Study and Analysis of Sonar Image Enhancement Using Image Fusion Techniques

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Abstract: The Paper presents a review on sonar image enhancement and object detection using image fusion techniques. Multisensory devices like sonar usually provide different information for the same scene. Image fusion is best suited for these systems. It combines the relevant information of some scene from multiple images. The final image will be more informative than any of the input images. Among all categories of image fusion, discrete wavelet transform (DWT) proved to be the best. The image processing techniques includes segmentation, object detection and classification are to be processed further. Usually the Pareto optimization methods are used to evaluate the image quality matrices.

Key words: Image fusion • DWT • Segmentation • Object detection • Classification • Pareto optimization

INTRODUCTION

A very fast development in the technology and instrumentation improves large number of applications including under water sea mining. There are so many equipments are available to detect the underwater objects like acoustic camera, interferometricsonar, side scan sonar (SSS), Synthetic aperture sonar (SAS), etc. All SAS and SSS are multisensory instruments used widely for the applications like mine detection, oil exploration, ocean drilling, sea bed mapping and even fish localization and soon [1, 2]. Though these two are multisensory equipments produces complementary data for the same scene. The image fusion is the only way to retrieve the required information from the received data.

Image fusion will combine the multiple information of same scene from different sensors and produce the resultant image which is more suitable for all applications with improved qualities and less distortion. The output fused image is used for further image processing steps involves segmentation, object detection and classification.

Finally we will get all the required details from the given input images. Three categories of image fusion are available [8-10], they are pixel level, feature level and decision level. Since the pixel level fusion is employed because it is easy to implement, simple and efficient. Our multisensory sonar devices gives as the multi resolution data. So a suitable fusion technique should be used for analysis.

Image Fusion Techniques: Basically we have three stages of evolution in image fusion, like simple image fusion, pyramid based decomposition and wavelength transform. The simple decomposition involves average methods, select maximum/minimum methods and principal component analysis. These Methods are not suitable for low contrast images [6, 7]. Because it reduces the overall contrast of the image so we go for next stage of fusion called pyramid decomposition gives us the best solution with less signal to noise ratios and distortions. There are many pyramid decomposition methods are used like laplacian pyramid, Gradient pyramid etc. discrete wavelength based decomposition provide the better spatial and spectral quality of multi resolution image fusion. The DWT is of different forms like DWT-Haar, DWT-Daubechies, DWT-Legal etc. [5].

Based on the image quality we got, choose appropriate technique by this study for multi-resolution sonar images, we prefer DWT.
Discrete Wavelength Transform: DWT is implemented by filtering and down sampling the source image is taken as x(n). Initially image registration & resembling are done for pixels alignment between the images.

It passes through the low pass filter g(n) and high pass filter h(n).

![Discrete wavelet transform coefficients](image1)

The resultant images produces approximation coefficients and detail coefficients. The below figure shows the 3 decomposition levels [2-4].

![DWT with three decomposition levels](image2)

For K level of decomposition we have one low frequency portion (LL) and 3K high frequency portions (LH, HL, HH).

The coefficients are fused by certain fusion rule. The inverse wavelength transform will be constructed based on the requirement.

MATERIALS AND METHODS

In my study 'young yang Donssunpark, shuying Huans and Niti Rao', proposed a new medical image fusion technique to be fused are decomposed by the wavelength transform. The coefficient in lower frequency band are selected with a visibility based scheme, and the coefficient in high frequency bands are selected with variance based method.

The window based consistency verification is done for all the coefficients of the fused image [9]. The evaluation parameter also proves this method is very effective and satisfactory result. In another study states that DWT with Hair fusion method as the one with best image quality metrics. In the paper [12] they proved that this method produces 63.33% of times better quality based on visual than any other algorithm. For a set of images like this for various applications visual perception also give various results [10, 11]. Quality of the fused image [12, 13] is measured mainly by structural similarity index metric, least mean squared error metric, peak signal to Noise ratio. Many other metric are also there for image quality evaluation. Multi-resolution sonar image also need best fusion technique. The best fusion techniques as already stated are simplified in sonar images and finally using optimality algorithms the one fusion technique which is superior to another fusion technique is identified.

**Step 1:** Input images are undergone registration and resampling for adjusting the images in to same dimension.

**Step 2:** The proposed fusion algorithm is implemented to get fused image. The image analysis is performed next through segmentation, object detection and classification.

**Step 3:** The segmentation is applied to partition the image. Object detection gives the exact boundary for the objects of the fused image.

**Step 4:** Finally classification technique produces the detailed description about the objects.

![Proposed algorithm](image3)
CONCLUSION

For future work, the desired algorithm is to be implemented for more than 2 images. An option to load and fuse more than 2 image at same time can also be done with the help of image processing tool kits. In remote sensing application, multi wavelength based image fusion techniques are highly suitable. So the sonar image fusion is also performed with more than 2 images with multi wavelength and its quality metrics are also calculated and evaluated in future followed by image fusion, the next stages of image analysis includes segmentation, object detection and classification are done.

REFERENCES