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Fuzzy Based Classification of X-Ray Images with Convolution Neural Network

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ABSTRACT

Nowadays technology is changing from day to day in almost all fields, that too much in the medical field. There are some techniques that are still continuing for a long time due to their popularity and their robustness. One among them is X-ray which is used for detecting the fractures in a bone. In some rural areas where the medical facility is poor it very difficult to have sufficient orthopaedics for treatment. Hence a computerized effective and robust X-Ray image classification technique is proposed which is the initial step for fracture detection. In this work a combination of high boost filtering technique, Fuzzy C means clustering, Statistical feature extraction technique along with different kinds of classifiers like Support Vector Machine (SVM), Convolution neural network, and Back-Propagation neural network (BPNN). A detailed comparison is done with the accuracy rates with all classifiers where the Convolution neural network gives an accuracy rate of 94.2% when compared to other neural networks. Hence Convolution neural network (CNN) is considered

Key words: X-Ray, CNN (Convolution neural network), Support Vector Machine (SVM), Backpropagation neural network(BPNN)

1. INTRODUCTION

Medical imaging is growing day-to-day life. Advancement in medical field leads to the penetration into the body and further used for detecting abnormalities in the body. Among the available MRI, CT, X-Ray techniques re popular in use. Among the available options X-Rays are mostly used due to its low cost compare to CT Scan and MRI Scan. X-Rays images are very popular in medical field in case of accidents or any traumas in a human body. It is necessary to automate the classification and further detection of fractures as it helps in taking immediate decisions for the orthopaedicians. For detecting the fractures in a bone it is very necessary to classify what kind of X-Ray image it is .in case of Computer Aided Detection (CAD) of fractures. This is the reason it has become the initial step as classification of X-ray image. For classification of X-Ray images a dataset of totally 2000 X-Ray images are collected from the NRI Medical Hospital, Department of Orthopaedics, Guntur, where 400 images are of skull,400 images are of Leg,400 images are of hand,400 images are of chest, and remaining 400 are neck. Detailed architechture of medical imaging is presented in the figure.1.

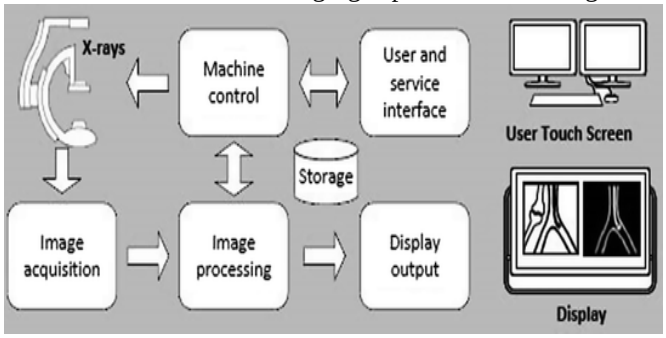

Figure 1: Image processing concept

2. LITERATURE SURVEY

Splits which occur due to any mishap is a bone fracture. Overall many kinds of bone fractures are there among them spiral, segmented, impacted, avulsed, oblige[1,2]. Mostly X-Ray images are segmented by using methods like Canny edge detection, Sobel Edge Detection, Roberts[3-6].[4]It is mentioned that among various segmentation or a clustering technique Canny Edge detection technique performs better[7].K-Means clustering is another clustering technique that performs well in image segmentation[8]. Fuzzy C Means is a clustering technique that adds better clustering as it adds membership function [9]. Weighted C means clustering is also another kind of clustering technique that adds in better performance of the system [10]. Statistical feature are the best feature extraction techniques [10]. Classification of type of image aids an orthopedic. For classifying the X-Ray images, Local binary patterns along with the Random Forests are used[10]. For segmentation purpose kernel weighted C-Means clustering and also the automatic segmentation correctness is proposed [11]. Fuzzy based X-Ray classification is proposed [12]. For classifying x-ray images texture feature extraction technique is proposed [13].

3. PROPOSED METHODOLOGY

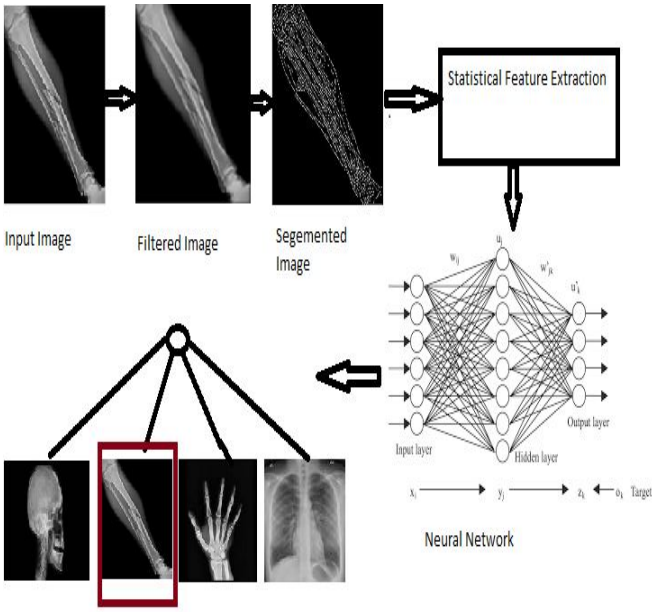

Figure 2: Architecture of proposed methodology

Figure 2 shows the architecture of proposed methodology where input image is given as input to the system and it is pre-processed first in order to remove the noise from the image. [14]Then the pre-processed image is fed as input for segmentation. Then from the segmented image statistical features are extracted which are given for training the classifiers[15].

3.1 High Boost Filtering

High boost filtering has a special characterization. It not only emphasized the high-frequency components but also it preserves the low-frequency components.[16] This makes to apply the high boost filtering for reprocessing. Here in the proposed work high boost filtering is applied for preprocessing as its gives more PSNR value.

$$I_{hb} = I_o + c\,I_{hp} = (W_{ap} + c\,W_{hp}) * I_o = W_{hb} * I_o$$

Where c is a constant.

$$W_{hb} = W_{ap} + cW_{hp} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} + c \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & -c & 0 \\ -c & 4c+1 & -c \\ 0 & -c & 0 \end{bmatrix}$$

$$W_{hb} = W_{ap} + cW_{hp} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} + c \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix} = \begin{bmatrix} -c & -c & -c \\ -c & 8c+1 & -c \\ -c & -c & -c \end{bmatrix}$$

3.2 Fuzzy c means

Data can be made belongs to the 2 or more clusters using FCM(Fuzzy C Means).Membership functions are added to this and this makes FCM to work more for clustering when compared to other clustering techniques.

1. $$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^{m} \left\| x_i - c_j \right\|^2 , \quad 1 \le m < \infty$$

$$u_{ij} = \frac{1}{\sum_{k=1}^{C} \left(\frac{\left\| x_i - c_j \right\|}{\left\| x_i - c_k \right\|} \right)^{\frac{2}{m-1}}} , \qquad c_j = \frac{\sum_{i=1}^{N} u_{ij}^{m} \cdot x_i}{\sum_{i=1}^{N} u_{ij}^{m}}$$

This iteration will stop when $\max_{ij} \left\{ \left| u_{ij}^{(k+1)} - u_{ij}^{(k)} \right| \right\} < \varepsilon$, where ε is for the termination criterion in between the values 0 and 1,whereas the k is used for looping. When there are 2 or more clusters are to be to be done fuzzy works better

3.3 Statistical Feature Extraction

For classification purpose some features are to be extracted here statistical features are taken .[17] Some of the statistical features here taken are kurtosis, entropy, and skewness, median.

4. RESULTS AND DISCUSSION

From a dataset of totally 2000 X-Ray images are collected from the NRI Medical Hospital, Department of Orthopaedics, Guntur, where 400 images are of skull out of which 200 are used for training and 200 are for testing,400 images are of Leg out of which 200 used for testing and 200 are used for training,400 images are of hand out of which 200 are used for testing and 200 used for training,400 images are of chest out of which 200 are used for training and 200 are used for testing, and remaining 400 are neck out of which 200 are used for training and 200 are used for testing.Table.1 represents performance evaluation of CNN classifier and fig.3 shows the statistical representation of CNN Classifier[18].

Table 1 : Performance evaluation of CNN

Class	Accuracy	Specificity	Sensitivity
Head	94	90	89
Leg	95	91	90
Hand	93	88	87
Chest	93	90	92
Neck	94	89	90

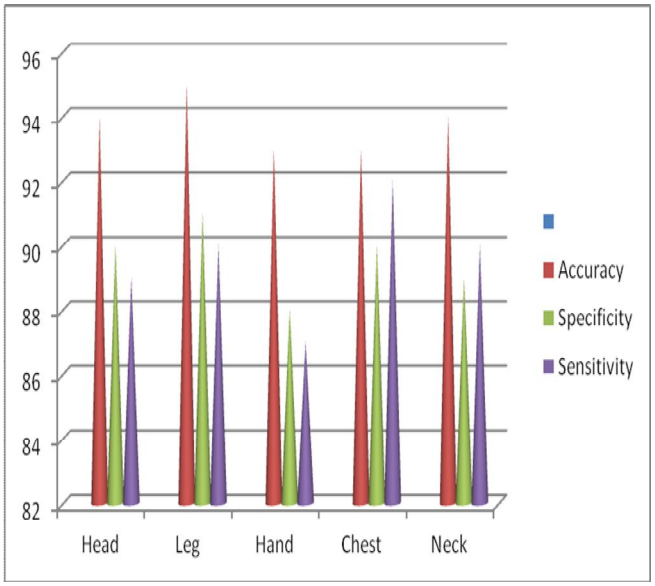

Figure 3 : Performance of classification using CNN

Table.2 represents performance evaluation of SVM classifier and figure.4 shows the statistical representation of SVM Classifier.

Table 2: Classification evaluation using SVM

Classification evaluation of SVM			
Class	Accuracy	Specificity	Sensitivity
Head	90	88	87
Leg	89	89	88
Hand	87	86	85
Chest	89	88	90
Neck	87	86	89

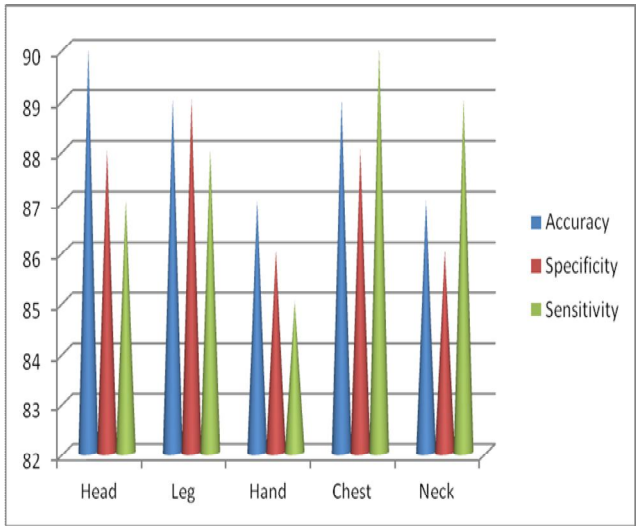

Figure 4 : Performance of classification using SVM

Table.3 represents performance evaluation of BPNN classifier and figure.5 shows the statistical representation of BPNN Classifier.

Table 3: Classification evaluation using BPNN

Classification evaluation of BPNN			
Class	Accuracy	Specificity	Sensitivity
Head	88	87	86
Leg	86	88	86
Hand	85	84	83
Chest	89	87	89
Neck	85	86	89

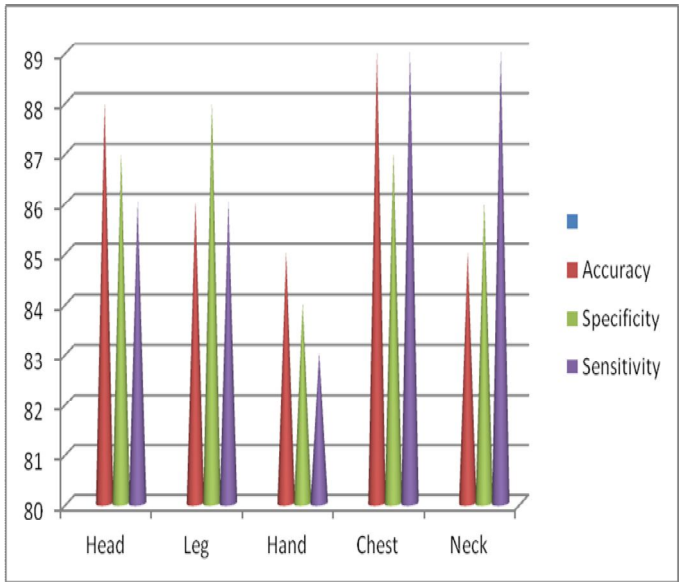

Figure 5: Performance of classification using BPNN

5. CONCLUSION

Hence a proposed methodology works better compared to other classifiers.CNN proved to be best among the results in terms of accuracy when compared to other classifiers like SVM and BPNN. the accuracy rates with all classifiers where the Convolution neural network gives an accuracy rate of 94.2% when compared to other neural networks like BPNN and SVM. Hence Convolution neural network(CNN) is considered.

6. FUTURE WORK

This work can be extended to fracture detection of bone using X-Ray images. Main purpose of classification of X-ray images is some works might be only for long bone Fracture detection and some might be only for curve bone fracture detection only. In this manner Classification of X-Ray images works as essential factor for fracture detection of bone using X-Ray images.

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