Segmentation of MRI Prostate Images

by

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18497

Dissertation submitted in partial fulfilment of
the requirements for the
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CERTIFICATION OF APPROVAL

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(ELECTRICAL & ELECTRONICS)

Approved by,

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(Dr. Norashikin Yahya)

UNIVERSITI TEKNOLOGI PETRONAS
BANDAR SERI ISKANDAR, PERAK
January 2017

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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AIMI ADHILAH BINTI MOHD REDUAN

ABSTRACT

In this work, we investigate the performance of two segmentation methods; level set, and texture-based, in segmentation of prostate region. Both segmentation methods are applied onto transverse view of T2-W-MRI slice of prostate acquired using a 3T scanner. Level set method is one of the popular partial differential equations (PDEs) based in image processing especially in image segmentation as it relies on an initial value PDEs for a propagating level set function. It also has been introduced in many disciplines, such as computer graphics, computational geometry, and optimization because this method acts as a tool for numerical analysis of surfaces and shapes. Besides, level set method can perform numerical computations involving curves and surfaces on a fixed Cartesian grid without having to parameterize the object. Prostate gland in MRI images is categorized as a texture image because the structures are not homogeneous and its surface has grey level values close to the neighbouring organs around the prostate which making it more difficult to detect the damaged tissues. Texture-based segmentation or factor texture segment method is introduced because of its ability to extract feature of neighbouring organs. By comparing the results of two different synthetic images, it shown that the texture-based method is preferable than level set because it can detect a smooth region boundary. However, the segmentation on the prostate images show a nonsmoothed result for both techniques. The modification is further studied to improve the end results.

ACKNOWKEDGMENT

First and foremost, all praise to be to Allah S.W.T, for bestowing me with His blessings and strength to complete my five years of study in Universiti Teknologi PETRONAS (UTP). With His permission and will, I am able to complete my Final Year Project (FYP) entitled "Segmentation of MRI Prostate Images".

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ABBREVIATIONS AND NOMENCLATURES

MRI	Magnetic Resonance Imaging
CT	Computerized Tomography
TRUS	Transrectal Ultrasound
PET	Positron Emission Tomography
DWI	Diffusion Weighted Imaging
DCE	Dynamic Contrast-Enhanced
IMM	Interacting Multiple Model
PDAF	Probabilistic Data Association Filter
iBRS	Inter-Slice Bidirectional Registration-based Segmentation
LOG	Laplacian of Gaussian
FYP	Final Year Project
UTP	Universiti Teknologi PETRONAS

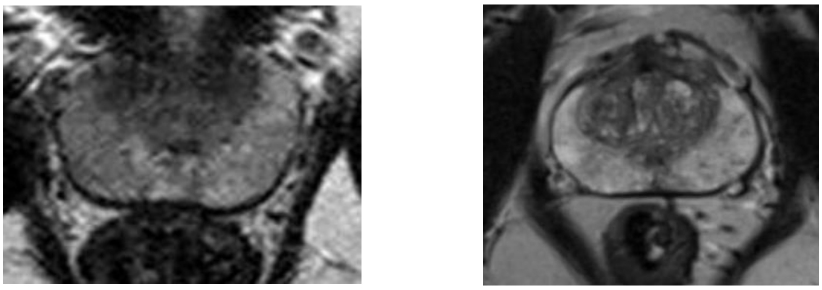
CHAPTER 1
INTRODUCTION

This chapter covers an overview on statistics of prostate cancer in Asia and West countries, and also discussing the importance of segmentation technique in detecting prostate cancer.

1.1 Background of Study

A Malaysia Oncological Society stated the highest incidence of prostate cancer is recorded by Chinese men in the oldest group compared to Malays and Indians. With this declaration, prostate cancer is categorized as sixth most frequent cancer in Malaysia. It is also accounts for 5.7% of cancer cases in males. However, the statistic of prostate cancer in Asia countries is said to be lower than West countries, claimed by Cancer Research UK. The researchers claimed the management of prostate cancer can be complex even though it is a treatable disease.

A sample image of normal and cancerous prostate MRI is shown in Figure 1.1. The difference of the normal and cancerous image is the growing of the cells in the prostate gland. One will experience the prostate cancer when the cells start to grow uncontrollably. Since the size of the prostate changes with age, it is difficult to see clearly the state of the cells. Early detection of the prostate cancer is important to prevent the growth of cancer cells to the surrounding organs, for example rectum and bladder as well as seminal vesicles which is a gland that produces fluid for semen.



(a) (b)

Figure 1.1: Sample image of (a) normal prostate MRI, (b) cancerous prostate MRI

There are several types of Medical Imaging have been done to look for possible cancer spread. Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET) and Computed tomography (CT), and Transrectal Ultrasound (TRUS) are the types of Medical Imaging which utilize electromagnetic radiation to produce images of internal structures of the human body for the purpose of accurate diagnosis [1]. This paper will focus on the segmentation of prostate gland in MRI compared to CT, TRUS and Bone Scan as the application of MRI in early detection of this cancer is better known because it can show detailed images of soft tissues in the body.

The phenomenon of segmentation in general is rearrangements of surface and near surface atoms. This process being driven by the energetics of the system and with all processes, there may be kinetic limitations which prevent or hinder these rearrangements at low temperatures. In medical field, this process increases the sample rate in the stacking direction in order to segmented sufficiently accurate appearance of the object and its internal anatomical structures. Image segmentation is performed to define tumor volume and distribution and to detect pathways of needle biopsies. Segmentation in diagnose imaging particularly aims to

(i) Prescribe the precise location of the tumor;
(ii) Recover a 3D shape from a region of interest;
(iii) Construct an appearance that is a good approximation of the data set and has some smoothness; and
(iv) Good for deformation and other dynamic operation on surfaces.

Segmentation techniques are central to many of the new applications of medical imaging. This process is widely covered in segregating images from non-uniformly sampled data and automatically focusing images. Ideally, it should be insensitive to data specified within the object of interest [2]. However, different methods produce different accuracy diagnosis of prostate cancer. As segmentation process plays a vital role in pre-processing stage for automatic cancer detection system, a trusted algorithm and method need to be conducted in medical imaging to evaluate the accuracy of synthetic data and real data.

Level set method is introduced in segmentation of the prostate gland as it is able to partitioning the image from disseminated data set into a number of regions. Points, curves and surface patches might be present in every data set resulting in construction of a weighted minimal surface-like model and implementation of its vibrational level set formulation along with optimal efficiency [3]. Segmentation using level set method will be developed and discussed further for MRI medical images.

Segmentation using Factor Texture Segment shows excellence results on partitioning textured images, which are generally considered more difficult to segment than nontextured images. Prostate image is categorized as textured image because it cannot be captured by individual pixel features. In image segmentation, local histogram is developed to address the boundary localization problem and extracting features from some local neighbourhoods of the appearances. In this work, a Texture-Based segmentation technique will be established and evaluated for MRI medical images specifically.

1.2 Problem Statement

Segmentation of prostate gland in MRI remains as a challenging task because several prostatic zones are not homogeneous and its surface has grey level values close to those of the neighbouring organs surface such as bladder and rectum. Even though, MRI imaging provides reliable information about the size and shape of the prostate gland, it is still limited by unsatisfactory sensitivity and specificity for cancer detection and initial localization [4]. The topology and deformation on the surface also difficult to handle as the presence of noisy and highly non-uniform data sets.

Additionally, every human has different body composition which resulted with a various type of soft tissue, shape, size, and texture information. Because of these reasons, the segmentation task in diagnosis imaging will be complicated [5]. In this work, level set method and texture-based technique will be introduced for segmentation of prostate gland due to its ability to represent boundaries of objects that change with time or are ill-defined. This research will include available MRI images obtained from a hospital.

1.3 Objective and Scope of Study

The main emphasis of this project is on the application of image processing in medical field. Particularly, it revolves the implementation of image segmentation method in detection of prostate cancer. The study of the image processing is related to Electrical and Electronic Engineering field as it is involving the usage of image processing technique implemented in MATLAB software. The author has been undergoing her years of study in Universiti Teknologi PETRONAS (UTP) with the knowledge and understanding on this field.

The objectives of this study are listed as below:

(i) To investigate the performances of level set and texture-based method in segmentation of prostate region in magnetic resonance imaging (MRI).

This study might not only be focused on the above matters, a systematic study on importance of image processing and its application to the medical field are also be discussed widely. A broad range of major topics are extensively investigated including the comparison of existing methods in image segmentation and application of level set and texture-based algorithm in various field.

CHAPTER 2
LITERATURE REVIEW

2.1 Image Modality for Prostate Cancer Detection

Consideration in choosing suitable image for further segmentation process is important because there are a lot of methods for early detection are introduced. Other than image, nuclear medicine is also used for cancer. Instead of segmenting the prostate image, this medicine used body's chemistry, metabolism, rather than physical shapes to produce a picture. For example, Positron Emission Tomography (PET) uses a form of radioactive sugar to detect the cancer cell among normal cell [1]. Though this method is proven to be effective in cancer detection, it can be quite dangerous because the radioactive components used may not be suitable for every patient.

Referring the Section 1.1, it mentioned several well-known image processing methods in prostate cancer detection. CT scan produced detailed cross sectional images of human body using x-rays. Basically, the purpose of CT scan is to only be looking at the lymph nodes of the prostate for any spreading cancer instead of prostate gland itself. Beside CT, TRUS uses a small robe to be placed in rectum. Sound waves will be produced and simultaneously creating echoes after the waves have entered the prostate. The result is only in black and white image of prostate. It is not efficient enough since it needs some support from other methods for the cancer detection.

Unlike CT and TRUS, MRI is proved to be the most efficient for providing a clear picture of prostate gland. It uses radio waves and strong magnets in order to produce a detailed image of soft tissue in the interest region. In order to produce a high contrast image, gadolinium is injected into a vein before the scanning. It also can perform a function as CT which is its ability to see if the cancer has spread outside the prostate into the seminal vesicles or other nearby structures. It is proven that this image can be used for further detailed segmentation [1] [12]. Summary of different type of image modalities for prostate are in Table 2.1.

Table 2.1: Summary of image modalities

Method	Advantage	Disadvantage
MRI	Produce a clear, detailed image of soft tissue	The expense of the procedure is high
CT	Produce cross sectional of prostate area	Expose to emitted radiation
TRUS	Least computation time	Produce low tissue resolution
PET	Able to detect cancer in short-time	Use radioactive substances

In [4], Firjani et al. proposed an early detection method for prostate cancer using two MRI image modalities, diffusion weighted imaging (DWI) and dynamic contrast-enhanced imaging (DCE-MRI). The method used MAP-based segmentation technique, followed by Laplace-based registration method to account for any local image deformation. The KNN classifier was used to classify the image into benign and malignant type. Based on a database of 28 patients, the proposed method gave 100% accuracy. However, the performance of the technique can be further improved using large database.

2.2 Image Segmentation in Medical Image Processing

Fast development of image processing technology has resulting in the presentation of several iterative methods in image segmentation in the previous years. The issue with handling the noisy data present in image processing has yet to be solved, though a few techniques are mentioned in literatures. The consideration of the size of data sets and linear system are important in designing an algorithm because there is no particular method can solve the problem.

Image segmentation role in medical image processing is quite important especially abnormality detection as it helps to extract suspicious and unhealthy region from the medical images. The advancement of technologies in this field is developing day by day. Although, there are some researches on classical method of image segmentation, the concern in its computational cost becomes questionable. As the day goes by, this popular technique often face challenges in outlining boundary of an image with a poor image contrast and diffuse region [21].

An experiment on the extraction of prostate contour from TRUS images was developed in [14]. A method for enhancing image contrast and reducing speckle, called Sticks Filter is introduced resulting in the ability to produce smooth segmentation. With the help of other additional methods, interacting multiple model (IMM) estimator, and probabilistic data association filter (PDAF), the algorithm of the filter is applied onto different prostate ultrasound images. The authors have proved the accuracy of the filter as it was able to converge to extract cavity contours details without selecting seed points inside the contours in a short time.

In medical imaging, it is important to outline the prostate boundary of patients with prostate cancer. Hu et. al. [15], have introduced an editing tool, a deformable model, to automatically deformed a better fit of problematic prostate boundary. Besides, volume estimation of the prostate gland is also significant because other than diagnosis, it also can monitor the activity of prostate cancer. An experiment on 177 patients, with MRI and CT images, was conducted [22]. Without the use of anatomical atlas, the algorithm called Inter-Slice Bidirectional Registration-based Segmentation (iBRS) exploited the interslice data redundancy of the image in volume data to segment the prostate gland.

Table 2.1 is the summarise of the existing methods in segmentation of prostate images, including TRUS, MRI, and CT scan.

Table 2.2: Methods used in prostate image segmentation

Author(s)	Image Segmentation Approach
Abolmaesumi et. al. (2004) [14]	Sticks Filter ▪ Contrast enhancing of TRUS prostate image ▪ Reducing speckle ▪ IMM estimator - fast converging ▪ PDAF - extract cavity contours detail
Hu et. al. (2003) [15]	Model-based Initialization and Mesh Refinement ▪ Outlining 3D ultrasound prostate boundary ▪ Initialization requires ▪ Use efficient deformable model
Khalvati et. al. (2013) [22]	Inter-Slice Bidirectional Registration-based Segmentation (iBRS) ▪ Volume estimation of MRI and CT prostate images ▪ Rely on interslice image registration of volume data ▪ Use three registration method to autosegment image slices

2.3 Application of Level Set Method in Image Processing

Mathematical methods in image processing including level set method are introduced since the advent of computerized tomography in radiology. Fast and robust level set method has been introduced other than standard level set method. The comparison between these two methods is made based on noise variants of the synthetic images [13].

Level set method can be used for segmentation from range of data by providing a general framework for the deformation of the appearances according to some rules. Zhao et al. [3] stated a desirable procedure of reconstruction from unorganized data sets is managed to handle topological flexibility, a simple data structure, and volumetric information. Differential geometry and partial difference equations is constructed in order to solve the general problem occurred in segmentation. By combining level set method and the segmented images, the authors aim to provide a general framework for image modelling and deformation [7].

Prostate gland came in different shape and size for every human. The shape optimization also needs to be considered in the reconstruction process. With its versatility and efficiency in computational, level set method is chosen for numerically tracking fronts and free boundaries. Shape sensitivity can be analyzed by deriving the front velocity from level set method. This method also can handle the case of a nonlinear elasticity [8].

Arising issue concerning the quantity on the interface to a neighbourhood of the interface can be solved using level set method. Mean curvature flow is one of the application which using the derivation of normal velocity in a neighbourhood of the interface to move the interface. However, in some other applications, the normal velocity is only given on the interface. It cannot be defined at all if the velocity is away from the interface [9]. This study can be implemented in detecting prostate cancer since the cancer also has a fear on the neighbourhood organ surfaces.

Level set method in image processing especially in image segmentation is extensively studied and the focus is identifying curves separating regions into diverse phases. However, there is no particular research proving the implementation of level set method in early detection of cancers [11]. Instead of level set method, Liu et al. [10] introduced voxel-based method which growing initial region with required topology by adding simple points to reconstruct central cortical surface. More broad study had done on the function and structure of the human brain as the surface illustration of the cerebral cortex is essential.

2.4 Texture-Based in Segmentation

The principles of texture analysis and its application in medical images are widely discussed. It is an ongoing research field with ranging of applications from the segmentation of precise anatomic structures, to differentiation between pathological and healthy tissue in distinctive organs [16]. Practically, the appearances and structure of prostate images is said to be complex as it composed of little volume blocks, represented by a set of coordinates in space which consists of grey-level intensity. Moreover, MRI images of prostate gland are incapable in providing microscopic data that can be visually assessed.

Martin et. al. formulated an accurately detection method in localizing boundaries of natural scenes that respond to oriented energy and brightness gradient, color gradient, and texture gradient. By applying the precision-recall framework using human-labeled boundaries in natural images, nonboundary will be discriminated from boundary pixels by formulating boundary-detection. Each discriminating performances will then be optimized and combined into a single detector. Based on a quantitative evaluation on 100 natural images, the result shown an appropriate conduct of texture is crucial in detecting boundaries of natural images [17].

With the used of spectral graph theoretic framework of normalized cuts, Malik et. al. [18] proposed an algorithm to find image partitions into regions of coherent texture. Natural images, such as prostate images contain both textured and untextured regions. The author introduced texton method to analyze texture differences based on the texturedness of the same region. A set of 1000 black and white natural images including images of animal, people, and man-made scenes are segmented using the proposed method. Color images will readily be included to further improve the performance of the algorithm.

Nearly 10 years ago, Liu and Wang have proposed a technique of texture-based segmentation based on local spectral histograms which provides a feature statistic for texture and nontextured regions by decomposing the segmentation process into initial classification stage, algorithm updates stage, and boundary localization stage [19]. They proved the accuracy of the projected technique is more precise than the other existing methods in texture segmentation activity. However, they suspected their method is not sensitive to the particular filters and integration scale. Hence, further research on the automatically choosing filters and integration scales need to be conducted for optimal segmentation results.

In addition, spectral histogram method was performed on discriminating image texture and texton modelling. This method solved several issues regarding texton characterizing and texture discrimination. A quantitative comparison was conducted to match with the psychophysical results on the systematic set of texture discrimination [20]. Images with different sizes is compared by providing a statistic of normalized feature and integrating responses from different filters using spectral histogram model. The performance evaluation of the developed model includes the comparison of 10 sets of synthesized texture images.

CHAPTER 3

METHODOLOGY

3.1 Research Methodology

3.1.1 Level Set Method

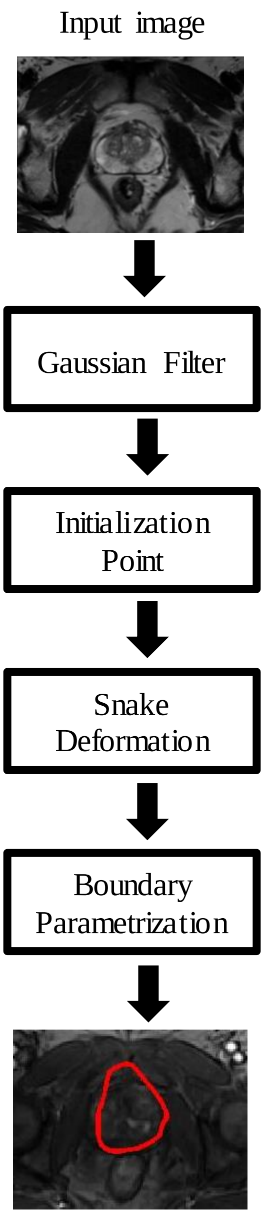


Figure 3.1: Block diagram of image segmentation using level set method

Figure 3.1 shows the general block diagram for image segmentation of MRI using level set method. MATLAB is computational software performing the image processing operations. The input image will undergo segmentation process to extract the texture features or surface of interest region. Gaussian filter is applied to give a smoothing effect on the image. The information of the surface will then be measured by appropriate algorithm to calculate ideal feature and optimization of the surface. Finally, the comparison on the quantitative accuracy performance of the image metrics will be calculated.

The algorithm of the level set method is tested using synthetic data, as well as the studies of the image segmentation. The proposed algorithm is chosen based on its ability to track a moving boundary and minimize a criterion using a PDE approach.

Let $\boldsymbol{\Omega}$ be the image domain with the initial value of level set function, φ. Then, φ has the following properties:

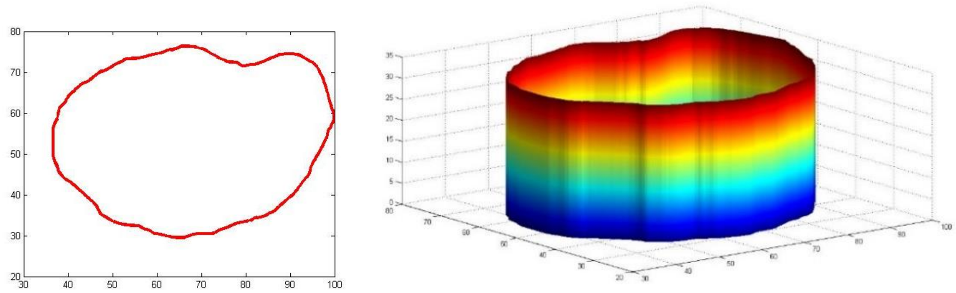
$$
\begin{aligned}
&\varphi(x,t) > 0 \; for \; x \in \Omega \\
&\varphi(x,t) < 0 \; for \; x \notin \Omega \\
&\varphi(x,t) = 0 \; for \; x \in \partial\Omega = \Gamma(t)
\end{aligned}
\tag{1}
$$

The motion is analysed by convecting the φ values or levels as the curve moves in the normal direction with the velocity field, $\boldsymbol{v}$. The elementary equation is

$$
\frac{\partial\varphi}{\partial t} + \boldsymbol{v} . \nabla\varphi = 0 \tag{2}
$$

Rather than follow the interface itself, the level set approach takes the original curve as shown in Figure 3.2 (a) and builds it into a surface. The cylinder-like surface shown in Figure 3.2 (b), has a great property. It intersects the x-y plane exactly where the curve sits and the surface is called the level set function, φ because it accepts as input any point in the plane and hands back its height as output. This is very similar to the minimization of the following properties:

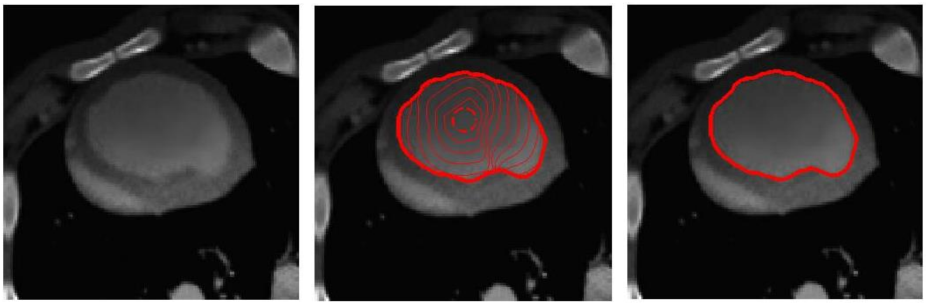
$$C(\varphi) = \int_{\Omega} \mu g \delta(\varphi)|\nabla\varphi| + \nu g[\varphi < 0] + \lambda_1 (\boldsymbol{I} - c_1)[\varphi < 0] + \lambda_1 (\boldsymbol{I} - c_2)[\varphi > 0]\, \partial x \partial y \quad (3)$$



(a) (b)

Figure 3.2: (a) The original curve, and (b) Cylinder-liked surface.

The proposed algorithm is then tested using real cardiac image shown in Figure 3.3 (a). Before the segmentation process, the image is initiated with the positive, negative, and zero value of the level set function, φ. The result would be the final level set function after the image undergoing the parameterization of boundary by iteration as shown in Figure 3.3 (c).



(a) (b) (c)

Figure 3.3: (a) Real CT image of cardiac, (b) Parametrization of boundary at 75th iteration, (c) Result of level set segmentation.

3.1.2 Texture-Based Method

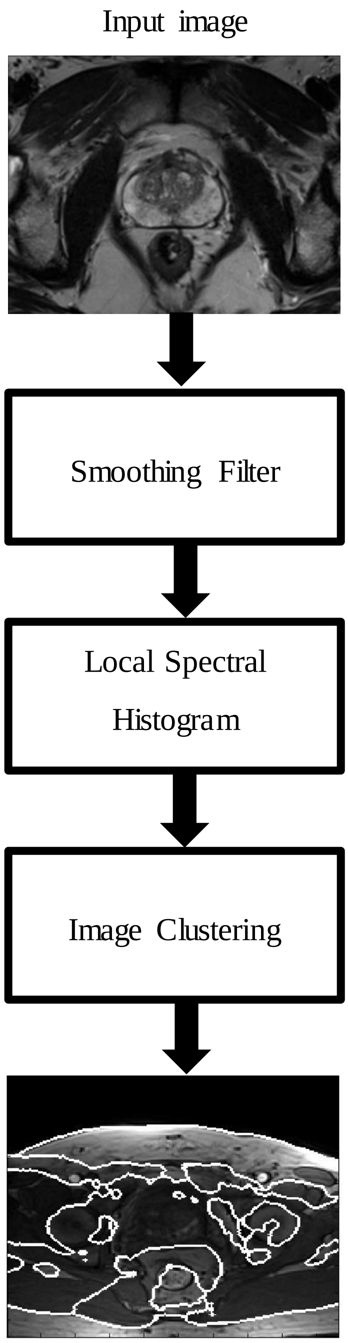


Figure 3.4: Block diagram of texture-based segmentation

Texture-based method is focusing on the segmentation of textured images. Its objective is also to extract the boundary of the prostate region. Based on the block diagram in Figure 3.4, local spectral histogram algorithm will be applied onto the input image as the localization process around the pixel.

For smoother result, Laplacian of Gaussian (LOG) filter is added to segment the images with a complex texture before performing local histogram algorithm. Every image has a different texture surface so the application of matrix factorization in the process can give more accurate result.

i. **Smoothing Filter**

In texture-based, LOG filter is applied to smooth out the edge in the image to get more accurate result in terms of boundary extraction. LOG filter is the variants of Laplacian filter and Gaussian filter. Laplacian refers to the 2nd spatial derivative in 2-D isotropic measure, whereas Gaussian filter is a low pass filter which usually used as a pre-processing tool in image processing. The purpose of applying LOG filter as the smoothing filter is to enhance and remove unwanted noise in the input image. The convolution of the image with LOG filter is represented by the function shown below.

$$LoG(x,y) = \frac{1}{\pi\sigma^4}\left[1 - \frac{x^2+y^2}{2\sigma^2}\right] e^{\frac{-(x^2+y^2)}{2\sigma^2}} \tag{4}$$

Where x is the x-coordinates, y is the y-coordinates, and σ^2 is the standard deviation.

ii. **Feature Extraction using Local Spectral Histogram**

Local histogram is used to characterizes the appearance of image window around a pixel on texture appearances because this type of images cannot be captured by individual pixel features as it needs features extracted from some local neighbourhoods. In order to use histogram however, it is important to address the boundary localization problem. Mathematical expression shown below is used to identify which region the selected pixel belongs to.

$$H_A = [H_1, H_2]\begin{bmatrix}\omega_1 \\ \omega_2\end{bmatrix} \tag{5}$$

Where H_A is histogram of square window around the selected pixel. While, H_1 and H_2 are the histograms of the left and right regions, and ω_1 and ω_2 are the weights. Based on the equations, the weights can be estimated using least square estimation if H_1 and H_2 are known, hence, local histogram of each pixel location in an image is computed. Using a smart technique called integral histogram, the computation of local histogram can be made in a short time regardless of the window size. Then, the features near boundaries is further analysed to all the features in the image. Thus, formulation shown below is applied when a window is completely within one region.

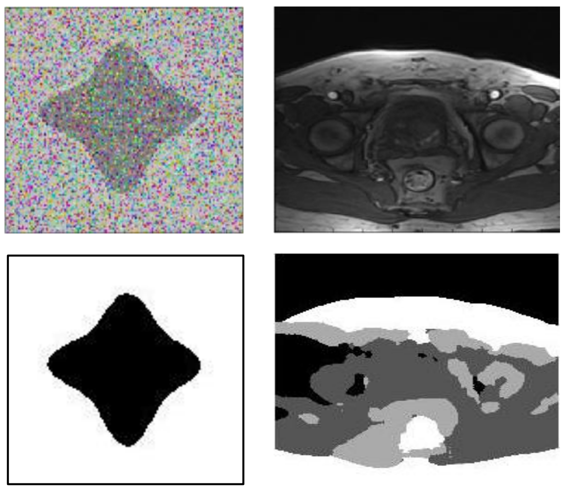
$$[H_A, H_B, .., H_n] = [Hr_1, Hr_2, .., Hr_l][\omega_1, \omega_2, .., \omega_n] + \varepsilon \quad (6)$$

iii. **Image Clustering Algorithm**

As noted earlier, one of texture-based segmentation ability is to distinguish the features and surfaces of an image. Due to the fact, this method uses k-means clustering algorithm to transform the image into different regions [23]. The algorithm is applied on the synthetic image and prostate image as shown in Figure 3.5, to further understand the performance of k-means clustering.

Original synthetic image

Image is clustered into different regions



(a) (b)

Figure 3.5: Result of image clustering on (a) Synthetic data, and (b) Prostate image

3.2 Project Key Milestones

Table 3.1: Project Milestone

No	Milestones	Percentage (%)
1	Complete the literature review based on the requirements of the project	85
2	Study the design of proposed algorithms	80
3	Complete the analysis of proposed algorithm	80
4	Complete development of proposed algorithms	80
5	Project documentation	100
6	Project completion	100

3.3 Project Timeline

Table 3.2: Project Timeline of FYP 1

Gantt Chart	Completion Week													
Activities	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Project selection	■													
Discussion	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Research / Literature Review	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Extended proposal submission						■								
Analysis Work Continuation							■	■	■	■	■	■	■	■
Proposal Defence									■					
Interim Draft Report Submission													■	
Interim Report Submission														■

Table 3.3: Project Timeline of FYP 2

Gantt Chart	Completion Week														
Activities	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Programming Phase	■	■	■	■	■										
Application of Method				■	■	■									
Algorithm Evaluation					■	■	■	■							
Progress Report Submission								■							
Design Finalisation								■	■	■	■	■	■		
Pre-SEDEX										■					
Final Report Submission														■	
Technical Paper Submission														■	
Viva															■
Hard Bound Dissertation Submission															■

CHAPTER 4

RESULT AND DISCUSSIONS

In this experiment, the performances of level set algorithm are compared to texture-based method in segmentation of three MRI prostate images from different patients and synthetic images.

4.1 Level Set and Texture-Based Comparison

4.1.1 MRI Prostate Images

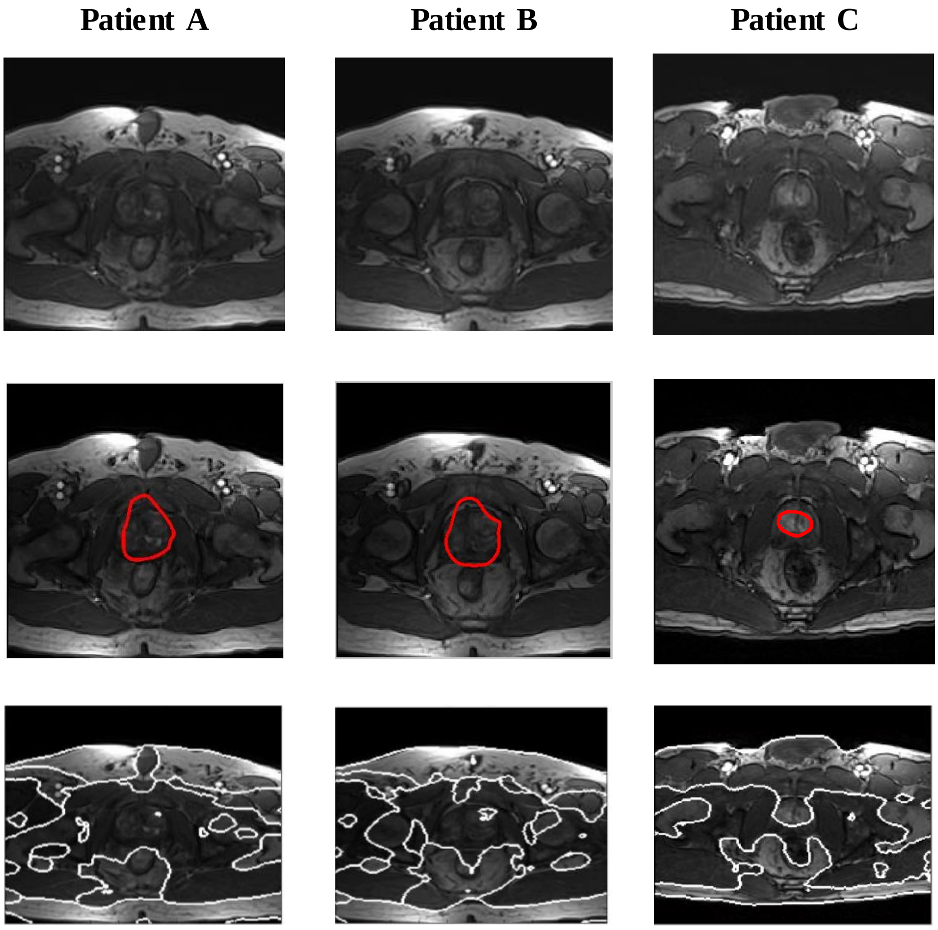


Figure 4.1: Segmentation of MRI images from 3 patients, A, B, and C (top row) using (middle row) level set method and (bottom row) texture-based algorithm.

The comparison made in Figure 4.1, have demonstrated the result of prostate images after segmentation. The difficulty to detect a smooth boundary is shown in Figure 4.1 (middle row). Theoretically, the cause of the defect is mainly due to the predicament in finding the initialization point of the region. The initialization stage in level set plays vital role as it helps in detecting accurate boundary of a region. Because of the complex texture appearance of the prostate images, it is quite difficult to outline the boundary using level set method. Instead of using initialization, texture-based method localizes the boundary of a region using window setting.

4.1.2 Synthetic Images

In this section, a nontextured image and a texture image is used to compare the performance of the two proposed methods.

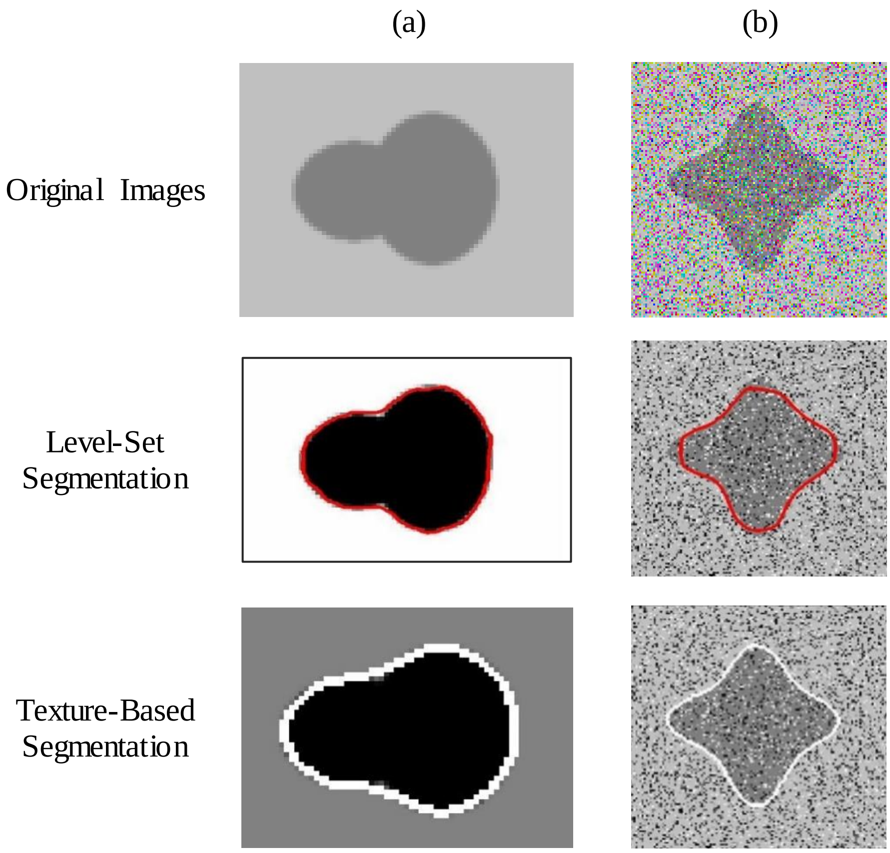


Figure 4.2: Result of segmentation on (a) Nontextured image, and (b) Textured image.

It is observed in Figure 4.2, the distinction between level set and texture-based method is severe. Texture-based technique however, is proven to be more reliable than level set method as it could extract the boundary of the synthetic image in Figure 4.2 (b). Since the surface of prostate images have complex texture appearances, it is important to identify which method is suitable for extracting purpose.

4.2 Auto-Cropping

Rather than outlining the expected boundary onto the image, a simple technique in cropping out the region after texture-based segmentation is applied. Thus, the end result can be more clearly seen. After the image undergo the segmentation, the desired boundary will be compared with the near boundaries by setting the parameter in terms of x-coordinates and y-coordinates. Then, the formula will be applied onto the other image using same parameter which resulting in cropping out desired boundary from its image. However, auto-cropping cannot be applied on the level set segmentation because of the difficulty in finding the suitable coordinate for cropping.

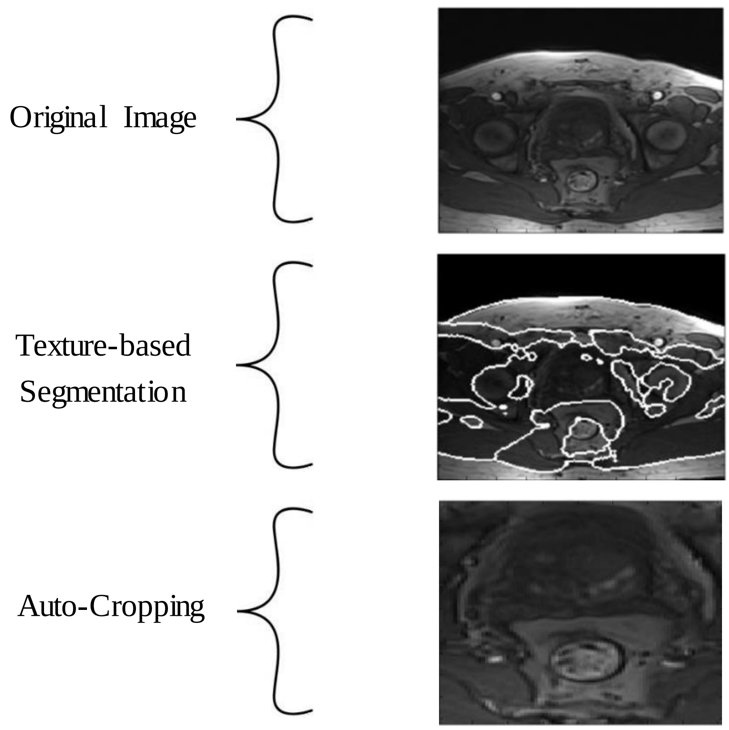


Figure 4.3: Result of auto-cropping on texture based segmentation

4.3 Quantitative Performance Approach

Quantitative performance is defined as regular measurement of outcomes and results to generate a reliable data on the efficiency of projects. Subsequently, in proving the effectiveness of the proposed methods, a quantitative measure is tested on a synthetic image after the image undergo texture-based segmentation.

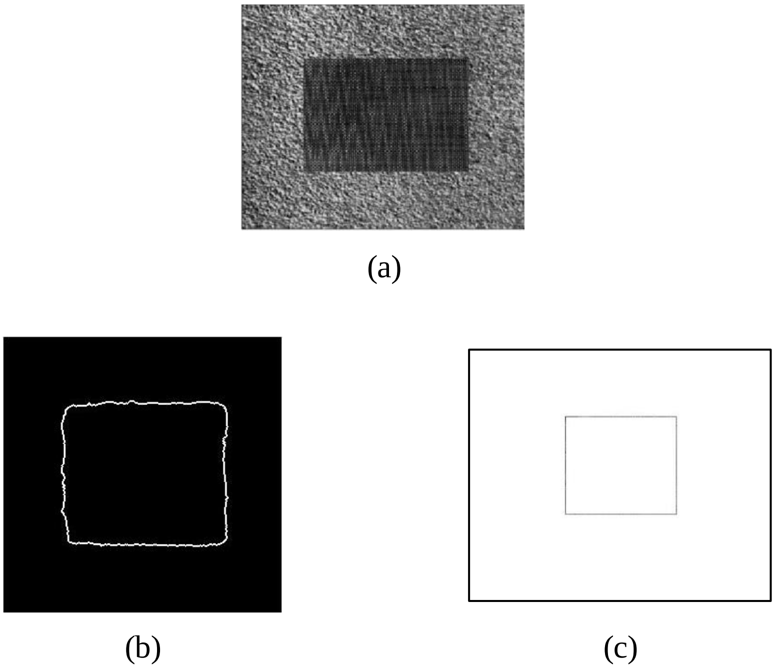


Figure 4.4: (a) Original image, (b) Edges obtained from texture-based segmentation, and (c) True edges from original image.

Based on Figure 4.4, the true edges of the original image in Figure 4.4 (c) is compared with the edges obtained from texture-based segmentation by initiate the true edges as value of 1. By using appropriate algorithm, it found that the efficiency of texture-based segmentation on the synthetic image is 23.1884 percent. This quantitative measure can be implemented using real prostate images after a smoothed result is obtained.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

As mentioned in the earlier section, level set method is one of the widespread method in image processing and same goes to the texture-based method. However, a few researches on the implementation of these methods in medical image processing are found in the recent years. With its exclusive abilities, these proposed methods are chosen as the most desirable solution for segmentation of prostate image as the image is found to be a challenging task in extracting its surface because prostate boundaries can change with time. As per the objective, this project is conducted to develop segmentation in view of level set and texture-based, and assessing the execution of the proposed algorithm on MRI images. The initial experiment of the segmentation was done on the cardiac image and several synthetic data by implementing the level set algorithm and the results of the segmentation process on the image is further studied by validating the algorithm and texture-based method with real prostate MRI image. In the next phase of this work, real MRI prostate images are used to demonstrate the versatility of level set and texture-based method. After comparing the result of both segmentation technique, further improvisation need to be done especially on level set method, to get an accurate and smooth result in extracting the prostate boundary.

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