Denoising And Contour Segmentation Using Region Based Segmentation Method For Medical Image Processing

Jayanthi Yasam[1] (MTech), Dr.K.Sreenivasulu[2]
[1]Dept of Computer Science
[2]Professor, Dept of Computer Science
[1, 2] G.Pullaiah College of Engineering, Kurnool, AP

Abstract- *Image processing (or Analysis) is a technique performed on an image to obtain information or required knowledge. Image segmentation occupies the extreme priority as its results influence the next process of image analysis in understanding the representation, measurement, classification, interpr etation and compr ession. The selection of features or attributes used for image partition and how well the attributes tolerate the noise, illumination and other effects influence the accuracy of the segmentation. Medical images are crucial in health care as they provide information for treatment, diagnosis, pathology, computer aided surgery, etc. For medical images, segmentation is of utmost priority as it forms the basic step of Medical Image Analysis (MIA). Image segmentation is used to divide an image into homogeneous regions to locate objects and boundaries such as curves, lines, regions, etc. Most of the segmentation approaches are influenced by the noisy local regions. They result in creating confusion and ambiguity for an efficient segmentation. Image pre-processing has significant effects regarding the extraction of features quality and the image analysis results. Image pre-processing is as equal as data set normalization and most commonly used step in the methods of feature extraction. In this project de-noising using various types of filters is implemented and region based segmentation is used to establish boundaries for the image segmentation.*

Keywords- Image preprocessing, Denoising filters, Region Based Segmentation

I. INTRODUCTION

Images provide information with more clarity for human analysis and to process the image data for storage. Importance of these images is increased and there is an enormous increase in the number and availability. They play a significant role in fields of science, technology and social sciences as varied as medicine, journalism, design, education, entertainment, etc to make important decisions. Images are reviewed as a part of the main method of fetching information, in computer vision, by collecting images.

The word image segmentation itself reveals that the image is partitioned. Any image is segmented into objects to retrieve information. The purpose of segmentation is dependent on the application for which the image is to be partitioned. Image segmentation has its importance in many areas like medical image, real-time visual tracking, Finger print Recognition, Face recognition, analyzing satellite images.

Image processing is a method that enriches unprocessed images received from different applications like day-to-day pictures, satellite images, etc. Image processing is a step by step process that includes various modules. In every module of image processing, various steps are involved in which output of each module is the input of next module, also the output at each stage gives some information.

The aim of pre-processing is enhancement of the image data that would smoothen unnecessary distortion/enhances few image features that are significant for further processing. Right choice of image preprocessing method is fundamental. Methods of preprocessing are different as the same is dependent on the source of image and image application. In few cases, pre-processing of an image such as corrections and enhancements are necessary to correct problems that would affect feature description. Pre-processing of an image may include objects in the images that need to be corrected before feature measurement and its analysis. Enhancements are used for optimizing particular feature measurement, rather than fixing problems. Commonly used enhancements consist of either sharpening or color balancing, or both. Pre-processing enhancements / corrections are descriptor dependent of the application and images.

Image segmentation has no generalized method that is suitable for any kind of image as it depends on the image type [12]. Image segmentation is the process of splitting an image into either multiple significant regions or pixel set depending on the application [3]. Acquiring an appropriate image for segmentation forms the initial step of the

segmentation process. In case of color image, transforming the color image to a grayscale image require more knowledge and it is the most beneficial image processing approach applied in various fields [4].

Steps involved in the processing of an image,

1. *Image formation:* Formation of digital image matrix.

2. *Image visualization:* Resultant output image after required manipulations on the image matrix.

3. *Image analysis:* This includes quantitative measurements, abstract interpretations, integration of knowledge into algorithms.

4. *Image management:* It is all about storing of images, communication and transmission and also archiving them and retrieval of the stored image data.

In the medical domain, there are three main aspects that hinder the priori knowledge so that the same can be integrated directly and easily into automatic algorithms of image processing.

1. *Heterogeneity of images*: The internal structure, size, shape of objects is not similar in all the cases, they vary from one person to other. Thus forming a universal system of image processing is impossible.

2. *Unknown delineation of objects*: In some cases the borderline or the shape of the object is unclear or only part of it is visible, this makes segmentation process problematic. Also, an image may contain background that may be relevant to the whole image and cannot be separated. Most of the medical images are processed at texture level.

3. *Robustness of algorithms*: Image processing algorithms have their own demand in medical field. Care must be taken in such a way that there are no wrong measurements in the process of automatic analysis.

Image segmentation methods are classified as below:

A. Region Based
B. Edge Based
C. Feature Based Clustering
D. Threshold
E. Model Based

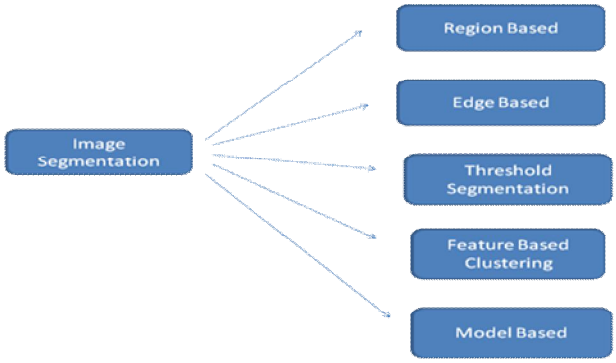


Figure: Classification Methods for Image Segmentation

In Region Based Segmentation technique, related pixels of an object are grouped. Partitioning is done by using grey values of the image pixels. It is also referred as "Similarity Based Segmentation" [5]. Basic techniques of region based segmentation are as below,

a. Region Growing
b. Region Splitting & Merging
c. Clustering
d. Threshold

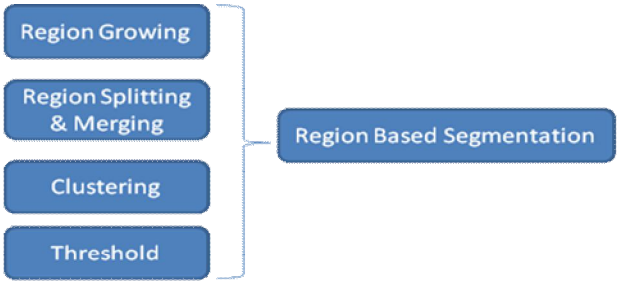


Figure: Methods of Region Based Segmentation

II. IMAGE SEGMENTATION

A segmentation method that is invariant in terms of shape, size, and intensity values is proposed for medical image applications. Segmentation methods can be classified in to supervised or unsupervised. Unsupervised segmentation has issues as it doesn't give priori knowledge of the available textures and hence its access is limited. In the beginning the process of unsupervised segmentation was based on pyramid node linking, split-and-merge methods, a quad tree method and selective feature smoothing with clustering. And later the segmentation techniques which were based on feature smoothing, local linear transforms, Markov random field models, autoregressive models, fractal dimension, multichannel filtering, wavelets, hidden Markov models, and Markov random fields for color textures are proposed. Though

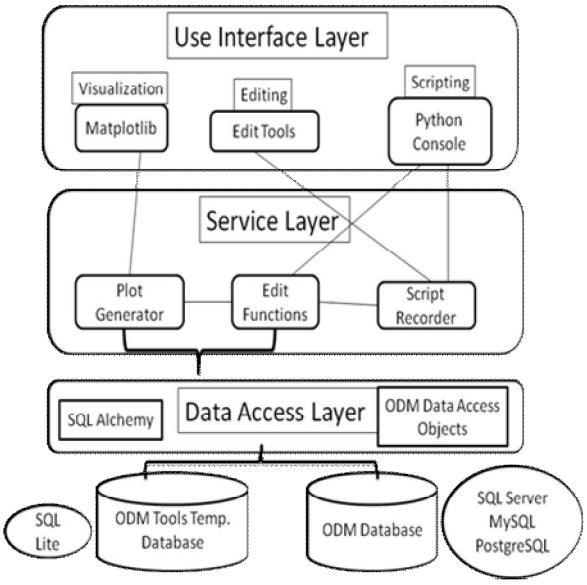
the results were effective, it required prior knowledge of textures of the regions in the image.

Depending on the various attributes, image segmentation divides an image into different regions. Computational complexity is the major issue. This can be addressed by implementing segmentation based on histograms. Even though there is extensive research reported on different methods for segmentation, there is no such result or system that can be applied for any kind of image.

III. TECHNOLOGY DESCRIPTION

Different kinds of images are produced in these days and to explore this data we definitely need sophisticated software tools that are,

- Easy to use
- Free and No Restrictions
- That can deal with challenges



WHAT IS PYTHON?

Python is an open-source object-oriented, high-level programming language created by Guido van Rossum in 1989. Its dynamic typing, binding and high-level built in data structures, make it suitable for speedy application development. It also supports packages and modules that improve code reuse and program modularity.

PYTHON APPLICATIONS

- Image Processing
- Computational and scientific applications
- Games
- Operating Systems
- Development of languages
- Prototyping
- Business and Enterprise applications

Advantages of Python

Some of the benefits of programming in Python include:

1. Third Party Modules
2. Broad range of Libraries
3. Open Source
4. Easy to learn
5. Fast
6. Data Structures
7. Productive

SCIKIT-IMAGE

Scikit-image: Implementation of image processing algorithms in Python programming language.

Sub-modules of Scikit - Image:

Sub - Modules of Scikit -Image	
Color	Input / Output
Data	Measure
Draw	Morphology
Exposure	Novice
Feature	Restoration
Filter	Segmentation
Graph	Transform
	Viewer

The purpose of scikit-image,

- Providing high-quality library
- Different image processing tools free of charge.

ADVANTAGES OF PYTHON OVER MATLAB

- Compressed and Readable code.
- Python is an open and free source.
- Using square brackets for indexing for converting code from one to another.
- Superior Data Structures.
- One can control the code and easy to maintain different libraries.
- Alternative graphics package and toolsets.

IV. IMPLEMENTATION

This project focuses on three main objectives as mentioned below.

1. Preliminary Analysis:

Acquiring an appropriate image for segmentation forms the initial step of the segmentation process. There are various types of medical image modalities available. They are,

- Compu ted Tomo graphy(CT)
- Magnetic Reson ance Imaging(MRI)
- Positron Emission Tomo graphy(PET)
- Ultra sound
- X-R ay

2. Preprocessing – De-noising of Image:

Noise removal is one of the preprocessing techniques that plays vital role in further processing on an image as it provides clarity of the image.

Denoising is opted as one of the preprocessing step as a better image with clarity gives better results.

Noise Sources: [1]

The principal sources of noise in digital images are:

Film grain
Damaged Film
Environmental conditions
Method of Digital Image Data Capture
Inadequate levels of light
Image Data transmission
Transmission channel Disturbances
Untidy Scanner Screen

Different sources of Noise [2]

- Acquisition of Image
- Transmission of Image

Different Noise models

Spatially independent noise models

– Gaus sian noise
– Ray leigh noise
– Erla ng (Gamma) noise
– Expo nential noise
– Impu lse (salt-and-pepper) noise

Spatially dependent noise model

– Periodic noise

Various Types of Filters Used to remove noises [2]:

- Mean Filter
- Median Filter
- Adaptive Median Filter
- Standard Median Filters
- Switched Median Filters
- Progressive Switched Median Filters
- Decision Based Algorithm
- Improved DBA
- Trimmed Median Filters
- Un symmetric Trim med Median Filter

3. Image Segmentation Using Region Based Segmentation:

As mentioned in the earlier chapter, Region Based Segmentation is one of the image segmentation techniques that provide two techniques,

- **Region Growing**

*Pros***:** Simple, Identified regions are thin and connected, noise tolerant.
Limitation: Over segmentation for noisy or various intensity images. Real image shading cannot be distinguished. It is time consuming [6].

- **Region Splitting and Merging**

Pros: Guarantees regions that are connected and lengthy neighbor problems during merging are reduced by IQM.
Limitation: Results in over segmentation (more regions) by splitting due to regular division. Normalized cuts method addresses this limitation.

1. Region Growing

It is the segmentation technique that clusters similar pixels into bigger region which is based on predefined criteria. In this method, pixels are combined with a centre seed that grows to corresponding regions by appending the seed points of the neighboring pixels which exhibit same properties such as texture, shape, color, grey scale and so on.

A segmentation is the partition of and image R into sub-regions{Ri} such that

$$\bigcup_{i=1}^{n} R_i = R; \quad R_i \cap R_j = \varnothing$$

s. t. Rt is a connected region

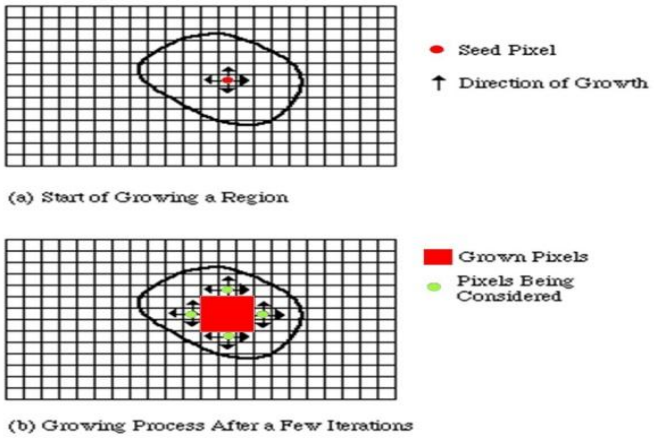
A region can be defined by a predicate P
such that P(Ri)=TRUE
if all pixels within the region satisfy a specific property.

$$P(Ri \cap Rj) = \text{FALSE for } i \neq j.$$

Region based segmentation algorithms are comparatively manageable and more immune to noise. The step by step process is, [8]

1. Seed pixels in the image are selected.
2. Region is grown from every seed pixel.

a. Region prototype for the seed pixel is set;
b. Region prototype and candidate pixel similarities are calculated;
c. Candidate pixel and its similar adjacent neighbors are considered;
d. Aggregate the candidate in case if both similarity measures are higher than experiment set thresholds;
e. Later new principal component is calculated to update the region prototype;
f. Finally move to the next pixel to be examined.

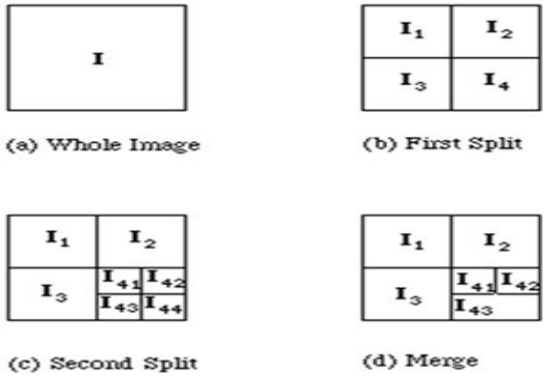


2. Region Splitting and Merging

Region splitting is a top-down approach. In region splitting, the whole image is considered as a single region which is then split into disjoint sets of regions which are logical within themselves. Merging technique is used after every split and merged after comparing with the adjacent regions. It begins with smaller regions and merges into larger regions that possess same characteristics such as grayscale, variance, etc.

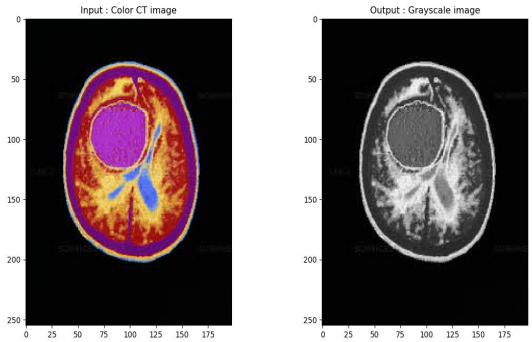
Two Parts: [6]

1. Firstly, the entire image that is viewed as a single region is split repetitively until there are no more possible splits, Quad tree is one of the splitting data structure.
2. Similar adjacent regions are merged and continued till there is no possible merging.

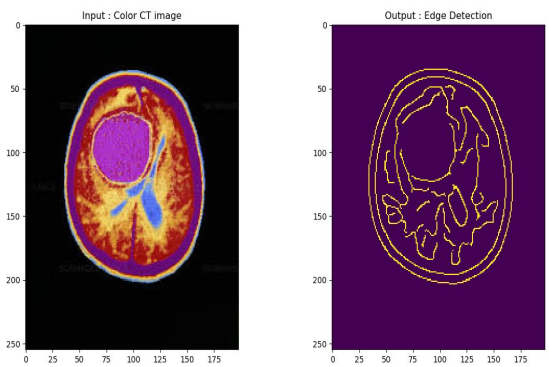


V. RESULTS

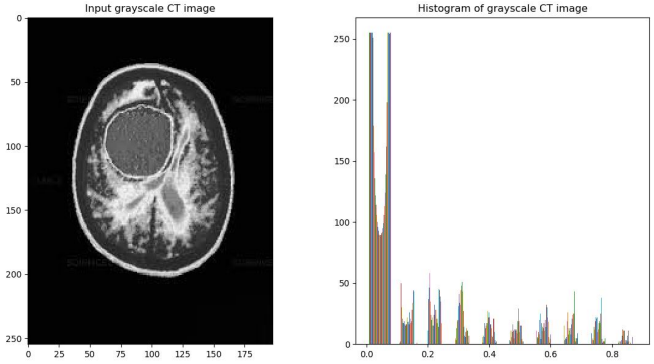
Color to Grayscale Conversion



Edge Detection

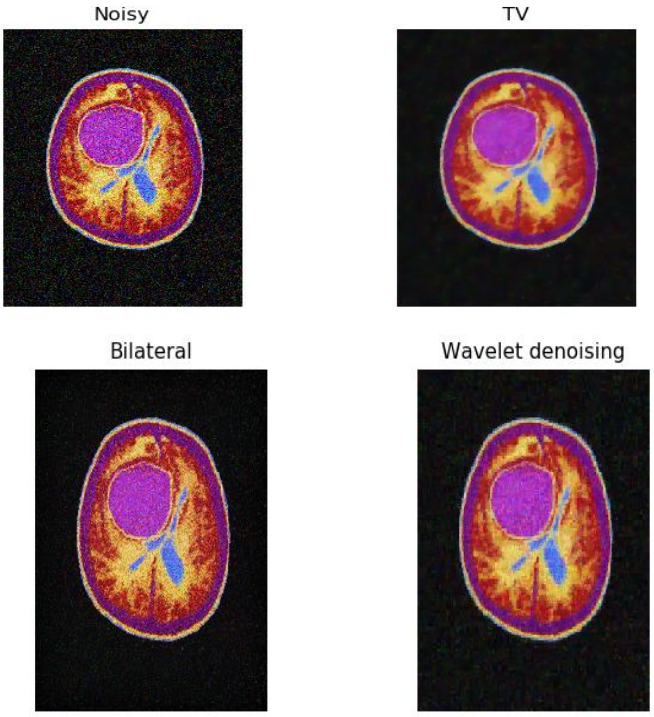


Histogram of the Image

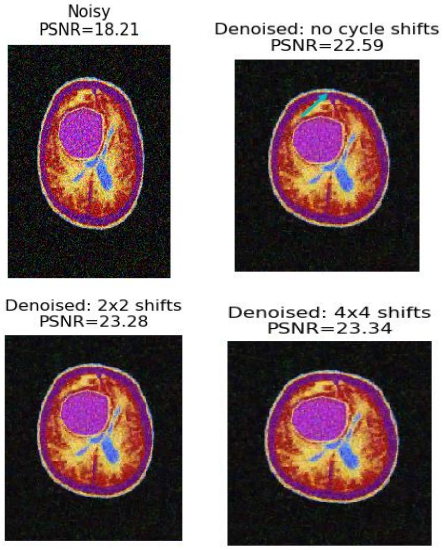


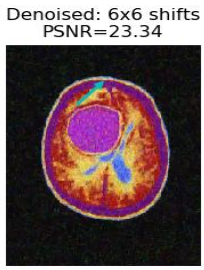
Denoising Using Filters

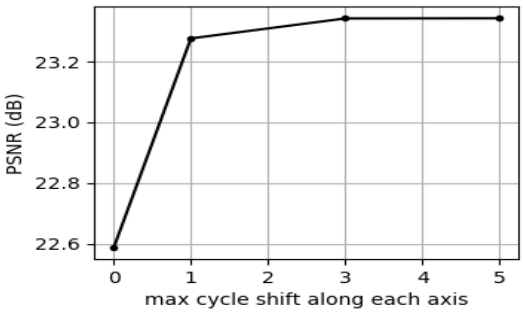
Estimated Gaussian noise standard deviation = 0.0986484385444893



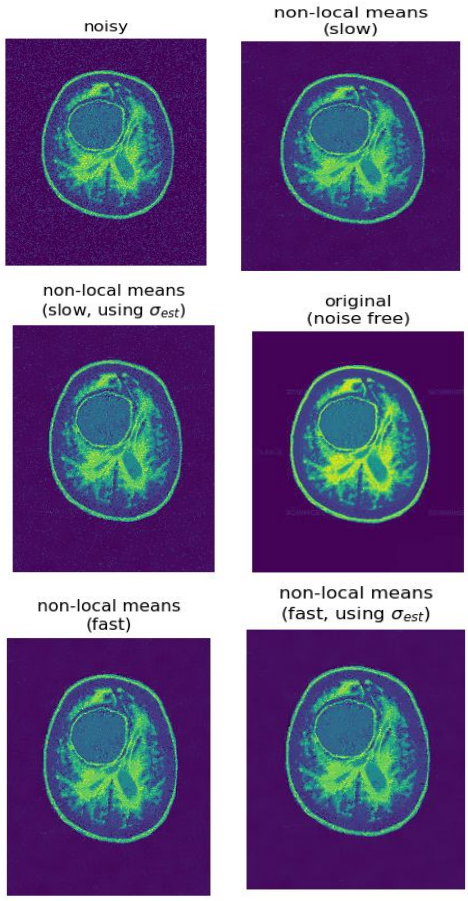
Denoising Using Wavelets





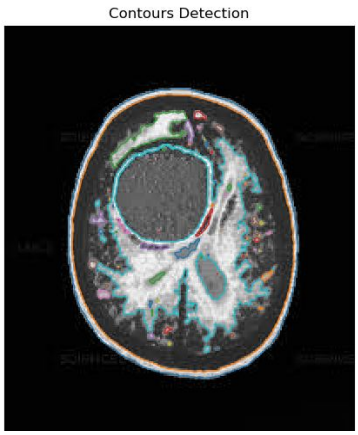


Denoising : Non - Local Means Algorithm



Estimated noise standard deviation = 0.05922876797274848
PSNR (noisy) = 23.57
PSNR (slow) = 27.07
PSNR (slow, using sigma) = 26.16
PSNR (fast) = 26.83
PSNR (fast, using sigma) = 27.20

Contours Detection



VII. CONCLUSION

With the rapid development of digital imaging techniques, mobile platforms and internet, more and more visuals, videos and graphics are available to public. Images are the most significant formats of media for human understanding and communication. Medical Image Analysis needs more methods and techniques for analyzing a digital image to acquire proper information/ knowledge for further interpretation that helps in many areas of healthcare. As there are no particular techniques for segmentation, segmentation methodologies vary which ultimately must provide better results. This project proposes a preprocessing technique for denoising and region based contour segmentation on medical images.

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