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Enhanced Lung Cancer Detection and Multi Level Classification of MRI with CT Images

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ABSTRACT: Lung Cancer, mass of abnormal cells detection by a medical consultant plays a foremost role for appropriate treatment of the patient, increasing the survival rate. Computed Tomography (CT) method uses x-rays projected at various angles to locate the tumour while Magnetic Resonance Imaging (MRI) technique involves field of magnetic powerful forces, and radio waves generate images. Fusing both the images gives better clarity as consolidated information of the both resides. Segmentation of tumour is performed by Region of Interest (ROI) method and Otsu's thresholding approach whereas Gray-Level Co-occurrence Matrix (GLCM) distinguishes the appearance unlike in the variogram and FFT technique. Feature extraction is accomplished by Discrete Wavelet Transform (DWT) approach that provides ROI given as input to classifiers while Inverse discrete wavelet transform (IDWT) aids in fusing. K-Nearest Neighbour algorithm (KNN) and Artificial Neural Networks (ANN) are two levels of classification with high accuracy compared to other methods. The objective is to classify the tumour into malignant and benign further identifying the cancer stages by various region parameters measurements of area, size, perimeter, eccentricity, diameter and centroid.

KEYWORDS: Artificial Neural Network, Discrete wavelet transform, GLCM, Image fusion, Inverse discrete wavelet transform, K-Nearest Neighbour algorithm, Lung cancer, Region of interest.

1. INTRODUCTION

Among other types of Cancers, the death rate of patients across the globe bearing with lung cancer has increased moderately, earlier detection can aid to better chances of survival rate. Image fusion aims at integration of redundant and complementary data to enhance the information visible in the images leading to more accurate data while fused data gives for robust operational performance such as better confidence, reducing ambiguity, improved reliability and exact classification. A CT scan image denotes the images of denser tissues, while MRI scan images denotes the soft tissues. Results based solely on any one of the above mentioned scan may turn out to be erroneous. Fusion of CT and MRI images procure more accurate results in detection of malignant tumour and their stages.

In Existing methods, Image fusion is conducted by Discrete Cosine transform (DCT) resulting in poor accuracy, more noise and to a lesser degree quality image. DWT is employed for the method, image fusion produces a clear detailed image.. Meanwhile single image modality does not provide practically much information. Image fusion is the ideal solution to rectify this problem. The action of retaining the features of two or more modalities of the same object is referred to as fusion. CT and MRI scan images can be fused to assist medical diagnosis. Fig.1.

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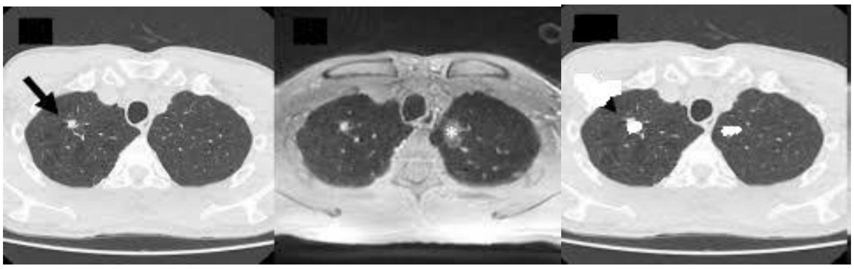

Figure 1: a) CT scan image of lungsb) MRI image of same lungs c) Fused image of CT and MRI

The proposed work is the extension of the paper "Lung Cancer Detection and Multi Level Classification Using Discrete Wavelet Transform Approach "carried out by the same authors.

II. LITERATURE REVIEW

Veeraprathap V et al., [1] proposed a lung cancer detecting system which classified lung cancer stages based on the region property measurements. Wide cases of CT images were simulated in Matlab and efficiency found was 98.67%. Wong et al., [2] proposed a LC detection method by exhaled breath using SVM as classifiers with results at efficiency of 84.4%. Cristian et al., [3] proposed a method using transthoracic ultrasonography (TUS) and US-guided biopsy technique for benefits of lung patients.

Swapnil R Telrandhe et al., [4] proposed a technique for detection of tumour in brain by MRI images, segmentation was carried out by thresholding technique. Chunran et al., [5] proposed a fully convolutional network (FCN) based on level set method used in segmentation nodules detecting method by threshold technique. Shaffie et al., [6] proposed a system to get an accurate diagnosis for the extracted lung nodules. 3D Local Binary Pattern (LBP) and higher-order Markov Gibbs random field (MGRF) models were utilized. Zhao et al., [7] proposed a patch-based 3D U-Net and contextual Convolutional Neural Networks (CNN) to unsupervisely segment and classify lung nodule. 3D U-Net used for segmentation, while Generative Adversarial Network (GAN) was used to enhance model performance.Abdillah et al., [8] proposed a detection method based on image segmentation by marker control watershed and region growing approach. Enhancement using Gabor filter, feature extraction performed provided good results with more accuracy and robustness. Bahadure NB et al., [9] proposed a method for analysing an image with different image processing techniques for the MRI scan of brain tumour and feature extraction for classifiers were done by support vectors machine.

Chapaliuk et al., [10] proposed an automated diagnose system with 3D convolution and neural networks. Accuracy of the networks was evaluated. Bhattacharya et al., [11] proposed a MEMS based sensor method. Based on the volatile organic compound concentration exhaled from breath of a victim, system identified the cancer patient. Katre et al., [12] proposed a system using Median filter for noise removal, High boost operator for enhancement, and marker controlled watershed for the purpose of segmentation. Various classification techniques for detecting tumour inside lung based on suspicious ROI obtained by feature extraction was mentioned. Prathamesh et al. [13] proposed a method using median filter, Watershed Segmentation and morphological operations. Gokulapriya V et al., [14] proposed a system for identifying cancer stages and detecting tumor inside lungs based on fusion of CT and MRI images given as input to segmentation.

III. METHODOLOGY

The proposed method is an efficient wavelet based fusion algorithm for lung cancer detection making effective use of complementary and redundant information from the Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) images. Fig.2. The necessity of fusing the MRI and CT scan images is integrated image provides out-and-out information useful for diagnosing the suspected lung cancer or ill patient by a medical consultant and for machine learning giving absolute informative than separate images. Discrete Wavelet Transform technique transforms pixels into wavelets, helps in accomplishing wavelet-based compression and coding. The reason behind image fusion is in

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medical image processing filed various sources of images produce complementary information and integrating all the sources gives us necessary and specific details required for the diagnosis. Fig.3.

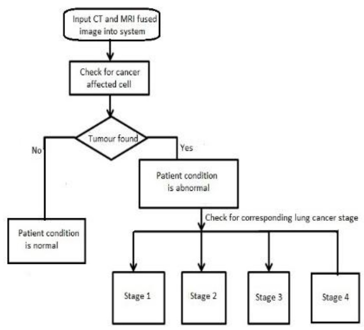

Figure2: Process chart of the methodology

The scanned lungs image obtained by CT and MRI are fused together to obtain a better clarity image. The features of the fused image are then extracted to exactly locate the tumor and then classified as benign tumor and malignant tumor further classifying it to their respective stages based on the area size of tumor assessed in pixels. Fig.4.

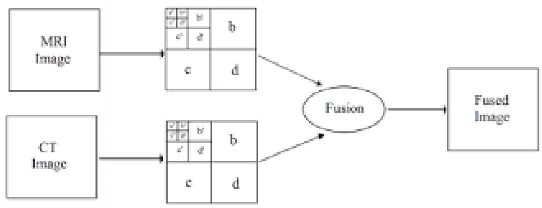

Figure3: Illustration of fusion technique

Stages of methodology proposed
1) Acquire MRI scan image of suspected person. 2) Acquire CT scan image of same suspected person.
3) Accomplishing fusion of MRI and CT image. 4) Pre-processing of image. 5) Segmentation using ROI and Otsu's threshoding approach. 6) Feature extraction using DWT algorithm. 7) KNN and Neural network classification.
8) Diagnosed result. 9) Treatment method.

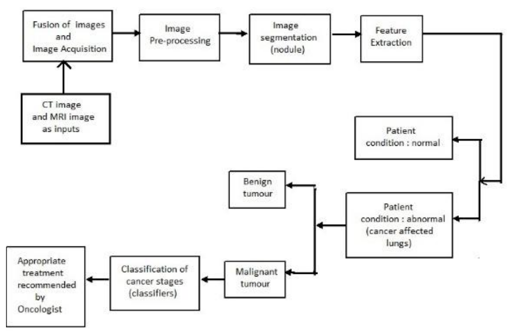

Figure4: The proposed system block diagram

Using MATLAB software, simulation results are obtained. Our motive is to obtain more accurate and precise results of the different stages of cancer than the earlier method by using different techniques. Once fusion of CT and MRI scanning is performed the technique improves the quality of the result data obtained. Proposed System Techniques are :

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1) Histogram Equalization 2) ROI extraction 3) Morphological Operations 4) Region properties measurement 5) GLCM 6) ANN 7) KNN 8) DWT. DWT is applied to the MRI and CT scan of a person bearing with lung cancer. The DWT splits the scan images into four side-bands namely low-low, low-high, high-low and high-high (LL, LH, HL and HH). The spatial frequency image fusion method is applied to LL bands, two techniques namely "maximization" and "averaging" are employed. Highest frequency of two images (i.e. MRI and CT) is compared and is taken as output for further processing referred to as maximization whereas lowest frequency of two images (i.e. MRI and CT) is taken and averaging is performed.Fig.5. For LH, HL, HH bands, we are using contrast based technique which generates histogram graph for each frequencies of two images (MRI and CT) and fuses the two LH, HL and HH bands. The IDWT fuses the images from both spatial frequency and contrast based image fusion techniques. Performance analysis is employed in order to eliminate noises in final product. Fig.6.

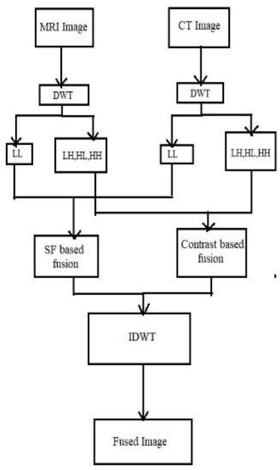

Figure5: CT and MRI Fusion based on DiscreteWavelet Transform

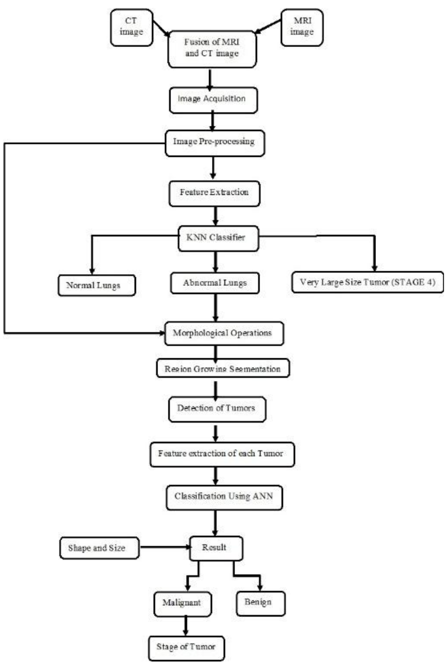

Figure6: Work-flow diagram of the proposed system

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IV.RESULTS AND DISCUSSION

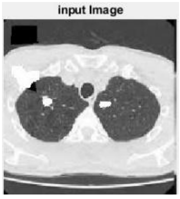

Figure 7: Input fused image.

Figure 8: Resized fused image, for further effective processing without reducing quality.

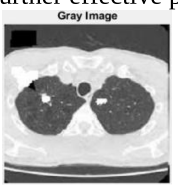

Figure 9: Gray scale conversion performed to the original fused image to convert the color into a grayscale.

Figure 10: Gaussian filter is a linear filter, performs smoothing and reduces noise.

Figure 11: Histogram equalized image, enhances the contrast of image, uniform distribution intensities exist in the result.

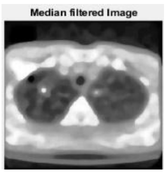

Figure 12: Median filtered image; removes salt and pepper noise, reduces impulsive noise and performs edge detection.

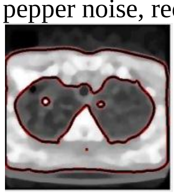

Figure 13: Segmented suspected lungs boundary is seen. Pixels representing information in image extracted and grouped.

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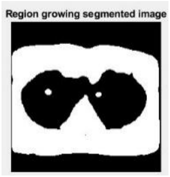

Figure 14: Binarization achieved; which helps further in thresholding operation.

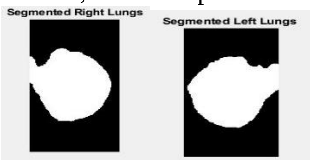

Figure 15: Right and left lung is segmented separately using row and column pixel values to obtain better accuracy detection.

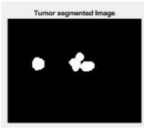

Figure 16: Tumor part is extracted from lungs after segmentation.

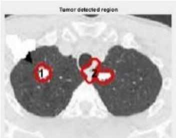

Figure 17: Abnormal lungs detected. Two tumours identified.


```
Command Window
  Select CT and MRI Fused Image of the Lung
  Region number          Area    Perimeter    Centroid        Diameter
  # 1                    387.0     68.1      54.6     79.2      22.2
  # 2                    848.0    146.6     129.7     79.1      32.9
                 Eccentricity1            Type of Tumor
  # 1                   0.3          Malignant
  # 2                   0.8          Malignant
  Stage4
fx >>
```

Figure 18: ROI area size in the fused resultant image is evaluated, declared as stage 4 cancer and malignant type of tumor, computations seen in command window.

V.CONCLUSION

System successfully detects and evaluates the tumour stages from CT and MRI scan fused images. The fusion of image gives better accurate results in contrast to the other detection systems using only CT scan image from the same database of cancer patients. The results show that best approach for fusion of image and main features extraction is Discrete Wavelet Transform algorithm, dataset is trained using feed forward type of Artificial Neural Networks and K-Nearest Neighbour along with binarization and GLCM techniques lead to high efficiency of the system at 99.27%. The consultants suggest appropriate treatment based on the severity of the LC stage.

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Veeraprathap V has completed his graduation in electronics & Communication from visvesvaraya technological university, Belagavi Karnataka , Master of Technology in Digital Electronics from Sri Siddartha Institute of Technology Tumkur And Currently Pursuing His PhD in field of WSN's at UVCE Bangalore University, Karnataka , India .

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