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A REVIEW PAPER ON PREDICTION OF OSTEOPOROSIS

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Abstract: Osteoporosis is the condition in which a low bone mass and altered micro-architecture of the bone leads to increased risk of fracture. The dynamic characteristics of bone which provides quantitative information concerning the mechanical properties of the bone along with measurement of Bone Mineral Density (BMD) can help in the early detection and better diagnosis of osteoporosis. Osteoporosis does not only depend on Bone Mineral Density (BMD) but also some other factors have significance i.e. age, weight, height, life-style etc. These all factors play considerable role to diagnosis osteoporosis. The most important concern in the medical domain is to consider the interpretation of data and perform accurate diagnosis. For accurate diagnosis of Osteoporosis many e-Health systems uses various Soft computing techniques.

Keywords: Osteoporosis, Bone Mineral Density (BMD), Fracture risk, Neural Networks, Accelerometers (ADXL 345), Bone Fracture.

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INTRODUCTION

Low bone mineral density and loss of bone tissue may lead to weak and fragile bones which are characteristics of Osteoporosis disease. This common public health problem has no symptoms and only technique available to diagnose is dual-energy x-ray absorptiometry (DEXA) scan. Generally bone mineral density (BMD) can be measured using DEXA, which is compared against the standard BMD values for diagnoses.

Osteoporosis not only depends on bone mineral density (BMD) but also on strength and characteristics of trabecular network. The formation of bone and characteristics of trabeculae depends on many factors that might be the cause of osteoporosis. These causes have significant impact on decision making of osteoporosis and fracture risk. To diagnose any medical related problem accurately, the diagnosis system has to take decisions based on multiple inputs. Achieving the goal of accurate diagnosing, the system engineers have to find the appropriate data, characteristics extraction and analysis of related medical problems.

The DEXA scan is a 'gold standard' to diagnosing osteoporosis from BMD. But the availability of DEXA machine in a country like India is a serious issue, because of its high cost and the high percentage of population living in rural areas with limited health care facilities. Nowadays different techniques used to measure bone mineral density (BMD) for diagnosing osteoporosis. The techniques such as Impulse Response Technique, Quantitative Association Rule Mining Techniques, Artificial Neural Network (ANN).

LITERATURE REVIEW

Osteoporosis is a serious health problem because of the significant morbidity, mortality, and costs of treatment. It can strike at any age but it occurs most often in older people and in women after the age of 50. According to the International Osteoporosis Foundation (IOF) , 53.9% of women after age 50 have osteopenia (pre-osteoporosis) while 28.4% have osteoporosis and 21.9% of males aged 20-89 have osteoporosis in Egypt. IOF indicates that by 2020 up to nearly 25% of the population in Middle East countries will be over 50 years old, and will grow to 40% by 2050, as a consequence the osteoporosis infection rates will be increased in the future years [20]. Osteoporosis occurs when bones lose an excessive amount of their protein and mineral content, such as calcium. Over time, bone mineral and bone strength, is decreased. As a result, bones become weak and break easily. The most common sites of osteoporotic fracture are the wrist, spine, shoulder, and hip.

One of the traditional techniques is Singh Index (SI) in which the radiograph used to determine the extent of osteoporosis. It has much to do with the patterns seen in radiographic imaging of the bones. A typical SI describes the patterns of trabeculae in the bone at the top of the femur. These patterns categorized into six different scales or grades corresponding to the degree of bone loss as, grade 6 (normal), grade 4 (osteopenia), grade 3 (osteoporosis) and grade 1 (severe osteoporosis)7. The problem with the technique is that no apparent change in the plain X-ray is seen until there is loss of about 40% of bone, which in many cases is too late [21].

In financially poor countries, due to the absence of DEXA machines, osteoporosis is diagnosed using X-Rays. Fracture risk requires that, if X ~ 3Y, the bone is deemed to be heavily osteoporotic. However, by this stage, it is too late to prescribe any medication that will reverse the disease, and the patient remains a high fracture risk candidate [5].

A WHO (World Health Organization) Scientific Group has done a lot of work to identify Osteoporosis and also tried to predict the risk. According to the report of a WHO Study Group meeting on Assessment of fracture risk and its application to screening for postmenopausal osteoporosis, osteoporosis has been recognized as an established and well-defined disease that affects more than 75 million people in the United States, Europe and Japan (1). [21].

Abdul Basit Shaikh et. al, worked on “Artificial Neural Network: A Tool for Diagnosing Osteoporosis” in which proposed system focused on use of Artificial Neural Network to detect osteoporosis efficiently[1].

Muhammad Sarim et. al, worked on “Bone Mineral Density Correlation against Bone Radiograph Texture Analysis: An Alternative Approach” in which they suggested use of x-ray radiographs to identify Osteoporosis[2].

Hui Li, Xiaoyi Li, Murali Ramanathan, and Aidong Zhang worked on” Prediction and Informative Risk Factor Selection of Bone Diseases” in which multi-tasking framework for osteoporosis that not only extracts the integrated features for progressive bone loss and bone fracture prediction but also selects the individual informative RFs that are valuable for both patients and medical researchers[3].

Walid Moudani et. al, worked on ” Intelligent Decision Support System for Osteoporosis Prediction”, in which Random Forest (RF) decision tree has been used to identify the osteoporosis cases[4].

MATERIALS AND METHODS

There are different techniques used to measure bone mineral density. Two techniques are discussed in this section are as follows:

- **Impulse Response Technique**

In this method there is no use of radiation; impulse response test [22] is used to measure BMD. The stress waves are generated in the tibial bone by the impact of impulse force hammer which are monitored by accelerometers are analyzed. Performance of this technique may not take much time. The results can be produced within few minutes. By means of storage past measured values can be obtained. Accuracy will be perfect. Children and adults with small bones, and/or very low bone density may get an accurate measurement because it can be able to identify the outline of the bones.

The experimental setup comprises an impulse force hammer and two ceramic shear type accelerometers (ADXL 345) within built charge, amplifiers. The coupler provides constant current excitation required by accelerometers and decouples the DC bias voltage from the output signal. Storage oscilloscope is used for online observation of impulse and stress wave signal. High-speed PIC 16F877A is used to digitize and acquire the impulse response data into a personal computer for further processing and analysis. The experimental setup for in vivo assessment of osteoporosis by impulse response is shown in Figure 1.

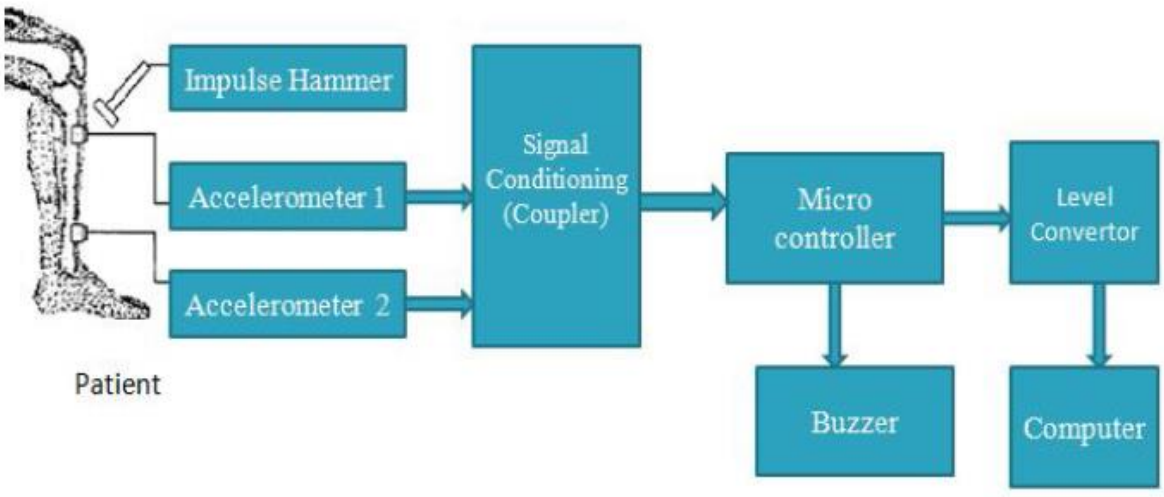

Fig.1 Schematic of experimental setup for detection of osteoporosis by impulse response technique.

- **Artificial Neural Network**

Since 1943 when McCulloch and Pitts proposed a computed neuron worked on fix weights to Donald Hebb that took variable adjusting connection weight, which is the fundamental learning rule in neural networks. Whereas, Rosenblatt first proposed the adjustable weighted perceptron model, which used perceptron learning law. The McCulloch defined the simple computational model that takes 'n' input and sum it, if the result is above a threshold then output is '1' else '0', as shown in figure-2, the system had lack of learning that latter was included by Rosenblatt.

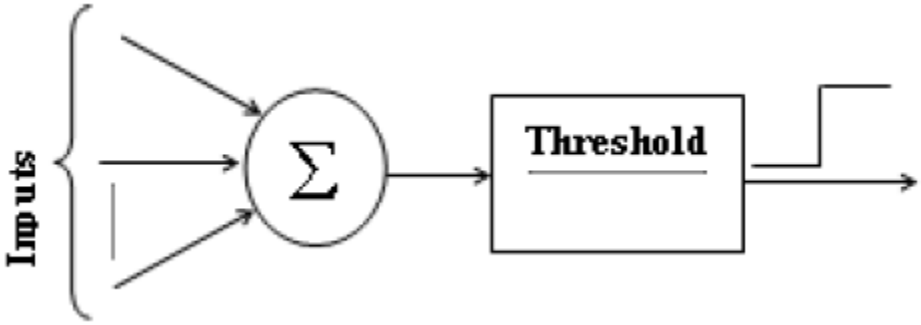

Fig. 2 McCulloch-Pitts Neuron

ANN is like a directed graph with weights, the different artificial neurons are (nodes and edges) connected to the input and output. Generally, ANN can be categories into two groups; Feed-forward networks, have unidirectional edges with no loops, and Feed-back networks, have unidirectional edges with loops for feedback connections.

In the field of medical ANN plays the vital role for diagnosis different diseases. The major work done in medical domain related to bone are; detecting bone tumor using ANN from MR images, reducing unnecessary bone scans by using ANN, and prediction of bone damages and injuries obtain by radio graphics images using fuzzy logic and ANN classification methods. These three are the major achievement of ANN application in the medical domain related to bone. Jensen et al. [23] used the DEXA values as input in ANN and predict fracture risk, the accuracy of this system is 86.6%.

CONCLUSION

This paper is based on early diagnosis and prediction of osteoporosis based on cost effective medical techniques. The aim of this paper to study different techniques such as Impulse

Response Technique, Artificial Neural Network (ANN) used to measure bone mineral density (BMD) for diagnosing osteoporosis. The impulse response technique for monitoring the stress wave propagation in tibia bone has been effectively used in the assessment of osteoporosis. The efficiency, reliability and accuracy of ANN system is used for predicting osteoporosis.

This work is expected to be useful to the government as a preventive measure against osteoporosis as well as fracture risks.

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