Texture Analysis and Fracture Identification of Bones X-Ray Images using K-Means

S. Sri Dharshini[1], S. Rajasekar[2], S. Sneha[3], G. Vigneshwari[4], M. Nikitha[5]

[1,2,3,4]Department of Computer Science and Engineering, Info Institute of Engineering, Coimbatore, TamilNadu, India
[5] Assistant Professor, Department of Information Technology, Info Institute of Engineering, Coimbatore, TamilNadu, India

---

Abstract - *The bone fracture is a common issue in human beings that occurs due to heavy pressure which is applied on bone or simple accident and also due to osteoporosis and bone cancer. In this process, X-ray/CT images are used for bone fracture analysis. The aim of this project is to develop an image processing based efficient system for a quick and accurate classification of bone fractures based on the information gained from the x-ray / CT images. Images of the fractured bone are obtained from hospital and processing techniques like pre-processing, feature selection, feature extraction, classification methods are adopted. The processed images will be further classified into fractured and non-fractured bone and compare the accuracy of different methods. Results obtained demonstrate the performance of the bone fracture detection system with some limitations and good accuracy of 90%.*

Key Words: Bone fracture, noise removal, feature selection, feature extraction, GLCM, K-Means Clustering.

1. INTRODUCTION

Bones are the solid organs in the human body protecting many important organs such as brain, heart, lungs and other internal organs. The human body has 206 bones with various shapes, size and structures. The largest bones are the femur bones, and the smallest bones are the auditory ossicles. Bone fracture is a common problem in human beings. Bone fractures can occur due to accident or any other case in which high pressure is applied on the bones. There are different types of bone fracture occurs are oblique, compound, comminute, spiral, greenstick and transverse. There are different types of medical imaging tools are available to detecting different types of abnormalities such as X-ray, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), ultrasound etc. X-rays and CT are most frequently used in fracture diagnosis because it is the fastest and easiest way for the doctors to study the injuries of bones and joints. Doctors usually uses x-ray images to determine whether a fracture exists, and the location of the fracture. The database is DICOM images. In modern hospitals, medical images are stored in the standard DICOM (Digital Imaging and Communications in Medicine) format which includes text into the images. Any attempt to retrieve and display these images must go through PACS (Picture Archives and Communication System) hardware.

2. EXISTING SYSTEM

In existing techniques, there are several algorithms were developed for bone fracture detection. In this context a detailed overview of the literature is presented with papers by Vijaykumar V et al. presented a filtering algorithm for Gaussian noise removal [1]. First estimating the amount of noise from the noisy image, then replace the centre pixel by the mean of the sum of the surrounding pixels based on a threshold value. Compared to other filtering algorithms such as mean, alpha-trimmed mean, Wiener, bilateral and trilateral, this algorithm gives lower Mean Absolute Error (MAE) and higher Peak Signalto-Noise Ratio (PSNR). Zain, M. L. et al. addressed the problem of image enhancement and speckle reduction using filtering technique [2]. The following step is feature extraction method. Chan, K.-P et al. proposed a method of feature selection by using three different methods such as wavelet and curvelets transform [3]. The highest accuracy value was given by Haar compared with other two methods. Tian, T. who proposed for fracture detection in femur bones which is based on measuring the neck-shaft angle of the femur. Chai, H. Y. et al proposed the GLCM based method is proposed to segment the x-ray image of the bone regions from the soft tissue regions [4]. Authors start with pre-processing techniques such as binary conversion and edge detection techniques. In this work, it is tried to automatic classification of bone fracture using image processing methods based on information gained from X-ray/ CT images with good accuracy and first time tried to all the types of bone fracture without concentrate on particular type of fracture. And also tried for CT images with some limitation.

Disadvantages in existing system:

- Difficult to get accurate results.
- They are not applicable for multiple images for bone images in a short time.

3. PROPOSED SYSTEM:

Fractures can be able to detect automatically take advantage x-ray images performed by using feature selection and extraction methods. Feature Selection helps to analyse the features such as texture, compositions and so on. Feature Extraction allow us to know existence and location of fracture with x-ray images. This research can be applied Gray Level Co-Occurrence Matrix (GLCM) and SVM Algorithm for analyzing the texture of bones images. And also K-Means algorithm is used, the clustering concepts are used for the better analysis of the bone images. The GLCM feature extraction process results an image characteristic with four parameters, such as Contrast, Correlation, Energy, and Homogeneity. They are done before the steps for identification of fractured or non-fractured (normal) bones. Hao, S. et al. proposed an automatic segmentation method of in x-ray hand images [5]. The results accuracy texture analysis of bones x-ray images using GLCM Feature Extraction Method, SVM and K-Means Algorithm is 85 percent.

Advantages:

- K-means clustering are much faster than multilayer due to their clusters.
- Bone image will be detected in an early stage.
- It responsible for extracting structural features.
- It also establishes textural features.

4. SYSTEM ARCHITECTURE:

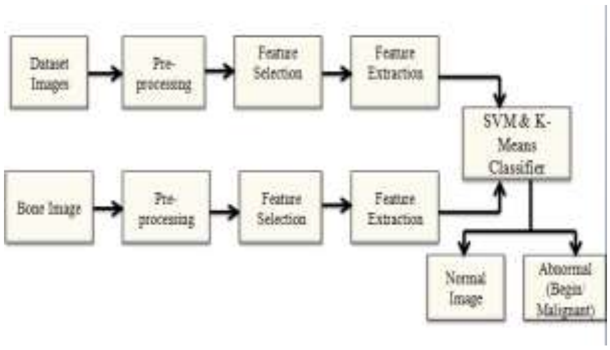

Fig -1: system architecture.

The system architecture consists of six entities they are bone x-ray images, Pre-processing, Feature Selection, Feature Extraction, Classification and Output Images. First, bone images are given as input and then pre-processed using DWT. The feature will be differentiated and chosen. And then features will be extracted using GLCM. Also, SVM classifiers are used along with the K-Means Clustering algorithm. Later, the results will be normal or abnormal.

5. ALGORITHM/TECHNIQUE USED:

1. Enhancement and Compression Techniques.
2. Discrete Wavelet Transformation (DWT).
3. Gray Level Cooccurrence Matrix (GLCM).
4. Support Vector Machine (SVM).
5. K-Means Clustering Algorithm.

Algorithm Description:

A. Enhancement and Compression Techniques

In Pre-Processing step, there are two techniques are used such as Enhancement and Compression Techniques. Enhancement technique are used to boost up the pixel value in the image. Compression technique are used to decrease the pixel value in the image. Here, mostly the noised image will be processed into denoised image.

B. DWT (Discrete Wavelet Transformation)

In this Feature Selection step, DWT (Discrete Wavelet Transformation) algorithm is used that is mainly used to convert spatial domain into frequency domain. Discrete wavelet transform (DWT) is a spectral evaluation approach used for studying non-desk bound information, and affords time-frequency representation of these information. Since facts contains non-desk bound traits, DWT have been extensively used for studying facts. DWT uses long term home windows at low frequencies and quick time windows at high frequencies, main to good time–frequency localization. DWT decomposes a sign into a set of sub-bands through consecutive excessive-bypass and coffee-pass filtering of the time domain. The high-skip filter out, g is the discrete mom wavelet at the same time as the low-pass filter, h is its replicate model. The downsampled alerts through first filters are referred to as first stage approximation, A1 and detail coefficients, D1. Then, approximation and detail coefficients of next stage are received through the usage of the approximation coefficient of the previous degree. The wide variety of decomposition ranges is decided depending at the dominant frequency components of the statistics. Scaling feature, /j,k(x) based on low skip filter and wavelet feature, wj,ok(x) based totally on high skip filter.

In DWT algorithm, there are four frequency sub bands such as LL, LH, HL, HH (where L denotes Low and H denotes High). Assuming that LL sub band is taken and that LL sub band has again four sub bands (like LL, LH, HL, HH). LH and HL sub bands are the nearer to perfect pixel values. By using these frequency sub bands we can able to calculate the energy and entropy values.

C. GLCM (Gray Level Co occurrence Matrix)

In this Feature Extraction step, GLCM (Gray Level Co occurrence Matrix) algorithm is used. Feature extraction is the main step in various image processing applications. Gray Level Co-occurrence Matrix isused for feature extraction and sel ection. GLCM was defined by Haralick in 1973.GLCM is main tool used in image texture analysis. Textures of an image are complex visual patterns that are composed of entities or regions with sub patterns with the characteristics of brightness, colour, shape, size, etc [7]. GLCM is a statistical way to indicate image texture structure by statistically sampling the pattern of the grey levels occurs in relation to other grey levels. We use the Gray Level Co-occurrence Matrix (GLCM) method to extract textural features such as entropy, contrast, correlation, homogeneity.

The Gray Level Co-occurrence Matrix (GLCM) method is a way of extracti ng second order statistical texture features [6]. A GLCM is a matrix where the number of rows and columns is equal to the number of gray levels, G, in the image. The matrix element P (i, j | Δx, Δy) is the relative frequency with which t wo pixels, separated by a pixel distance (Δx, Δy), occur within a given neighbourhood, one with intensity 'i' and the other with intensity 'j'. The matrix element P (i, j | d, ɵ) contains the second order statistical probability values for changes between gray levels 'i' and 'j' at a particular displacement distance d and at a particular angle (ɵ). Using a large number of intensity levels G implies storing a lot of temporary data, i.e. a G G matrix for each combination of (Δx, Δy) or (d, ɵ). Due to their large dimensionality, the GLCM's are very sensitive to the size of the texture samples on which they are e stimated. The results can be displayed on the screen.

D. SVM (Support Vector Machine)

Classifying data is a common task in machine learning Suppose some given data points each belong to one of two classes, and the goal is to decide which class a new data point will be in. In the case of support vector machines a support vector machine constructs a hyperplane or set of hyperplanes in a high- or infinite-dimensional space, which can be used for classification, regression, or other tasks like outliers detection.

Atmost, a good separation is achieved by the hyper plane that has the largest distance to the nearest training-data point of any class (so-called functional margin), since in general the larger the margin the lower the generalization error of the classifier.

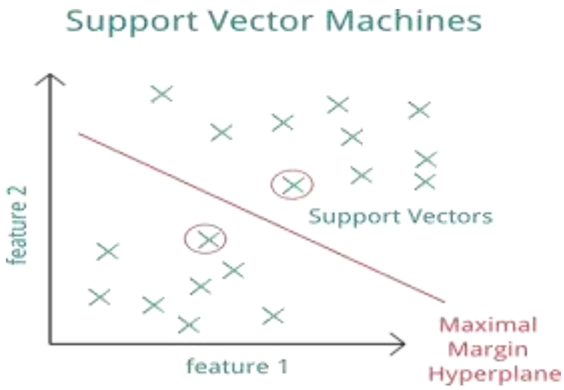

Fig -2 : support vector machine (SVM).

Whereas the original problem may be stated in a finite dimensional space, it often happens that the sets to discriminate are not linearly separable in that space. For this reason, it was proposed that the original finite-dimensional space be mapped into a much higher-dimensional space, presumably making the separation easier in that space. To keep the computational load reasonable, the mappings used by SVM schemes are designed to ensure that dot products of pairs input data vectors may be computed easily in terms of the variables in the original space, by defining them in terms of a kernel function. The hyper planes in the higher-dimensional space are defined as the set of points whose dot product with a vector in that space is constant, where such a set of vector is an orthogonal (and thus minimal) set of vectors that defines a hyper plane. The vectors defining the hyper planes can be chosen to be linear combinations with parameters. The fact that the set of points mapped into any hyper plane can be quite convoluted as a result, allowing much more complex discrimination between sets which are not convex at all in the original space.

E. K-Means Clustering

Clustering is a process of grouping data objects into disjointed clusters so that the data in the same cluster are similar, but data belonging to different cluster differ. A cluster is a collection of data object that are similar to one another are in same cluster and dissimilar to the objects are in other clusters. The demand for organizing the sharp increasing data and learning valuable information from data, which makes clustering techniques are widely applied. Cluster analysis is a tool that is used to observe the characteristics of cluster and to focus on a particular cluster for further analysis [8].

The simplest K-Means algorithm is as follows [9]:

- Input D = {d1, d2, d3, ... dn} where set n of number of data points K and K is the number of the desired clusters.
- Output: A set of cluster K
  1. Select k points as initial centroid.
  2. Repeat the step 1.
  3. From K cluster by assigning each data point to its nearest centroid.

4. Recompute the centroid for each cluster until centroid does not change.

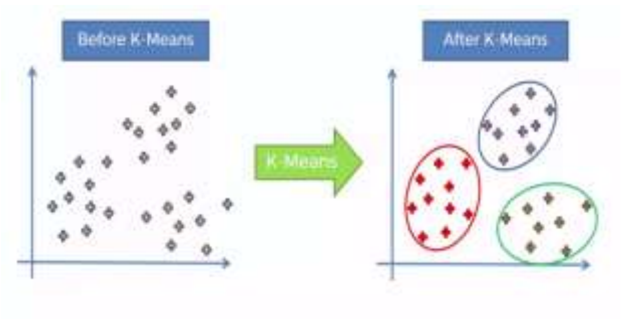

Fig -3 : K-Means Clustering.

6. IMPLEMENTATION:

a) Image training: As the first step of the process, datasets will be collected that is fractured and non-fractured X-ray images. Then the images will be trained in the system. After that these images can be ready for the further processing.

b) Pre-processing: After the images are trained, the second step will be the pre-processing. Here, the noise removal process is done by using the enhancement and compression techniques. As the result of this process, we will get the denoised images.

c) Feature Selection: After the images are preprocessed, the third step will be the feature selection. The features will be trained in the early stages. The features are like texture, composition and so on. And by using the DWT algorithm, these features will be selected.Then these images will be sent to the extraction process.

d) Feature Extraction: In the feature extraction process, the above processed images will be given as the input of this step. And by using the GLCM algorithm, the features will be extracted by changing the gray scale images in this process. The results are entropy, contrast, correlation, homogeneity. These outputs will be given to the classification step.

e) Classification: In the classification process, the SVM (Support Vector Machine) algorithm is used and also K-Means clustering is also used. SVM classifier is used for differentiating the features of the image. And the K-Means clustering process is used for grouping up the similar features together to find the better results of the image. By using these processes, it is able to obtain the results whether it is normal or abnormal, it also provides the percent of 90.

7. CONCLUSION:

A computer based analysis techniques for the detection of bone fracture using X-ray/CT images has been presented in this work. It starts from the preprocessing to remove the noise by using enhancement and compression techniques. After the feature selection process, the area of the fracture is calculated. The method has been tested on a set of images and results have been evaluated based on GLCM features. And by using the SVM classifier along with the K-Means clustering algorithm, the results can be displayed and accuracy of this method was 90%. It is fully implemented to CT images and also classify the type of fracture is occurs in the future works.

REFERENCES

[1] Vijaykumar, V., Vanathi, P., Kanagasabapathy, P. (2010). Fast and efficient algorithm to remove gaussian noise in digital images. IAENG International Journal of Computer Science, 37(1).

[2] Zain, M. L. M., Elamvazuthi, I., Begam, M. (2009). Enhancement of bone fracture image using filtering techniques. The International Journal of Video and Image Processing and Network Security, 9 (10).

[3] Chan, K.-P., Fu, A. W.-C. (1999). Efficient time series matching by wavelets. Data Engineering. In: Proceedings, 15th International Conference on, p. 126– 133. IEEE.

[4] Chai, H. Y., Wee, L. K., Swee, T. T., Hussain, S. (2011). Glcm based adaptive crossed reconstructed (acr) k-mean clustering hand bone segmentation. p. 192–197.

[5] Hao, S., Han, Y., Zhang, J., Ji, Z. (2013). Automatic isolation of carpal-bone in hand x-ray medical image. In Informatics and Management Science I, p. 657–662. Springer.

[6] A.V. Manjari, G.S.N.S.Ajay Kamal, U.N.Subhadra Devi, Dr.M.Satyanarayana, "Detection and classification of Bone Fractures Using GLC Features", IJRASET, September 2017, vol.5, Issue 9, pp 581-586

[7] Lu Ming, "Image Segmentation algorithm research and improvement", IEEE, August 2010, vol.5, pp 211-214.

[8] J. Yadav and M. Sharma, "A Review of K-mean Algorithm," Int. J. Eng. Trends Technol., vol. 4, no. 7, pp. 2972–2976, 2013.

[9] U. R. Raval and C. Jani, "Implementing & Improvisation of K-means Clustering Algorithm," Int. J. Comput. Sci. Mob. Comput., vol. 5, no. 5, pp. 191–203, 2016.