A STUDY ON DETECTION AND DIAGNOSIS METHODS OF OSTEOPOROSIS USING TEXTURE ANALYSIS TECHNIQUES

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ABSTRACT:

Osteoporosis is a dangerous disease and it occurs when the bone density decreases in the body. Through study on this disease, it can be understandable that the numbers of osteoporosis patients are increasing over the years, and it became common in elderly persons. And in fact, this problem is more severe in women than men, especially for the people having more than sixty years of age. Detection of osteoporosis disease in early stage may help to get rid of this disease. Various models are implemented to detect the osteoporosis disease in early stage, but many of the implementation methods are not up to the mark to produce the exact result and few of the implemented methods are failed to identify the healthy bone and the osteoporosis effected one, as all the images will be looks same for eye vision in early stage of this disease. The attack of osteoporosis, which is a serious disease, will make the bones weaker and finally leads to breakage of the bone. So, this osteoporosis disease is one of the major reason behind the bone breakage of old age people. And the results of many surveys have revealed that this disease attacked more than two hundred million people till now all over the world. And this figure is expected to increase much in near future. Another problem is we can't identify the osteoporosis through any early symptoms. We will come to know about this only when the bone gets fractured. And from there weakening of the remaining bones in the body will start and it will get fracture even when for a small stress applied. Many of the researchers have done considerable work in identification and for diagnosis of osteoporosis. In this paper, we have discussed about the recent implementation strategies in the process of osteoporosis identification. All the methods are discussed along with the advantages and disadvantages of each method.

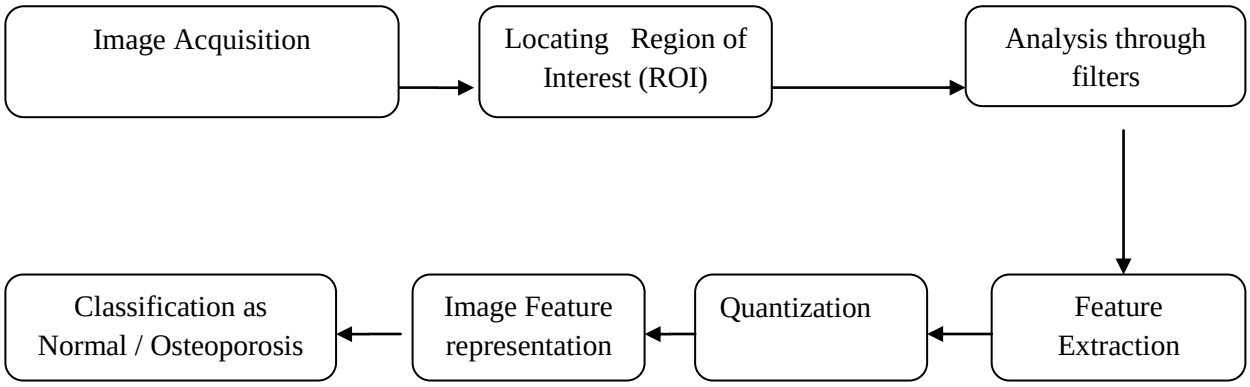
Keywords -- Osteoporosis; Thickness; Identification; Bone breakage;

1. INTRODUCTION TO OSTEOPOROSIS AND DISEASE DETECTION MODEL:

Osteoporosis is a disease due to which the problem of bone breakage increases due to insufficiency of bone strength. Therefore, the identification of osteoporosis in early stage will help us to get rid out of bone breakage by taking necessary steps of increasing bone density. Generally, the diagnosing procedure of osteoporosis is possible by measuring bone mineral density which is commonly known as BMD. And the reference standard examination procedure for BMD measurement is dual-energy x-ray absorptiometry (DXA) method. But these procedures are costly and available only in limited fashion. The above mentioned dual energy based X-ray absorptiometry methods will encapsulates the changes in the bone, using which bone density can be prepared. But, the possibility of recognition of this dangerous osteoporosis using bone mineral density is very less. The terminology known as bones trabecular structure has a crucial part and its characteristics are most required in the identification process of osteoporosis using BMD. And of course, the complete study of bone architecture may require biopsy of the bone. So, the suspected bones trabecular structure and its parameters are required to recognize the disease using BMD measurements.

The procedure of feature extraction finds application in different fields like face recognition, medical image analysis and comparison of images. Usually the healthy bones image and osteoporosis bone image looks same in 2D analysis. So, feature extraction using texture analysis can be used to identify the given image is healthy one or osteoporosis one [14]. This analysis is useful in identification of disease at an early stage. By identifying in early stage, the bone breakage can be estimated and prevention steps can be taken through exercises, food. This process may increases the bone density, and possibility of disease attack decreases. The procedure of texture analysis helps not only in identification of small variations in the internal portion of the images; it also identifies external differences of the image. But, to the best of our knowledge, the efficient automatic osteoporosis detection systems are not upto the mark. And there is a possibility of improving the efficiency of the existing models. The general model of osteoporosis detection is shown below in figure 1. As per the model, the detection system is having multiple number of steps in identification. We need to consider a input 2D image produced from X-ray, CT-scanner etc. After the image consideration, the particular portion of the input image needs to be selected for the next process. The background or the foreground in the image is not necessary for extracting the textures. Therefore, we can remove the particular portions which are not necessary and we need to consider the part of the image which is required is defined as region of interest. Then processing of the image with filters will be used.

Fig. 1: General Model for detection of Osteoporosis



Then it is necessary to extract the features from the image. The features can be extracted by using scale space, which contains linear and non-linear operators. These linear and non-linear operators will extract the maximum responses to represent the dissimilar classes of analyzed textures [1]. Then, the extracted portion of images is then converted to the digital texture based codes with the help of multi-scale based thresholding. This process is called quantization level. In final, we combine all these obtained texture codes and encode over all scales to construct the histogram of the image. In this paper, we present various existing techniques for detection of osteoporosis along with merits and demerits of each method.

2. LITERATURE REVIEW:

In paper [1], the proposed method uses texture analysis method along with optical way of approach. In this paper 14 texture features were extracted with the help of GLCM [Gray level Co-occurrence matrix] by considering optical microscopic images of insulating paper samples of various age people. Which capturing the image, there may be some brightness effects. To negotiate the effects of above mentioned brightness, here two parameters are considered. Generally using algorithm in image processing, histogram equalization is also used. And to validate the features which were extracted, extreme learning machine [ELM] algorithm which is supervised type, K-means clustering algorithm which is unsupervised type and multivariate regression were selected. K-means clustering algorithm is useful here to classify the samples of insulating papers of various ages. And finally the multivariate regression [MR] is used for predicting and verification of aged samples quality. The classification process for aging condition is done using extreme learning machine algorithm. It is observed that when ELM or ANN methods were used, the accuracy of classification is high, which is 93.3% for ELM and it is 90 % for ANN.

In paper [2], With the Digital Panoramic X-Ray Images and texture analysis, the characteristics of Dental caries were analyzed. Here two different algorithms were used to detect the dental anomalies. One part of the paper focused on innovation methodology to detect dental caries which uses hybridized negative transformation. Remaining part of the paper focused on dental images statistical texture analysis with dental caries. Texture features were extracted with the help of GLCM [Gray level Co-occurrence matrix]. Here, the characteristics of the cystic image are studied using various texture parameters like entropy, contrast, homogeneity, energy and correlation. These different features energy, entropy, homogeneity, contrast and correlation were obtained from GLCM. The above derived feature used for final result. The proposed method is tested on 10 image datasets. In this, seven images got true positive result through proposed algorithm. Final results are evaluated by two maxillofacial radiologists and found to be good to detect. It has been observed that there is no that much variation in two features (Energy and homogeneity). In this energy feature is unique and it is in the range of 7.3117 to 0.2645. Contrast and correlation lies around 0.6179 and 0.92305 respectively.

In this paper [3], for the process of texture analysis and classification, the Radon transforms histograms along with texton matrix were used. This is found to be innovative and effective procedure for the classification of texture images. To obtain co-occurrence matrix of new type, in this paper, an effective procedure introduced for the classification of texture images. For texture image classification, 20 statistical features were extracted by using co-occurrences matrix. Out of these 20 features, 7 statistical features are first – level order and 13 statistical features are second- level type. For classification procedure, SVM model and KNN algorithms were used. To get the co-occurrence matrix from TM and TOM, here dominant texture orientation and TM were used. The results obtained in proposed method are compared with 7 existing methods and proved to be good. The total analysis and classification procedure was divided as three phases. In first phase, with the use of Radon transform, the TOM and TM , the dominant texture orientation was computed to derive the co-occurrences matrix (OT_COM). For Classification process of

textures, texture features were extracted from the new OT_COM matrix.

In this paper [4], the predictive models were built with the help of text cloud technology by taking osteoporosis as an example. So, this paper presents a predictive system of osteoporosis is implemented using the text cloud mining analysis. The proposed model identifies a potential osteoporosis patient as per symptoms, status and medical records. A collection of use cases were implemented first as per collected osteoporosis patients. And the measure is computed for a person and the cases in the collection. If it is found that a person with higher matching to the case of osteoporosis, then the osteoporosis suffering chance is very high.

In paper [5], for analyzing the characteristics of Bone X- Ray, Fractional Brownian Motion and Geodesic Rao Distance were used. Now days, the diagnosis of osteoporosis has observed to be more particular and attention. The identification of osteoporosis in bone X-ray images is an important challenge in pattern recognition and medical applications. To calculate the comparability with Rao geodesic distance, the fractional Brownian motion (fBm) method and the PDF were presented in this paper for the classification of trabecular bone X-ray images. The presented model produced the expected results and synthetic images good classification was achieved when it is tested on synthetic fBm images with the Hurst parameter. With 2 different female persons who are affected with osteoporosis, one clinical survey was done on textured bone X-ray images. Here the proposed model used KNN classifier with a single parameter k. In the process of data allocation, the 10-fold cross validation model was proposed. In the proposed method, geodesic Rao distance was used for calculation of comparability between the samples. And the classification performance is measured by using ROC curves, AUC curves, FPR, FNR, Accuracy and the F1 score. To reach the good results, few parameters were tuned to choose the set which produces good accuracy in classification. The procedures were repeated for 100 times to verify. The presented model has achieved Area under Curve (AUC) rate of 97%, which is good.

In paper [6], Continuum of Colorectal Cancer for abnormal cell images prediction model using texture analysis is shown. The characteristics of continuum of colorectal cancer are calculated by 3D texture approach. By using the features extracted, type of the cell is analyzed from GLCMs. By using PCA, the chosen features were decreased in count, through which cumulative variance value is 97%.

In paper [7], a comparison to detect breast cancer with the help of LBP and LGP using texture analysis is presented. Breast cancer is a dangerous problem in USA and UK. And the death rate of the people who are suffering with breast cancer is very high. Cancer is irregular growth of cells that starts from blood tissue and tumor which are malignant or benign. By identifying the disease in early stage, the possibility of survival will increase, which in turn decreases the rate of death. Here, a comparison is taken in the approach methods to classify the mammogram based on the extracted features with the help of LBP and LGP and their histograms. Generally, these LBP and LGP methods are useful for analysis of texture pattern. By using the above pattern result and with the help of SVM classifiers, the tumors classification is performed. Initially, the preprocessing of mammogram images with the help of operations like dilation, erosion, opening, closing , top-hat transform and bottom – hat transform. By applying the morphological operations, the contrast image is obtained.

Through the final result comparison, we can observe that the accuracy of LGP is better than LBP. We can observe the reason for the above from the generated histograms. And the detection error of LGP is small in comparison with LBP. And the simplicity of computation is high in LGP in comparison with LBP.

In paper [8], texture analysis is used for detecting the infrared Myocardium on MRI. Here DEMRI procedure is used for the detection process because the manual process of segmentation is very difficult. For the characterization of infarcted myocardium, 3 different texture analyses like run length matrix, co-occurrence matrix and autoregressive model were utilized along with combination of histograms. In order to choose the discriminating features and for training the SVM classifier, 10 patients with chronic infarction were considered to evaluate. And the proposed method was also utilized for the segmentation purpose of 5 human being hearts from the STACOM DE-MRI challenge at MICCAI 2012. For comparing the segmented result with existing from STACOM dataset, dice coefficient was chosen as evaluation parameter. By using the proposed texture analysis, the dice co-efficient produced is 0.71 ± 0.12 (mean ± standard deviation) which is better results.

In paper [9], In order to improve the results of Content based image retrieval (CBIR), texture descriptors used as a comparative Study. In image processing research, choosing of the proper descriptor to perform texture analysis in CBIR is one of the demanding issues. In the process of texture analysis comparison, it allows for chosen of proper integration of descriptors for CBIR. And the descriptors like Co-occurrence matrix, Tamura technique and Log-Gabor filters are found to be good for analysis and efficient systems for CBIR. The proposed models are evaluated on 3 different texture databases. The effectiveness of the proposed model is calculated using the parameters precision and recall for CBIR. By using STex database, the effectiveness is measured as good and are close enough not exceeding 77% against 95% for Ponce Research Group and 90% for KTH_TIPS database.

In paper [10], the bone fracture identification is analyzed through real time machine learning techniques. Due to osteoporosis, which is one of the skeletal disorder, will decreases the bone mass and increases the probability of fracture in bone. The physics based approach is replaced through machine learning model to predict the average strain. The training of the model is based on synthetically generated cancellous bone anatomies database. Here, by using physics based FEA model, the target values were calculated. The effectiveness of the proposed method is analyzed through comparison of predictions with physics-based approach on other test data set. The correlated values of machine learning analysis against physics based approach were resulted as good (0.842, $p < 0.001$).The Average execution time[AET] was decreased by a factor of 300, in comparison with physics based method, which leads to average strain real time assessment. In FE model by using machine learning approach, AET decreased around 0.01 ± 0.005 seconds from 32.1 ± 3.0 seconds.

In paper [11], MRI Texture Analysis application for Posterior Fossa Tumors Growing Trend is discussed. In order to do analysis and identification of three kinds of brain tissues, tumor region, tumor diffusion region and normal brain tissue region, various texture analysis models utilized. This helps in the study of posterior fossa tumor for children and shows assistant basis for the treatment or surgery of

tumors. Texture features were extracted from the patient's tumor MRIs. In order to analyze the feature space, CFS (for feature selection) and PLSR (partial least squares regressions) were used. Finally, various classification models applied and the results of classification prove that proposed texture analysis is good.

In paper [12], with help of texture analysis, treatment of kidney microanatomy is presented. To monitor the status of kidney, quantitate analysis is used along with texture analysis of OCT images. In paper [13], a survey work on detection and diagnosis of osteoporosis is presented. To identify osteoporosis, the process of BMD calculation is discussed after the ROI selection. In paper [14], the early osteoporosis identification for radiographic images of bone has used 2D texture analysis model. The images were taken from university D'orleans, which consists of 87 radiographic images of bone and 87 with pathology. For the classification procedure, feed forward neural network had been used achieved 97% sensitivity.

In paper [15], texture parameters of 1st order were utilized for early detection of osteoporosis. Different parameters were calculated for X-ray images of osteoporosis and normal bone. The derived results show that the proposed model is good. The accuracy of 6 images out of 9 is correctly diagnosed with 66.66% accuracy. And 8 images out of 9 are correctly diagnosed with 88.88% accuracy.

3. COMPARISON TABLE:

Ref. paper No.	**Name of the Author**	**Published year**	**Feature Extraction**	**Classification**	**Results**
1	Shuaibing Li, Guoqiang Gao, Guangcai Hu	*2017*	GLCM-optical way of approach	ELM or ANN	93.3% for ELM and it is 90 % for ANN
2	*Veena Divya K., A. Jatti, R. Joshi and Deepu Krishna S.*	2017	Hybridized negative transformation and GLCM	---	Energy feature is in the range of 7.3117 to 0.2645
3	*C. Di Ruberto*	2017	Radon transforms histograms	SVM model and KNN	Compared with 7 existing methods and proved to be good
4	*S.T. Chang, H.W Huang,*	2016	Text cloud mining analysis	--	Higher matching suffering is very high

5	*M. E. Hassouni, A. Tafraouti,*	2017	Fractional Brownian Motion	KNN classifier	Area Under Curve (AUC) rate is 97%
6	*Ahmad Chaddad, Camel Tanougast*	2017	3D texture approach and GLCM	---	Cumulative variance value is 97%.
7	*N.Ponraj, Poongodi*	2017	LBP and LGP and their histograms	SVM classifier	simplicity of computation is high in LGP in comparison with LBP
8	*A. Larroza, M. P. López-Lereu,*	2017	DEMRI procedure	--	Dice co-efficient produced is 0.71 ± 0.12
9	*K. Zekri, A. G. Touzi and Z. Lachiri*	2017	Co-occurrence matrix, Tamura technique	--	Effectiveness is 77% against 95% for Ponce Research Group
10	*C. F. Ciuşdel, A. Vizitiu,*	2017	Machine learning model to predict the average strain	---	correlated values resulted as good (0.842, $p < 0.001$)
11	*M. Li, Z. Shang, Y. Dong, Y.*	2017	CFS and PLSR	---	Results of the proposed model is good
14	*Kavya R , Dr.Joshi Manisha Shivram*	2015	2D texture analysis model	Feed forward neural network	Achieved 97% sensitivity
15	*Dr.Pravin G.U , Vamsha Deepa , Abrar Ahmed*	2017	Texture parameters of 1st order were utilized	----	8 images out of 9 are diagnosed with 88.88% accuracy.

4. CONCLUSION & FUTURE SCOPE:

Osteoporosis is a serious disease which affects the life of human being, for those who are suffering with less bone density. In case if we detect this at an early stage, and then there may be chance to recover. In order to evaluate the osteoporosis, mostly BMD calculated with the help of dual energy X-ray absorptiometry. But problem is, the possibility of disease identification in this BMD calculation procedure is very less because the above method captures the bone fracture variation in moderate way. So, for detailed analysis, 2D structural analysis method can be used, but both the healthy bone and osteoporosis bone looks same in this procedure. So, texture extraction of 2D images need to be performed. This texture analysis procedure is good not only in recognizing the internal small variations of the images, but also it identifies the external variations in the image. Texture analysis method works even if the image is rotated, illumination change occurred or any changes in the formation of the image. The transform features of the osteoporosis image need to be extracted to represent the shape of the texture and the difference between them. So, texture analysis helps in early identification with efficient manner. Various existing methods in texture analysis is discussed and compared in this paper. We can understand that still there is lot of scope to improve the efficiency / accuracy in the identification procedure of osteoporosis. In future work, we plan to work on various methods to counter the above discussed issues in the process of early detection of osteoporosis.

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