Medical Imaging Analysis:
Image Modalities 3D Ultrasound and MRI

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1 Introduction

The goal of this lab is to understand Medical Image Modalities, DICOM standards. Here as an example we have used 3D ultrasound volume and MRI modalities. Also, an approach towards transformation of a prostate phantom to make it more realistic has been proposed.

2 Image Information

DICOM is a standard for medical image files, that is nowadays use for most of the medical equipment providers and medical environment in general. This file other than technical information also contains patients information like name, age, gender etc to avoid mismatch. But sometimes when anonimity is tobe maintained, the patients name is replaced with substitutes, for e.g, ID number. Here we have considered a set of MRI images of prostate and also a 3D volume of ultrasound scans of prostate. The .dcm files have been accessed by using the MATLAB functions $dicomread()$ and $dicominfo$. The details are mentioned below.

Modality	Dimensionality	no. of pixels /frame	pixel spacing
MRI	512x512x22	2,62,144	3
Ultrasound	186x904x1x125	1,68,144	not mentioned

Table 1: Image Information describing the dimensionality and pixel information for each modality

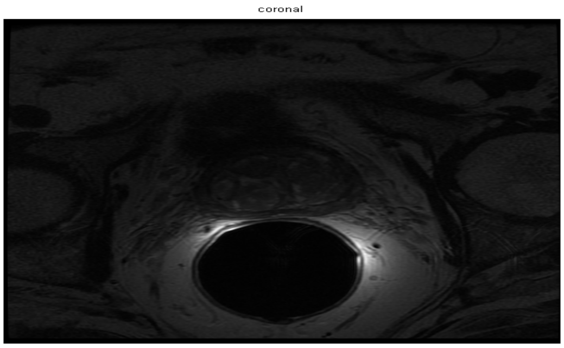

Figure 1: Coronal slice of the MRI volume

Figure 2: axial slice of ultrasound volume

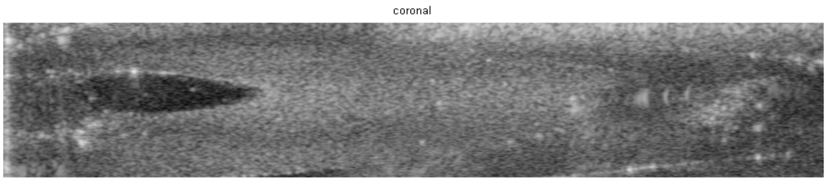

Figure 3: axial slice of ultrasound volume

The initial step was to obtain technical information about the two datasets, which are shown in $Table1$. We can say that the files anonymous as there is no patient name mentioned in the details. The next step was to visualize the histograms of the volumes while observing few slices of the 2 volumes. The code used to accomplish this task is added along with this report. The observations are shown in the images below.
The images show various slices of the 2 volumes in different orientations. The figures are labelled accordingly and can be observed. We could extract all the orientations from the ultrasound volume but as the MRI volume only has 22 frames in the data set, it did not make any sense to extract the axial and sagittal orientations of the image.The resulting images for MRI were thin slices from which one cannot percieve any information. // By looking at the images one can infer that the scans are of uterus of a woman taken from the coronal plane with slice thickness of 22 for MRI and 125 for ultrasound.

3 US Image transformation

3.1 Why this distortion appears?

The original image is the one that doctors captured from patients' body. The theory is that the probe contains a large number of transmitters set in a line along its length. Typically up to five of these firing simultaneously generate a short pulse of ultrasound that travels in a narrow column away from the probe. The transmitters then act as receivers and record the intensity of the reflected sound.

The process is repeated sequentially along the length of the probe. The time taken for an echo to return is used determine the distance from the probe and is calculated assuming that sound has a constant speed. The strength of the echoes returning from any point is represented by the brightness of that point on the screen.

So, every column the probe captured is saved in one column of the image(matrix), which can only appears in a square but not physically appears the structure of the body. That's why it looks distorted.

3.2 What would you propose to transform the slice in figure 4 (a) to the one in (b)?

Basically, we have to map the input image into polar coordinate first and then convert it to cartesian coordinate system for output image.

1. Mapping

   Every row of input image is extracted to form the radius of the fan-shaped output image. And every column of input image is relevant to the angle of transformed image. Here, we set the equation of columns of input image and angle of transformed image as linear.

   The equations for transforming cartesian coordinate of input image to polar coordinate system of output image.

$$ro = ropp + xi$$

$$\theta o = \frac{(\theta low - \theta up) * yi}{h} + \theta up$$

3.2 What would you propose to transform the slice in figure 4 (a) to the one in (b)? 4

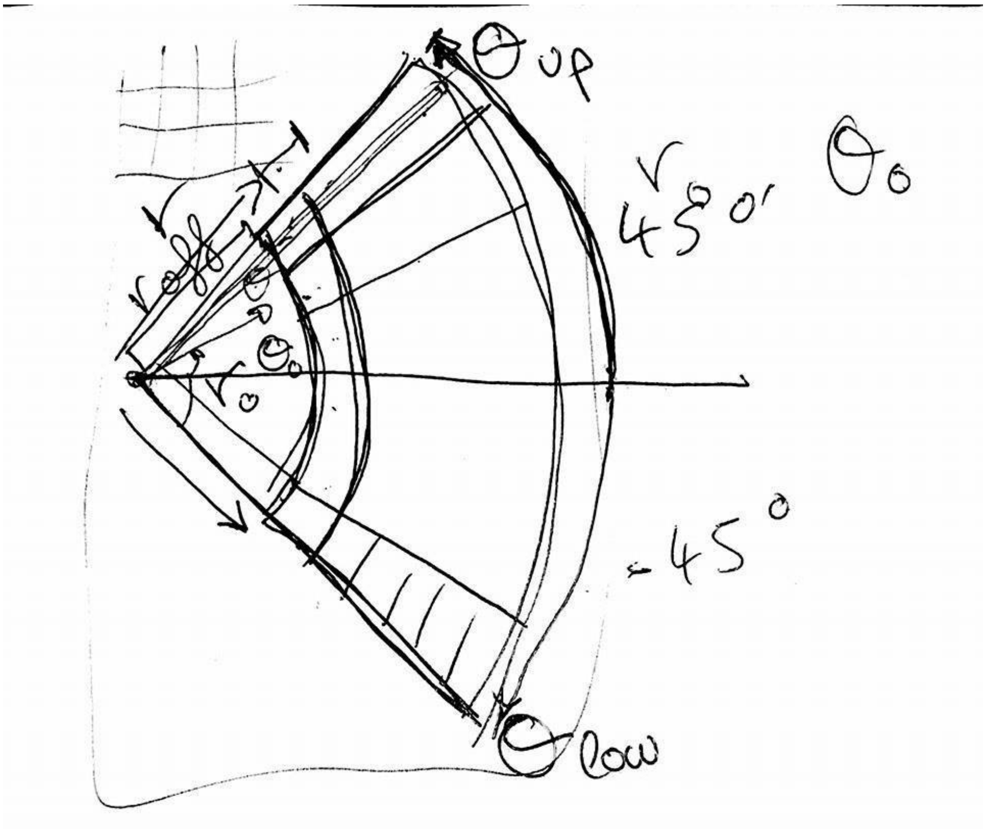

Figure 4: Sketch of the transformed polar coordinate

2. Converting

   After we mapping the coordinate to polar coordinate, we have to do the inverse mapping from input image to output image.

   The final equation is that

$$xi = \sqrt((xo)^2 + (yo)^2) - roff$$

$$yi = \frac{(\arctan(\frac{yo}{xo}) - \theta up) * height}{\theta low - \theta up}$$

   Where the height is the height of the input image.

3.3 Can you think of any problems for the above transformation?

About the above transformation, we have to define the angle of fan-shaped output image ourselves. It is flexible but also not strict. It may cause different diagnoses for different doctors.