LIVER ULTRASOUND IMAGE SEGMENTATION USING MARKOV RANDOM FIELD

submitted in fulfilment of the requirement for the degree of

Bachelor of Technology

In

ELECTRONICS AND COMMUNICATION ENGINEERING

By

NIKHIL YADAV (181013)

UNDER THE GUIDANCE OF

DR. NISHANT JAIN

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY,WAKNAGHAT, SOLAN (HP) - 173234

TABLE OF CONTENTS

DECLARATION

I hereby declare that the work reported in the B.Tech Project Report entitled **"Liver Ultrasound Image segmentation using Markov Random field"** submitted at the **Jaypee University of Information Technology, Waknaghat, India** is an authentic record of our work carried out underthe supervision of **"Dr. Nishant Jain".** I have not submitted this work elsewhere for any other degree or diploma.

Name: Nikhil Yadav

Roll No.: 181013

This is to certify that the above statement made by the candidates is correct to the best of myknowledge.

Dr. Nishant Jain

Date: 28th May 2022

Head of the Department/Project Coordinator

ACKNOWLEDGEMENT

Foremost, I would like to express our sincere gratitude to the Department of Electronics and communication of my university for its continued support and encouragement and for providing great learning opportunities throughout.

The completion of this project could not have been accomplished without the support of my mentor Dr. Nishant Jain. I cannot thank him enough for his patience, motivation, and immense knowledge. His guidance has helped me in doing the research work for this project and I couldn’t have imagined a better advisor.

Last, but not least, I would like to thank my parents for their support, care, prayers, and sacrifice and for showing concern even during the hectic times.

LIST OF FIGURES

ABSTRACT

The project comprises of segmentation of liver Ultrasound Image . the segmentation of Ultrasound image is performed . The segmentation is done considering different factors involved as well as by using different image segmentation filtering techniques.The segmentation is basically the process of differentiating out the fore ground image from the back ground image and it is taken into consideration by applying image processing techniques. In this process as I have applied filters on US image to segment out the disease are from the overall liver US . The basic emphasis is given to Markov random field and subsequently other filters are applied such as k mean clustering , fuzzy c mean to compare the results with each others . The suggested procedures are implemented using MATLAB and offer the most accurate results with the least inaccuracy. The project's principal objective is to better medical diagnosis by automatically recognising concerning patterns and categorising problems. Medical picture segmentation is a critical stage in contouring during radiation planning. I have opted to concentrate on Ultrasound photos since Ultrasound imaging is impeded by the presence of signal-dependent noise known as speckle. The radiologist evaluates the Us image form different processing techniques and will be able to recognise the image and processing giving the best result.sort of lesion So, to make it more efficient I have utilised image processing.

CHAPTER 1

INTRODUCTION

1.1 IMAGE PROCESSING

1.1.1 What Is an Image?

The dimensions (height and breadth) of a picture are determined by the number of pixels. Example, an image's dimensions are 300 × 200 (width x height), the image's total number of pixels is 60000. It has following kinds :

• Grayscale - A pixel is a value which spans from 0 to 255.

• RGB - RGB picture comprises of three colours red , blue , green with values range from 0 to 255.

• RGBA - It's an expansion of RGB with the inclusion of a field that reflects the image's opacity .

Picture processing demands a series of actions that are carried out at each pixel of the picture.

1.1.2 Image Processing

Image processing is the process of taking out important information from an image by turning an image into it's digital form .

These are the kinds of image processing:

Visualization of an Image - Find protests that are not obvious in the picture

Recognition of a picture - identifies things in an image.

Sharpening and restoration - improved picture is created from original input image.

Pattern recognition - deals with the categorization of diverse pattern contained inside the image.

Retrieval– Images may be sought for and pulled out from vast data bases .

1.1.3 Fundamental Image Processing Steps

Image Acquisition

The initial stage in image processing is picture acquisition. In image processing, this stage is also called as preparation. It needs getting the picture from a source, frequently hardware-based.

Image Enhancement

The practise of bringing out and accentuating key areas of interest in a picture that has been concealed is known as image enhancement. This may require modifying the brightness, contrast, and other settings.

Image Restoration

The process of completely changing the features of the filter , done with image processing at done with taking the pre conceived data .

Color Image Processing

In this method the image is changed to different forms such as changing the colour or maybe we can say that by converting the image taken from some source.

Segmentation

The process of converting image or categorization in the form of fore ground and background is called segmentation.

Representation and Description

Each part or area of image comprises of different characteristics which is changed to the basic of representation as well as the mode of effectiveness towards the discretion of each region.

Recognition Based on its description, recognition offers a label to an item.

1.1.4 Applications of Image Processing

1.Medical Image Retrieval

2.Traffic Sensing Technologies

3.Image Reconstruction

4.Face Detection

1.1.5 Benefits of Image Processing

1. The image processing is currently opted in approx. all the field in developing a product by a firm or for reasearch purposes .
2. The image can be obtained in any colour or contract which we can say is the best feature in processing we have got .
3. The pictures are so much better which is obtained that it matches a persons or humans IHS understanding of eye.

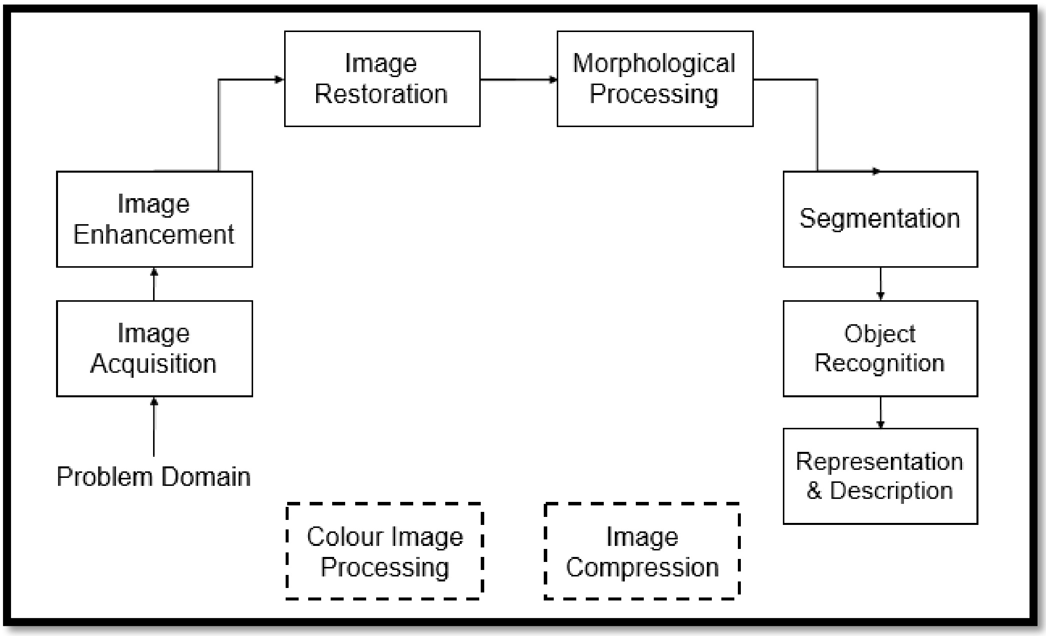


Figure 1.1 Block diagram of Digital Image processing

1.2 Medical Image Processing

The processing of images in medical field takes alot to consider and to recognise an image. Now a days as image processing is becoming a critical part of day to day activities from google implementation of image proceesing to developing new products similarly it is also able to take control over the medical field for implantation of it on different medical instruments as well as different modalities .

1.2.1 Different technique

Picture visualisation is all out taking an image , reading it showing it into binary or pixels value by representing it in the form of matrix and ploting the same . the images are then analysed based of different analytical approaches the by applying algorithm of methods or by implementing it using techniques such as contract and more .

In processing of an image the image management plays an effective role as well from storing the image to converting it into double , binary and other techniques based on pixel value and requirement.

The enhancement of an image refers to the approach of an image towards the changing of colour , contrast and brightness of an image as well. The techniques such as histogram ploting and contract stretching are performed .

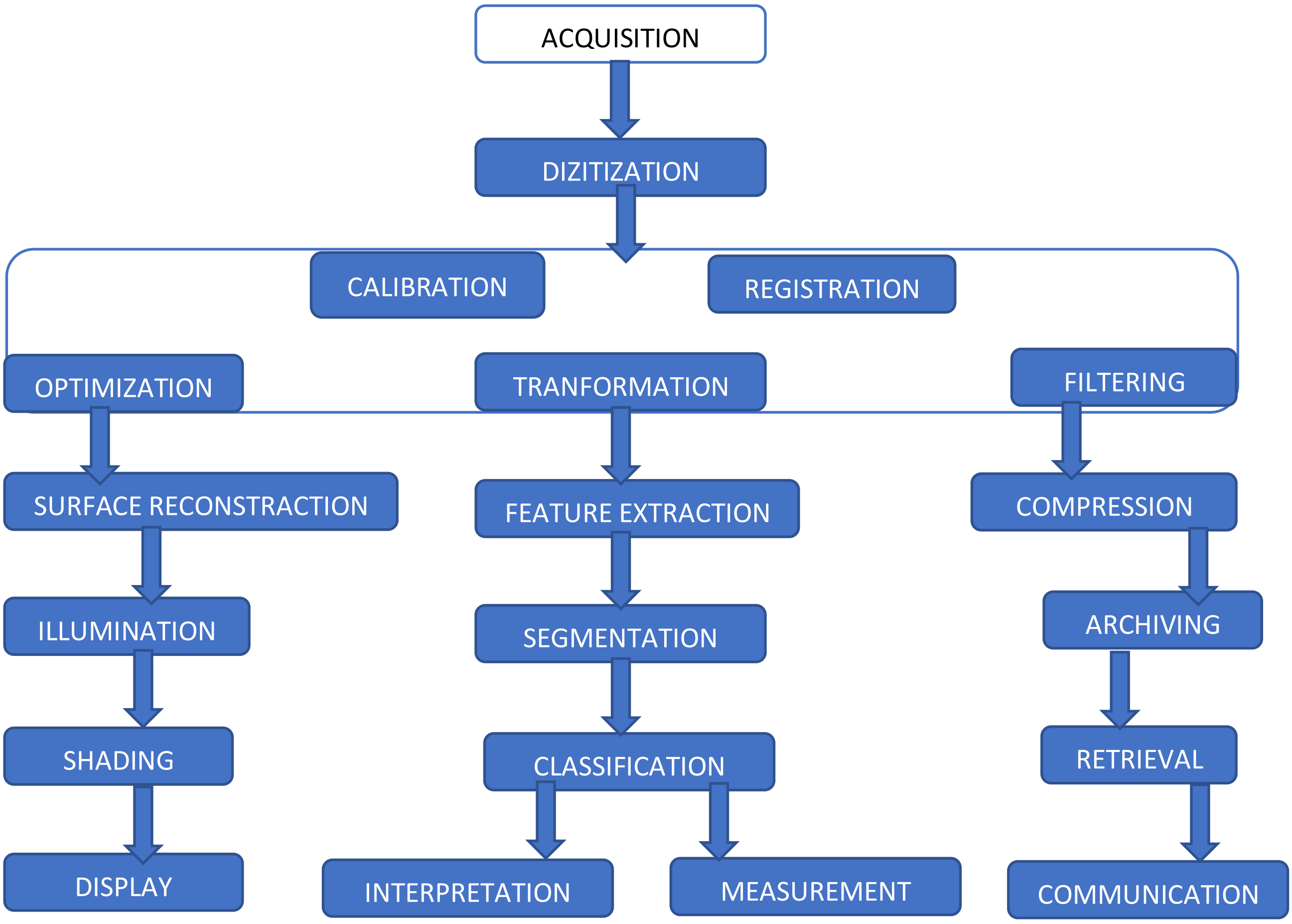


Figure 1.2 Block diagram of Medical Image processing

1.2.2 What are the benefits of medical image processing?

There are numerous numbers of benefits involved in digital image processing which is changing from recent time to much more advance phase , the processing of medical images provides in depth information out the image , gives and scope to do some betterment in the image for the more effective result , today in present time almost every filed of medical as recognised medical image processing and use it as well as it also eps in developing 3D models and helps in best informed diagnosis of and individual . For example, in ultrasound image the most of the problem is due to speckle noise which reduces the effectiveness of the ultrasound image and to counter that spackle noise , I have also applied image processing to extract only the required information out of the US image.

The improvement in the era of medical images and image processing has kind of built the relations between them . The tools are modified and new algorithms are developed the imaging od diseases as moved to more advanced phases and that is ever growing and it has built a relation between human anatomy to the image processing.

1.3 MEDICAL IMAGING TYPES AND MODALITIES

Medical imaging may be exploited for both diagnostic and therapy purposes, making it one of the most powerful tools available to properly take care of the subject that is to refereeing patient .

In terms of diagnosis, common imaging types include:

1. CT (Computer Tomography)
2. MRI (Magnetic Resonance Imaging)
3. Ultrasound
4. X-ray
5. PET

1.3.1 ULTRASOUND

The ultrasound approach takes use of high-frequency sound waves, which are reflected off tissue to create photographs of different anatomy of humans . the wave is passed through tissues of the body and the it is received by the receiver which ultimately generated the imaging. The process is cheap and used and valuable/available everywhere.Ultrasound is considered as the safest way of medical imaging .

Ultrasound is also a no siring or nonenvasive process for which high sound wave are passed.

1.3.2 Ultrasound Imaging working

Ultrasound also known as sonography, takes use of high-frequency sound waves, which are reflected off tissue to create photographs of different anatomy of humans . the wave is passed through tissues of the body and the it is received by the receiver which ultimately generated the imaging. The process is cheap and used and available everywhere.

This information is sent to produce graphics on a computer screen which tells the abnormality, size and other features.

1.3.4 Benefits of Ultrasound

Ultrasounds have several advantages:

1. painless .
2. Patients aren't treated to ionising radiation
3. Ultrasound takes photos of fragile tissues which x ray is not able to.
4. costs less.

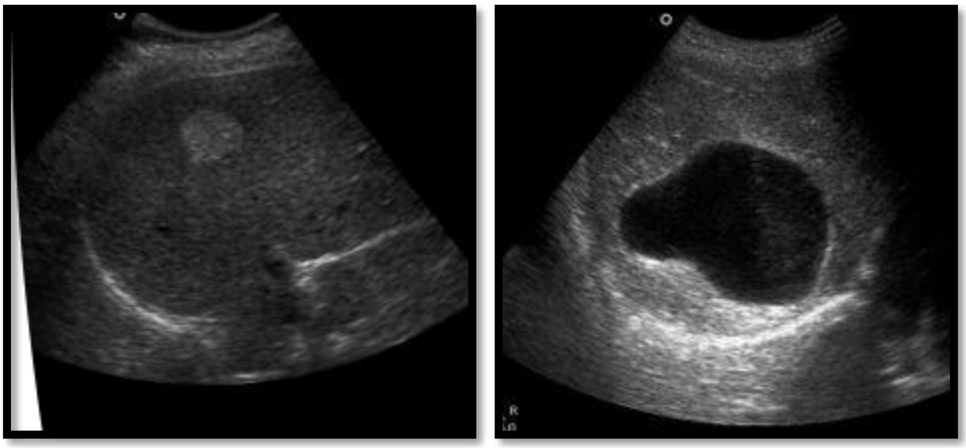


Figure 1.3 Ultrasound images

1.4 MATLAB

It supports representation and coding for mathematical implication as well as for applying algorithms ; development of user interfaces; linking with programmes written in other languages, including C, C++analysing data; developing algorithms, and producing models and applications. It contains several built-in instructions and math functions for calculations, producing graphs,.

1.4.1 Applications of MATLAB

MATLAB It supports representation and coding for mathematical implemation as well as for applying algorithms ; development of user interfaces; linking with programmes written in other languages, including C, C++analysing data; developing algorithms, and producing models and applications. It contains several built-in instructions and math functions for calculations, producing graphs, MATLAB provides tools and functions for smooth implementation of different signals as well as for image processing.

The most important part of matlab is on the basis of implementation as well as the impregnation over signal and signal processing.For the project all codes are done on matlab as to project the perefect results obtained from different algorithms . In this project I’m using matlab to implant it over image processing by applying different algorithms as well as image processing tools from library.

1.4 SPECKLE NOISE

- The presence of speckle noise in the picture reconstruction process is a basic challenge in optical and digital holography. Speckle is granular noise that appears fundamentally in images and diminishes their quality.

- In a picture, speckle noise is both random and predictable. Speckle has a detrimental influence on ultrasound imaging. A radical loss in contrast resolution may be to blame for ultrasound's poor effective resolution.

1.4.1 Aim and goals of the research

The major objective of my research is to enhance physician diagnosis by automatically recognising alarming patterns and categorising anomalies. During radiation planning, medical image segmentation is a critical step in contouring. Reliable approaches are necessary for the delineation of anatomical structures and other location of interest.

To automate the technique we have used mrf to project the maximal right result with the preferred accuracy , i.e., the results are not damaged by weariness, data overload, or missing human phases.

Speckled noise contaminates ultrasound scans, making the texture of separate areas overly convoluted and intermixed, making it difficult to find the area of interest or the disease are , and effective implementation can be difficult to implemant.

CHAPTER-2
LITERATURE REVIEW

2.1 Liver Ultrasound Image Segmentation Using Region-Difference Filters [4]

This study provides region-difference filters for segmenting hepatic ultrasonography (US) images. The biggest difference between the averages of two sections are of interest .the centre pixel is examined using region difference filters. When the filter are applied to the full picture, a region difference image is created. This picture is then translated to a binary image and morphologically analysed in order to segment the needed lesion from the ultrasound image.

2.2 Segmentation Technique [2]

Segment is a frequent and effective strategy in the realm of image analysis. the segmentation approach is take out and show the disease or area of interest for medical information purpose. The major goal of this research is to analyse and explain an effective segmentation technique. While performing comparative research on segmentation methodologies for medical image analysis using,K-Nearest Neighbors ,and the Conv. Neural Network. To get high accuracy, the Convolutional Neural Network may be utilised as a segmentation tool in medical photo processing. ML presently is not the same as ML in the past owing to the reliance of recent technologies and image analysis approaches. Recently, there has been enormous progress in the technological domain, and deep learning has assumed the role of ML, which is a subdivision of ML, to boost image analysis accuracy. Image analysis methods' principal goal is semi-automated or automatic medical diagnosis. The segmentation approach permits the qualitative improvement and visualisation of medical pictures in a range of modalities such as PET, MRI, CT, and so on. The fundamental goal of this research is to determine the optimum segmentation approach for medical pictures. Using a range of mach. learning and DL methodologies, the findings reveal that CNN excels in all instances requiring medical imaging issues. CNN demonstrates the incredible results that may be reached by the correct application of both sophisticated theoretical principles.. The ability of a convolutional neural network to match a given objective defines its success.

2.3Medical Image Segmentation Methods, Algorithms, and Applications [3]

Medical images have made major contributions to all medical diagnosis and treatment . Image segmentation is the most crucial part of image processing. This paper covers a range of image segmentation algorithms for medical picture analysis. We have presented the most current segmentation methods utilised in medical image analysis in this study. The pros and cons of each technique are examined, as well as a study of each algorithm's employment. Each approach is explained individually, along with its capabilities and features for grey-level image analysis. In order to examine the segmentation outcomes, the final component offers some usual benchmark measures. Each strategy will be reviewed in depth, including its methodology, merits, and pitfalls.there are numerous types involved from clustering to hybrid mode. Thresholding is among the simplest and fastest segmentation techniques, based on the premise that images are made up of sections with varied Gray levels. Image histograms comprise distinct peaks and troughs that may be used to break photographs into discrete regions. A threshold is a number in a histogram that splits intensities into two parts: the foreground, which includes pixels with intensities higher than or equal to the threshold, and the background, the thresholding is taking into consideration for separating out wrt to threshold and pixel value whether it is less or more than the thresholding. Region expanding is an interactive segmentation strategy that starts with the initialization of certain seed points. This technique splits a region of images based on intensity information using a preset algorithm. In its most basic form, region development needs just one seed point, and the region is grown dependent on its homogeneity characteristics as determined by nearby pixels. The search for patterns in data, known as pattern categorization, is a basic topic with a historical history. Classification is basically a pattern recognition strategy that detects patterns using training data. A associated target labels is supplied in the training data. This strategy is known as supervised learning because it involves training data that is manually segmented and then fed to the automated process. For image processing, a number of classifier methods have been applied. In this portion, we will go over two prominent classifiers: k-nearest-neighbor and maximum likelihood. Clustering algorithms function similarly to classification approaches, with the distinction that clustering methods do not need training data. These algorithms act similarly to finding desity, in that an unlabelled data algorithm aims to summarise and show data based on its key properties. In clustering, numerous data mining approaches have been applied. We explore three major clustering algorithms in this section: k-means, fuzzy C-means, and expectation-maximization. The ROI and boundary are the underpinnings of hybrid techniques. To split the photos, these techniques make use of both border and regional information. These algorithms give superior results than prior segmentation methods used in medical imaging. This paper discusses various recent image processing methods that are frequently applied in medical picture analysis.

2.4 Image segmentation K-means algorithm

The process of segmenting out an image can be hectic and critical at the same time and computer vision. This study proposes an adaptive K-means image segmentation strategy that gives trustworthy segmentation results with a single operation and minimises the requirement for interactive K value input. First, the colour information of pictures is transformed into LAB colour space using this process. In order to restrict the effect of light on image segmentation, the luminance component values are modified to a specified value. Then, after defining the threshold, the comparable connection between Values of k and the number of connected domains is applied to adaptively segment the imagethe final segmentation results are obtained. Experiments reveal that the technique recommended in this paper is not only easy, but also precise and successful. In this paper, they provide image segmentation technique that serves as a technical basis for volume computation. There are numerous benefits to this tactic over the standard method. To begin, the K-means technique optimises the manner of calculating K, and the loop is used to compare the number of connected domains that fulfil the conditions in the previous phase, and once they are identical, the K value is successfully calculated. When compared to other traditional approaches such as the elbow approach boost efficiency. Second, the mechanism presented in this study for translating pictures into a specified LAB colour space isn't particularly available in earlier ways. The parameter may effectively filter the effects of the background on the image, resulting in more accurate segmentation results.

2.4 Image Segmentation using Subtractive Clustering Algorithm

The categorising of a photograph into numerous categories is known as image segmentation. Many research on segmenting out the image via clustering and have been undertaken. There are various approaches, with the k-means clustering algorithm being one of the most prevalent. The K-means clustering method is an unsupervised approach that is used to segregate the area of interest from the background. However, before employing the K-means approach, the image is treated to partial stretching treatment to boost its quality. Subtractive clustering is a sort of data clustering that produces the centroid based on data value of a data set . As a consequence, subtractive clustering is used to generate the initial centres, which are subsequently utilised in the k-means approach for image segmentation. Finally, filter such as averaging filters mean , mode and a median filter is used to the segmented image to exclude any undesirable areas. The recommended solution comprises contrast stretching, subtractive clustering, k-means clustering, and a median filter. The bulk of medical pictures used for segmentation have low contrast.After enhancing the image's quality, the subtractive clustering approach is utilised to create the centres based on the image's potential value. The number of centres is determined by the number of clusters k. This centre is employed as the starting point for the k-means algorithm. The image is separated into k groups using the k-means algorithm. Even after image segmentation, the picture may still include some undesirable region or noise. The median filter is used to remove these disruptions. The k-clustering technique was used to segment an image, with the subtractive cluster being employed to generate the initial centroid. Simultaneously, contrast stretching to an extent is performed to boost the quality of the original picture, while the median filter is utilised to improve the segmented image. And when the final segmented output is compared to the k-means clustering approach, we can deduce that the recommended clustering algorithm performs better in terms of segmentation. The output images are also customised by altering the hypersphere cluster radius, and we can conclude that by varying its hypersphere cluster radius, we may receive diverse outcomes. As a consequence, we should approach the value of the hypersphere cluster with care. Finally, root mean square error and mean square error and peak signal to noise ratio , and it is determined that they have small and huge values, respectively, which are necessary for satisfactory image segmentation quality. And a comparison of , root mean square error and mean square error and peak signal to noise ratio the recommended method and the traditional K-means algorithm is done, and it is revealed that the novel strategy outperforms the usual mean algo. In the future, we may employ the morphological approach to raise the quality of the final picture even more and acquire better performance metrics. We may also utilise the subtractive clustering methodology to develop alternative clustering algorithms. Finally, we may apply and assess image segmentation in multiple regions.

2.5Image Segmentation with Markov random field

Dynamic contrast-enhanced imaging is used to detect some of the disease , as well as diagnosis of the diseases and it can also be used to monitor the diseases. .the process of segmentation os these images are not easy to do though as of some physical factors. So to extract out the iamge and to perform segmentaion Markov random filed is seen as one of the efficient way to segment the desired are of interest in the image, the region is because it works on homogeneity of an image and depect the homogeneous are within the image which is applicable for both Us and MR images . But this algoritm hass weaknesse wrt to finding the complexity as well as the parameters . To solve these challenges, in this study, we provide Improved-Markov Random Field approach for segmentation in MR images. IN this algorithm the icm is not applied instead the problablistic approach to the Neighbouring element is taken to arrange the neighbouring pixels accordingly and segment out the images but changing the attached pixel values.

CHAPTER-3

METHODOLOGY AND RESULT

3.1 FUZZY C MEANS CLUSTERING

Fuzzy clustering is a kind of clustering in which the date of a data set is divideded into different no. of clusters. The clustering is divided by deciding the no. of clusters it has to be divided in on the bases of similar data value.. The clusters are devided on the basic of functions such as mean and then after finding the mean the distance function is used as a method to separate out the clusters which are similar and neared to mean value and this way the clustering is done .

3.1.1 Advantages

1)Produces the best results for overlapping data sets .

2)In k mean the data is only considered to one cluster centre, but in fuzzy the data points are assigned membership to each cluster centre, enabling them to belong to more than one cluster centre.

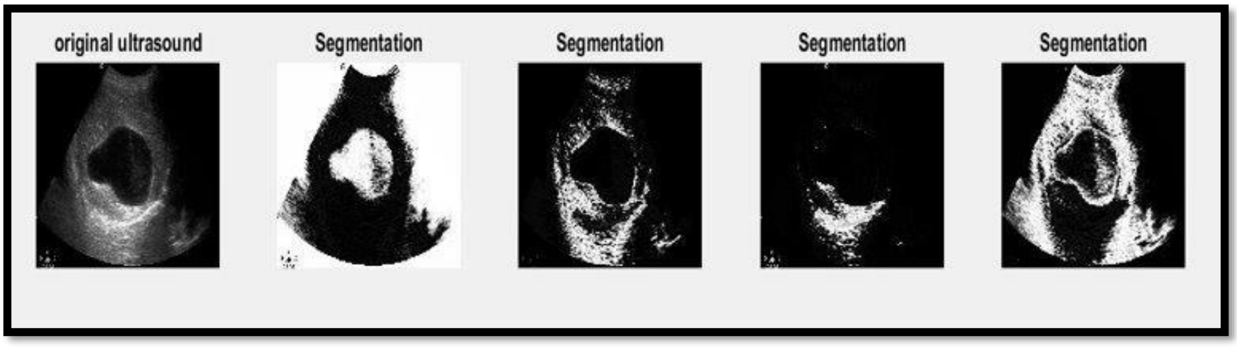
3.1.2 Disadvantages

1)The number of clusters is not stated.

2)A lower value delivers a better output but at the expense of a bigger number of repeats.

3)Euclidean distance measurements may weigh underlying items unequally.

OUTPUT IMAGE



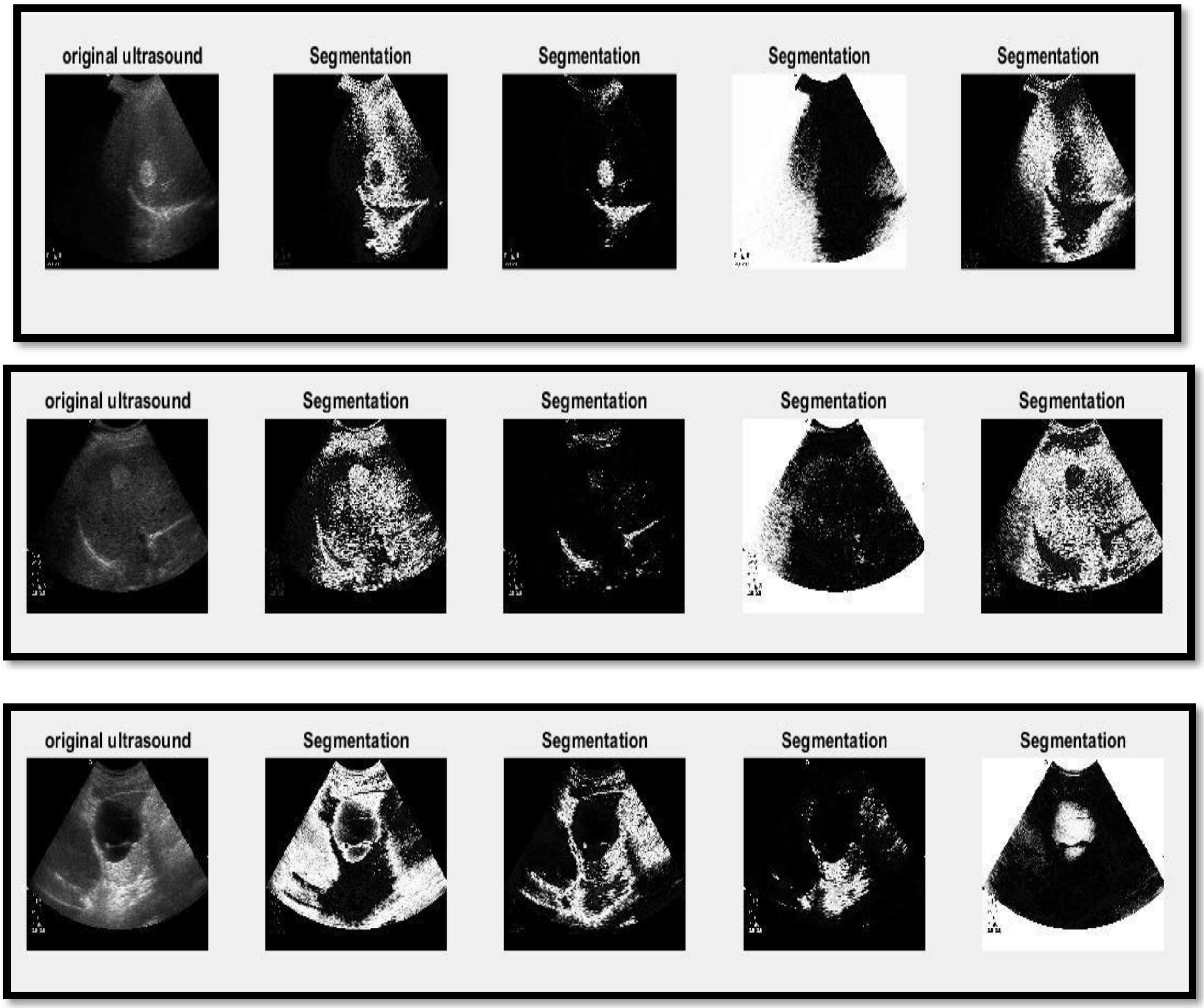


Figure 3.1 FCM applied on Ultrasound Image

3.2 K- MEANS CLUSTERING

K Means is a clustering method. Clustering algorithms are unsupervised algorithms that essentially operates without being aware of the end output. methods. The clustering is divided by deciding the no. of clusters it has to be divided in on the bases of similar data value.. The clusters are devided on the basic of functions such as mean and then after finding the mean the distance function is used as a method to separate out the clusters which are similar and neared to mean value and this way the clustering is done .Here, k denotes the number of clusters.

The stages entailed in K-means clustering are as follows –

1.Choose the number of clusters you wish to locate which is k.

2.Assigning the date values based on similarity to clusters as of for forming cluserting.

3.Then determine the centroid of the clusters.

k-means clustering is a vector separation and mathematical technique originated from processing the signal to processing the image that aims to partition n observations into k clusters, with respect to similarity. As a consequence ,the date is divided in small cells. variances are minimised by k-means clustering, but not traditional Euclidean distances, which is the more difficult Weber challenge: the mean optimises squared errors, but only the geometric median minimises distances.

The digitization is demanding , good strategies rapidly converge to a local point in the data set . The k-means and Gaussian mixture are techniques that extract out the maximazation of the process and stpes to obtain the distributio. They both utilise cluster centres to describe the data; the k mean clustering identifies the size of the date , while the Gaussian used to identify the size of the clusters .

The unsupervise k-means technique is connected to the k-nearest neighbour classifier, a prominent supervised machine learning methodology for classification that is commonly confused with k- means because of their similar names.

3.2.1 Advantages

1. Implementation is pretty easy.
2. Scales effectively with massive data sets.
3. Convergence is ensured.
4. Centroids' locations may be warmed up.
5. Adapts readily to new examples.
6. Generalizes to different shapes and sizes of clusters, such as oval clusters.

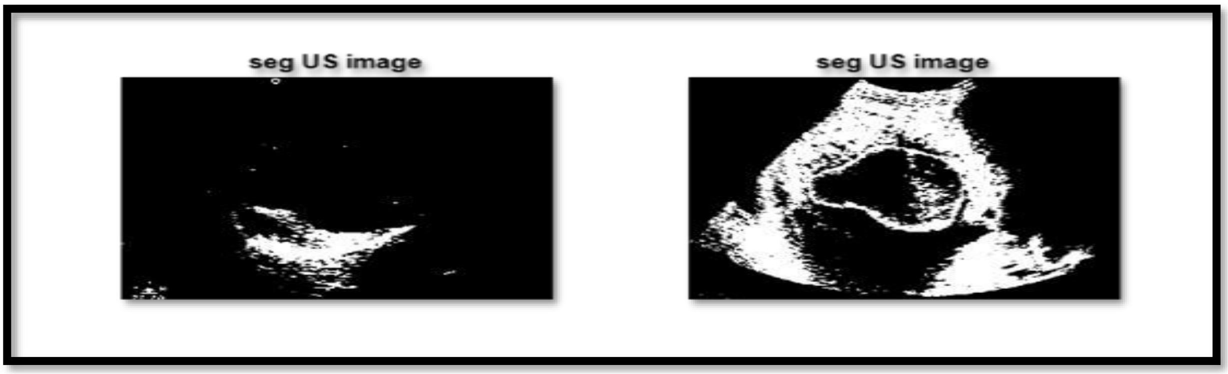


Figure 3.2: K means applied on Ultrasound Image.

3.3 IMAGE SEGMENTATION BASED ON ADAPTIVE K-MEANS ALGORITHM

This study provides an advance form of K-means image segmentation approach that produces correct segmentation results in a single operation and removes the demand for interactive K value input. This process starts by translating image colour information into LAB colour space. The brightness component values are adjusted to a predefined value to limit the influence of light on image segmentation. The similar connection between Values of k and the number of linked domains is then utilised to adaptively segment the picture once the threshold has been determined. The final segmentation results are obtained following an image processing techniques . Experiments reveal that the approach suggested in this research is not only simple but precise and successful as well.. In this paper, they provide an accurate image segmentation technique that serves as a technical basis for volume computation. There are numerous benefits to this tactic over the standard method. To begin, the K-means technique optimises the manner of calculating K, the obtained value is used to find the similar data thatis able to fulfil the conditions of a phase opined before , and once they are identical, the K value is successfully calculated. When compared to other traditional approaches such as the elbow approach,this idea if amplected accordingly can save a lot of time and reduces the life of code as well. . Second, the mechanism offered in this study for translating pictures into a specified LAB colour space isn't particularly available in earlier methods.

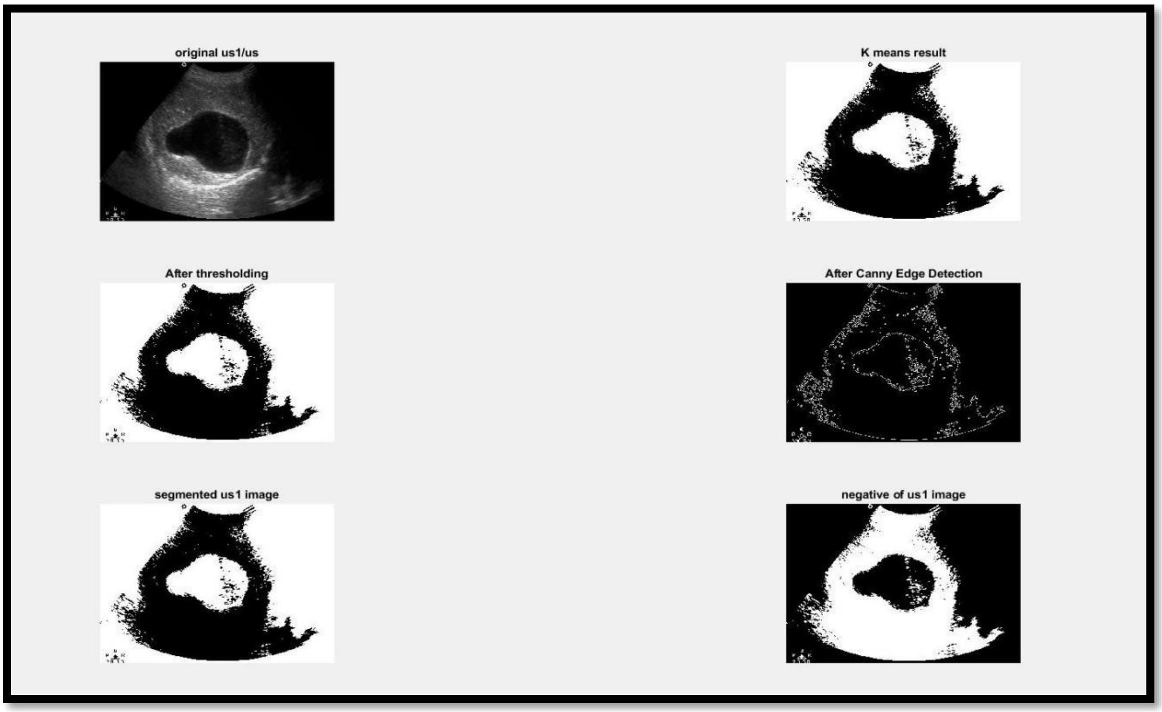


Figure 3.3: image segmentation based on adaptive k-means algorithm

3.4 MARKOV RANDOM FIELD

A Markov Random Field is a network whose nodesis used to represent random variables, and edges are used to describe desired local impacts among pairs of them.

A natural MRF that models this has a node for each of the pixels. An edge links two nodes that are nearby (on the grid) (on the grid). Below is an example MRF on a 3x3 grid. The vertical and horizontal lines are its edges.

$$p(x) = \frac{1}{z}\prod_{C=1}^{C} \phi_C(x_{\mathbb{C}})$$

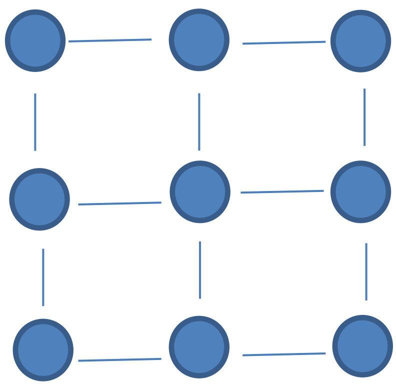


Figure 3.4:Grid and Edges graph

3.4.1CLIQUES AND ENERGY FUNCTIONS

- A clique in a network is a collection of nodes in which every pair is linked by an edge. A clique is maximum if it is not part of a bigger one.
- A clique (green, orange) is a subset of vertices that are entirely connected.

- A maximum clique (orange) is a clique that cannot be expanded by any other vertex.

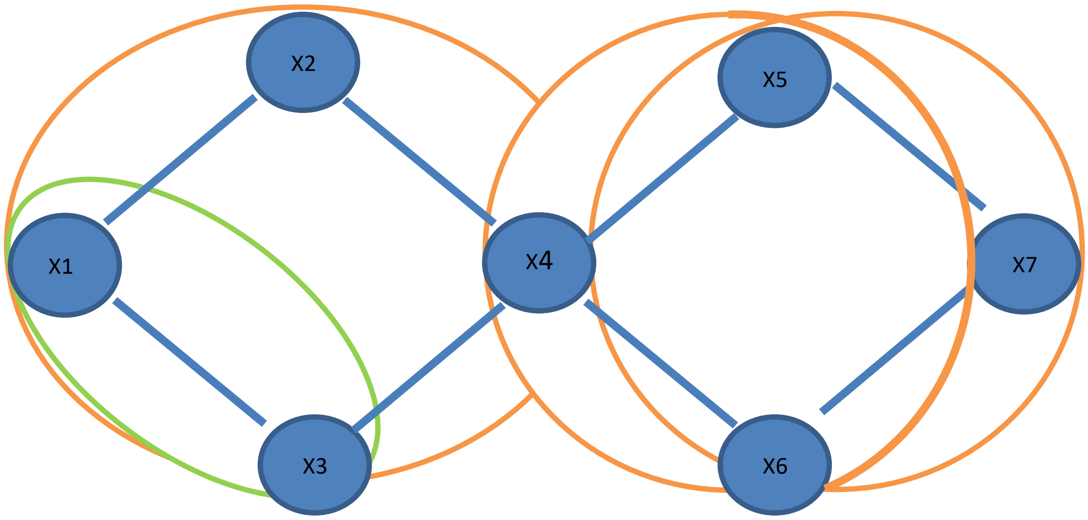


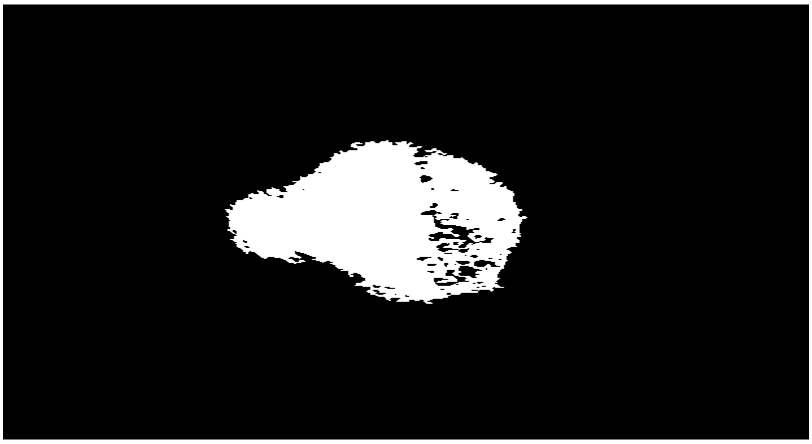
Figure 3.5: Clique in a graph

3.4.2 CLIQUES AND ENERGY FUNCTIONS

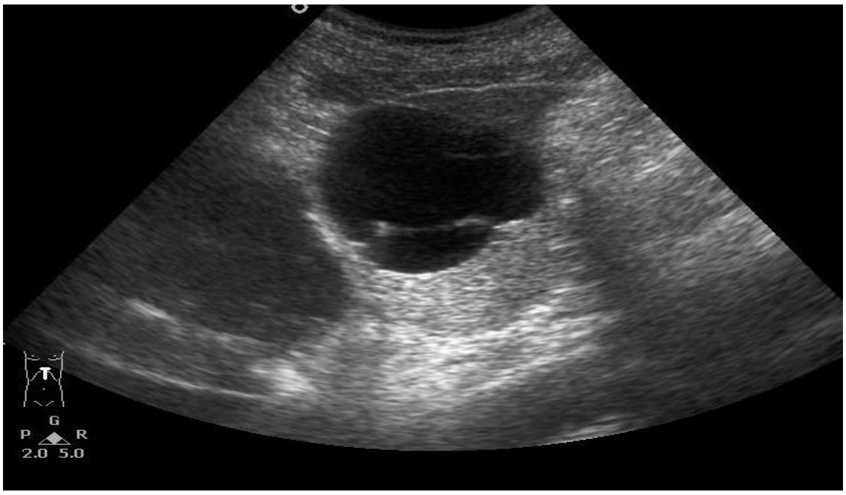
A clique in a network is a group of nodes in which every pair is connected by an edge. A clique is maximal if it is not part of a greater one.

INPUT CYST IMAGE 1:

OUTPUT CYST IMAGE



INPUT CYST IMAGE 2:



OUTPUT CYST IMAGE :

Fig 3.6 : Markov result for image Segmentation

So, from the output images of Markov random fields it is quite clear that we are able to extract the disease out of the input ultrasound image of the liver . The segmentation process is making layers of markov model with foreground and background image labelling as to separate out the area of interest from the image . The process to extract the are of interest is followed by no. of iteration as to get the best result .

CONCLUSION

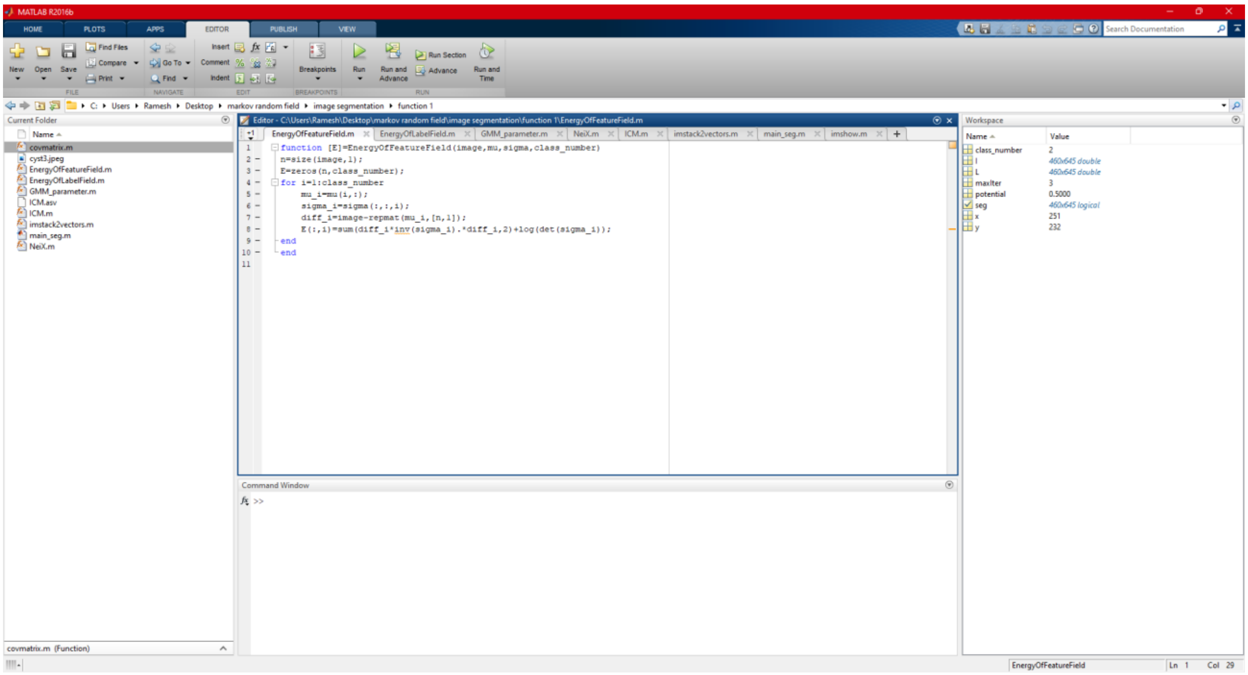
As proposed, Markov random field and other algorithms were applied on liver Ultrasound Images to segment out the disease are from the spackle noise and surrounding liver . Various techniques and algorithms constituting techniques like fuzzyC means, K-means and Markov random Field were implemented on US image of human liver and found that the Markov Random Filed performs best in all other segmentation methods in terms of performance and by qualitative analysis it is quite noticeable that the markov random field segmenting out with the best result, also k means results are better than fuzzy c mean and with the adaptive K means approach, the subtractive clustering technique improves the outcomes significantly and also the canny edge can be detected with thresholding which can be said to be a pre-processing implementation . The low pass filter was also applied for the smoothing of image but when compared with the normal image there was not much difference in the result , So, the segmentation filters can be applied directly as well. The segmentation is giving the liver disease clearly and removing all the spackle noises from the ultrasound image

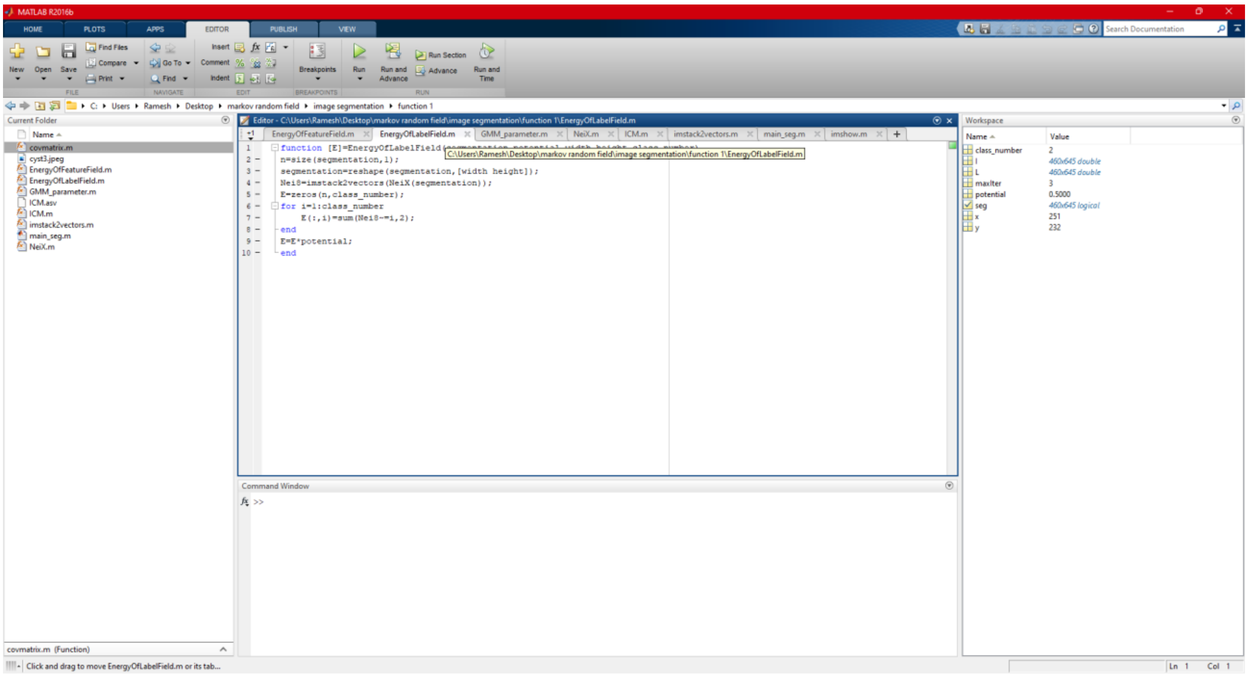
REFERENCES

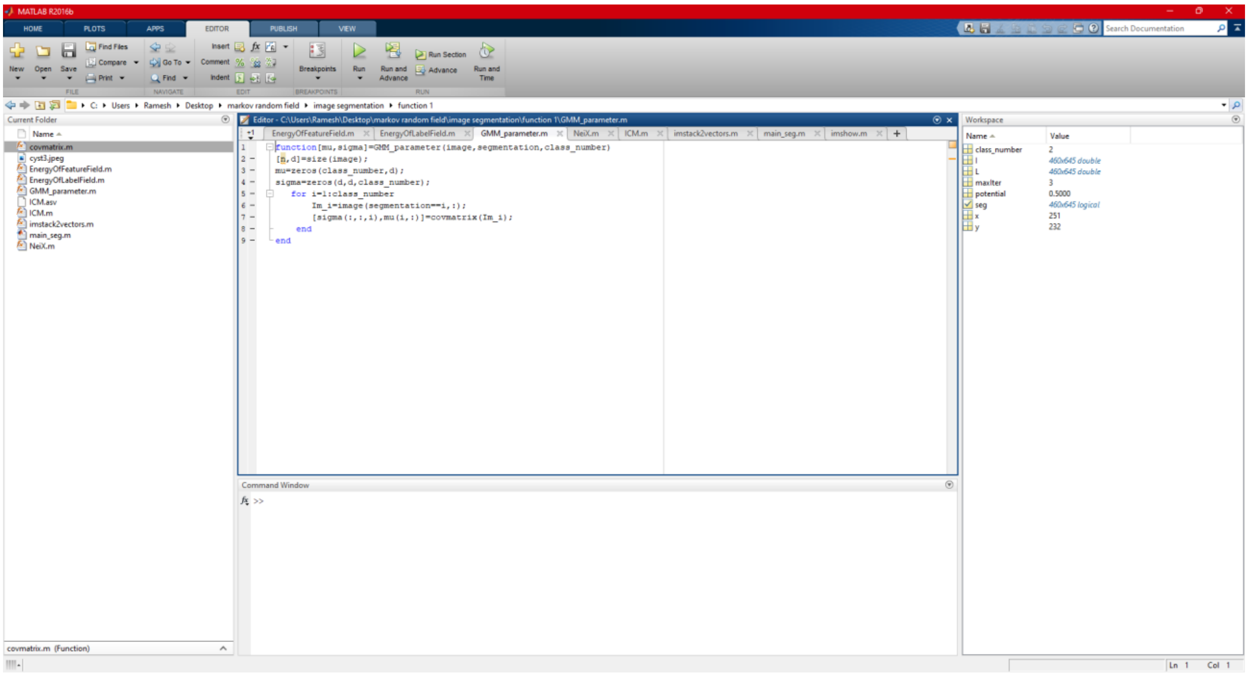
1. D. Gupta, R. Anand, and B. Tyagi: A hybrid segmentation method based on Gaussiankernel fuzzy clustering and region-based active contour model for ultrasound medical images. Biomedical Signal Processing and Control 16:98–112, 2015
2. J. Xu, K. Chen, X. Yang, D. Wu, and S. Zhu: Adaptive level set method for segmentation of liver tumors in minimally invasive surgery using ultrasound images.In: Bioinformatics and Biomedical Engineering, 2007. ICBBE 2007. The 1st International Conference on 1091–1094, 2007
3. W.-L. Lee, Y.-C. Chen, Y.-C. Chen, and K.-S. Hsieh: Unsupervised segmentation ofultrasonic liver images by a multiresolution fractal feature vector. Information Sciences 175:177–199, 2005
4. Nishant Jain & Vinod Kumar , Liver Ultrasound Image Segmentation Using Region-Difference Filters , Journal of Digital Imaging volume 30, pages376–390 (2017)
5. V. Caselles, R. Kimmel, and G. Sapiro: Geodesic active contours. Internationaljournal of computer vision 22:61–79, 1997
6. W.-L. Lee: An ensemble-based data fusion approach for characterizing ultrasonicliver tissue. Applied Soft Computing 13:3683–3692, 2013.

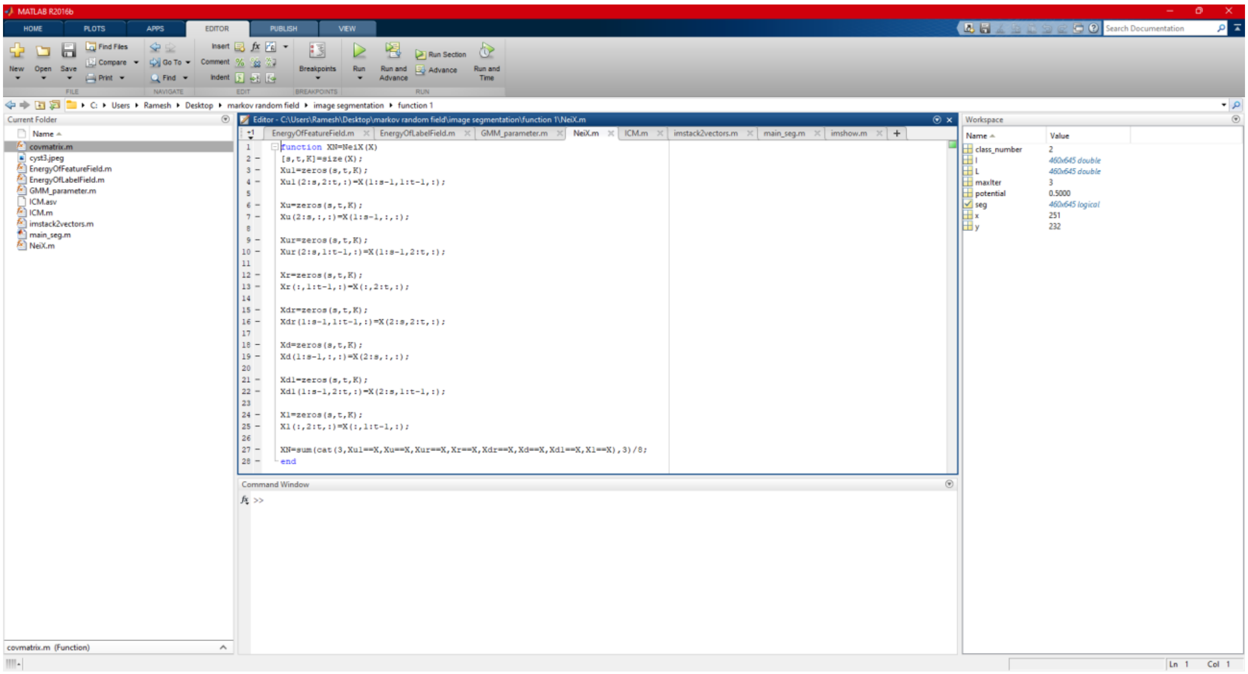
APPENDIX

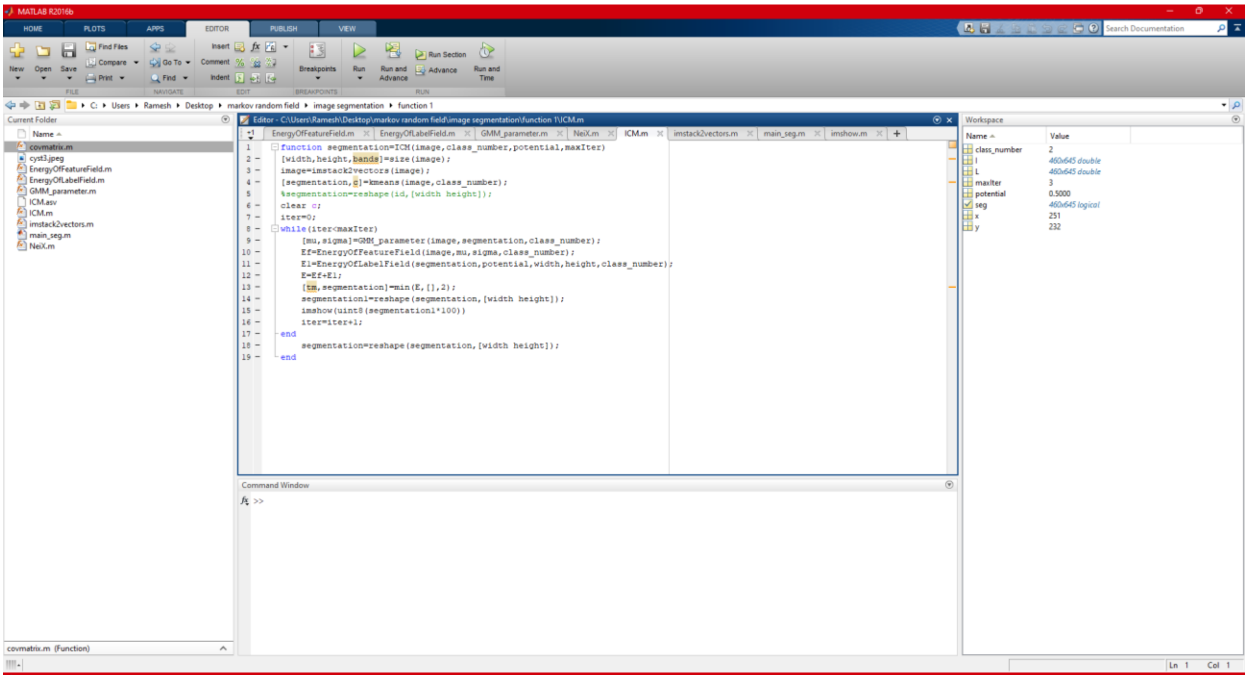
MATLAB FUNCTIONS AND CODES

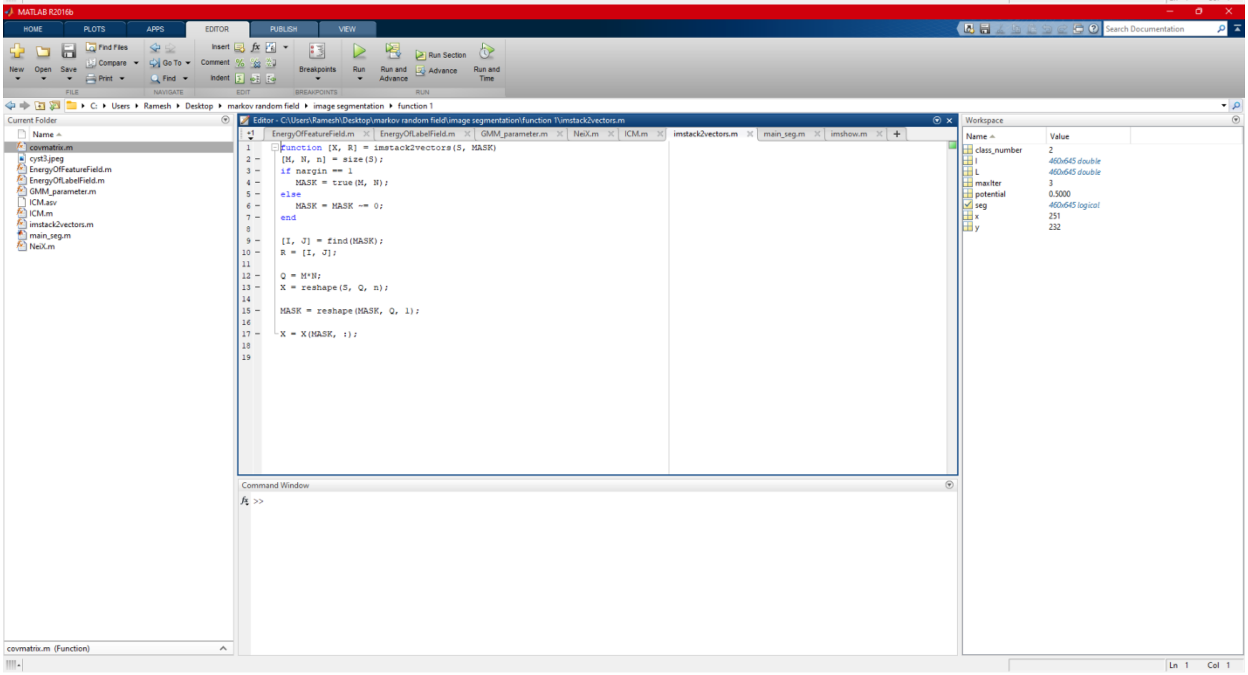


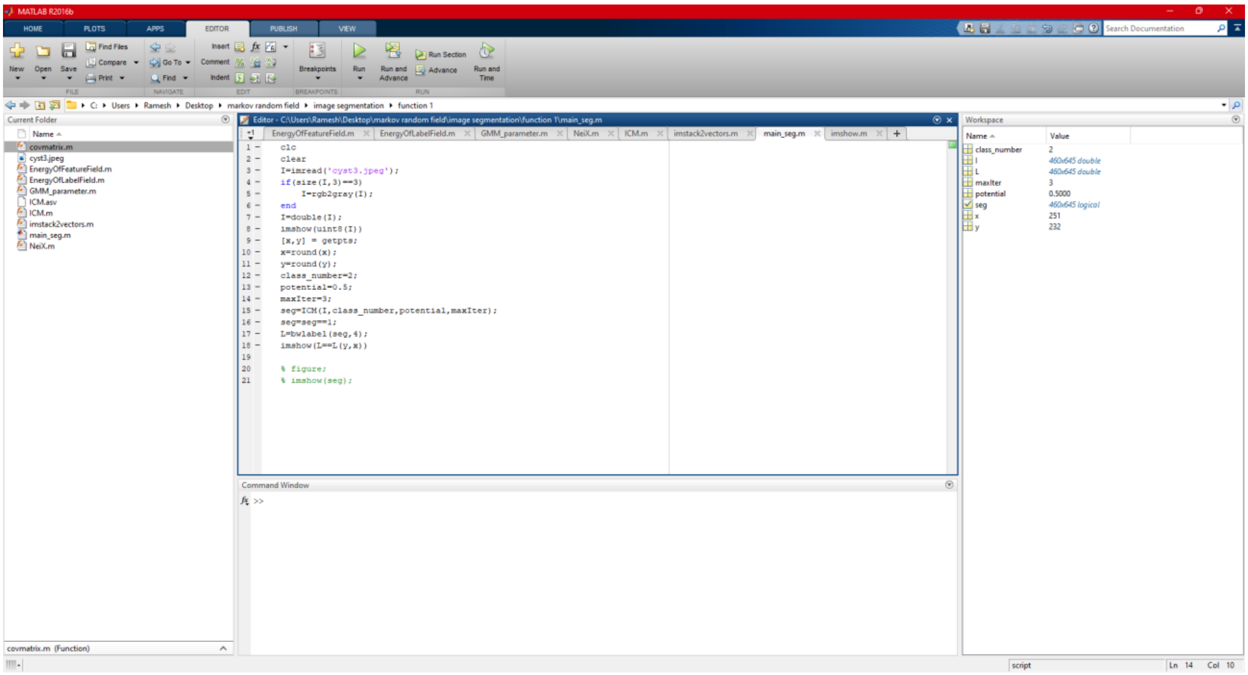



Editor - C:\Users\Ramesh\Desktop\markov random field\image segmentation\function 1\GMM_parameter.m
function[mu,sigma]=GMM_parameter(image,segmentation,class_number)
[n,d]=size(image);
mu=zeros(class_number,d);
sigma=zeros(d,d,class_number);
for i=1:class_number
Im_i=image(segmentation==i,:);
[sigma(:,:,i),mu(i,:)]=covmatrix(Im_i);
end
end


Editor - C:\Users\Ramesh\Desktop\markov random field\image segmentation\function 1\NeiX.m
function XN=NeiX(X)
[s,t,K]=size(X);
Xul=zeros(s,t,K);
Xul(2:s,2:t,:)=X(1:s-1,1:t-1,:);
Xu=zeros(s,t,K);
Xu(2:s,:,:)=X(1:s-1,:,:);
Xur=zeros(s,t,K);
Xur(2:s,1:t-1,:)=X(1:s-1,2:t,:);
Xr=zeros(s,t,K);
Xr(:,1:t-1,:)=X(:,2:t,:);
Xdr=zeros(s,t,K);
Xdr(1:s-1,1:t-1,:)=X(2:s,2:t,:);
Xd=zeros(s,t,K);
Xd(1:s-1,:,:)=X(2:s,:,:);
Xdl=zeros(s,t,K);
Xdl(1:s-1,2:t,:)=X(2:s,1:t-1,:);
Xl=zeros(s,t,K);
Xl(:,2:t,:)=X(:,1:t-1,:);
XN=sum(cat(3,Xul==X,Xu==X,Xur==X,Xr==X,Xdr==X,Xd==X,Xdl==X,Xl==X),3)/8;
end


Editor - C:\Users\Ramesh\Desktop\markov random field\image segmentation\function 1\ICM.m
function segmentation=ICM(image,class_number,potential,maxIter)
[width,height,bands]=size(image);
image=imstack2vectors(image);
[segmentation,c]=kmeans(image,class_number);
%segmentation=reshape(id,[width height]);
clear c;
iter=0;
while(iter<maxIter)
[mu,sigma]=GMM_parameter(image,segmentation,class_number);
Ef=EnergyOfFeatureField(image,mu,sigma,class_number);
El=EnergyOfLabelField(segmentation,potential,width,height,class_number);
E=Ef+El;
[tm,segmentation]=min(E,[],2);
segmentation1=reshape(segmentation,[width height]);
imshow(uint8(segmentation1*100))
iter=iter+1;
end
segmentation=reshape(segmentation,[width height]);
end


Editor - C:\Users\Ramesh\Desktop\markov random field\image segmentation\function 1\imstack2vectors.m
function [X, R] = imstack2vectors(S, MASK)
[M, N, n] = size(S);
if nargin == 1
MASK = true(M, N);
else
MASK = MASK ~= 0;
end
[I, J] = find(MASK);
R = [I, J];
Q = M*N;
X = reshape(S, Q, n);
MASK = reshape(MASK, Q, 1);
X = X(MASK, :);


MATLAB R2016b
Editor - C:\Users\Ramesh\Desktop\markov random field\image segmentation\function 1\main_seg.m
clc
clear
I=imread('cyst3.jpeg');
if(size(I,3)==3)
I=rgb2gray(I);
end
I=double(I);
imshow(uint8(I))
[x,y] = getpts;
x=round(x);
y=round(y);
class_number=2;
potential=0.5;
maxIter=3;
seg=ICM(I,class_number,potential,maxIter);
seg=seg==1;
L=bwlabel(seg,4);
imshow(L==L(y,x))
% figure;
% imshow(seg);
Command Window
Workspace
class_number 2
I 460x645 double
L 460x645 double
maxIter 3
potential 0.5000
seg 460x645 logical
x 251
y 232