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Thickness Computation Under In-Vivo Trabecular Bone CT Imaging

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Abstract **- Adult bone diseases, especially osteoporosis leads to increased risk of fracture which associated with substantial morbidity, mortality and financial cost. Clinically osteoporosis is defined as low bone mineral density. However, increasing the evidence suggests that the micro architectural quality of Trabecular Bone (TB) is more determinant of bone strength and fracture risk. Here, we present a new robust algorithm for computing TB thickness and marrow spacing at a low resolution. The star line tracking algorithm that effectively deals with partial voluming effects in vivo imaging with voxel size comparable with thickness. Also the method avoids the problem of digitization associated with conventional algorithm based on sampling distance transform. Accuracy and robustness was examined by repeat scan reproducibility under in-vivo condition and correlation between thickness values computed at ex-vivo and in-vivo resolution. Finally, the method was evaluated in a human study involving 40 healthy young adult volunteers and ten athletes. Across the wide range of voxel sizes, the new method is significantly more accurate and robust as compared to conventional method.**

Keywords **- Osteoporosis, Trabecular Bone, in-vivo, ex-vivo, thickness**

I. INTRODUCTION

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it.

Osteoporosis is an adult bone disease leads to increased risk of fractures. Clinically, osteoporosis is defined by low bone mineral density. It can be measured dual energy X-ray absorptiometry (DXA). It is more common in women than men. The secondary cause includes hyperthyroidism, calcium and vitamin-D deficiency. The prevention of osteoporosis includes proper diet during childhood. For these diagnostic criteria, BMD is transformed into a T-score, which reflects the number of standards deviation (SD) above or below the mean in healthy young adults.

A medical evaluation to diagnose osteoporosis and estimate your risk of breaking a bone may involve one or more methods. Other tests that may be used to get information about your bone health, but are not used to diagnose osteoporosis include biochemical marker tests, x-rays, vertebral fracture assessments (VFA), and bone scans.

Computed Tomography (CT) makes use of computer processed combination of many x-ray images taken from the different angles to produce cross-sectional images of specific areas of a scanned object, allowing the user to see inside the object without cutting. Medical imaging is the most common application of x-ray CT. Its cross sectional images are used for diagnostic and therapeutic purposes in various medical disciplines. CT produces a volume of data that can be manipulated in order to demonstrate various bodily structures based on their ability to block the x-ray beam.

The remainder of this paper is organized as follows: in section II we review the texture synthesis techniques. In section III, we detail the proposed algorithm including embedding and extracting procedures. In section IV experimental results followed by conclusions and future scope in the final section.

II. RELATED WORK

Harry k. Genant and Yebin Jiang [4] has developed a non-invasive and or nondestructive techniques can provide structural information about bone, beyond simple bone densitometry. The methods for quantitatively assessing macrostructure include dual X-ray absorptiometry (DXA) and computed tomography (CT), particularly volumetric quantitative computed tomography (vQCT).

Carolina A. Moreira Kulak and David W. Dempster [3] introduced a technique of bone histomorphometry, a histological examination of undecalcified transiliac bone research tool for studying the pathogenesis of metabolic bone diseases as well as for defining mechanisms by which drugs affect the bone. Histomorphometry has traditionally been assessed in two dimensions by means of histology, where the structural and remodeling parameters are measured on sections, and the third dimension is extrapolated using standard stereology theory.

Osteoporosis in postmenopausal men [1] is mainly characterized by a reduction in cancellous bone volume resulting from a progressive loss of entire trabeculae leading to reduced trabecular connectivity, and to a lesser extent resulting from a trabecular thinning.

Klaus Engelke and Judith E. Adams [6] introduced a new quantitative computed tomography (CT) is a three-dimensional non-projectional technique to quantify bone mineral density (BMD) in the spine, proximal femur, forearm, and tibia. The cortical and trabecular bone can be separated, trabecular volumes of interest (VOI) are largely independent of degenerative changes in the spine, and 3D geometric parameters can be determined.

Sherry Liu X and Henry Zhang X [10] has developed Measurement of areal bone mineral density (aBMD) by dual-energy X-ray absorptiometry (DXA) is currently the only validated method for diagnosis of osteoporosis and assessment of fracture risk in postmenopausal women and men over age 50.

Along with clinical risk factors [2] such as age and a previous fracture, skeletal properties of trabecular microstructure, cortical thickness and porosity, and bone geometry are key independent determinants. Together these skeletal features contribute to bone's biomechanical properties such as elastic stiffness and failure load.

Majumdar S and Genant H.K [7] has developed high resolution magnetic resonance (MR) images in premenopausal normal, postmenopausal normal and postmenopausal osteoporotic women. Extensions of standard stereological techniques were used to derive measures of trabecular bone structure from these segmented images. Fractal-based texture parameters, such as the box-counting dimension, were also derived.

Correlations between the indices of trabecular bone structure measured [9] from these high-resolution MR images, age, BMD, and osteoporotic fracture status were examined. Trabecular spacing showed the greatest percentage change and increased with age. In addition, significant differences were evident in spinal BMD, radial trabecular BMD, trabecular bone volume fraction, trabecular spacing, and trabecular number between the postmenopausal non-fracture and the postmenopausal osteoporotic subjects.

Janet golden stein and Galateia kazakia [5] has observed the first observational study examining cortical porosity in vivo in postmenopausal osteopenic women and to incorporate data from two different imaging modalities. The goal of this study was to combine high-resolution peripheral computed tomography (HR-pQCT) images, which contain high spatial resolution information of the cortical structure, and magnetic resonance (MR) images, which allow the visualization of soft tissues such as bone marrow, to observe the amount of cortical porosity that contains bone marrow in postmenopausal osteopenic women.

Punam K. Saha and Zhiyun Gao [8] developed A novel multiscale topomorphologic approach for opening of two isointensity objects fused at different locations and scales is presented and applied to separating arterial and venous trees in 3-D pulmonary multidetector X-ray computed tomography (CT) images. The method is intended to solve the following two fundamental challenges: how to find local size of morphological operators and how to trace continuity of locally separated regions.

III. PROPOSED METHOD

A star-line-based algorithm is used for an accurate and robust measure of TB thickness and marrow spacing at in vivo resolution in the presence of significant partial voluming. The FDT-based approach assumes that an axial voxel where the FDT value is sampled coincides with the true axis of the object and any difference between the two directly contributes to thickness error.

Recently, in vivo imaging techniques including magnetic resonance imaging (MRI), high-resolution peripheral quantitative CT (HR-pQCT), and multi row detector CT (MD-CT) have emerged as promising modalities for high quality TB imaging at peripheral sites that avoid the problems of invasive bone biopsies. Therefore, an accurate and robust algorithm for computing TB thickness and marrow spacing that is applicable to in-vivo imaging would be useful as an effective indicator of quantitative bone quality for clinical trials designed to evaluate fracture risks under different clinical conditions.

Here, we present such an algorithm and evaluate its accuracy, robustness, and sensitivity to bone strength. Adult bone diseases, especially osteoporosis, lead to increased risk of fracture which in turn is associated with substantial morbidity, mortality, and financial costs.

Clinically, osteoporosis is defined by low bone mineral density; however, increasing evidence suggests that the micro architectural quality of trabecular bone (TB) is an important determinant of bone strength and fracture risk.

Accurate measures of TB thickness and marrow spacing is of significant interest for early diagnosis of osteoporosis or treatment effects. There are many kinds of bone problems are increasingly apparent. Although HR-pQCT was developed recently, its ability to detect age or disease-related changes in bone micro architecture and to provide additional fracture risk determinants has been demonstrated.

The proposed detection and classification of several bone diseases using artificial neural network classifier. Here, we present such an algorithm and evaluate its accuracy, robustness, and sensitivity to bone strength.

Although, in this paper, the method is applied and evaluated on MD-CT imaging, it may be adapted for other in vivo 3-D imaging modalities including MRI and HR-pQCT.

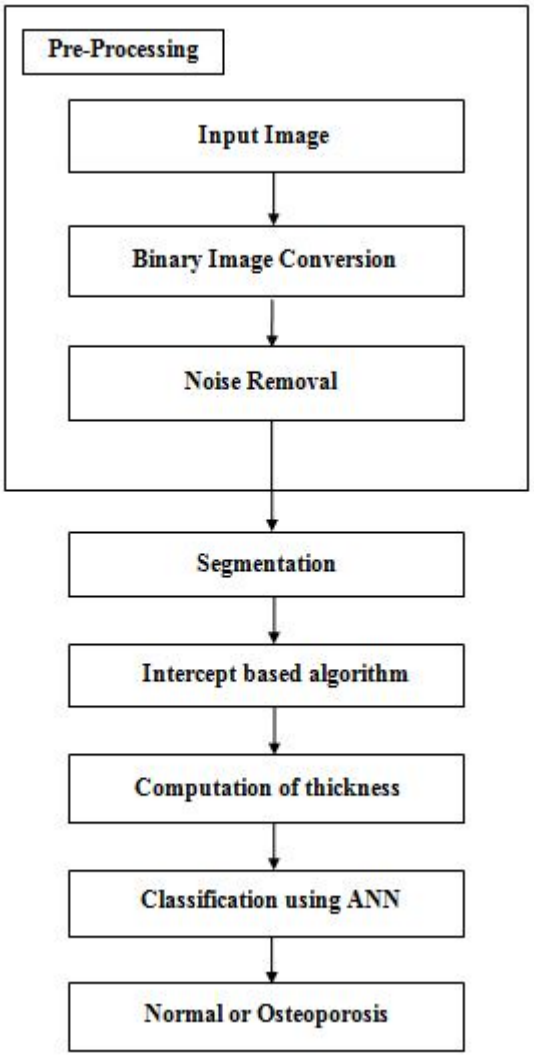

Fig.1 System Architecture

First we have to load the input images and the image is converted into binary image conversion. After conversion an image is filtered from noise by applying 'Kalman filter' in the pre-processing steps.

For computing thickness at axial voxels that overcomes the digitization error. In case of the intercept-based approach, the true axis of an object always orthogonally intersects a minimum intercept line. Therefore, even when an axial voxel deviates from the true axis, the error caused by the intercept approach is minimized.

The new thickness computation methods consists of two major modules

1. Computation of local thickness at axial points
2. Inheritance of local thickness value at a non-axial Points from the nearest axial points.

The proposed thickness computation algorithm for fuzzy digital objects is summarized in three steps:

Step 1: Computation of the surface skeleton A of a fuzzy digital object O.
Step 2: Computation of thickness $\tau O\ (a)$ at all the axial voxels a ∈ A.
Step 3: Inheritance of thickness $\tau O(p)$ at all the non-skeletal voxels. p ∈ O – A.

IV. EXPERIMENT RESULTS

In the first step is to read the input image and then in that image we have to find out whether the bone is normal or affected. After that we need to do preprocessing steps.

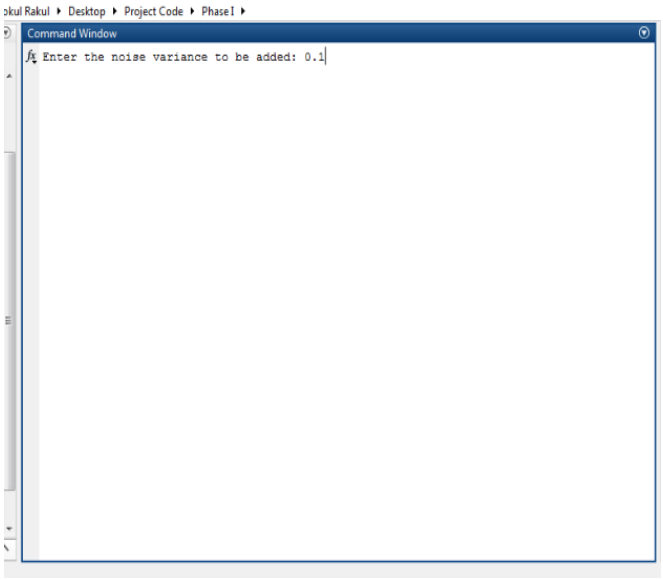

Fig.2 Insertion of variance value in Command window

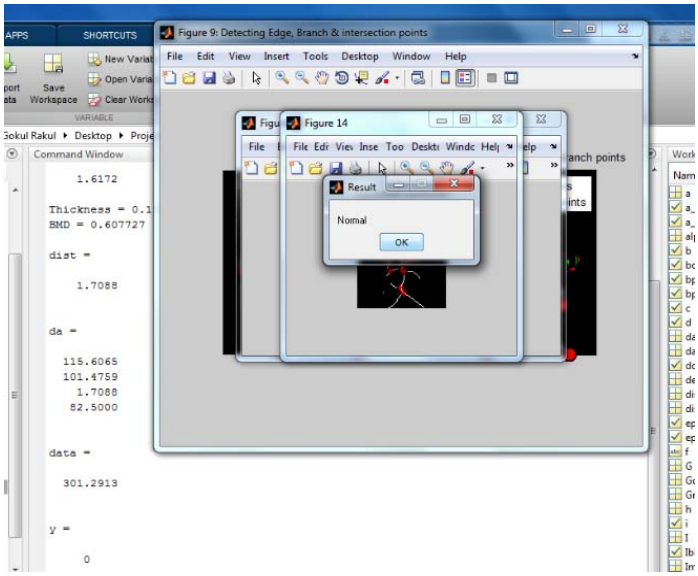

Fig.3 Result shows that the bone is normal

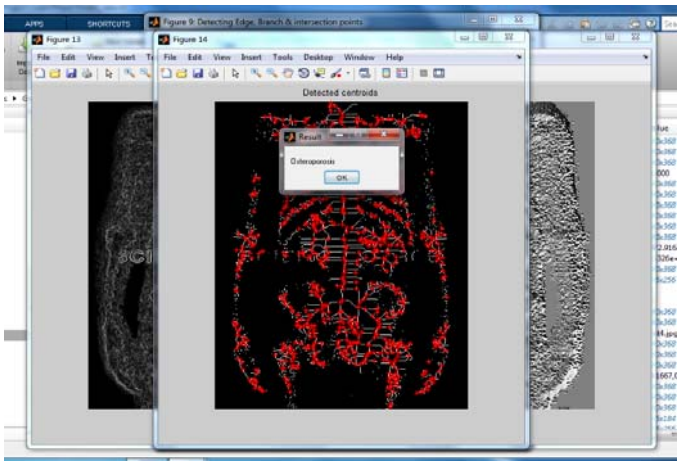

Fig.4 Result shows that the bone has osteoporosis

Fig.7 Insertion of variance value in Command window

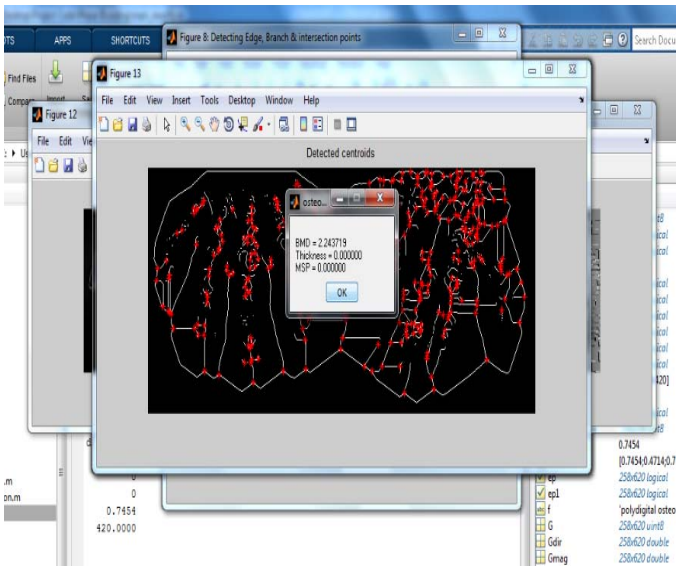

Fig.5 BMD & Thickness value

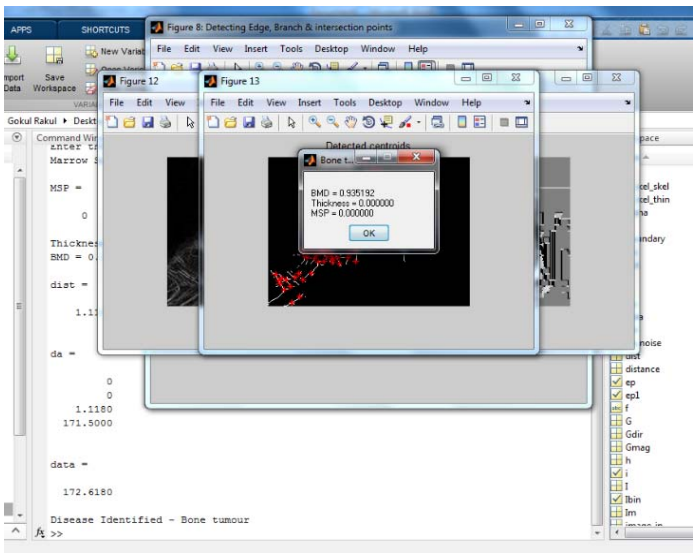

Fig.8 BMD, Thickness & MSP value

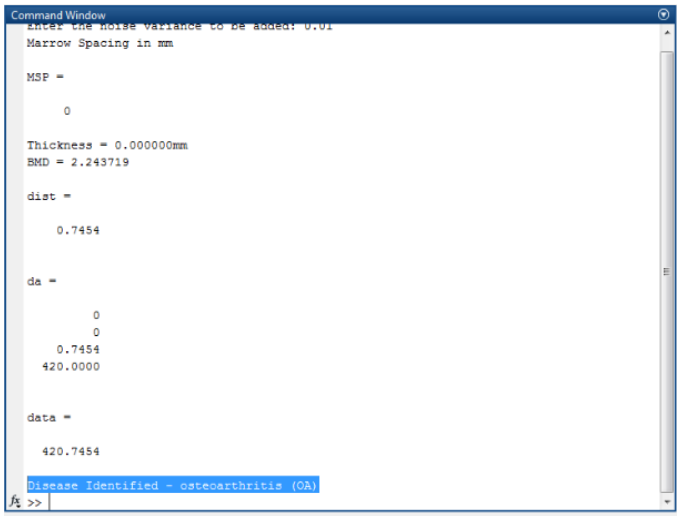

Fig.6 identification of osteoporosis

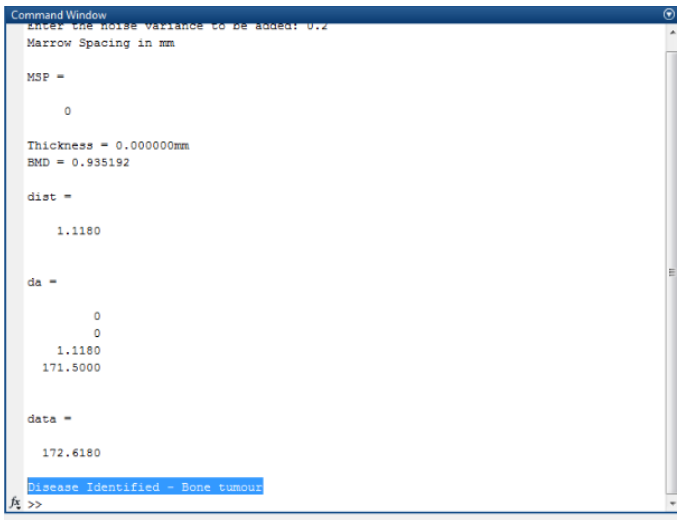

Fig.9 identification of Bone tumor

V. CONCLUSION AND FUTURE WORK

A new thickness computation algorithm for fuzzy digital objects at relatively low resolution and investigated its role in computing TB thickness and marrow spacing measures through MD-CT imaging under *in vivo* conditions. Also, high repeat MD-CT scan reproducibility of the new thickness computation method was observed in the cadaveric ankle study. Although similar differences of TB thickness and marrow spacing between males and females were observed for FDT-based measures, differences were not statistically significant.

A similar analysis using FDT-based measures marginally failed to demonstrate statistically significant differences in TB thickness and marrow spacing between and athletes and healthy matched controls. The current method demonstrates the application of the proposed method in a young population, but it has yet to be tested on an osteoporotic population.

One of possible future study is the current thickness computation method lies in the increased computation time needed to compute interpolated intensity values at multiple sample points on individual star-lines for each axial voxel. Considering the fact that the method is fully automated and it can be run on multiple images in a batch mode, the additional computation time may not be an important concern for most applications.

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REFERENCES

[1] Benito M, et al., "*Deterioration of trabecular architecture in hypogonadal men*," J Clin Endocrinal Metab, vol. 88, pp. 1497-1502, 2003.

[2] Boonen S and Singer A J, "*Osteoporosis management: impact of fracture type on cost and quality of life in patients at risk for fracture* I," Curr Med Res Opin, vol. 24, p. 8, 2008.

[3] Carolina A. Moreira Kulak and David W. Dempster," *Bone histomorphometry: a concise review for endocrinologists and clinicians*," Arq Bras Endocrinol Metab. 2010

[4] Harry K. Genant AND Jebin jiang," *Advanced Imaging Assessment of Bone Quality,*" Ann. N.Y. Acad. Sci. 1068: 410–428 (2006).

[5] Janet Golden stein and Galateia Kazakia*," In Vivo Evaluation of the Presence of Bone Marrow in Cortical Porosity in Postmenopausal Osteopenic Women*," Annals of Biomedical Engineering, Vol. 38, No. 2, February 2010.

[6] Klaus Engelke and Judith E. Adams," *Clinical Use of Quantitative Computed Tomography and Peripheral Quantitative Computed Tomography in the Management of Osteoporosis in Adults*," Journal of Clinical Densitometry, vol. 11, no. 1, 123e162, 2008.

[7] Majumdar S and Genant H.K," *Correlation of Trabecular Bone Structure with Age, Bone Mineral Density, and Osteoporotic Status: In Vivo Studies in the Distal Radius Using High Resolution Magnetic Resonance Imaging,*" journal of bone and mineral research volume 12, number 1, 1997.

[8] Punam K. Saha and Zhiyun Gao*," Topomorphologic Separation of Fused Isointensity Objects via Multiscale Opening: Separating Arteries and Veins in 3-D Pulmonary CT,*" IEEE transactions on medical imaging, vol. 29, no. 3, march 2010.

[9] Saha P K and Wehrli F W, "*Measurement of trabecular bone thickness in the limited resolution regime of in vivo MRI by fuzzy distance transform," IEEE Transactions on Medical Imaging*, vol. 23, pp. 53-62, 2004.

[10] Sherry Liu X and Henry Zhang X," *High-Resolution Peripheral Quantitative Computed Tomography Can Assess Microstructural and Mechanical Properties of Human Distal Tibial Bone,*" Journal of Bone and Mineral Research, Vol. 25, No. 4, April 2010, pp 746–756.