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Segmentation of Fused CT and MRI Images with Brain Tumor

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***Abstract* - This paper proposes an approach for combining two multimodality images [CT and MRI] with tumor cell, helps to delineate the anatomical and physiological differences from one dataset to another using Wavelet transform and its inverse transform. Image fusion is the process that matches two or more image datasets resulting in a single image dataset. There are many fusion processes that can take place at different levels, in this paper focuses on pixel level fusion process, where each pixel from the input images [CT and MRI] are taken as composite input data for further processing. In this project the next proposed step is to segment the tumor using Otsu's Algorithm. Segmentation process is performed to detect the tumor from all the above three images i.e., CT, MRI and Fused Image by using OTSU's segmentation algorithm for future comparison. The fused image contains both soft tissue information's like Tumor and also hard tissues information's like bones, helpful for physician and doctors to quantify the area of tumor for surgical planning. This paper also reduces the treatment cost to patient where there is no need of separate imaging device to obtain CT/MRI imaging modality.**

***Keywords*: Fusion, Inverse wavelet transform, Otsu's Algorithm, Segmentation, Wavelet transform.**

I. INTRODUCTION

A brain tumor is an intracranial solid neoplasm, which is defined as an abnormal growth of cells, within the brain or the central spinal canal. Any brain tumor is serious and life-threatening because of its invasive and infiltrative character in the limited space of the intracranial cavity. The American Cancer Society estimated that 18,500 people worldwide (10,620 men and 7,880 women) would be diagnosed with brain Tumor and those 12,760 men and women would die of brain Tumor in 2009 with reference [13]. In India Brain Tumor is a major public health problem. Currently, one in 4 deaths in India is due to cancer in the survey in 2011 subjected to ''Annual Report to the Nation on the Status of Cancer' as given in the reference [14] [15]. Imaging plays a central role in the diagnosis of brain tumors. The high-resolution techniques, such as computed tomography (CT) scans and especially magnetic resonance imaging (MRI) are used for diagnosing tumor. But the consequences faced by doctors are they can't find Brain Tumor in CT image so they go for MRI Imaging where soft tissues are diagnosed clearly but in MRI imaging high density objects like bone are not diagnosed. So this paper proposed to fuse both CT and MRI image where both soft tissues and bone tissues are diagnosed clearly by doctors for identifying Brain Tumor for surgical procedures. For fusion wavelet transform, curvelet transform, Region based fusion algorithms are performed using image processing tool. For segmentation of brain tumor various method like K-Means clustering, Thresholding, C-Means clustering, Otsu's algorithm, Edge based segmentation, Watershed segmentation are performed. In this paper Otsu's Algorithm is used to segment tumor [7] [8].

The paper is structured as follows: Section II describes in detail about the methodology of proposed paper. Section III describes the Result and Discussion of output images and paper is concluded in Section IV. Future work may be extended for the proposed work described in Section V.

II. METHODOLOGY

Source images like CT and MRI image [12] are used as input image for fusion process and along with the source image fused output image is also used as input for segmentation process. Wavelet transform [1] [7] is used for fusion of CT and MRI images [6]. Algorithm for fusion is performed and output images are obtained and taken as an input for segmentation algorithm to segment tumor alone from input images. Otsu's segmentation algorithm is used to detect the tumor from the input image. Fused image is taken as an input image to delineate the anatomical and physiological differences from one dataset to another as shown in the figure 1 below.

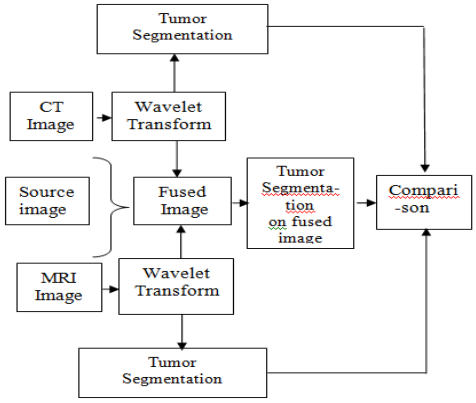

Fig.1 Methodology for Proposed method

III. RESULTS AND DISCUSSION

Medical Image Fusion Based on An Improved Wavelet Coefficient Contrast method is applied for input image the fused output of CT and MRI images are shown in the figure 2. Segmentation algorithm is performed for CT Images using Otsu algorithm [2] and tumor cells alone segmented from background as shown in the figure 3. With respect to the medical diagnosis, the edges and outlines of the interested objects is more important than other information. Therefore, how to preserve the edge-like features is worthy of investigating. As we know, the image with higher contrast contains more edge-like features. By using edges in the medical images physicians can easily identify the abnormality and it helpful in various applications like to measure distance between outer bone and tumor and to identify the tumor density. The edge detection algorithm is performed on tumor output image and outputs of edge detection are shown in the figure 4.

Various algorithms used for fusion of two images are curvelet transform, region based fusion, and edge based fusion [3] [4] [5]. But the basic requirement for fusion is, the region of interest (ROI) and the pixel size of image should be same in the source image. In this paper fusion of two input images [CT image & MRI image] are performed using wavelet transform algorithm.

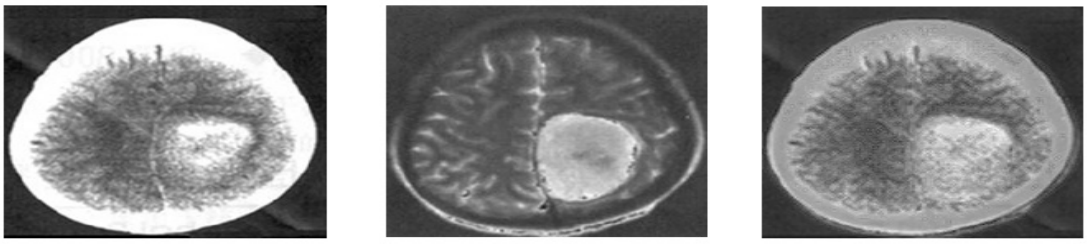

Fig 2: Input Images a) CT Image b) MRI Image c) Fused Output Image

Fig.3: Segmented Images of a) MRI Image b) CT Image c) Fused Output Image

Fig..3: Segmented Images of a) MRI Image b) CT Image c) Fused Output Image

Wavelet transform [10] is the simple method to implement the fusion algorithm as it doesn't need any preprocessing steps compared to curvelet transform algorithm where more pre processing steps are required. In addition to it, curvelet algorithm requires a wrapping method for fusing two images. Wrapping is the method to divide the image into various windows by taking each window as input for fusion. Depending on the frequency of input image, wrapping is done. But in wavelet transform the image is divided into four sub bands with respective to the coefficient of input image and inverse transform is performed at final stage to obtain output as shown in the figure 2. Fusion rule implemented to obtain the final fused image. So wavelet transform is simple to implement compare to other fusion algorithms

The implementation of Segmentation process is performed using both the Otsu segmentation algorithm and edge detection methods [9]. The implementation is carried out using Matlab software [11] for three sets of input image i.e., CT Image, MRI Image and Fused output Image (obtained from region based fusion method).

1. For MRI image with tumor the Otsu's segmentation algorithm is performed to segment the tumor part alone from the input image. And the tumor part is been segmented from the background as shown in the figure 3(a)
2. The segmented result on CT image is not as clear as shown in figure 3(b), since in CT image only hard tissues can be figured out rather than soft tissues like tumor.
3. The fused image having a clear figure of the tumor is taken as the input image for segmentation using Otsu's algorithm and tumor cells are segmented and differentiated from background without any loss of information. The segmented image is shown in the figure 3(c).
4. In order to verify segmentation results, the edge of the tumor cells are detected using normal edge detection algorithm namely canny edge filter is used.
5. With the results obtained, significant differences in image segmentation algorithm and its performances are brought into light
6. The subjective method of identifying the tumor cells using edge detection algorithm for all three input images are performed using edge detection algorithm and shown in figure 4(a) 4(b) and 4(c)
7. For fused image, the edges are segmented clearly compared to CT image and MRI image
8. From the above results, it can be concluded that the identification of Tumor abnormality is clearly seen in the fused Image output than in the CT or MRI images

IV. CONCLUSION

This paper specifically evaluates the effectiveness of Fusion of medical images like CT image and MRI image using Wavelet transform and introduces an efficient way of segmentation of tumor from three sets of input images i.e., CT image, MRI image and fused image using Otsu's segmentation algorithm. Achieving results with all the desired segmentation result are actually difficult, since there is no theory of image segmentation. The main objective of the project is to acquire more information on fusion using two modality of images and the abnormality in the input image (i.e.) tumor is segmented from the fused image which helps doctor to delineate the anatomical and physiological differences from one dataset to another.

The fusion of CT and MRI images also reduces the medical cost. For analyzing the combined CT and MRI information, doctors would mostly prefer imaging technique using PET-CT scanner etc. But by fusion of that information using image processing software reduces the cost of entire device. The most important and complicated factor is to fuse multimodal images of CT and MRI without any loss of information because in medical imaging, the abnormalities are diagnosed using imaging techniques.

V. FUTURE WORK

The major research directions that can be pursued and improvements to be made in the future segmentation method and various applications are involved in this fusion of medical imaging concepts which depends of doctors and physicians. Major research is to deal with the method of acquiring the input image with same ROI (Region of Interest) and same size of medical images.

Future work also leads to apply the fusion concept in various applications in various fields. To help surgeons and physicians in various applications include measuring distance between bone region and abnormal location, to measure tumor density and size from output image. Fusion rule can be expanded to various input source images like PET/CT fusion and comparison with normal image from PET/CT scanner where the enormous amount of cost has been reduced since medical cost and expenses are very high nowadays. To implement fusion process for real time medical images acquired from the various diagnostic equipment from the hospital.

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