PIXEL-LEVEL IMAGE FUSION ALGORITHMS FOR MEDICAL IMAGES

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Abstract-

Image fusion is an important research topic in many related areas such as computer vision, automatic object detection, remote sensing, image processing, robotics, and medical imaging. Image fusion techniques can improve the quality of image and increase the application of these data. In this paper, a new fusion technique is proposed for multi-modal medical images based on maximum and minimum pixel values. This method enables the decomposition of input images into coarse and detailed layers, and utilizes its pixel values for combining two images. This method preserves more detail in the source images and further improves the quality of the fused image. The final fused image is obtained from the superposition of selected coefficients in the coarse and detailed layers.

Index Terms— Image registration, coarse layer, detail layer

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1. Introduction

Image fusion is a combination of visual information contained in any number of input medical images into a single image without introducing distortion or information loss. Fusion of multimodal imaging system combines optical, radioactive and magnetic properties combine of MRI and CT as well as PET, SPECT and other imaging. Medical image fusion can be performed at three broad levels such as pixel level, feature level and decision level[1]. Pixel based fusion is performed on a pixel-by-pixel basis, generating a fused image in which information associated with each pixel is selected from a set of pixels in the source images. Medical image fusion at the feature level requires the extraction of salient environment dependent features, such as pixel intensities, edges, or textures. Decision-level fusion involves merging information at a higher level of abstraction, combining the results from multiple algorithms to yield a final fused decision.

In this project fusion is performed at pixel level and is performed on pixel by pixel basis so, generated a fused image associated with each pixel which is selected from a set of pixel in the source image. A CT and MRI images are used as a source images, CT image show bony structure and MRI gives tissues, vain and other detail of body organ [2]. Next step is to decompose an image into multi-layers of the same size as the original. Image decomposition is based on multilevel local extrema (MLE) by edge preserving method [3]. This method enable decomposition of input image into coarse and detail layer in MLE scheme and utilize local energy and contrast fusion rules for coefficient selection in different layers so, this decomposition scheme separate texture from original image. (MLE) representation has been shown many advantages over conventional image representation method. This preserves more detail in the sources image and further improves quality of fused image. Pixel-level fusion algorithm for multi-modal medical images based on their local extrema, we decompose an image into multi-layers of the same size as the original. Similar to the wavelet-like method, we decompose an image into coarse and detailed layers. The proposed method utilizes the detailed layer, which reflects the regional pattern and edge information of the image, to guide the fusion process.

Different fusion methods were performed to enhance results of fused image [4][5], the simplest method is to average the input images to generate a fused version. This method will heavily degrade the brightness of the input images. The IHS fusion algorithms have been extensively used for relatively simple fusion schemes. Multi-resolution analysis (MRA) based fusions, such as Pyramid-based image fusion methods, Wavelets and their related Contourlet transform (CT) and Nonsubsampled CT (NSCT). Many neural network models have been proposed for image fusion, such as Self-Organizing Feature Maps (SOFM) and Pulse Coupled Neural Networks (PCNNs).

2. Flow Diagram

The block diagram of proposed image fusion technique is shown in fig.ure 1 originally medical images are in DICOM format for project we have to convert format of image into required format. Initially input images CT and MRI are taken, these two images should be properly aligned, and these properly aligned images are called as registered images.

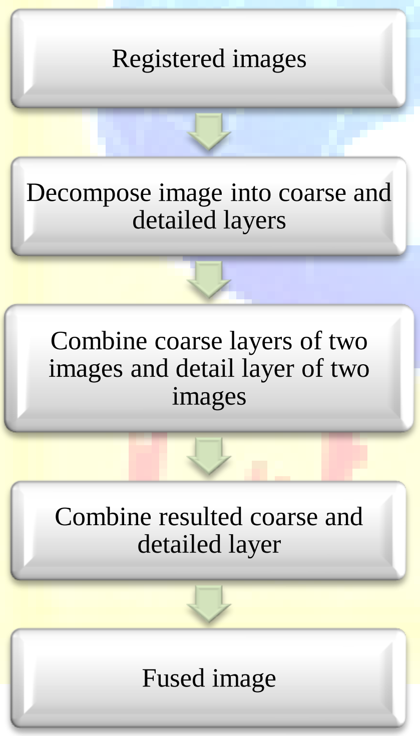

Figure 1: Block diagram of proposed image fusion algorithm

The input images are decomposed into two layers coarse layer and detailed layer. Then coarse layers of CT and MRI are combined and detailed layers are combined likewise. Final fused image is obtained by combining these two combined layers.

2.1. Image Registration

Image registration is a determination of a geometrical transformation that aligns points in one view of an object with corresponding points in another view of that object or another object. For image registration initially two images of same view to be registered and the output is a geometrical transformation, which is merely mathematical mapping from points in one view to points in the second. The corresponding points are mapped together. Here we have taken already registered images.

3. Image decomposition

Image decomposition is important step in the proposed algorithm. A single image can be decomposed into a coarse layer and detailed layers. The coarse layer is an approximation of the original image, and the detailed layers show high frequency details such as edges and textures in different levels of the w*w sample window.

3.1 Coarse Layer:

The coarse layer contains the intensity distribution and easily perceivable amplitude of intensity variation of the original image. In the medical image, the coarse layer reflects anatomical and functional information of tissues and organs. The coarse layer can be obtained by averaging the local minima and maxima envelopes. The image I can be decomposed into a coarse layer M and detailed layers dL; L= 1... N, represented as I = M. From L = 1...N, image I can be further decomposed into a coarse layer C_L

$$M=1/N\sum_{L=1}^{N} C_L \qquad (1)$$

3.2 Detail layer:

The detailed layer contains the texture pattern and local edge information of the original. It also reflects the texture and local edges of the tissue. The detailed layer can be obtained by subtracting the coarse layer from the original input image. After obtaining M, the final detailed layer d_L; L = 1 . . . N, is given by

$$d_L = D_L + (C_L - M) \quad (2)$$

The essence of medical image fusion is to integrate as much valuable information for diagnosis as possible from different sources into one image. The valuable information is always in the form of anatomical and functional tissue and organ information, as well as the texture and local edges of the tissue. Information of high diagnostic value is mostly concentrated in regions containing dramatic changes in both the coarse and detailed layers.

4. Fusion Algorithm

In the fusion of medical images, a good result should preserve all the salient features from multi-modal images and introduce as few inconsistencies as possible. Image registration is an important step before image fusion. The registered image is decomposed into coarse and detailed layers. Detail layer generated from multi-level window sizes can expose the local properties of images better than existing image representation methods. Based on these attributes, this method is proposed to fuse medical images from different sources.

This medical image fusion algorithm combines different levels of coarse and detailed layers from multi-source images using new fusion rules. This creates a fused image that contains more information than a single source image, and is more suitable for human visual perception and object detection in clinical applications. In this project registered CT and MRI images are taken. The registered images are then decomposed into one coarse layer and several detailed layers using the local extrema envelope method.

Procedure for proposed fusion technique

1. Decompose registered image into coarse and detailed layer.

2. Fuse coarse layer of CT with coarse layer of MRI using morphological operations

3. Fuse decomposition layer of CT with decomposition layer of MRI using morphological operations.

4. Combine pixel values of CT and fused MRI and create image fusion of CT and MRI image.

5. Experimental Results and Discussion

Results obtained by applying proposed algorithm to fuse CT and MR images are shown here

in Figure 2 registered CT and MRI images which we want to fuse. Decomposition layers i.e. coarse and detail layers of input images are Figure 3 shows layers of CT and Figure 4 shows layers of MRI. Fusions of coarse layers are shown in Figure 5 and detail layers are shown in Figure 6. And the fusion of coarse and detail layers are shown in Figure 7.

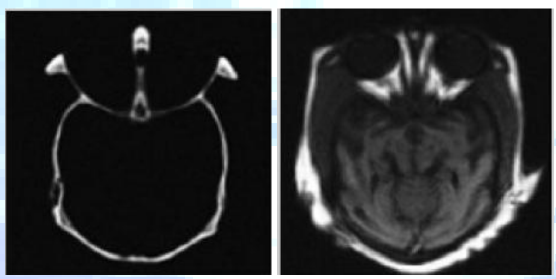

Figure 2 : Registered input CT and MRI

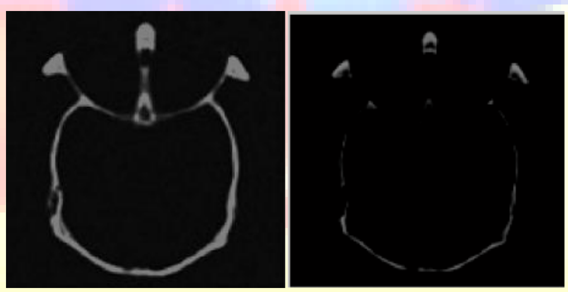

Figure 3 : Coarse and detailed layer of CT

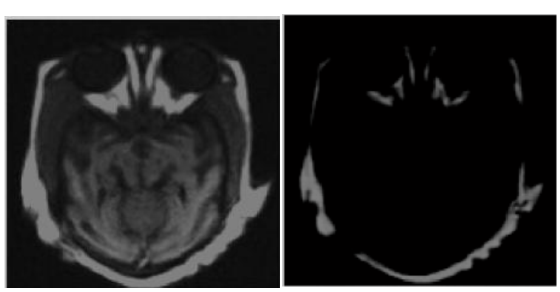

Figure 4 : Coarse and detailed layer of MRI

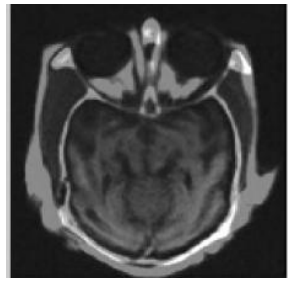

Figure 5 : Fusion of coarse layers

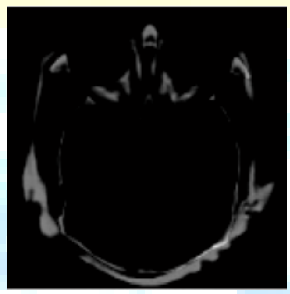

Figure 6 : Fusion of detailed layers

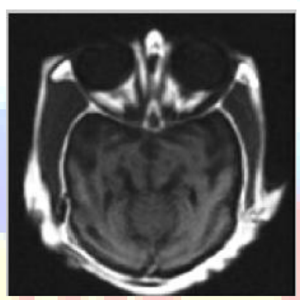

Figure 7 : Fusion of detailed layers

4. Conclusion & future work

In this paper, we proposed a efficient method for medical image fusion. The system has been tested on many images of CT and MRI's. The proposed system works quite well however, there are still areas for improvement. Getting registered and low noise image is the great challenge for image fusion.

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