files compressed with lossy compression. Also with lossless compression, a file may be compressed one tenth the size of the original.

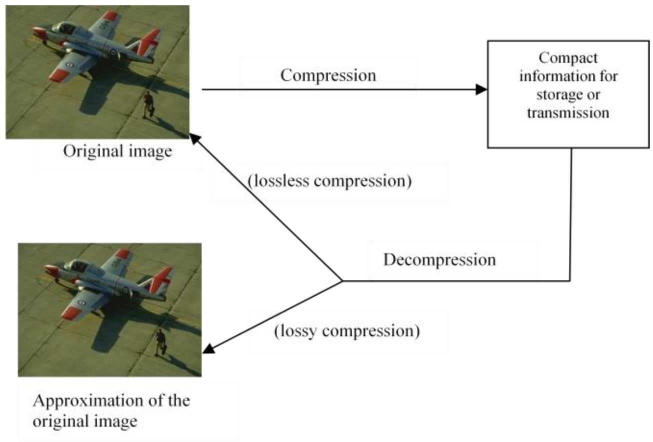

Fig 1. Process of Compression & Decompression

3.3 Wavelet Compression Technique

It is one of the lossy compression techniques. A 'wavelet' is a small wave which has its energy concentrated in time.

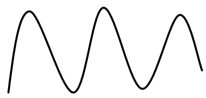

Fig 2.Representation of a wave

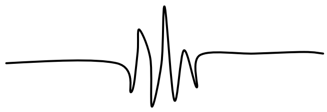

Fig 3. Representation a wavelet

The wavelet packet compression procedure involves four steps[14]:

Step 1: Compute the wavelet packet decomposition of signal x at level N.

Step 2: Computation of the best tree for entropy and compute the optimal wavelet packet tree. This step is optional.

Step 3: Apply thresholding for each wavelet packet coefficients.

Step 4: Reconstruction.

Compute wavelet packet reconstruction based on the original approximation coefficients at level N and the modified coefficients. Wavelet-Based Image Compression is an effective Algorithm due to overlapping basis functions and better energy compaction property of wavelet transforms [6], it also provides high quality result at low bit rate.

The quality of the image are evaluated with the metrics such as Peak Signal to Noise Ratio (PSNR), Mean Square Error (MSE), Compression Ratio (CR).

Compression Ratio (CR)

Compression ratio is defined as the ratio between the original image size and compressed image size [15].

$$\textbf{Compression Ratio (CR)} = \frac{Original\ Image\ Size}{Compressed\ Image\ size}$$

4. IMAGE SEGMENTATION

Image segmentation [7] is a process of partitioning an image into its constituent regions or objects. In digital image processing, image segmentation is widely used in every field such as medical imaging, radar imaging, remote sensing imaging, traffic imaging etc. The level to which the subdivision should be stopped based on the objects of interest in an application has been isolated [8].

4.1 Edge Detection

Edge detectors are local image processing methods designed to detect edge pixels in an image [9]. Mainly, Edge detection differentiates the background color and the foreground color. The result of edge detection of an image is represented as an outline of the borders.

The morphological gradient of the compressed image is computed to overcome over-segmentation problem. The morphological transition is applied to the gray scale image, it returns to high values when sudden transitions in gray level values are detected, and produce low values if neighborhood pixels are similar.

4.2 Computing Internal and External Markers

An approach used to reduce over segmentation is based on the concept of markers a connected component. Computing markers are direct application of watershed segmentation algorithm leads to over segmentation due to noise and other local irregularities of the gradient. There two types of markers, internal and external markers. Internal markers are associated with foreground pixels of an image. External markers are associated with background pixels of an image [10]. The procedure for foreground markers, which must be connected blobs of pixels inside each of the foreground objects. Then the morphological techniques called opening by reconstruction and closing by reconstruction are applied to clean up the image. These operations will create flat maxima inside each object that can be located using image opening [11].

Openings by reconstruction operations are performed with a closing can remove the dark spots and stem marks. Compare to a regular morphological closing with a closing-by-reconstruction. A regional maximum is calculated from the reconstructed image to obtain good foreground markers. In the resultant image, the dark pixels represent the background, with a threshold operation. The background markers are too close to the edges of the objects try to segment.

Thinning operation is performed the background by computing the skeleton by influence zones. This can be done by computing the watershed transform of the distance transform and then looking for the watershed ridge lines of the result.

5. EXPERIMENTAL RESULT

The experimentation is done with the standard data base Berlkey segmentation dataset. In the first phase the preprocessing is done. Then the resultant image is compressed with Harr wavelet. After the extraction of foreground and background markers, the image is segmented with watershed based segmentation [12] is applied on marker images. Dilation operation is used to superimpose the segmented object boundaries on the original image.

The table 1.1 shows the performance measure of watershed segmentation using with compression and the performance measure of watershed segmentation using without compression. The PSNR value of watershed segmentation using without compression is increased and MSE is decreased than the watershed segmentation using without compression. The three images considered are represented as image number they are, 3096 of 481x321 dimensions, 45096 of 481x321 dimensions and 143090 of 481x321 dimensions.

Table 1.1 – Experimentation Result

S.No	**Image Id.**	**Wiener Filter**		**Watershed segmentation with Compression**		**Watershed segmentation without Compression**	
		MSE	**PSNR**	**MSE**	**PSNR**	**MSE**	**PSNR**
1	3096	0.39	52.2581	1274.68	7.11	1449.48	6.55
2	45096	0.64	50.094	2586.86	14.04	2641.99	13.95
3	143090	0.84	48.9107	8159.48	9.05	8045.21	8.6

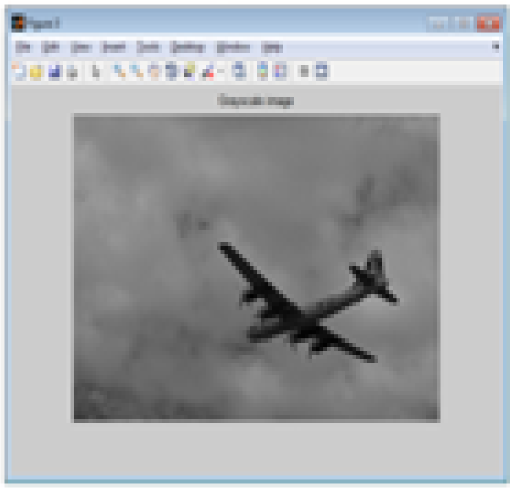

Fig 4. Original Image

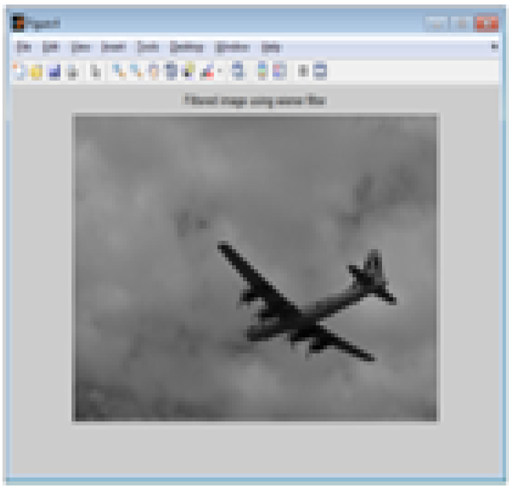

Fig 5. Wiener Filtered Image

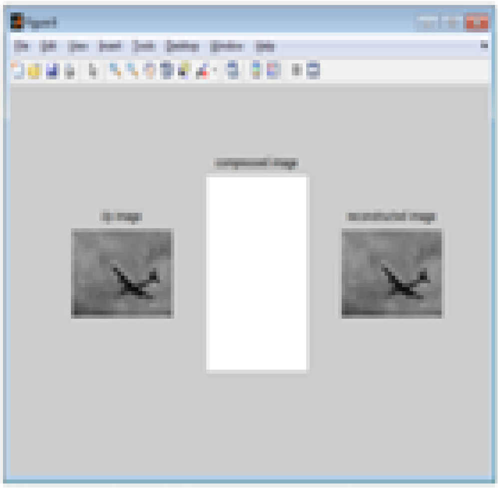

Fig 6. Haar Wavelet Transform

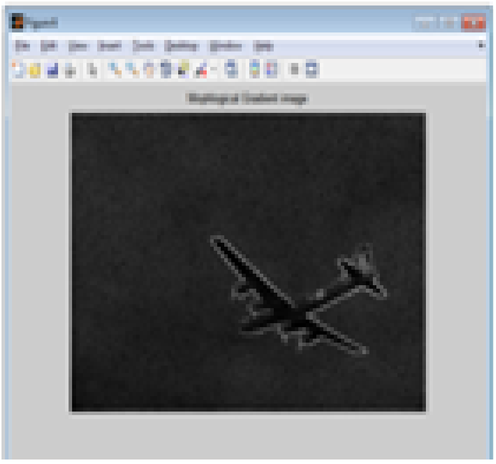

Fig 7. Morphological Gradient

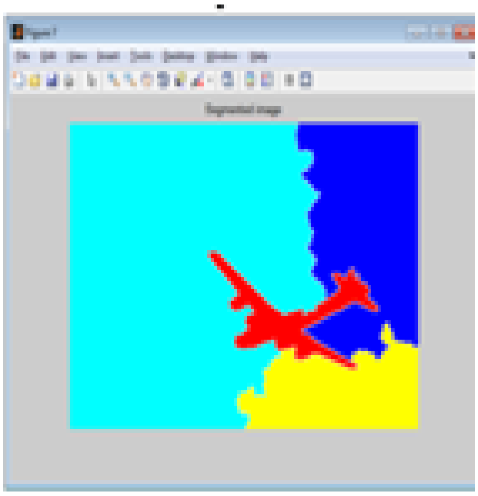

Fig 8. Watershed Segmentation with compression

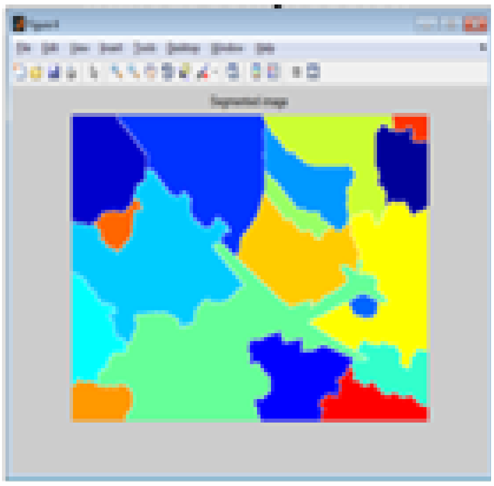

Fig 9. Watershed Segmentation without compression

6. CONCLUSION

Due to the rapid growth in the field of digital image processing; image segmentation plays a vital. In this paper various methods and wrapped to and simplified. Pre processing is accomplish with the wiener filter and compressed the image with harr segmentation and finally, segmentation is made with watershed algorithm. The experimentation is done with the proposed methods and the results are presented. The proposed methods include noise removal techniques with the wiener filter. The results show that the proposed method achieves more accuracy segmentation results than the existing method.

7. FUTURE ENHANCEMENT

In future this technique will be applied in medical images for diagnosis purpose and in satellite images for segmenting the objects.

- To propose a new filter for noise removal.
- To propose a novel compression model.
- To develop a new segmentation algorithm.
- To develop a common framework for an Image enhancement and segmentation.

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