

Detection and Prediction of Osteoporosis using Image Processing Techniques: A Literature Review

¹Niharika Gogate, ²Katoushka Gracias, ³Prof. Prajakta Bhangale

¹Student, ²Student, ³Professor

¹Department of Information Technology Engineering,

¹Fr. Conceicao Rodrigues College of Engineering, Bandra, Mumbai, India

Abstract : Osteoporosis is a skeletal disease caused by low bone mineral density (BMD) and micro-architectural deterioration of bone tissue, leading to bone fragility and increased fracture risk. By using bone densitometer, we get the values of bone density in terms of T-score and based on T-score values bone is determined to be a normal bone or a osteoporosis/ osteopenia bone. IDEXA machines are used for obtaining accurate result and KNN Classifier algorithm together can differentiate between osteoporosis and osteopenia.

IndexTerms - Osteoporosis, Osteopenia,BMD, IDEXA, KNN Classifier.

I. INTRODUCTION

Osteoporosis is a bone disease that weakens bones making them fragile and more likely to fracture, it leads to bone injury. It develops gradually over several years, hence occurs in elderly people and is only detected due to a minor fall or sudden impact on the bone. Image processing is an essential phase in order to improve the accuracy for diagnosis procedure. A research also states that based on the scanning machines osteopenia diagnosis varies up to 28 % to 45%. For the time being, DEXA is considered as a high standard to measure BMD and osteoporosis. It is not widely available and is an expensive technique, so a more cost effective alternative should be agreed upon that does the same process. IDEXA is a breakthrough from DEXA, as it can differentiate between osteoporosis and osteopenia as IDEXA provides values that are accurate unlike DEXA.

II. PAPER SUMMARY

The paper [1] is carried out on the tibial bone to detect osteoporosis, a surgical hammer is used for this technique. The human leg is subjected to a lot of loading action due to running, walking, jumping and various activities and hence is considered as an ideal region to carry out these operations. The vibrations that were generated by the surgical hammer were collected by the accelerometer to process. ADXL 335 is a 3-axis accelerometer with signal conditioned voltage outputs.

The study of artificial neural network is used for decision making system. For computations, Feed Forward back propagation algorithm is used. Here the factors other than bone mineral density are considered for the prediction such as age, gender, height, weight, history of injury or surgery, drug history.

In paper [2] on Trabecular Bone Quality Metric from X-ray images of Osteoporosis Detection. The techniques used in this paper were X-ray Imaging and Fuzzy Expert System. The main advantage is that it is cost effective, easily accessible and a harmless osteoporosis detection technique but a major issue is that accurate values may not be detected. Bone injury and fracture due to osteoporosis can be detected using X-ray Imaging techniques. The international federation of osteoporosis reveals that there 0.26 DXA machines for million of people all over the world. DXA scan is 10 times more costlier than the normal X-ray scanning techniques. In addition to this the DXA machine gives more information about the bone quality details rather than the actual bone quality.

In paper [3] A Survey on Detection and Diagnosis of Osteoporosis, the fuzzy expert system along with some X-ray Imaging techniques was used to diagnose Osteoporosis. C 4.5 decision tree was used as a classifier for accurate diagnosis of Osteoporosis. Using MATLAB, the values of IDEXA machine were simulated and given to the KNN (k-Nearest Neighbors) Classifier algorithm. These values were further used to differentiate between Osteoporotic and Osteopenia patients. BMD (Bone Mineral Density) was used to detect Osteoporosis efficiently in women after menopause. This paper also described the rules that determine the degree of Osteoporosis by taking into consideration certain parameters like age, gender, heredity, BMI, alcohol consumption and physical stress.

In paper [4], Calibration of Osteoporosis using Artificial Neural Networks, EMG (Electromyography) was used as a tool for diagnosing Osteoporosis. It checks the muscle health and also the nerve cells that control the motor neurons which transmit electrical signals. These signals are translated by the EMG into numerical or graphical values that can be used to calibrate the bone mineral density. Further, Filtering methods were used to remove noise from the signals so as to get an accurate output value. The filtered signal values were then fed to the FEED FORWARD ANN algorithm. Based on the output that is the T-score value, the patients were classified as normal and abnormal. Abnormal was further classified as Osteoporosis and Osteopenia.

Diagnosis	T-score relative to BMD
Normal	T-score: ≥ -1
Osteopenia	$-1 > \text{T-score} > -2.5$
Osteoporosis	$\text{T-score} \leq -2.5$

Fig. 1: T-score values used for Classification of patients

In the current system [5], Detection of Osteoporosis and Osteopenia using Bone Densitometer, BMD is calculated using bone densitometer to classify the type of fracture in the bone. IDEXA (Dual Energy X-ray Absorptiometry) was used as the scanning technique. These values were fed to the KNN classifier algorithm. Several experiments were performed by taking into account three fields: T-score, age and BMD. Calculation of BMD was done for different types bones in the human body and these classifications were analyzed for differentiating between Osteoporosis, Osteopenia and Normal bone. These results proved that age and t-score were irrespective of each other. This paper also showed that apart from aged and post menopausal women, Osteoporosis is also common in sports' personalities. They are characterized into two types: weight bearing and non-weight bearing activities. The later have higher impact of Osteopenia rather than the weight bearing sports' personalities.

III. CONCLUSION

Regular X-ray can show changes in bone mineral density if the bone loss is more than 40% while, DEXA scanning technique can detect change in the density even if it is as low as 1%. In some situations, DEXA might not be able to differentiate between trabecular and cortical bone that plays an important role in measuring bone density. Also, it cannot measure bone density in people weighing more than 300 pounds. Due to these issues, IDEXA is considered to be the most accurate scanning technique as it is able to detect difference between Osteoporosis and Osteopenia very easily.

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