A Practical Training Report/Seminar Report on

Radiogrammetric Measurement Of Third Metacarpal Bone From Hand Radiogram Using Active Contour Model

undergone at

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING,

Under the guidance of

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1 Introduction

1.1 Objective of the project

The main objective of this project is to provide a cheaper method to find the presence of Osteoporosis in human. The present methods need an improvements. Some methods gives good result but are often found to be costly. We can improve finding o fthis disease either by having a good instrument to capture image or better prepossessing of image. So to have a cheap method to find this disease I have suggested an approach which does better prepossessing and gives good result.

1.2 Problem Statement

Osteoporosis is characterized by reduced bone mass and structural deformation of bone tissue, bone fragility and an increased possibility to fractures of hip, spine and wrist. The condition often remains painless and undiagnosed until a fragility fracture occurs.According World Health Organisation (WHO) survey osteoporosis is second only to cardiovascular diseases as a global health problem. Statistics show that in 2012, the number of osteoporotic cases in India was around 55 million (4%) and by 2022, it is expected to rise to 75 million (5%). There is many techniques like gold standard technique Dual Energy X-ray Absorptiometry (DXA). DXA is accurate and highly precise and has low radiation dose but the cost of DXA scans costs in ranges between Rs.1800 to 4500. So, we need low cost method for the early diagnosis of osteoporosis and fracture risk assessment. An alternatively we can do manual measurement from radiographs is known as radiogrammetry. It is low cost but suffers from subjective errors precision and reproducibility is so poor and it is time consuming.We need Geometric measurements of the cortical bone such as cortical width, cortical thickness, cortical area, length of the bone, etc. are measured from a radiograph. Bone indices derived from these measurements such as Combined Cortical Thickness (CCT), Metacarpal Index (MCI), ExtonSmith Index (ESI), Pediatric Bone Index (PBI), etc. are used to diagnose osteoporosis.To overcome issue of radiogeommetry, various automated methods for radiogrammetric measurements have evolved. As we know osteoporosis is a systemic disease in which bone loss occurs in the whole body, measurement of bone loss in any part of the skeletal body reflects the bone loss at all other parts. Hence, radiogrammetric measurements from metacarpal bone of hand can be used to measure the bone loss at any skeletal site. Computerised metacarpal radiogrammetry reduces the above errors .There are various techniques of segmentation present these days. In this project segmentation is done using active contour model (chan-vese model).We will see the result.

2 Technologies Used

- **MATLAB 2015a :** It is used to do prepossessing of image like contrast enhancement, noise removal and edge detection. Also segmentation app is used to use active contour method.
- **X-Ray Digital Images :** To carry out above mentioned operations.

3 Work Done

The work done by me is explained in the flow Chart below:

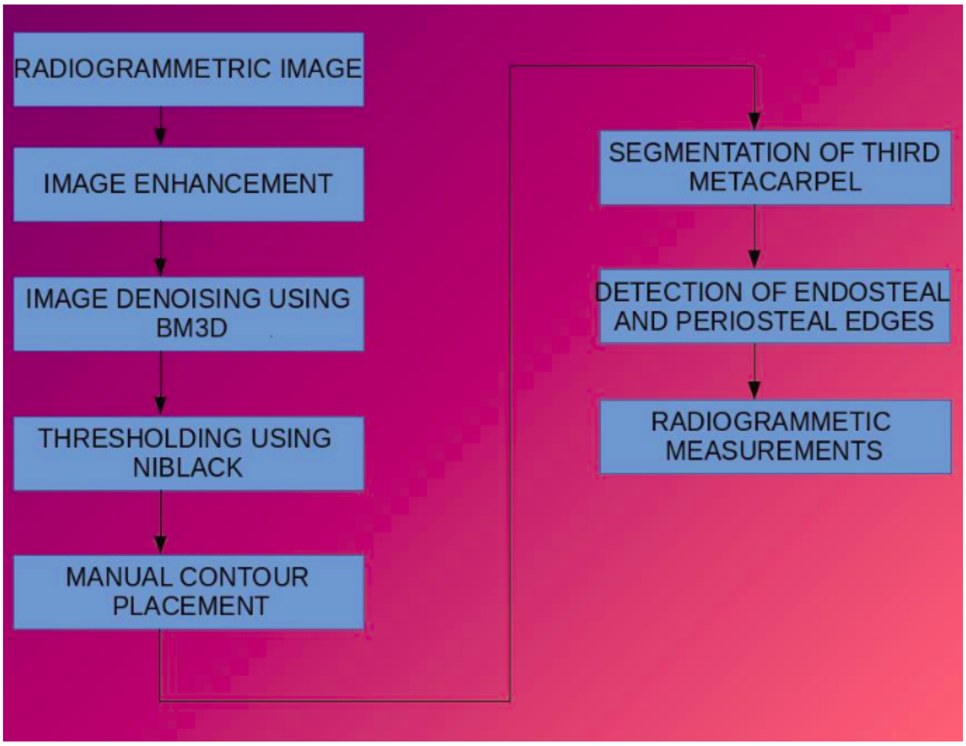

Figure 1: Flow chart of work done

- **Image Enhancement:** In this step I have used imadjust(Image) function to enhance the contrast of the image.
- **Image Denoising:** Here I removed the noise from the image. I also tried various other algorithms to reduce the noise like local mean, median, averaging but BM3D algorithm gave best result.
- **Thresholding:** It is used to convert the gray-scale image to binary image so that various operations like imclose(Image, StructuringElemen can be performed to highlight the edges and perform segmentation.
- **Active Contour Method :** Active contour models or snakes is to evolve a curve, subject to constraints from a given image, in order to detect objects in that image. For instance, starting with a curve around the object to be detected, the curve moves toward its interior normal and has to stop on the boundary of the object.

1. Edge detection: The process of labelling the locations in the image where the grey level's rate of change is high.
2. Edge integration: The process of combining local and perhaps soarse and non-contiguous edge data into meaningful long edged curves for segmentation.

$$F_1(C) + F_2(C) = \int_{inside(C)} |u_0(x, y) - c_1|^2 \, dx \, dy + \int_{outside(C)} |u_0(x, y) - c_2|^2 \, dx \, dy$$

Figure 2: Formula of Image Fitting

The above formula is used for moving the seed. C1 is average of inside pixels and C2 is average of outside pixels. As it can be seen in first part of image the region outside the seed is having same pixel that is it is homogeneous, hence when each of its pixel is subtracted from C2 it gives 0 and inside is combination of two intensities, so we will get some positive value which makes the seed to move inward. Similarly in second part of image the inside region gets 0 signifying the pixel to move outward. In third part of image according to the value obtained seed adjusts itself and finally encapsulates the while of object as shown in fourth part of the image.

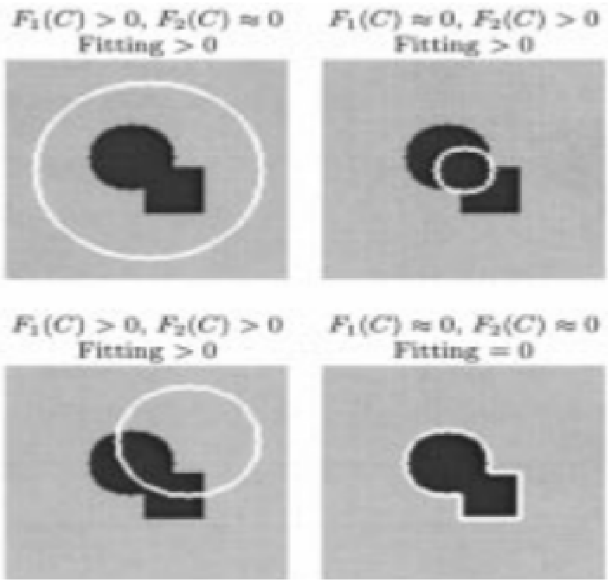

Figure 3: Seed Propagation

- **Segmentation:** It is performed to take out the third metacarpel bone from the image for calculating various parameters.

- **Metacarpal radiogrammetry :**is the technique by which cortical measurements are taken from third metacarpal bone using hand radiograph. The different measurements taken from metacarpal bone are cortical width, D, medullary width, d and length of metacarpal bone, L, as shown in Fig.1. Other measurements obtained from radiogrammetric analysis are combined cortical thickness T and cortical area A [3], defined as
cortical area, A = $\pi TD(1 - T/D)$

where, cortical width, D
medullary width, d
cortical thickness, T = (D-d)
length of the bone, L

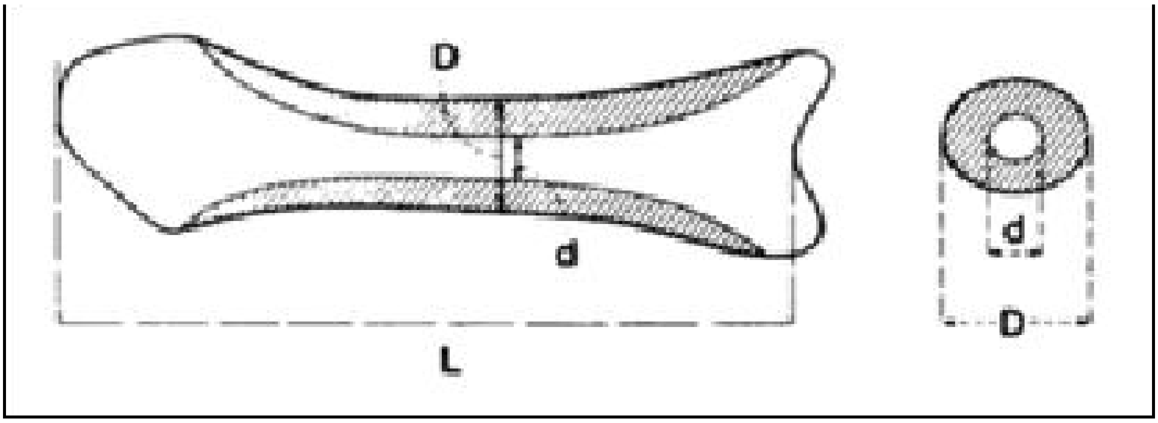

Figure 4: Cortical Measurements

4 Code

```
BM3DALGO
I2=niblack(I3,[30 30], 0.01);
imtool(I2,[])
I4=imfill(I2);
// to find inner edge use I2 or I4;
imtool(I4,[])
se=strel('disk',4);
I5=imclose(I2,se);
imtool(I5,[])
se=strel('disk',2);
I5=imclose(I2,se);
I6=imfill(I5);
//use I6 to find outer edge;
imtool(I6,[])
imtool(I5,[])
I7=double(BW);
I7=imfill(I7);
//inner edge in I7;
I8=double(BW1);
I8=imfill(I8);
//outer edge in I8;
I9=xor(I7,I8);
imtool(I9,[])
//final image in I9. use this to find area and length of the bone;
x=imread('11001final.bmp');//having I9
imtool(x,[]);
y=im2bw(x);
 p q
=find(y==1);
min(p);
l=min(p);
u=max(p);
l=u-l;//length of image;
a=regionprops(x,'Area');
b=a.area;
b=a.Area;
w=b/l
//width of image;
```

5 Results and Snapshots

5.1 Pre-processing Result

Figure 5: (a) Original Image (b) Contrast enhanced Image (c)De-noised Image (d)Thresholded Image for endosteal detection (e) Thresholded Image for periosteal detection

5.2 Segmentation Result

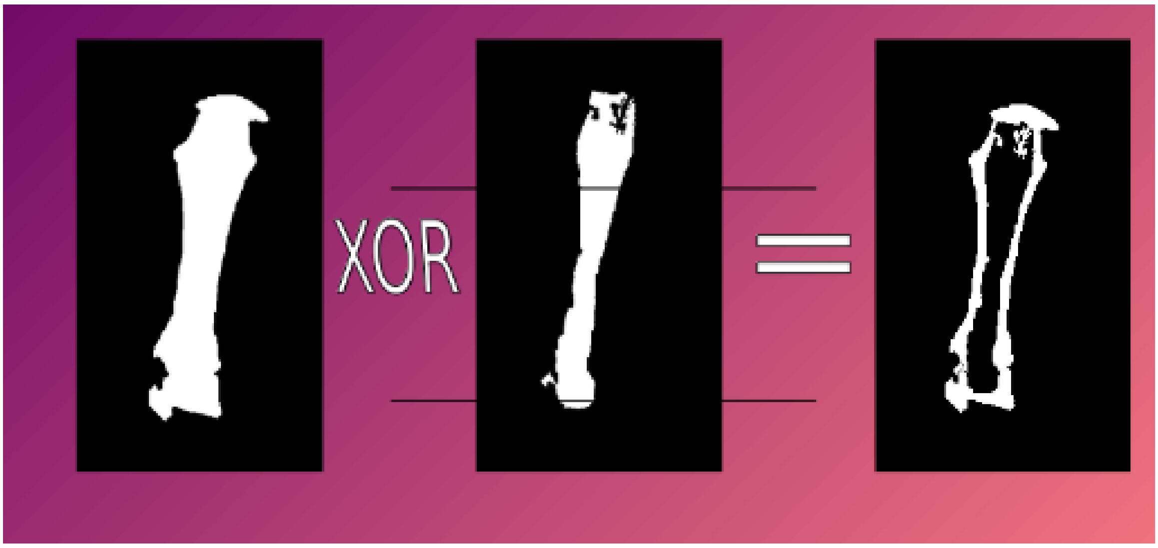

Figure 6: XOR(inner edge, outer edge)

5.3 Length and Width Finding

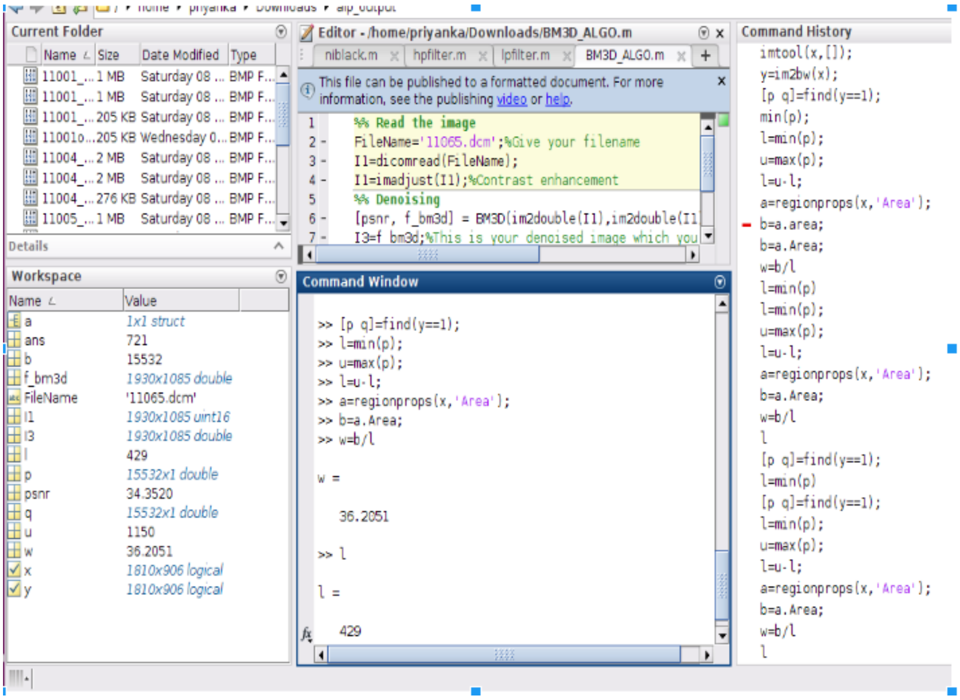

Figure 7: Length and Width Calculation

5.4 Standard Cortical Measurements

Data	Age	Pixel dimension (cm)	CW (cm)	MW (cm)	CCT (cm)	CA (cm^2)
1	26	0.023	0.92	0.65	0.27	0.55
2	40	0.01	0.88	0.53	0.34	0.57
3	40	0.01	0.99	0.63	0.35	0.7
4	42	0.022	0.97	0.64	0.33	0.66
5	62	0.01	0.87	0.69	0.19	0.4
6	64	0.027	0.84	0.5	0.35	0.54
7	70	0.01	0.8	0.56	0.24	0.43
8	80	0.01	0.81	0.55	0.27	0.46

Figure 8: Cortical Measurements of Third Metacarpal Bone

5.5 Final Result

Pixel dimension=0.144 mm

No. of pixels in length= 429

No.0f pixels in width 36.2051

Length = 429 * 0.144 = 61.776 mm = 0.617 cm

Width = 36.2051 * 0.144 = 5.21353 mm = 0.521 cm

Figure 9: Width and Length calculation

6 Conclusion and Future Work

In conclusion, active contour model (chan-vese model) is used in extraction of third metacarpal bone and detection of periosteal and endosteal edges from hand radiograph. With this we were able to detect whether a person is infected by Osteoporosis disease or not. Doctors maintain standard tables to compare with the obtained result to check for the disease. Using cheaper radiographs I was able to detect the presence or absence of the disease.
Cortical measurement (cortical thickness) shown a error of 0.69 mm. With this we were able to detect whether a person is infected by Osteoporosis disease or not. Doctors maintain standard tables to compare with the obtained result to check for the disease. So for better results we will need better prepossessing techniques to resolute the different areas in image.We can automate segmentation procedure.

References

[1] Fully Automated Radiogrammetric Measurement of Third Metacarpal Bone from Hand Radiograph, Anu Shaju Areeckal, Sumam David S, Michel Kocher, Nikil Jayasheelan, Jagannath Kamath.

[2] Active Contours Without Edges , Tony F. Chan, Member, IEEE, and Luminita A. Vese

[3] http://in.mathworks.com/