Development of Fracture Detection System using Classification Technique

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Abstract: *we are highlighting in this paper on longitudinal bone femurs texture based feature combinations, BPNN classification method to for the fracture detection system. As the need in medical diagnosis features day by day new solutions are designed for solving fracture classification and other issue in bones. In this work we have used the femur bone x-ray images for classification. Feature combinations of texture based MRF and Gabor features are used. The combinations of these features are used in classification process. Finally, Back propagation neural network (BPNN) was used to classify the database.*
Keywords: *BPNN, Diagnosis, Femur bone, Fracture.*

I. Introduction

The Many people around the world face the problems with the bone for different reasons. As per the WHO and osteoporosis foundations the problems for the longitudinal bone will increase in next decades. One of the longitudinal bone, femur gets problem of cracks due to various reasons. There are various types of cracks occurs in the in the bone, there detection and diagnosis are the challenging tasks performed by clinicians and radiologists. Clinicians, orthopedic surgeons, radiologists suggest that patients have to take x ray images of the bones for diagnosis purpose. This process is manual, time consuming, and suffers patient if proper diagnosis is not made. A tired clinician, radiologist can miss a suspected case, it causes patient to suffer problems of bone, time, money etc.

The IOF, WHO suggest that problems of bone can increase as the population grows rapidly in next decades. Now a day's radiology going to be digital so digital image is part of the diagnosis process for the fractures in the bones. So we propose the computer aided diagnosis using image classification methods which will improve the diagnosis process by automatically screening the suspected cases for the clinicians. We have to develop an automated system so that it can help clinicians, orthopedic surgeons, radiologists and assure patient for proper diagnosis.

II. Problem Specification

Many people suffer from bone fractures worldwide. The international Osteoporosis Foundation [1] reported that, worldwide, woman has 30%-40% lifetime risk of getting osteoporotic fractures while men have a lower risk of 13%. Osteoporosis occurs in a condition when bone losses minerals, such as Calcium and Phosphate [2]. The number of hip fractures could rise from 1.7 million worldwide in 1990 to 6.3 million by 2050. The most dramatic increase is expected to occur in Asia during the next decades. World Health Organization confirms that osteoporosis is second only to cardiovascular diseases as a leading health care problem [1]. X-ray technology is being increasingly employed for the clinical diagnosis and remedies in recent years [3]. Image enhancement, is to improve the visual effects and purposeful emphasis the whole or part characteristic of the graphics in the designated applications to enlarge the difference between the different objects in the graphics [4]. X-ray imaging is a transmission-based technique in which X-rays from a source pass through the patient and are detected either by film or an ionization chamber on the opposite side of the body; Contrast in the image between different tissues arises from differential attenuation of X-rays in the body [5].

In clinical practice, doctors and radiologists in large hospitals have to visually inspect x-ray images containing healthy bones, a tired radiologist has been found to miss a fractured case among the many healthy ones. A computer vision system can assist the doctors by screening the x-ray images for obvious cases and flagging suspicious cases for closer examinations. A non destructive detection system based on X-ray for grocery check, thickness measure, wire ropes conveyer belt, the measure of the density of bone, and customs inspection, is designed by using X-ray detection technology [6].

Automated screening of x-ray images can thus help to reduce the radiologist's workload and direct the doctor's attention to suspicious cases to improve the timeliness and accuracy of their diagnosis. Clinicians,

Orthopedic Surgeon expect that automated tool is required for analysis of x–ray images so that suspicious cases may not miss and improves clinician's performance in diagnosis. Therefore, such a computer vision system is extremely useful for clinicians and is now feasible because all clinical radiology is going digital. Digital x-ray images are now routinely captured using digital x-ray machines [7]. Fractures of a bone can occur in many ways. As such, no one single method can accurately detect all kinds of bone fractures.

III.   Literature Survey

The international Osteoporosis Foundation reported that, worldwide, woman has a 30%-40% lifetime risk of getting osteoporotic fractures while men have a lower risk of 13%. The number of hip fractures could rise from 1.7 million worldwide in 1990 to 6.3 million by 2050. The most dramatic increase is expected to occur in Asia during the next decades. World Health Organization confirms that osteoporosis is second only to cardiovascular diseases as a leading health care problem [1].

Medical Author Benjamin C. Wedro et al., state that diagnosis of a fracture includes a history and physical examination. X-rays are often taken. Occasionally, CT or MRI is used to find an occult or hidden fracture or provide more information regarding the damage to the bone and adjacent tissues [8], [9], [10]. To find hidden fracture a more accurate visualization is needed so that diagnosis can be done properly. The children fracture is so hard to visualize.

Sapthagirivasan V., in his paper proposes a segmentation of femur bone based on principal component model (PCM). The PCM is an analysis of principal component along with shape and appearance model of an object. Principal Component Analysis (PCA) is mostly used as a tool in exploratory data analysis and for making predictive models. An active shape model segmentation scheme is presented that is steered by optimal local features in the original formulation [11]. PCA tool is useful for identifying fractures before diagnosis.

S.K. Mahendran et.al in their paper state that, bone x-ray images are complex in nature and the output of segmentation algorithm is affected due to various factors like partial volume effect, intensity in homogeneity, presence of noise and artifacts and Closeness in gray level of different soft tissues [12]. There are internal or external melodies which affect the x-ray images so care must be taken to store them properly. Affected x-ray image must be improved.

Douglas, Tania S. et al. suggests that, X-Ray helps in Early Detection of Fractures with Low-Dose Digital X-Ray Images in a Pediatric Trauma Unit. Low dose x –ray images has the application to represent the early detection of fracture so that human error can be minimized by clinicians [13].

Ron Jenkins et.al, they suggest that in X-Ray, Astronomy x-ray is useful for visualize the images of astronomy and finding the smaller area in study of astronomical objects [14]. X ray is useful for finding astronomical objects as well as related thing so that a closer study may be possible.

Ying chen1et al. in their paper suggest that extraction of bone contours from x-ray images is an important first step in computer analysis of medical images. It is more complex than the segmentation of CT and MR images because the regions delineated by bone contours are highly non uniforms in intensity and texture [15]. Bone extraction needs to find the fractures in the diagnosis process where decision can be taken to perform operation on it.

M P Deshmukh et al., in their paper gives that there are various methods that can be used to classify x-ray images. The study proposed to be more efficient with single classifier [16]. The classifiers like support vector machine, naïve bay's gives good results compare to other classification techniques.

IV.   Proposed Methodology

The proposed work carried out on X-ray images of femur bone collected from online database like radiopaedia.org, e-radiography.net, Image processing place. Regional database of femur x-ray images collected from imaging centers, clinicians and radiologist i.e. Lifeline Hospital, Renu Hospital, Deshmukh Hospital, Gurukrupa Diagnostics center, Tirupati Diagnostics center, Disha Diagnostics center, Beed (MS) India. The femur x-ray image database was approved from orthopedic doctors, radiologists for testing and training. There was collection of 500 femur x-ray images collected for testing, out of these images, 270 were femur bone images with fractures and rest were normal femur x-ray images. Two hundred and seventy eight fractured femur x-ray images and 230 from normal femur x-ray images were used during training.

The proposed methodology includes different steps; the flow of working is as shown in fig 1. First step involve acquiring the digital x-ray images, preparing their sets for training and testing. Then the images preprocessed to enhance their quality using filtering methods. The noise removal process gives enhanced images, which were used to find the ROI of images using segmentation.

Based upon the techniques of feature extraction different features like shape, texture, GLCM and statistical feature are used for further processing. The features like Energy, Contrast, Correlation, Sum of square, Inverse difference moment, Sum Average, Sum Variance, Entropy, Sum Entropy, Difference Variance, Difference entropy, Measures of Correlation, Maximal Correlation coefficient etc. the GLCM feature are also

measured. Next step involves the classification of the images, using classification methods, which results the image has suspected case or not i.e. fractured or non-fractured.
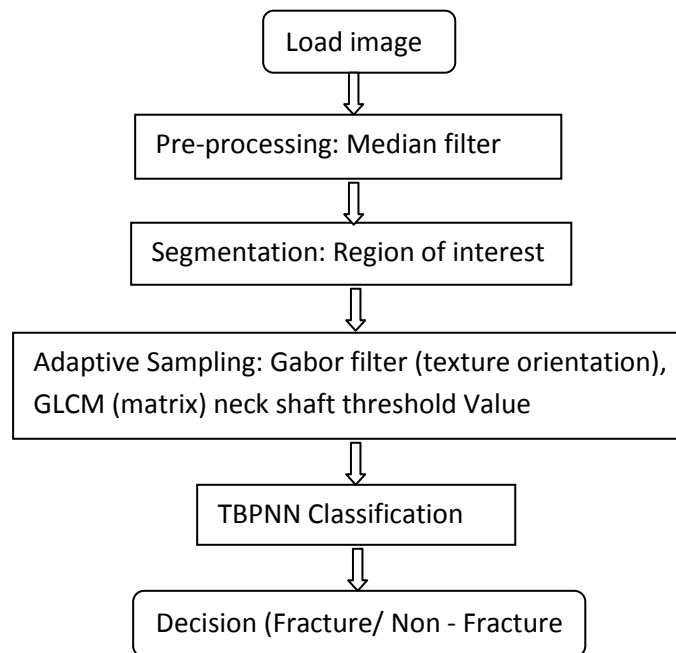
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┌─────────────────┐
│   Load image    │
└─────────────────┘
         ⇓
┌─────────────────────────────┐
│ Pre-processing: Median filter │
└─────────────────────────────┘
         ⇓
┌─────────────────────────────────┐
│ Segmentation: Region of interest │
└─────────────────────────────────┘
         ⇓
┌──────────────────────────────────────────────┐
│ Adaptive Sampling: Gabor filter (texture orientation), │
│ GLCM (matrix) neck shaft threshold Value       │
└──────────────────────────────────────────────┘
         ⇓
┌─────────────────────┐
│ TBPNN Classification │
└─────────────────────┘
         ⇓
┌──────────────────────────────────────┐
│ Decision (Fracture/ Non - Fracture    │
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Figure 1: Methodology flow Steps

The proposed methodology is represented in three steps as shown below.

4.1 Preprocessing and Segmentation

This was the first step, where following steps are performed during experimentation,

Algorithm steps:

Step1   Acquire the digital image

Step2   Convert to grayscale image

Step3   Apply Median filter for noise removal

Step4   Segment the image for finding the ROI

Medical images are converted from one to another, such as digitizing, transmitting, scanning etc., some form of noise occurs at the output. So it is necessary to remove the noise using the various Noise Removing Techniques. As per the literature studied median filter is one of the best techniques for the x-ray image enhancement. Median filter has been implemented for x-ray image enhancement and the set of original images and enhanced images has been stored.

For the "optimal" enhancement of femur bones apply the median filter and find the ROI of x ray image from the input image using segmentation methods and add the responses of median filter for visualization.

4.2 Feature Extraction

The bone and the skin were expected to have different textures. It is one of the phase under which the different feature form the images are extracted for diagnosis purpose. The feature like Intensity Features, Shape Features, Texture Features, and Statistical Features can be measured for bones. The features that are commonly used in bone diagnosis are shape and texture features.

4.2.1   Texture Features

Texture Feature is used to measure random texture. Here the measures are based upon the moments of a joint PDF (Probability Density Function) that is estimated as the joint occurrence or co-occurrence of gray levels known as gray level co-occurrence matrix (GCM), also known as spatial gray-level dependence (SGLD) may be computed for various orientations and distances as, Energy, Contrast, Correlation, Sum of square, Inverse difference moment, Sum Average, Sum Variance, Entropy, Sum Entropy, Difference Variance, Difference entropy, Measures of Correlation, Maximal Correlation coefficient. These features were measured and used to train and test classification with TBPNN classifier.

4.3 Classification (Texture based Back-propagation Neural Network (BPNN) Classifier)

The number of types of ANNs and their uses is very high. An ANN which learns using the back propagation algorithm for learning the appropriate weights is one of the most common models used in NNs, and many others are based on it. The back-propagation algorithm is used in layered feed-forward ANNs. This means that the artificial neurons are organized in layers, and send their signals "forward", and then the errors are propagated backwards [17].

The back-propagation algorithm uses supervised learning, which means that if the inputs to the algorithm and outputs of the network are provided and then the error (difference between actual and expected results) is calculated. The idea of the back-propagation algorithm is to reduce this error, until the ANN learns the training data.

The activation function of the artificial neurons in ANNs implementing the back-propagation algorithm is a weighted sum (the sum of the inputs multiplied by their respective weights). The most commonly used activation function is sigmoidal function, since this allows a smooth transition between the low and high output of the neuron. The goal of the training process is to obtain a desired output when certain inputs are given. Since the error is the difference between the actual and the desired output, the error depends on the weights, and there is a need to adjust the weights in order to minimize the error. The back-propagation algorithm calculates how the error depends on the output, inputs, and weights. Then the weights can be adjusted using the method of gradient descent [17].

The TBPNN classifiers performance measured as fracture detection rate and the classification accuracy with the texture feature as shown in table1.

Table 1: Fracture Classification and Detection rate

Features	Classifiers	Classification Accuracy	Fracture detection rate
MRF features	Texture based BPNN	98.80%	100%
Gabor Features	Texture based BPNN	100%	100%

The classification of fracture with Gabor feature is good than the MRF features. The texture based Back propagation neural network classifier performs better with Gabor features.
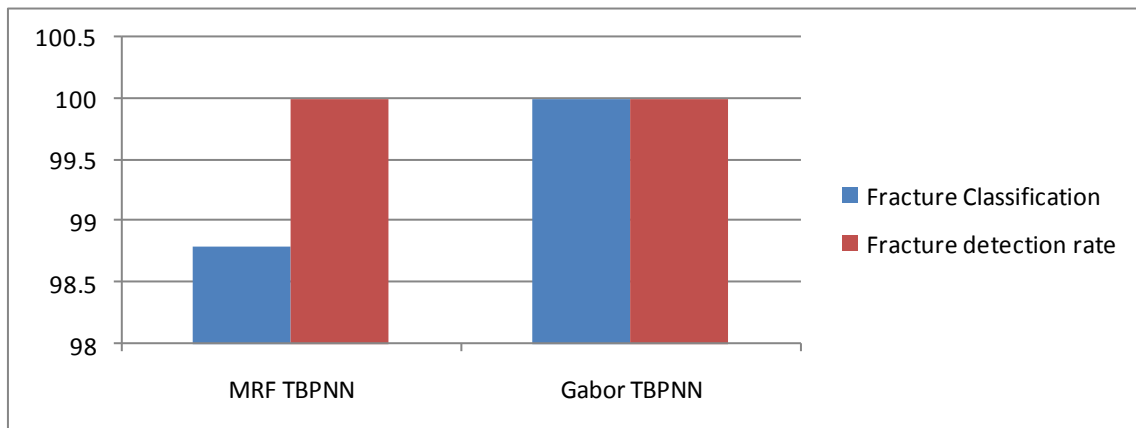
Graph 1: Result Analysis

1.4 Result Analysis:

According to the observations TBPNN classifier with Gabor feature produce better fracture detection results i.e. 100% and the classification accuracy is 100%. The Individual classifiers fracture detection rate and classification accuracy shown graphically for table 1 in Graph1. The graph1 also shows that with MRF features the TBPNN classification technique gives 98.80% classification result, where as the fracture detection rate was100%. The error rate in classification with MRF feature is 1.2%.

V.   Conclusion

Fracture detection and classification from x ray images is an important step in clinical practice in order to identify the crack area in a bone of a patient and minimize the error during the search and much more. Proposed methodology gives 100% classification and 100% fracture detection rate for the given database. In future as a researcher, I will further work to improve the same by using other classification techniques and making fusion of them to improve results.

Acknowledgements

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