University of Girona

Spain

Medical Imaging Analysis

Lab 1 - Image Modalities 3D Ultrasound and MRI

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1 Introduction

In this lab, we know about how to open DICOM images and check the information of different modalities. Also, we use interpolation technique for transforming the original ultrasound slice to B-mode ultrasound image. In the following section, we will answer the questions in the handout and then discuss the transformation details.

2 Question Answer

2.1 Image Information

- **What is the dimensionality of the data for each modality, number of pixels and pixel size?**

  1. Ultrasound image
     - The dimensionality of ultrasound : 186×904
     - The number of pixel is : 168144
     - There is no pixel size information for ultrasound image.
  2. MRI
     - The dimensionality of MRI: $512 \times 512 \times 22$
     - The pixel number of MRI: 5767168
     - The pixel size of MRI images: 0.3125 in x direction, 0.3125 in y direction, 3.5 in z direction

- **Check the DICOM info concerning the patient information and verify the files are anonymised.**
  The list of the name of different modality is as follow:

  1. The patient name of ultrasound image is: PHANTOM.TRANSVER.2
  2. The patient name of MRI image is: 002

  As we can see in the above, all the files are anonymised.

- **Visualize the histogram of the two volumes**

  1. Histogram of Ultrasound volume:

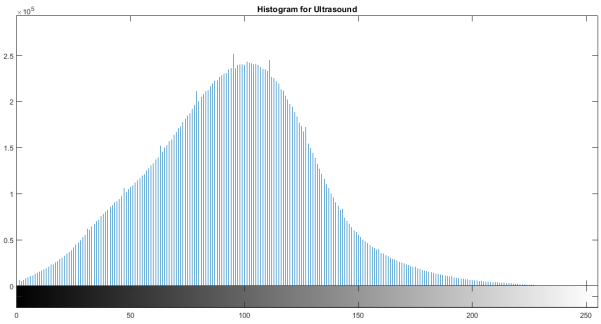

Figure 1: Histogram of Ultrasound volume

2. Histogram of MRI volume:

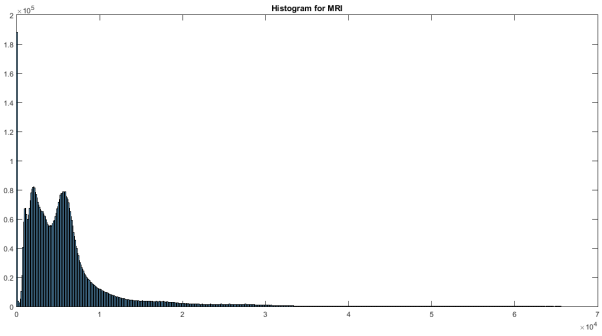

Figure 2: Histogram of MRI volume

- **Visualize some slices in Matlab for the MRI and 3D US, does it make sense what do you see?**

  We have taken the few pictures of MRI and slicing pictures of ultrasound, which are shown below.

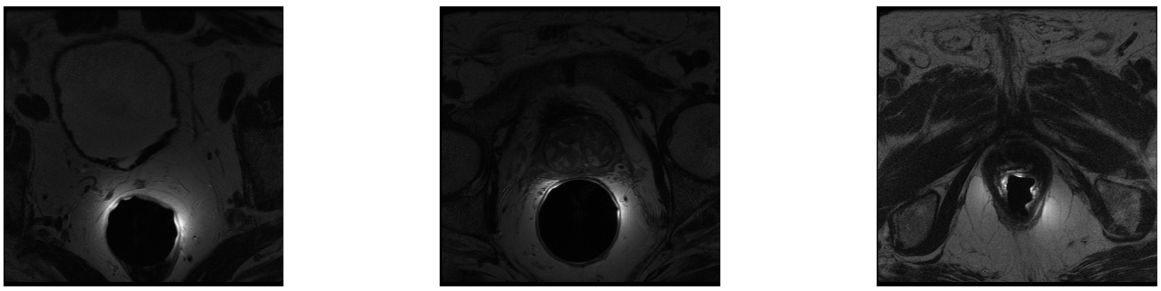

Figure 3: MRI images 1, 11 and 21

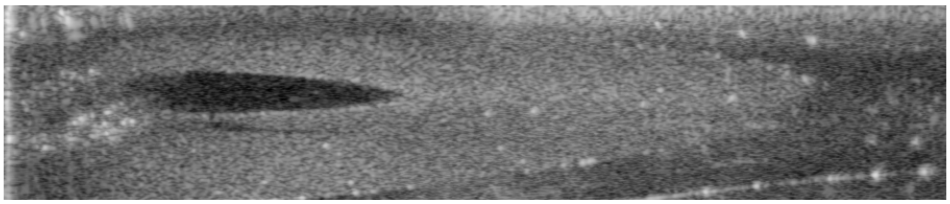

Figure 4: Ultrasound image - 70th slice

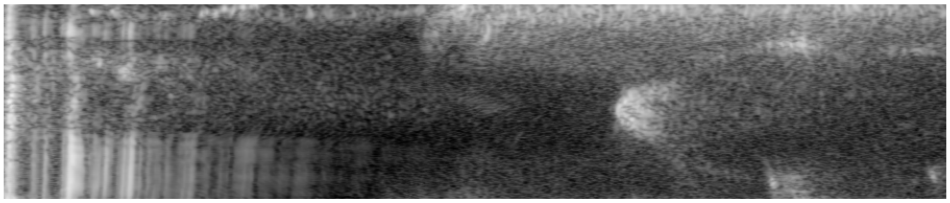

Figure 5: Ultrasound image - 109th slice

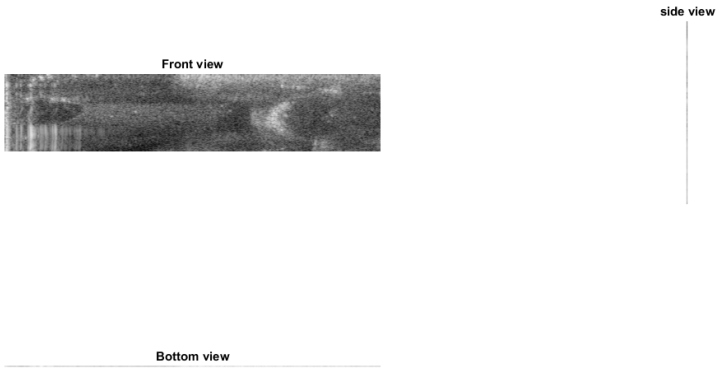

Figure 6: Slices of Ultrasound at different views

- **Provide the Matlab code for the questions above.**
  The code is attached with the .zip folder

2.2 US Image Transformation

1. **Why distortion appears in the original slice?**
   The distortion occurs because the transducer sweep and the elements on the transducer receives the data and saves the data in many lines in an array. But these lines are from different angle. As the data is stored in an array in each slice, hence the original slice appears to be distorted one.

2. **Transformation method proposal**
   Linear Interpolation
   The over-sampled vectors coupled with simple linear interpolation is used to perform the scan conversion. As shown in Fig. 8, the data is over-sampled in the radial direction providing two data points on adjacent vectors that lie approximately along a linear path with the needed pixel. Simple linear interpolation can be performed between these two data points in order to determine the value of the pixel. Equation (1) shows how the interpolation is computed; A is the value of data point A along vector $\theta 1$, B is the value of data point B along vector $\theta 2$, and C is the distance between the pixel and B.

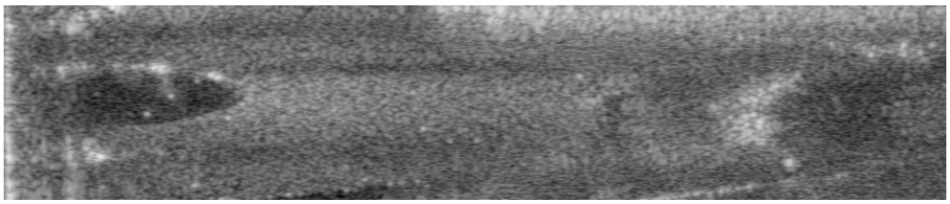

Figure 7: Ultrasound image original slice

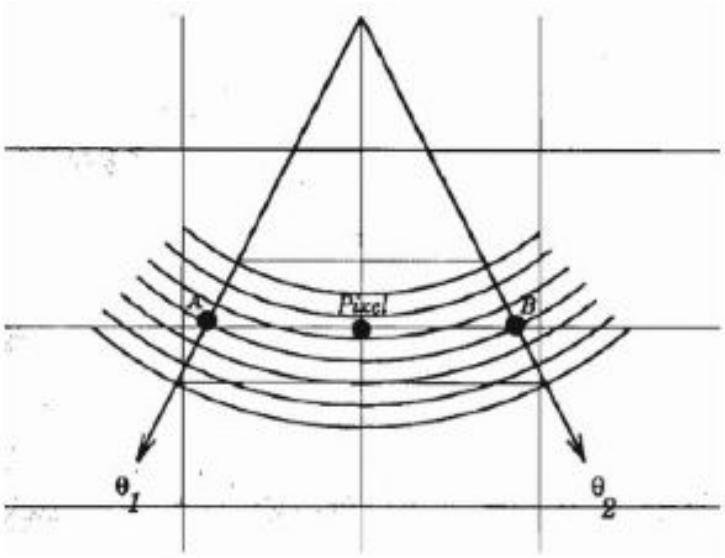

Figure 8: Linear Interpolation algorithm. Given 4x over-sampling in the radial direction, the pixel is computed using the two closest pixels from adjacent vectors.

$$Pixel = A * C + B * (1 - C) \tag{1}$$

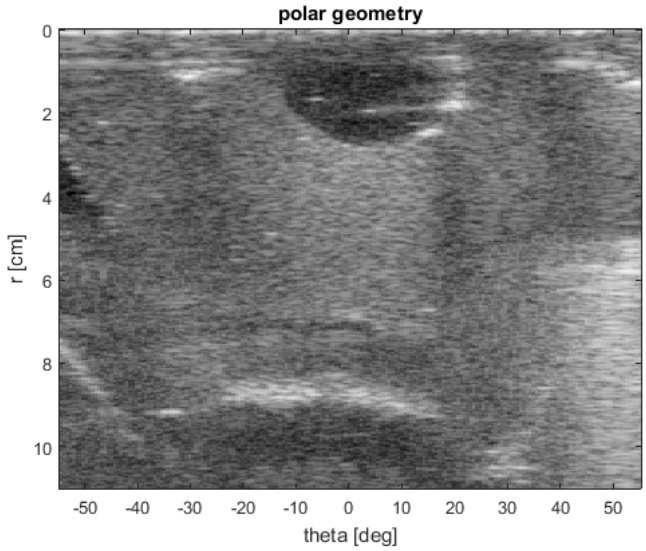

Figure 9: Ultrasound image slice in polar coordinate frame

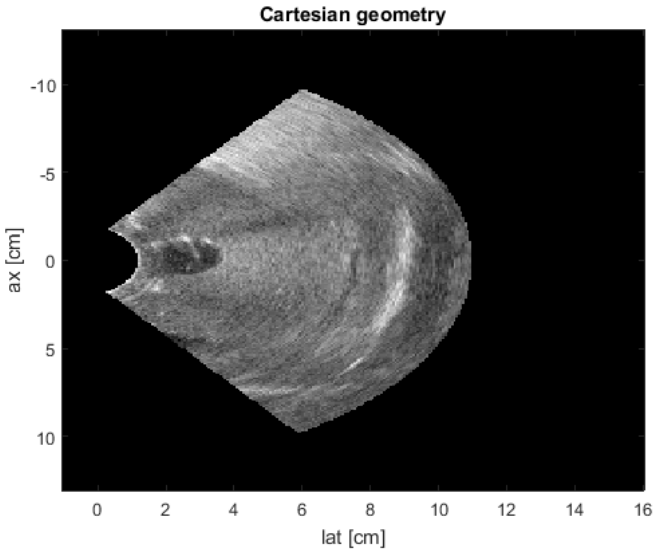

Figure 10: Transformed Ultrasound image slice using Linear Interpolation

In Matlab, there is a direct function for linear interpolation *interp2* which is used for transforming the original slice of ultrasound image.
Other Methods for transformation

- Nearest Neighbor interpolation
- Bilinear interpolation

3. **Can you think of any problems for the above transformation?**

   (a) There could be loss of information due to interpolation, which may introduce some noise. Speckle is a particular type of noise which affects the medical ultrasound images.

   (b) Problem of missed pixels.

   (c) Smoothing or blurring function is needed to remove those missed pixels.

   (d) Also the quality decreases on the outer radius of the transformed slice.

4. **Provide the Matlab code for the above transformation.**

   The code is attached with the .zip folder

3 Conclusion

In this lab, we not only play with some basic operating of DICOM images, but also apply linear interpolation technique for transforming the original ultrasound slice to B-mode frame ultrasound image. A reasonable transformation can give us realistic looks and could be used for diagnostic purposes.