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Brain Tumor Detection Using CT and MRI Image Fusion

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Abstract: Image fusion is the integration of information from multiple images into a single image that gives more complete and accurate description about the object. Computed Tomography (CT), Magnetic Resonance Imaging (MRI), PET, X-ray are different medical imaging techniques. MRI gives best information about soft tissues and CT gives information about hard tissues. Therefore, the fusion of these images helps the physicians for better diagnosis. This paper presents a method of brain tumor detection based on image fusion. First, fusion is done based on NSCT domain. Second, segmentation is done based on SOM (Self Organization Map) clustering. Then, classification is performed.

Index terms: ComputedTomography(CT), Magnetic Resonance Imaging (MRI), PET, X-ray, NSCT (Non-subsampled Contourlet Transform).

I. INTRODUCTION

One of the serious kinds of disease in the medical field is considered to be the brain tumor. So it must to have the fast and accurate detection. Different algorithms are provided for the tumour detection and segmentation. The important approach in the brain tumor segmentation is to identify the various stages includes benign, malignant and the normal. The brain tumor are generally named and classified according to either of the following: The type of brain cells in which they originate The type of location in which the cancer develops. Primary tumors are those which develop in the brain. The initial growth of the abnormal and the unwanted tissues in the brain is called as the primary tumor.

Depending on the concentration the primary tumor are classified into two types. Benign tumor is a tumor where they are having their boundaries or the edges in which they does not spread over the other parts of the body. Benign tumor is considerably quite serious if they are meant to be in the vital areas of the brain. On another hand, benign tumor can step in to the disability and even it lead to the death. In malignant tumor are considered to be the most serious one and they develop rapidly. They affect the various vital organs which may leads to the death. About 80 of the malignant tumors are referred to as the gliomas. Gliomas refer to the tumors which have been originated from the glial cells of the brain. Secondary brain tumor is a tumor where the tumor in the brain is arisen from the other tumor in the body. They are mainly formed from the cells that have broken away from the primary tumor and have spread in the bloodstream to the brain. The primary source for the secondary tumor is the lung or the blood cancer.

Currently, MRI and CT are the standard diagnosing techniques to detect brain tumor. CT provides best information about denser tissues. MRI offers better information about soft tissues. Combining these two images will generate an image that can offer more information than each other separate. The final obtained image can be useful in diagnosis process. That‘s why image fusion has become an important research field.

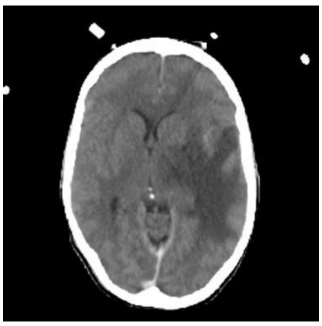


Figure 1:CT Image

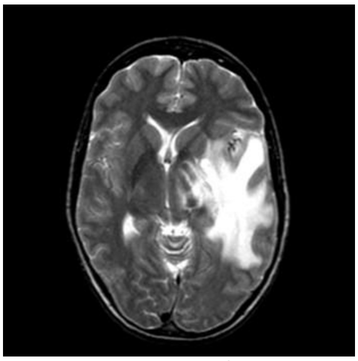


Figure 2: MRI of Brain

The objective of this paper is to fuse the CT and MRI images so that the resulting image has best components from both CT and MRI images.

II. RELATED WORK

Image fusion is the integration of information from multiple images into a single image that gives more complete and accurate description about the object. Computed Tomography (CT), Magnetic Resonance Imaging (MRI), PET, X-ray are different medical imaging techniques [1]. The main two advantages of image fusion are: First, gives complete and accurate description of the object. Second, reduce the cost and storage. Pixel level, feature level, decision level are different types of fusion [2].

Medical image fusion uses pixel level fusion because it contains original measured quantities. Principal Component Analysis (PCA), Independent Component Analysis (ICA), Contrast Pyramid (CP), Gradient Pyramid (GP) is different pixel level fusion [3]. In simple average method the average of pixel values of each image is taken. So, it will include both the good and bad information. In the selected maximum method highest pixel intensity is taken. It produces highly focused image. Select minimum method is same as select maximum only minimum pixel intensity is considered. PCA is used to reduce dimensionality. But it produces spectral degradation in the fused image [4].

Wavelet Transform (WT) is the ideal method for fusion in the multi-scale decomposition. But the disadvantage of wavelet is not good at edges and textured region [5]. In Discrete Wavelet Transform (DWT) provides multi-resolution analysis of an image. Here, low-pass filter and high-pass filters are used as scaling function and mother wavelet. But in DWT spatial resolution of output image is less.

MRI and CT give information about soft and hard tissues respectively. CT gives structural information and MRI gives functional information. So, fused final image give better information than CT alone and MRI alone [6]. Spatial features are anatomical information and spectral features are functional information. NSCT is a kind of multi-scale and multi-direction computation [7]. There is two stages, First, applying Non-subsampled Pyramid (NSP) and then apply Non-subsampled directional filter bank (NSDFB). NSP offers the multi-scale property and NSDFB offers the NSCT with MUTLI-directional property [8].

Medical imaging has become a vital component of a large number of applications, including diagnosis, research, and treatment. In order to support more accurate clinical information for physicians to deal with medical diagnosis and evaluation, multimodality medical images are needed such as X-ray, computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET) which usually provide complementary information.

III. PROPOSED METHOD

The input CT and MRI images are fused using directive contrast based multi-model medical image fusion in NSCT domain. Then fused image is preprocessed using median filter .Then features are extracted for classifying the image. SURF is used for feature extraction and SVM is used for classification.

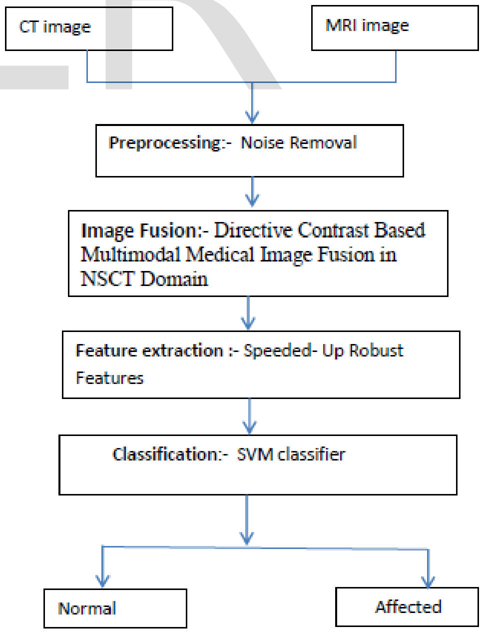
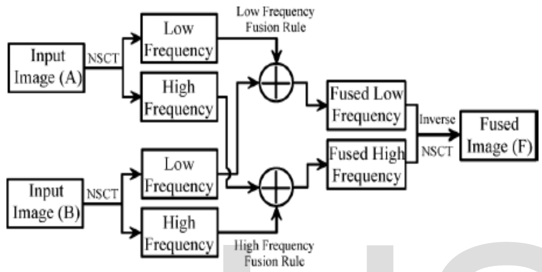


Figure 3: Proposed Work

First, the input images are preprocessed using meadian filter. Medical images contain salt and pepper noise due to minute grayscale variations in the image. Median filtering is an image enhancement techniques to remove impulse noise without affecting image sharpness.

The proposed fusion is done based on two fusion rules. Low- frequency coefficients are combined using phase congruency. High frequency coefficients are combined using directive contrast. Phase congruency selects contrast-and-brightness invariant components in the low frequency coefficient. Directive contrast selects the texture and edge information from the high frequency coefficients.

NSCT is a kind of multi-scale and multi-direction computation. There is two stages, First, applying Non-subsampled Pyramid (NSP) and then apply Non-subsampled directional filter bank (NSDFB). NSP offers the multi-scale property and NSDFB offers the NSCT with MUTLI-directional property.



First, the features are extracted from low-frequency sub-images using the phase congruency extractor and fused using following rule.

$$C_\ell^F(x,y) = \begin{cases} C_\ell^A(x,y), & \text{if } P_{C_\ell^A}(x,y) > P_{C_\ell^B}(x,y) \\ C_\ell^B(x,y), & \text{if } P_{C_\ell^A}(x,y) < P_{C_\ell^B}(x,y) \\ \dfrac{\sum_{k\in A,B} C_\ell^k(x,y)}{2}, & \text{if } P_{C_\ell^A}(x,y) = P_{C_\ell^B}(x,y) \end{cases}$$

Then high-frequency sub-images are fused using directive contrast.

$$C_{l,\theta}^F(x,y) = \begin{cases} C_{l,\theta}^A(x,y), & \text{if } D_{C_{l,\theta}^A}(x,y) \geq D_{C_{l,\theta}^B}(x,y) \\ C_{l,\theta}^A(x,y), & \text{if } D_{C_{l,\theta}^A}(x,y) < D_{C_{l,\theta}^B}(x,y) \end{cases}$$

1. Perform l-level NSCT decomposition.
2. Fuse low frequency sub-images using phase congruency.
3. Fuse high frequency sub-images using directive contrast.
4. Perform l-level inverse NSCT on the fused low-frequency and high-frequency sub-images, to get the fused image.

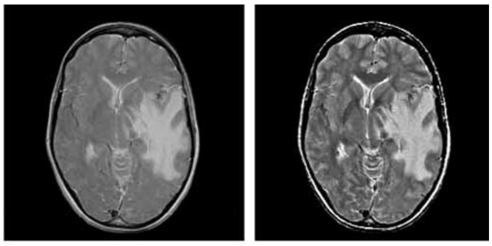


Figure 4: Input CT and MRI Images

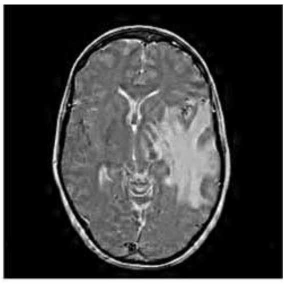


Figure 5: Fused Image

After fusing the input CT and MRI images feature extraction is done using SURF (Speeded-Up Robust Feature). SURF is a local feature detector and descriptor. Detector locates the interest points in the image. Descriptor describes the features of the interest points and constructs the feature vectors of the interest points [9]. SURF algorithm is implemented in three divisions :-

Detection :- In SURF detector find points of interest. Automatically identify interesting points.

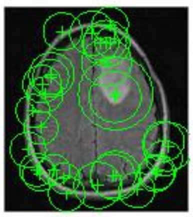


Figure 6: SURF interest points

Descriptor :- Descriptor is to provide a unique and robust description of an image feature.The first step is to fix an orientation based on information from a circular region around the interest point.Then a square region from the selected orientation is found, and the SURF descriptor from it is extracted.

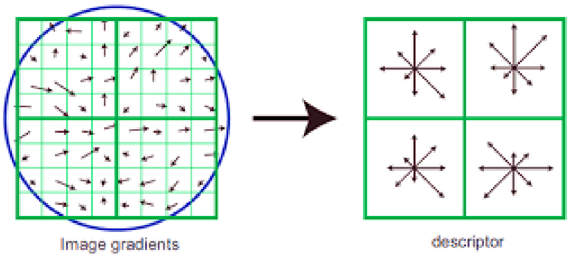


Figure 7: Key points of interest points.

Matching:- Matching pairs are found using the comparison of descriptors obtained from various images.

Finally, classification using svm classifier is done.It is a machine learning approach used for classification and regression analysis. Supervised learning model and trained by learning algorithm. Analyses large amount of data and find pattern from them. Divides into two categories by a clear gap.(partitioning by a plane called hyper plane) [10]. SVM creates hyper planes that have the largest margin in a high dimensional space. Larger margin implies lower error of the classifier.

IV. EXPERIMENTAL ANALYSIS

In this paper, for the purpose of detection of brain tumor, we have chosen medical cases with patients who have suffered from different brain tumors, where in the tumor is diagnosed in fused image of CT and MRI of a same patient. The proposed algorithm is developed using MATLAB.

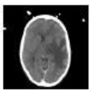
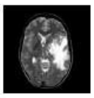
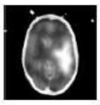
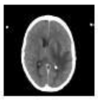
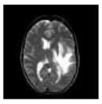
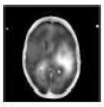
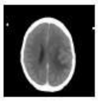
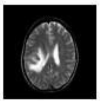
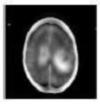
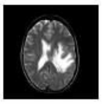
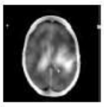
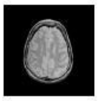
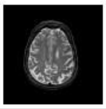
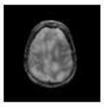
Input CT	Input MRI	Fused Image	Resut
			Tumor Detected
			Tumor Detected
			Tumor Detected
			Tumor Detected
			No disease Found

Figure 8: Final Result .

	Accuracy	Sensitivity	Specificity
Fused Image	.933	.92	.95
MRI Image	.888	.88	.91
CT Image	.866	.84	.90

Figure 7: Performance Comparison

V. CONCLUSION

Medical imaging techniques became crucial for medical diagnosis. CT and MRI image fusion technique is more precise than either by CT alone or by MRI. MRI-CT fusion can reduce the uncertainty of brain tumor detection. The proposed system helps in easy diagnosis of normal and abnormal brain.

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