

Management and Post Processing of Prostate MRI using Matlab

Medical Image Analysis Lab.

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Abstract

This lab report presents the management and pre-processing of the prostate cancer. Adenocarcinoma of the prostate appears in older men. It appears before an age of 50. 85 % of cases are diagnosed in men over 60 years. Prostate cancer is a common cancer whose the incidence and mortality are now steadily increasing (85,000 new cases per year in Europe). It is the second most common cancer after lung cancer and the third leading cause of cancer death in men (9 % of all cancer deaths in men in Europe). We have successfully performed the management of DICOM file, the segmentation using active contour or Snake technique applied to the region like Tumor, Central zone, etc., managing the DICOM file, displaying their representation in 3D view and finally calculating the area and volume of each region.

Chapter 1

Introduction

Age is one of the strongest risk factors for prostate cancer, with around 85 % of all the cases diagnosed in those aged over 60 years from Adenocarcinoma of the prostate and estimated incidence of only 0.1 % in those aged under 50 years.

During this recent years, deaths from prostate cancer made up to 0.7 % of all deaths in men under 60 years. However, the number of deaths continues to be highest most of the case in Europe in those aged 85+ years and the proportion of all prostate cancer deaths in those aged 85 years and over has steadily increased this last decade.

Currently, there are four anatomically glandular areas within the prostate:

- Peripheral zone (ZP)
- Central zone (ZC)
- Transition zone (ZT)
- Anterior Fibromuscular Tissue (AFT)

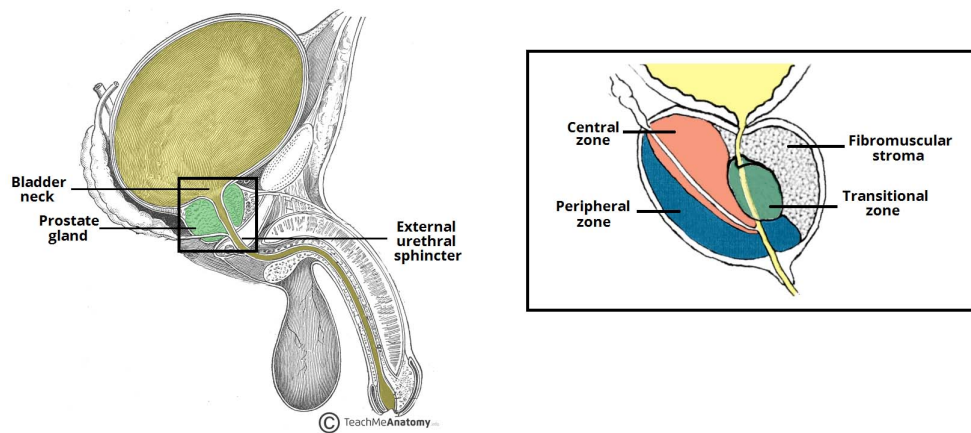


Figure 1.1: Prostate Gland Location

[figure1]

Adenocarcinoma arises in 75% of cases in the ZP, in 20 % of cases in the ZT and in 5 % of cases in the ZC.

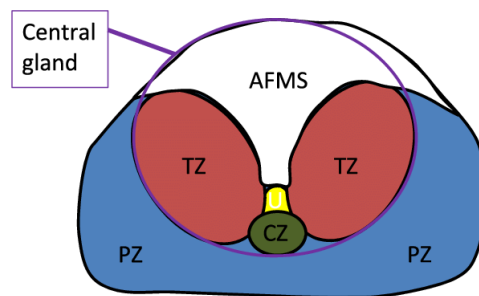


Figure 1.2: Block Diagram of face recognition systems

[figure2]

1.1 Diagnostic

The Magnetic Resonance Imaging (MRI) provides high-resolution images in all planes of space, allowing precise anatomical visualization of the prostate. MRI of prostate cancer benefits from technological advances that expand more indications. MRI is a valuable tool to guide therapeutic management of prostate cancer through acquisition sequences as follows:

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- **Anatomical imaging** 3D - T2 weighted imaging
- **Diffusion imaging** ADC (Apparent Diffusion Coefficient)
- **Perfusion imaging** DCE (Dynamic Contrast Enhancement) (Observation from signal-intensity time curve)
- **Spectroscopy**

1.2 What to do ...?

This work was subdivided into 3 stages. Given a set of MRI prostate image in Dicom file, we aim to develop an interface GUI in MATLAB for different tasks as outlined below:

- **1st Stage: DICOM management**
 - Display the information of DICOM (PatientName, PatientID, Patient-BirthDate, StudyID, StudyDate, SliceLocation, InstanceNumber)
 - Anonymize DICOM images: Modify the following fields (PatientName, PatientID, and BirthDate) for all the set of images
 - Save the anonymized images (Create a new folder containing the new anonymized images)
 - Convert the DICOM image in JPG format (Be careful with the DICOM information!)
 - Convert the JPG image into DICOM format
- **2nd stage: Snake Segmentation and visualization**
 - **2.1.- Segmentation** Segmentation for each region (only ZP, ZT, ZC, and the tumor region).
 - **2.1.-Visualization**
 - * Show a 3D representation of the prostate gland. (all the prostate)
 - * Show a 3D representation for PZ and CZ

* Show a 3D representation of the tumor region.

- **3rd stage: Numerical calculation**

- For each region calculate the surface (Surface = number of pixels x spatial resolution)
- Calculate the volume for each region.

Chapter 2

DICOM Management

DICOM standard was developed to handle , store and transmit information primarily of radio logic images. It stands for the Digital Imaging and Communications in medicine. In this format, additional patient information, we call **metadata** folder is wrapped around an image . We can attach disseminating data like a patient's name, Patient's ID, Social Security number, patient's Birth Date, Insurance number etc. to an image. Having this identifiers helps a physician to call up the right images when he or she examines a patient's medical record. Taking picture of a patient is a very good idea but you can understand that an image in *DICOM* format is even a better idea especially when dealing with thousands of patients.

Hence, Image saved to an electronic medical record should be in DICOM format because we may need to access the relevant information inside. Moreover the attribute may contain multiple "frames", allowing storage of cine loops or other multi-frame data.

2.1 Functionality of the GUI

A graphical user interface (GUI) is an interface through which a user interacts with electronic devices such as computers, hand-held devices and other appliances. in this lab, we created a GUI using Matlab and this can be seen in figure below

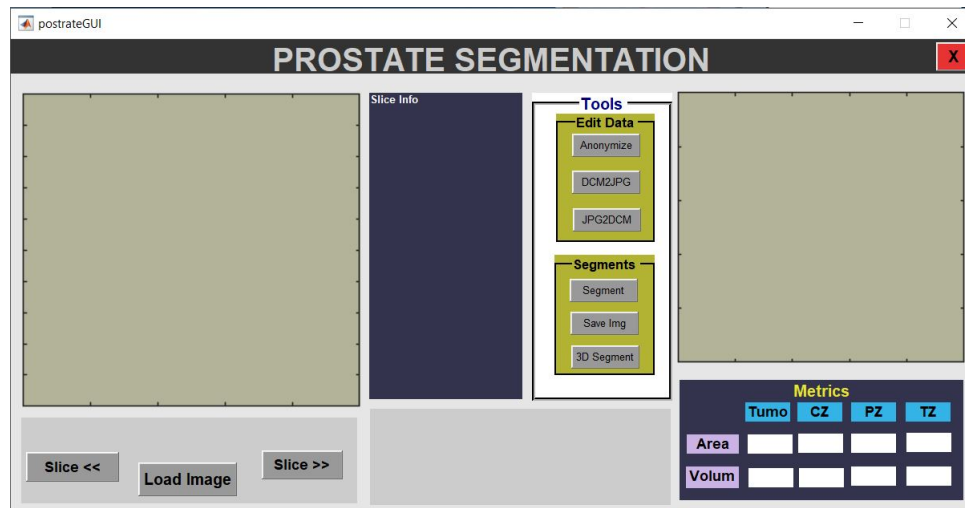


Figure 2.1: Graphical User Interface GUI Design

[GUIDesign]

Here , you can find some tips how to get in touch with our GUI:

1. First of all, all of the images are loaded from the folder database (DICOM format) into our GUI clicking the button **Load image** button in the lower part of the GUI as shown in 2.2. Select the folder which contains images in a popup dialog box that appears after clicking **Load Image** button. Based to our algorithm see *prostateGUI.m* there is no need to load single image sequentially. After loading images into GUI, the first image appears in the image section and the corresponding patient information is listed on the right panel as explained early.

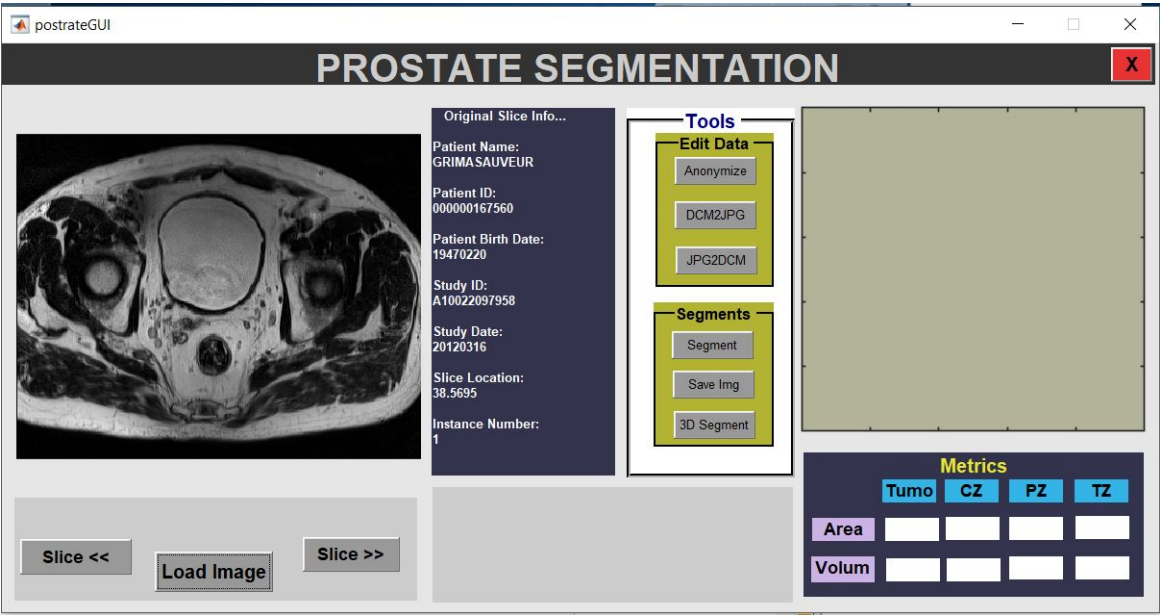


Figure 2.2: Control Panel
[C.Panel]

- 2. Anonymized data is needed sometimes to de-identify medical images for teaching, publishing or research.



Figure 2.3: anonymize Dicom file
[anonymize Dicom file]

It allows us to easily remove personal identifying information from the header of DICOM image files, as well as from any other kind of DICOM datasets. Here the button called **Anonymize** images as required removes all the information about the patient recorded in the right blue panel and the **Save Anonymize Images** saves the images and data in DICOM format to **newDicom** folder in current working directory(cwd) and this is done automatically once clicking in

Anonymize. It will everytime update the folder *newDicom*. the new directory is now uploaded in the new workspace .

3. The button **DCM2JPG**” converts the DICOM images to JPG and we save them in the **metadata** folder in cwd. Here, we simply converted dicom images to gray format and scaled it to 255 and converted to unsigned integer 8 (uint8) and saved in 'Jpg Images' folder in cwd.

As an observation, since our GUI is set to read the DICOM file , we were not able to display the jpg file in the GUI. In case ones want to read the JPG image , we kindly advice to read it from the saved folder called **dicom2jpgFolder**

4. In ”convert to Dicom” panel **Edit data**, we click on **JPG2DCM** button that select by default the folder **dicom2jpgFolder** for Jpg images. Here the idea is to load **Dicom Info** from the **metadata** required to convert to dicom format. Thus the image is saved in the folder **jpg2dicomFolder** in cwd.
5. In the **Segments** panel , the button **segment** is clicked to segment the prostate. Regions names in the **Metrics** panel are used to manually select the regions accordingly by using the Matlab in-built function *imfreehand* and the segmented regions images will be saved into the ”Segmented Images” folder in cwd with their standard names of regions like : tumor.jpg
6. The **3D Segment** panel is used to visualize the selected slices of gland in 3D. After selecting the slices of the gland , we can now see the segmented images in the folder called **segmentedImageFolder** . Later, the **Area** and **Volume** from **Metrics** panel contains buttons to calculate area and volume of selected four regions of the gland.

***IMPORTANT : A README.txt file is attached with this lab report and code folder will further focus on all the Matlab files used or created throughout and will explain all the steps required to safely run the *prostateGUI.m* and as well as the code is well commented for user understanding**

Chapter 3

Manual segmentation of the regions of interest

In this section we will discuss about the snake implementation for prostate segmentation. In our case, we will focus on manual segmentation using *activecontour* build in function in matlab. Our GUI has a dedicated section as shown in 3.1.

3.1 Single slice segmentation

The main problem we faced during the construction of our segmentation part of the program was laying into our understanding of the practical. Indeed, we were thinking at a moment that the segmentation had to be semi-automatic, including predefined shapes from which snake function would start.

In reality, the segmentation has to be done manually by the expert in a simple way, from which *activecontour* function refines the ROI. In this practical, delineations of **Central Zone**, **Peripheral Zone**, **Transition Zone** and **Tumor area** must be performed.

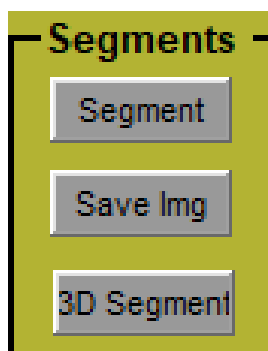


Figure 3.1: Segmentation menu

`[segment]`

To perform this task, we used another build in function, *imfreehand*(*gca*, '*closed*', '*false*'), which allows the user to draw the general ROI shape he wants. From there a binary mask is created and given as input to the snake function. A new region is returned, with boundaries made visible as shown in 3.2. True and false keyword are used to allow finished and auto-completion ROI draw.

The process should be completed to be valid, meaning the user has to draw the 4 regions of interest (although when one is absent, a dot can be drawn). For each regions, the active contours method is iterated 400 times, using '*edge*' and a contraction bias of 0.1, determining the amount of shrinking of the region.

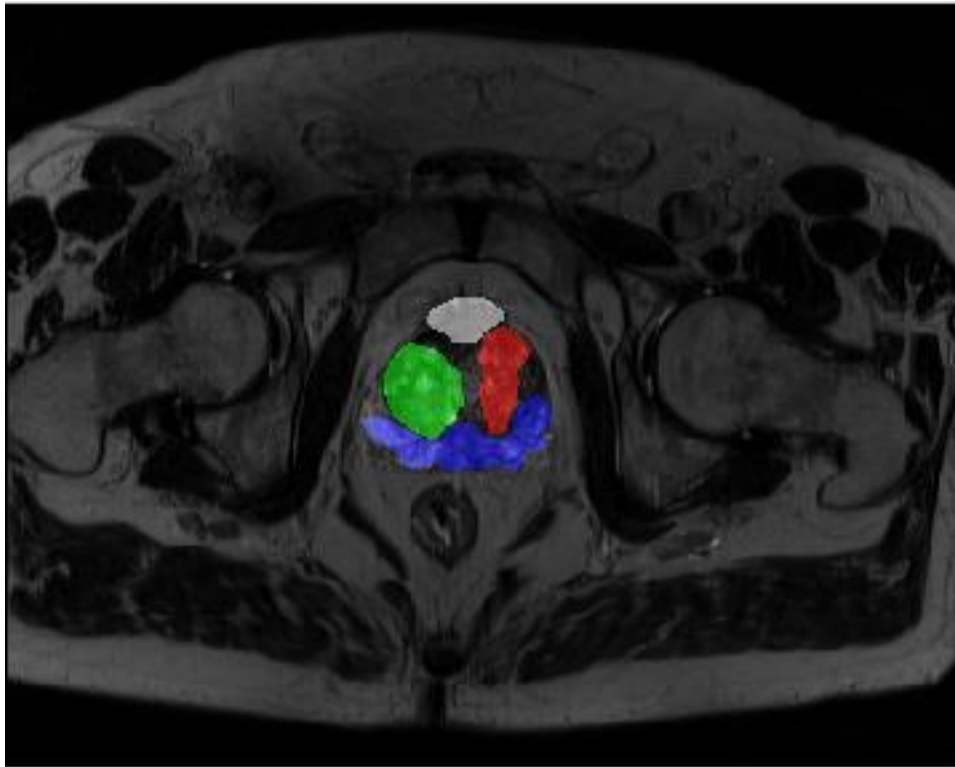


Figure 3.2: Fully segmented slice

[figure4.2]

3.2 Multiple slices segmentation, 3D modeling, Volume and Area extraction

The second segmentation task we performed was to create a 3D model of all the segmented regions. Several objectives can be seen from this procedure. The first being the visualization of the several ROI in 3D, the second being the possibility to estimate their volumes.

There are two possible ways to represent these areas in 3D. the first one by repeating a single segmented slice, the second one by segmenting multiple slices and stack them in a 3D volume^{3.4}. We choose the second option there as we estimated that more realistic results will be obtained in this way.

In order to accelerate the process, we performed segmentation on 10 different slices instead of the entire DICOM images set. However, for further settings we read and store all of the images in two container assigned for information and images, respectively *data* and *cine*. From there a loop is given to iterate segmentation 10 times on consecutive slices. The number of iterations for the snake method was lowered to 200 to gain time. Each segmented areas are stored in a container that is passed into 3D volume. The slices are stacked together and displayed in a volume corresponding to the number segmented slices.

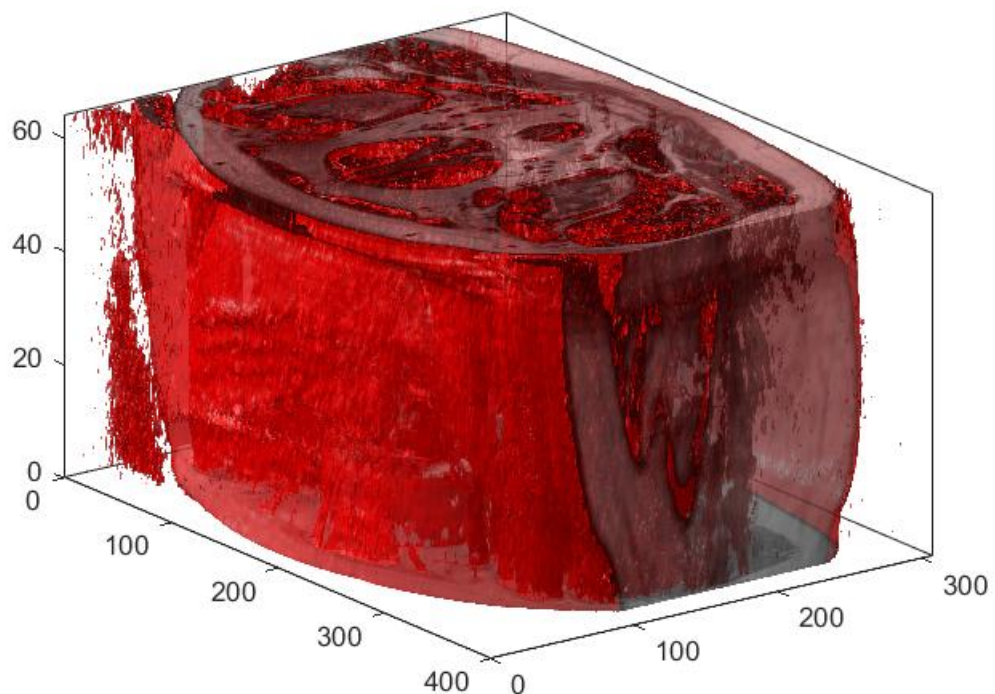


Figure 3.3: all Slices in 3D

[all slices in 3D view]

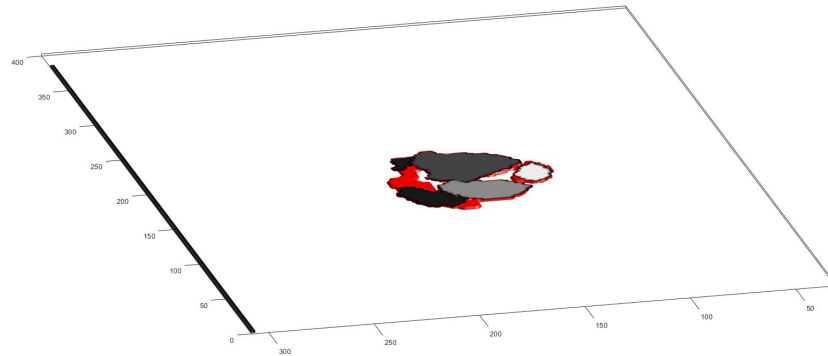


Figure 3.4: Slices volume

[figure4.3]

We calculated volume and area for a given segmented slice. To do so, we created *calculateArea* and *calculateVolume* function. The first one take as input the previously segmented regions and for each of them count and sum the "true pixels" of their binary mask. This returns the computed areas in pixels, passed in their respective text box. The second one takes the previously computed area and multiply it by the slice thickness, giving volume for each ROI.

Chapter 4

Conclusion

In this practical, we have performed processing of MRI data to put in evidence tumor of the prostate. We have been familiarized with the use of DICOM format data, as well as some useful manipulations such as anonymization, format conversions or data extraction to perform further computations (such as area and volume). We have also learned to perform manual segmentation using snake through matlab in-built function, as well as making 3-dimensional modelization for spatial observation.

On another hand, the practical was also a good opportunity to understand and use tools necessary to build a GUI, as well as the needed organization to make it clear and user friendly.

4.1 Erratum

ProstateGUI.m = postrateGUI.m seen in the code

Bibliography