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Underwater Image Reconstruction Using Image Fusion Technique

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Abstract

In proposed work the image fusion technique is used for reconstruction of underwater image. The main purpose of proposed work is to improve resolution of underwater image. There are various method employed for reconstruction of underwater images but some have limitations such as low resolution. Resolution is one of the parameter which is important for quality of images. Wavelet based image reconstruction may improve resolution of underwater images. Image fusion technique has three levels 1) data or pixel level 2) feature level 3) decision level. Here data or pixel level image fusion technique is used.

Keywords: Underwater imaging, wavelet, image fusion.

Introduction

Underwater imaging is widely used in ocean exploration and other fields, however, due to absorption and scattering effects from the environment, serious degradation exists in underwater images, mainly in the form of noise, blur, etc. Reconstruction of underwater image is challenging task. Underwater images may contain distortions. Distortion may be caused by both motion blur and refraction. It also contains some quality degradation. So that it is necessary to improve the quality of images. Reconstruction of images from blurred and noisy images may improve the quality of images.

There are various methods employed to reconstruct underwater images. R Shefer, M. Malhi, and A. Shenhar [2001] [1] presented method of underwater image reconstruction using average based method. In this method they used sequences of underwater image. They used backward projection algorithm and then obtained reconstructed image by averaging four distorted images. Alexei A. Efros_Volkan Isler, Jianbo Shi and Mirk´o Visontai [2005][2]studied the problem of recovering an underwater image from a video sequence. Because of the surface waves, the sequence consisted of distorted versions of the image to be recovered. They also worked on formulation of the reconstruction problem as a manifold embedding problem and also included a new technique, based on convex flows, to recover global distances on the manifold in a robust fashion. This technique solved the leakage problem inherent in recent embedding methods. Arturo Donate and Eraldo Ribeiro [2006][3] presented new method for removing geometric distortion in images of submerged objects observed from outside shallow water. They focused on the problem of analyzing video sequences when the water surface is disturbed by waves. The water waves affected the appearance of the individual video frames such that no single frame is completely free of geometric distortion. They used a multistage clustering algorithm combined with frequency domain measurements that allowed selecting the best set of undistorted sub-regions of each frame in the video sequenceZ.Y. Wen, D. Fraser, A. Lambert[2007][4] Presented bispectrum method where thet analyzed the raw image sequences and recover the phase information of the true object. Although this technique is standard and promising this techniques has limitations such as it requires large computer memory due to heavy computations and low resolution .while Kim-Hui Yap and Li Chen[5] presented cross bispectrum method for noisy images and also found the solution of reducing complexity of computation.the second limitation is resolution.

The proposed technique gives better results for resolution of underwater images. Image fusion is powerful technique which is used to improve resolution. Here wavelet based image fusion is used.

Image Fusion

A. BASICS

The image fusion is combination of two or multiple images taken from same or multisensors. The resulting image will be more informative than any of the input images. The applications of image fusion technique are Image Classification, Aerial and Satellite imaging Medical imaging Robot vision

Concealed weapon detection,Multi-focus image fusion. There are levels of image fusion technique

1) Data or pixel level
2) Feature level
3) Decision level

Pixel-based fusion is performed on a pixel-by-pixel basis. It generates a fused image in which information associated with each pixel is determined from a set of pixels in source images to improve the performance of image processing tasks such as segmentation. Feature-based fusion at feature level requires an extraction of objects recognized in the various data sources. It requires the extraction of salient features which are depending on their environment such as pixel intensities, edges or textures. Decision-level fusion consists of merging information at a higher level of abstraction, combines the results from multiple algorithms to yield a final fused decision. Input images are processed individually for information extraction. The obtained information is then combined applying decision rules to reinforce common interpretation.

B. Slandered Image Fusion Methods

Image fusion methods can be broadly classified into two groups - spatial domain fusion and transform domain fusion. The fusion methods such as averaging, Brovey method, principal component analysis (PCA) and IHS based methods fall under spatial domain approaches. Another important spatial domain fusion method is the high pass filtering based technique. The disadvantage of spatial domain approaches is that they produce spatial distortion in the fused image. Spatial distortion can be very well handled by frequency domain approaches on image fusion. The multiresolution analysis has become a very useful tool for analyzing remote sensing images. The discrete wavelet transform has become a very useful tool for fusion. Some other fusion methods are also there, such as Lapacian pyramid based, curvelet transform based etc. These methods show a better performance in spatial and spectral quality of the fused image compared to other spatial methods of fusion [www.wikipedia.com]

In proposed method the pixel level wavelet based image fusion technique is used.

Wavelet Based Image Fusion Technique

The block diagram of proposed system is as follows

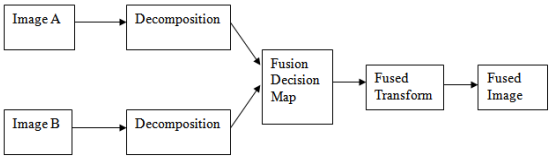

Figure 1. Block of proposed work

Process can be divided into following steps

- With wavelet multi-resolution analysis transform, the algorithm first decomposes an image to get a approximate image and a detail image, which respectively represent different structures of the original image.
- Then targets for all floors of the image feature domain and processes them with special fusion algorithm, so the effect of fusion will be much better i.e. the source images A and B are decomposed into discrete wavelet decomposition coefficients: LL (approximations), LH, HL and HH (details) at each level before fusion rules are applied.
- The decision map is formulated based on the fusion rules.
- The resulting fused transform is reconstructed to fused image by inverse wavelet transformation and is as shown in Fig 1.

Algorithm

Image Pre-processing

Image acquisition and pre processing is first step of the fusion algorithm. Images are captured by using the multisensor or same sensor. There are lots of pre processing methods used for underwater images. This involves contrast stretching, brightness adjustment.

Decomposition of Images

1) After pre-processing, decomposition of images is carried out by using wavelet transform. Decompose the images by using wavelet analysis where it will be decomposed at different level. The purpose of decomposition is to obtain high and low resolution frequency bands. One level decomposition produces 4 frequency bands i.e. Low-Low (LL), Low-High (LH), High-Low (HL) and High-High (HH). Next level decomposition will be applied to the LL band of the current decomposition stage, which will forms a recursive decomposition procedure. Thus, N-level decomposition will finally have *3N+1* different frequency bands, which include *3N* high frequency bands and just one LL frequency band. The frequency bands in higher decomposition levels will have smaller size

Fusion Rule

The wavelet transform is used to construct the wavelet coefficients of fused image using multiple operators according to different fusion rules. Fusion will be carried out based on set of fusion

rules. Fusion rules are used for selection of wavelet coefficient. It includes

1) Selection of low frequency sub band
2) Selection of horizontal and vertical orientation
3) Selection of diagonal high frequency sub band coefficient

Reconstruction of Fused Image

The fusion decision map is formulated according to fusion rule. Carry Inverse Discrete Wavelet Transform for obtaining fused image.

Result and Discussion

Here the two underwater images are taken by 16 mega pixel digital camera. The blurred effect is added and deblurred by wiener and Lucy Richardson filters. The output of these two filters is fused by using above algorithm. the results are compared using parameter PSNR and results are shown in tables given in below .

Table 1 gives results of psnr of wiener and lucy richerdson algorithm.

Table 2 gives PSNR of fused image with different wavelets.(image of size 512x384)

Size of image	Wiener filtering	Lucy Richerdson
64x48	39.65	22.4646
128x171	40.4926	23.7099
256x341	43.7601	26.8431
512x384	47.2481	29.1615

Table 1:PSNR for different sizes of images

Wavelet	PSNR
Haar	19.0857
Db2	19.4290
Db6	19.1851.
Db10	17.5878
Db16	16.2537
Sym2	19.4290
Sym6	17.8861
Bior1.3	18.7396
Bior2.8	17.778
Coif1	19.0025
Coif5	17.0908

Table 2: PSNR for different wavelet

Conclusion

Here it can be seen that deblurring technique gives better peak to signal noise ratio from table 2 it can be seen that the results of wavelet ‘db2’and ‘sym2’gives better results than other wavelets it can also be seen that as size of images are increases the psnr increases.

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