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A Novel Strategy to Image Decomposition for Wireless Capsule Endoscopy Images

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Abstract: ***Now a day wireless capsule endoscopy (WCE) is broadly used for detection of gastro internal organ diseases. WCE is produces quite 55000 images but still there is challenging task of it that captured noisy images. Removing noise from images is difficult aspiration for image denoising technique. Therefore, various redundant blur and amounts of remaining noise ought to be analysis to research the particular results of denoising method. In this research article, different methods are used for image denoising and evaluated performance for wireless capsule endoscopy images. The proposed approach is suggested Bidimensional Empirical Mode Decomposition (BEMD) for WCE images. Here evaluate performance of BEMD method and wavelet. Computer simulation proved that proposed technique offer considerable advantage than other method.***

Keyword- Bidimentional Empirical Mode Decomposition, Wireless Capsule Endoscopy, Intrinsic Mode Function.

I. INTRODUCTION

In advance medical science, endoscopy is powerful tool to examine GI track and identify the diseases. In decade ago, conventionally endoscopic technique is used for examination of upper and lowers a part of GI track. Gastroenterologists face challenges to examine the whole intestine, in particular pose [1]. The length of human intestine is about 20feet and it having several windings and it creates the examination is really painful and complicated.

In 2000, wireless capsule endoscopy came in medical science. It has enabled painless and effective diagnoses of GI track. In wireless capsule system having camera mounted on capsule, storage system and compatible system software. The WCE is not reusable. After swallowing the capsule, it takes images of the entire intestine. The captured images are stored at recorder system. Recorder system is ware by patient. This process is approximately 8 hours or till battery exhausts [1]. Figure 1 show wireless capsule endoscopy. Finally all images are downloaded in computer and evaluated by physician.

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The captured images having noise and it is generated due to poor quality of camera and lens, fixed light source and reflection. This situation image preprocessing is major factor before use of images. It is known that removal of noise is challenging problem in demonizing filter. Recently number of image decomposition technique is existing for example wavelet, Fourier, empirical mode decomposition etc.

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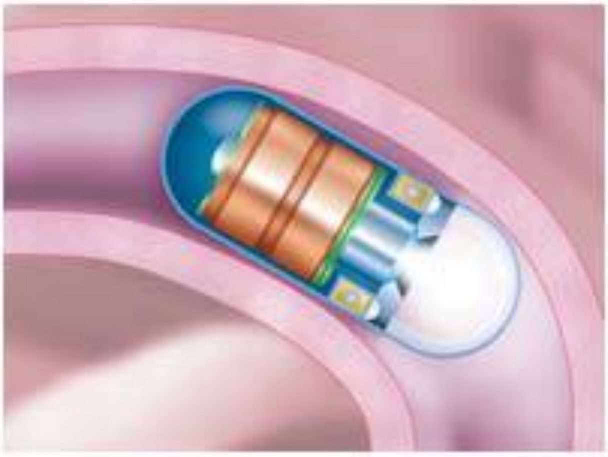

Fig. 1 Wireless Capsule Endoscopy

In this article we are evaluate performance of BEMD method and wavelet method with Mean Absolute Error(MAE), Mean Squared Error(MSE), Correlation Coefficient(CC) and Peak Signal to Noise Ratio (PSNR).

II. BIDIMENTIONAL EMPIRICAL MODE DECOMPOSITION

Data denoinsing is an important process in digital image processing. In few decade researcher is working in this area and aim is reducing noise without degrading the quality of noise. Now days, in digital image processing numbers of decomposition methods are apply for noise removal. Wavelet, Fourier and Empirical Mode Decomposition (EMD) are mostly used for decomposition [3]. BEMD methods have significant advantages than others.

In wavelet and other methods assume test data is liner and stationary. Huang et al proposed new method called EMD [2]. In EMD technique, signals are decomposed into intrinsic mode functions (IMF's). IMF's having small and finite numbers of signals. The proposed method is highly efficient because it is adaptive. Base of EMD is on local characteristics time scale of data.

Each IMF contains extrema as well as zero crossing with same numbers. Empirical Mode decomposition is applied on data signal then it generates IMF's. First IMF has higher frequency than next IMF. Every IMF satisfy below criteria.

1. The zero crossing and extrema are equal or different by 1.
2. The local minima and maxima should zero which is defined by envelope.

If above condition is strictly satisfy by any oscillation is called IMF.

Here consider X(t) is original signal. First step to calculate IMF by finding local extrema. This step is applying for whole signal and means signal calculated which m1 is. Cubic spline is used for this process. The m1 is subtracted from original signal and called as h1.

$$h1 = X(t) - m1 \quad (1)$$

Here h1 is prototype IMF if satisfy above 2 condition and stoppage criteria. If stoppage criteria is not satisfy then same process is performed on h1.

$$h11 = h1 - m11 \quad (2)$$

Here h11 is first IMF if satisfy condition. We notify C1 is first IMF.

$$C1 = h11 \quad (3)$$

If h11 does not satisfy condition of IMF then repeat process k time.

$$C1 = h1k \quad (4)$$

When finalize first IMF then next step is to calculate rest of signal by using following equation.

$$r1 = X(1) - C1 \quad (5)$$

Here r1 is residue signal consider as new signal and repeat the sifting process to find more IMFs.

We can reconstruct signal using following formulas.

$$X(t) = \sum_{j=1}^{n} Cj + rn \quad (6)$$

Where j^{th} IMF is cj and lower frequency residue is r_n. The lowest value of j having highest frequency component i.e. C1. The low frequency component is found when j is increases. Figure 2 shows example of EMD. Where data is decomposed with 5 IMFs and residue signal.

In multidimensional signal required multidimensional EMD. Tow dimentional EMD is called Bidimensional EMD[5]. Graphical representation of BEMD shown in figure 3.

III. SIMULATION RESULTS

a. BEMD Algorithm

The projected system is simulated in MATLAB 2014a. The image taken from WCE. The image decomposed by BEMD method. The input image to the BEMD method is shown in Fig. 4.a. By simulating BEMD algorithm on original image, it generated different IMF's and residue images. Here we select numbers of iteration is three for BEMD method.

Thus three IMF's are generated by this method and one residue which is shown in fig. 4.b-e. As per fig. 4.b shows first imf which have high spatial frequency and fig 4.c is second imf with lower frequency than first. The Residue contains lowest spatial frequency. The original image is reconstructed by adding residue and three IMFs.

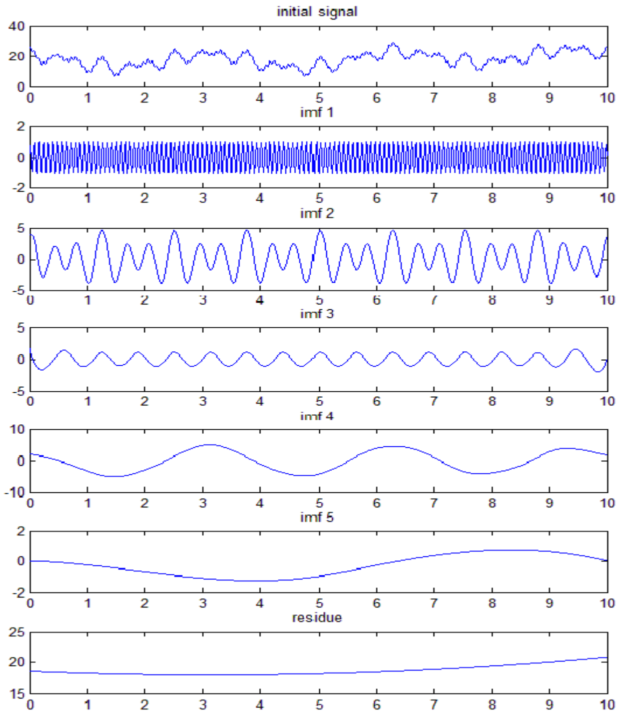

Fig. 2 EMD analysis

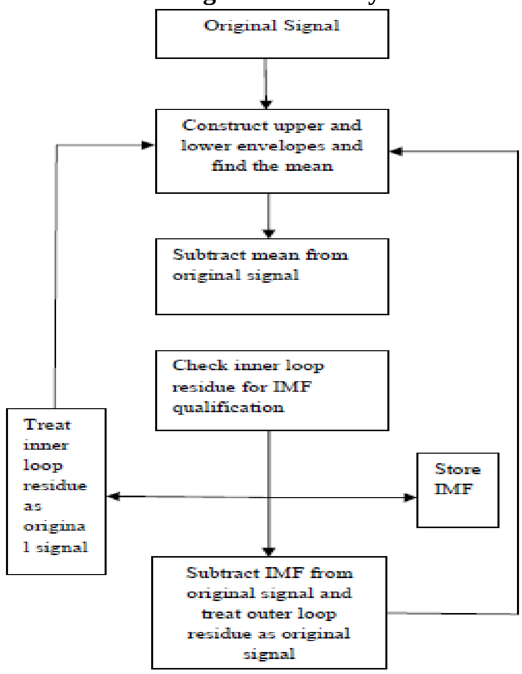

Fig. 3 Graphical representation of BEMD

b. Wavelet Method

Last decades, several constructions of wavelets are introduced in each the mathematical analysis and in signal processing literature. In mathematical analysis, wavelets were originally constructed to analyze and represent geophysical signals using translates and dilates of one fixed function. In image processing, wavelets originated in the context of sub band coding, or more precisely, quadrature mirror filters.

Figure 4.a Original Image

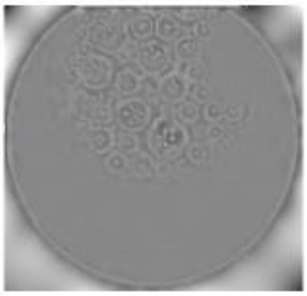

Figure 4.b IMF 1

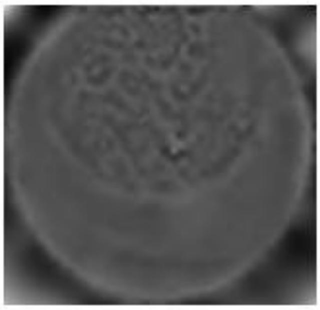

Figure 4.c IMF 2

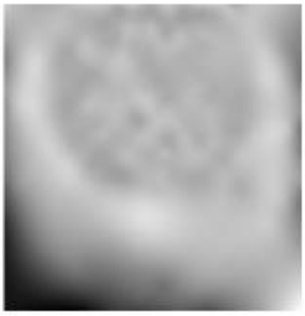

Figure 4.d IMF 3

Figure 4.e Residue image

The connection between the two approaches was made by the introduction of multi resolution analysis and the fast wavelet transform by Mallat and Meyer.

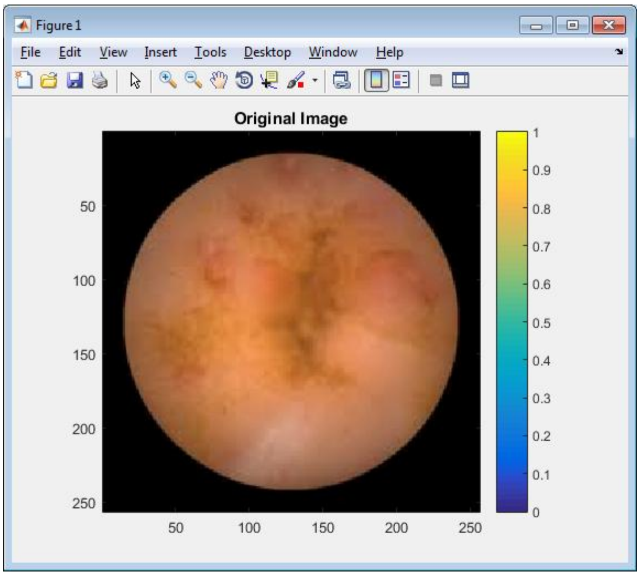

Fig. 5.a Original Image

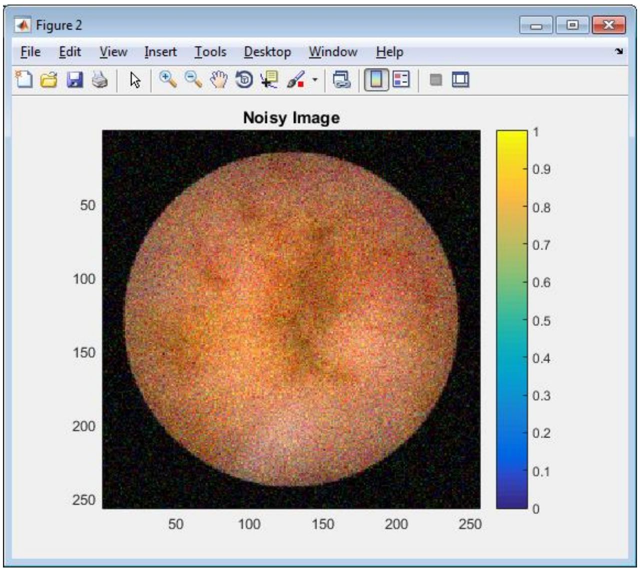

Fig. 5.b Noisy Image

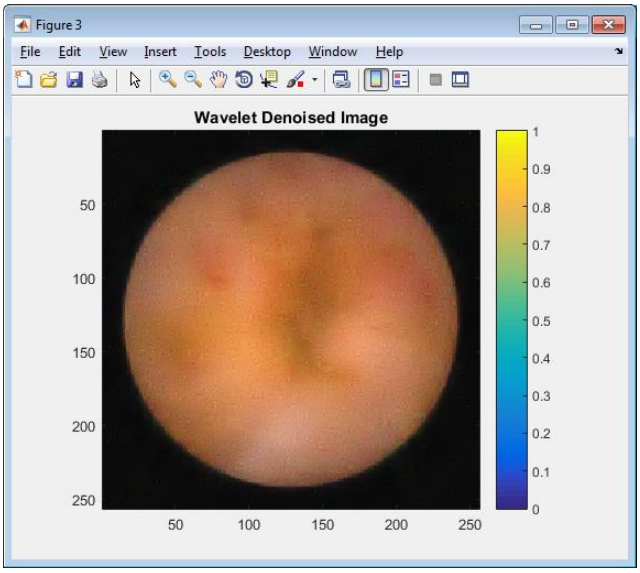

Fig. 5.c Wavelet de-noised image

The input image for wavelet transform is WCE image shown in fig. 5.a. Here we add Gaussian noise in original image which is shown in fig. 5.b. The output of wavelet transform with decomposition of image is shown in fig. 5.c.

IV. STATISTICAL RESULTS

It is known that noise removal from WCE is major task. Image denoising technique is used for removal of noise. Performance of denoising methods must be evaluated by different technique. Most common methods To check performance of image denoising method is visual inspection and object measurement based on pixel wise difference between processed image and original.

For measurement of noise cancellation MSE or PSNR is used. To evolution of edge preservation MAE metrics are applied. All the mentioned method measures are typically evaluated in the RGB coordinate system, therefore the most popular color space for a variety of applications.

Table No. I Comparison chart of PSNR

	BEMD	Wavelet
Image1	27.1729	23.7938
Image2	28.1847	23.5959
Image3	27.4816	22.2869
Image4	27.1677	21.7462
Image5	27.9717	23.5424
Image6	28.0729	24.0815
Image7	27.7166	22.9657

Table No. II Comparison chart of MSE

	BEMD	Wavelet
Image1	0.0019	0.0041
Image2	0.0015	0.0043
Image3	0.0018	0.0059
Image4	0.0019	0.0066
Image5	0.0016	0.0044
Image6	0.0015	0.0039
Image7	0.0017	0.005

For simulation we took seven different images of WCE and applied BEMD algorithms as well as wavelet transform. Evaluate performance of both method using PSNR, MAE, MSE and CC.

Table No. III Comparison chart of CC

	BEMD	*Wavelet*
Image1	0.9915	0.9724
Image2	0.9925	0.9733
Image3	0.9891	0.9679
Image4	0.9907	0.9741
Image5	0.9934	0.976
Image6	0.992	0.9698
Image7	0.9953	0.9829

Table No. IV Comparison chart of MSE

	BEMD	*Wavelet*
Image1	9.8457	10.8059
Image2	8.2405	11.6309
Image3	8.4705	13.4658
Image4	8.8344	14.651
Image5	8.5127	11.4477
Image6	8.5378	10.8577
Image7	8.6315	12.2296

Performance of BEMD algorithm is better as compare to wavelet. Table no. I to IV shows that performance evaluation of BEMD and wavelet. PSNR of BEMD algorithm is improved than wavelet. The mean squared error (MSE) measures the average of the squares of the errors that is, the average squared difference between the estimated values and the actual value. MSE value of is near to zero. Smaller value of MSE is more accurate. Above table shows BEMD MSE value is smaller than wavelet.

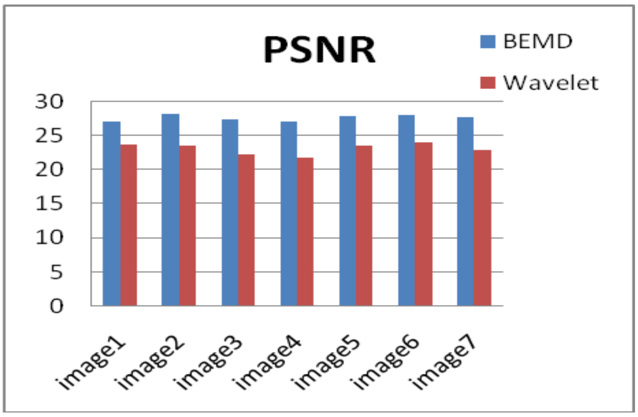

Fig. 6.a Comparison by PSNR Method

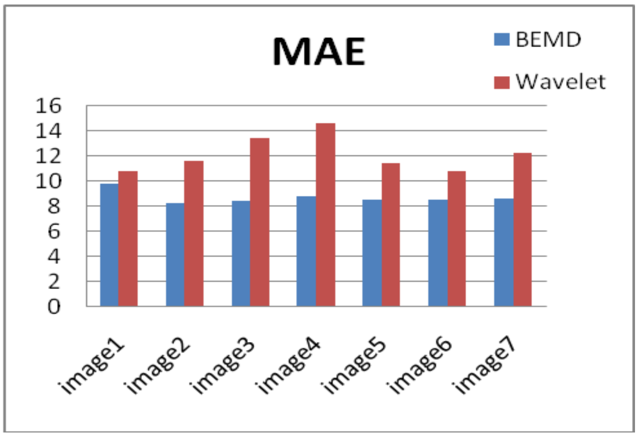

Fig. 6.b Comparison by MAE Method

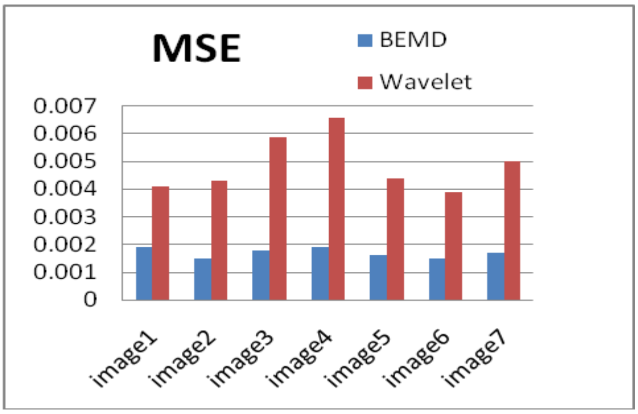

Fig. 6.c Comparison by MSE Method

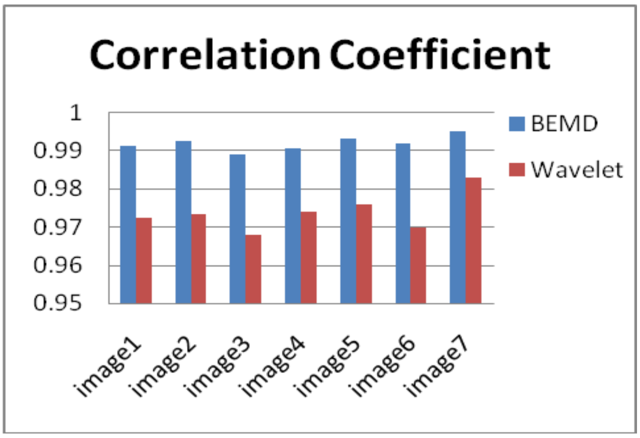

Fig. 6.d Comparison by CC Method

V. CONCLUSION

This research paper was to performance analysis of image decomposition technique for WCE images. Here performed image decomposition using BEMD technique and wavelet transform. As per performance, Cubic spline technique is suitable for implimention of BEMD. It is flexible and simple. BEMD is deal with non stationary and non liner signal. BEMD method having more advantage than wavelet transforms. Simulation result proved that BEMD algorithm is more accurate than wavelet. But time required for simulating BEMD is more than wavelet in MATLAB platform. Experimental results showed that image decomposition using BEMD outperforms the state-of-the-art methods significantly in terms of PSNR, MSE, MAE and CC.

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