Detection of Lung Tumor Using Watershed Transformation Algorithm-Based Image Enhancement

Arun B. Mathews[1], Krishna Prasad K.[2]
[1] *Post-Doctoral Research Scholar, Srinivas University, Mangalore, India*
[2] *Associate Professor College of Computer Science and Information Science, Srinivas University, Mangalore, India*

Abstract- Lung tumor detection and classification is one of the challenging tasks in medical image processing because of large variation in density, size, location of tumor and low contrast in images. The accuracy of such segmentation system should be high because it directly affects the mortality of humans. Existing classifier yields poor accuracy when volume of input increases. Hence it is more important to derive an algorithm with higher accuracy in lung tumor detection. In the proposed system, the image obtained from CT scan is processed using median filtering to remove noise and artifacts caused during transmission and other environmental facts. Then the filtered image is segmented using watershed segmentation algorithm and pixels are grouped to extract useful information for analysis. Performance of this algorithm is evaluated based on various metrics and value of bit error rate is calculated about 0.0153%. The result of this segmentation algorithm is better than the existing algorithms and also it preserves the edges of an image with minimum error rate.

Indexed Terms- Lung, CT scan, Lung Tumour, Watershed transformation algorithm and Performance

I. INTRODUCTION

[Medical Image Processing (MIP) is an interdisciplinary research field that has grown rapidly in recent decades, with a wide range of applications for redundant clinical problems. It combines knowledge from various disciplines such as computer science, engineering, statistics, physics, biology, and medicine. MIP has been used to create applications that use computerized systems to solve medical diagnosis problems in the fields of science mentioned above.

II. RESEARCH GAP

Tumor classification is the critical task in medical image processing, although several algorithms were proposed for classifying tumors. Due to digitalization of medical data, there is a rapid increase in volume. Existing classification algorithms yield poor performance when applied to large volume of data. Existing classification algorithms require a separate feature extraction model, wherein the developers specified the minimum set of features. Hence there is a necessity to derive a classification algorithm integrated with feature extraction which deals with large dataset. Also, during medical image segmentation, many researchers' focuses on over segmentation problem, which intern reduce the performance of enhancement algorithms.

III. SURVEY OF THE WORK

NOVA filter was designed with the specific goal of quantifying emphysema in low-dose CT images using prior knowledge of the data in mind. The NOVA filter has a lot of parameters and requires a lot of iterations. If no information about the imaged object is available, the iterative scheme was modified using the parameter settings [1].

Edge preservation is critical for detecting a disease, so the WB-Filter for de-noising is used, which is a combination of the Wiener and bilateral filters [2]. It focuses solely on the removal of speckle noise and Gaussian noise in CT scan images. This filter does not provide the best results for reducing salt and pepper noise. It is very effective at removing noise at high frequencies but performs poorly at removing noise at low frequencies.

A method for image filtering based on Laplacian. The Laplacian is a noise removal function that has been known as an edge detection function. Image de-noising can be summarized as the reduction of pixel values with their associated Laplacian values weighted by a local noise estimator. The main disadvantage was the filtering action on the area of the image with low intensity edges [3].

Using a levelset-based segmentation method, the region of interest in various medical images presented [4]. The first step is to determine the threshold of an input image so that the entire pixel falls below the threshold value of 0 and the value is used as the original image. This aids in preserving the original image's properties and keeping all values fixed as the original image except for the pixels that are not required for the analysis. Then, using a morphological technique, some small ignorable parts are removed. Finally, for segmentation, the variational level set method is used [5]. For large image sets, the thresholding-based segmentation method achieved lower accuracy while taking a long time to compute.

APSO with a parameterized transformation function that makes use of the image's local and global information [6]. In this case, an objective criterion for measuring image enhancement is used, which takes into account the image's entropy and edge information. Edge information (E), Entropy (H), and Fitness (F) are used to describe the input images and provide information about their size (F). The simulation results show that the APSO-based image enhancement algorithm outperformed the traditional techniques; however, accuracy is one of the drawbacks.

IV. LAYOUT OF PROPOSED WORK

Images obtained from electronic devices such as CT scanners are more susceptible to noise during the capturing and transmitting process. An image obtained after transmission is frequently corrupted by various types of noises, so de-noising is a necessary step before applying segmentation, feature extraction, and classification. The median filter is used to remove noise in this case.

After removing noise from an image, the morphological watershed transformation algorithm is used to divide it into regions. In watershed segmentation, a morphological gradient is introduced, and reconstruction operators are used to reconstruct the gradient image. The gradient pixels with low values are then removed, while gradient pixels with high values are kept. The HPSO algorithm, which is a population-based enhanced optimization algorithm, improves the quality of the segmented image. All particles have fitness values that are optimized by the fitness function, as well as velocities that direct the flying particles.

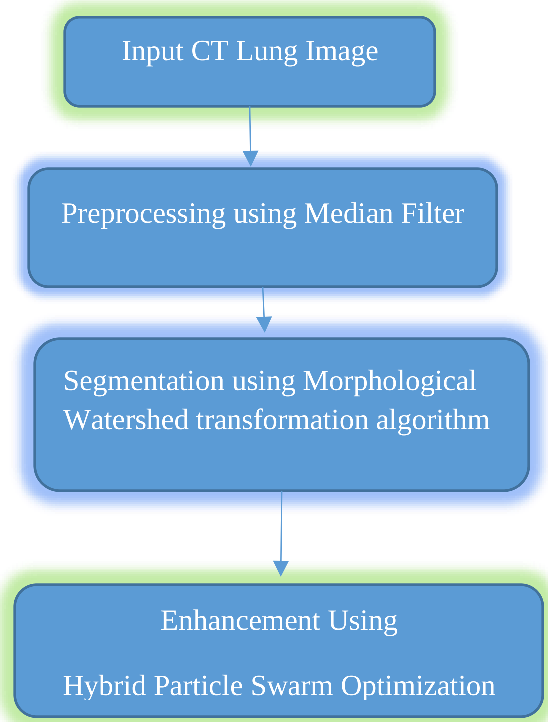


Figure 1: Proposed work flow

Because medical images are obtained directly from acquisition devices, they contain noises and other artefacts such as gaussian, speckle, and impulse noise. Gaussian noise appears as white intensity values at random, with a probability distribution function equal to that of the normal distribution. Data transmission errors cause speckle noise. Impulse noise, also known as salt and pepper noise, is an image that contains dark pixels in bright regions and bright pixels in dark regions. This type of noise can occur in medical images during the analog-to-digital conversion process. Smoothing is an image processing technique that is used to reduce noise in images. To remove high frequency noises from an image by performing a smoothing operation on it using filters.

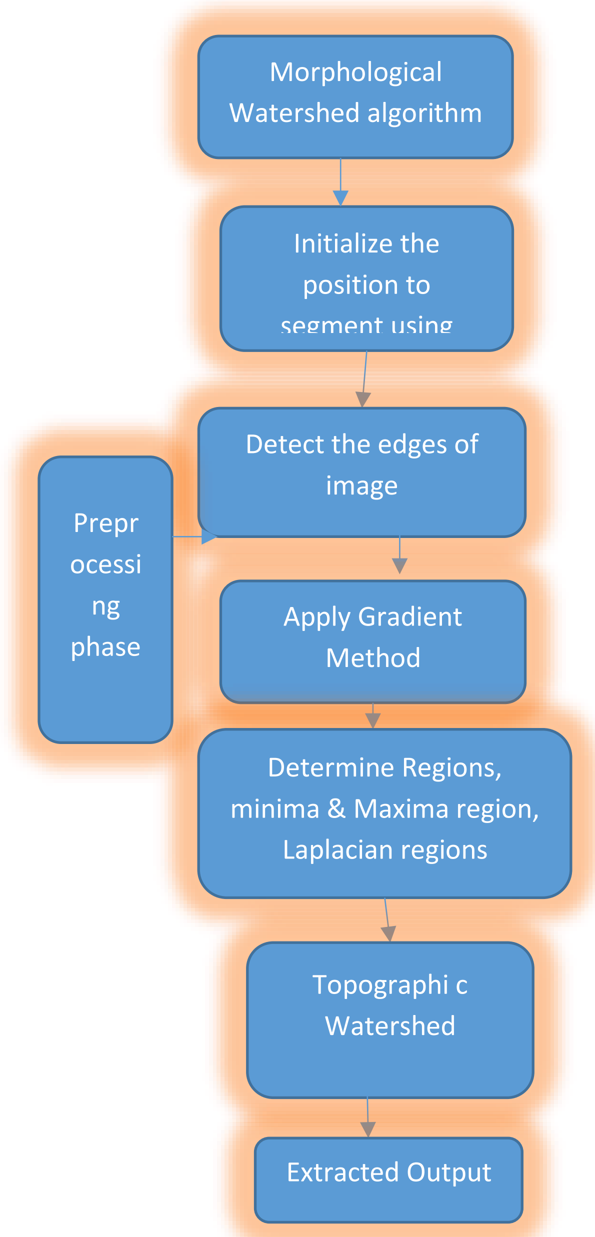


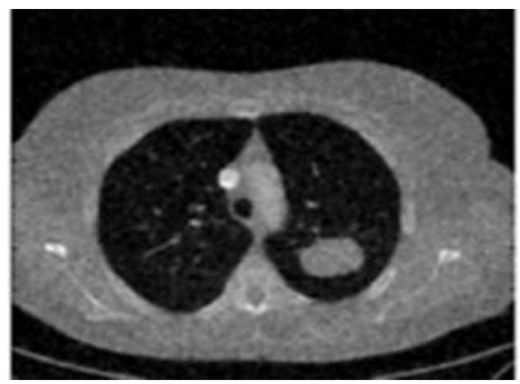
Figure 2: Watershed segmentation procedure

Procedure for watershed segmentation:

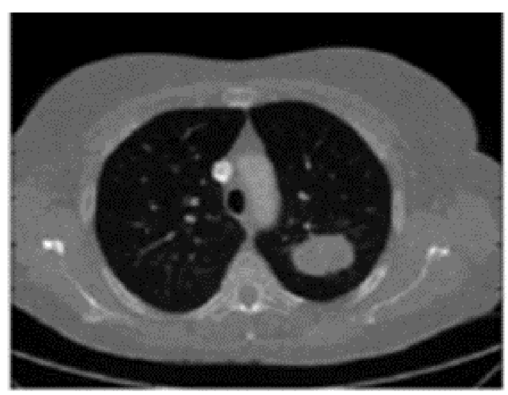
i. Input: Image received from median filter
ii. Initialization: the position of image to segment
iii. Edges are detected and extracted in term of vertical and horizontal
iv. The gradient method is applied to find the tumor regions
v. After finding the gradient of an image the minima and maxima regions are determined.
vi. Topographic relief is generated.
vii. Finally, the segmented image is received.

V. EXPERIMENTAL SETUP

Because Simulations are performed using GPU architecture with MATLAB R2018a for CT lung image enhancement and classification. Size of an input image is 512× 512 pixels, which is collected from Lung Image Database Consortium (LIDC) with Image Database Resource Initiative (IDRI) and Kaggle database for evaluation.



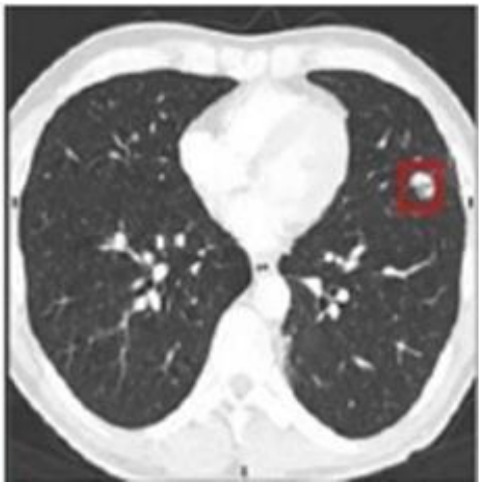
(a)



(b)

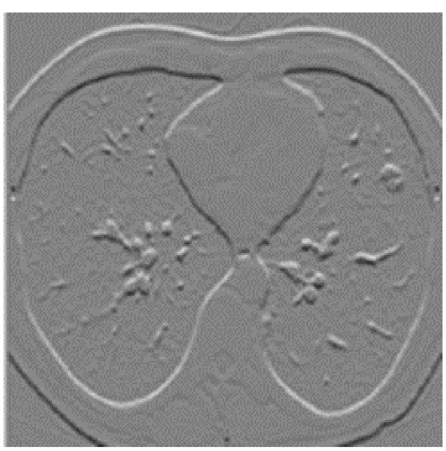
Figure 3 (a) CT Lung Noisy Image (b) Median filtered image

The Figure 3 shows that the CT lung image affected by impulse noise while receiving and next image is output which is received from median filter. The lung images are smoothed and the edges are defined as well as the intensity of images is increased. Image quality also improved with free of noise so the diagnosis is done efficiently and automatically.



a

b



c

d

e

Figure 4: Segmentation process (a) Input Image (b) After topological Gradient method(c) Vertical texture (d) Edge and regions of image (e) Segmented image

The Figure 4 presented the entire watershed segmentation process. Initially the CT lung input image processed with topological gradient method. After finding of gradients vertical and horizontal textures are taken as tomography relief. Then the regions and edges are extracted and finally the segmented image is received.

Table 1Performance Evaluation of Watershed Segmentation with Existing Algorithms

Segmentation Algorithms	MSE (%)	BER (%)
RM	29.0478	0.3386

FCM	32.9567	0.1942
Histogram Thresholding	21.6350	0.4832
DWT	18.0484	0.1728
Watershed algorithm	14.6432	0.0153

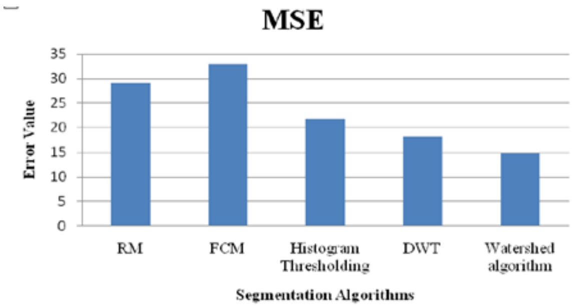


Figure 5 Mean Square Error Comparison with existing algorithms

The following Figure 5 shows that, the FCM algorithm having highest error value and the watershed algorithm gets minimum error rate

CONCLUSION

Medical image generation and transmission are frequently subjected to various levels of noise intrusion and influence. It will reduce image quality and have an impact on subsequent image processing such as segmentation, enhancement, and classification. Noise is defined as random variations in image intensity that appear as grain in the image. Here, median filtering is used, and it produces better results for removing salt and pepper noise. Understanding the image and extracting information from it is an important aspect of the diagnosis system. Image segmentation is the first step in comprehending the image. It serves as the foundation for image analysis and the comprehension of image feature extraction and recognition. The watershed segmentation presented in this section, preprocessed CT lung image given as input and processed with different stages. The performance is analyzed using MSE and BER metrics and the results shown that the watershed segmentation algorithm achieved better results.

REFERENCES

[1] Bin-Habtoor, Abdulaziz Saleh Yeslem, and Salem Saleh Al-amri. "Removal speckle noise from medical image using image processing techniques." International Journal of Computer Science and Information Technologies 7, no. 1 (2016): 375-377.

[2] Sarah, Benmazou, Layachi Soumia, and Hayet Farida Merouani. "Segmentation of Images based cellular automata-reactive agent implemented in Netlogo platform." International Journal of Computer Applications 975 (2012): 8887.

[3] Divya, K. A., and K. I. Roshna. "A survey on various image enhancement algorithms for naturalness preservation." International Journal of Computer Science and Information Technologies 6, no. 3 (2015): 2043-2045.

[4] Patil, Dinesh D., and Sonal G. Deore. "Medical image segmentation: a review." International Journal of Computer Science and Mobile Computing 2, no. 1 (2013): 22-27.

[5] Nithila, Ezhil E., and S. S. Kumar. "Segmentation of lung nodule in CT data using active contour model and Fuzzy C-mean clustering." Alexandria Engineering Journal 55, no. 3 (2016): 2583-2588.

[6] Polat, Huseyin, and Homay Danaei Mehr. "Classification of pulmonary CT images by using hybrid 3D-deep convolutional neural network architecture." Applied Sciences 9, no. 5 (2019): 940.

[7] Na'am, Jufriadif. "Edge detection on objects of medical image with enhancement multiple morphological gradient method." In 2017 4th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI), pp. 1-7. IEEE, 2017.