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Bone Tumour detection Using Feature Extraction with Classification by Deep Learning Techniques

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Article History	***Abstract***
Received: 22 January 2020 Revised: 14 April 2020 Accepted: 19 May 2020	The majority of early deaths worldwide are attributed to a group of diseases known as bone cancers, which are characterised by unchecked cell development. This research propose novel technique in detection of bone cancer based on feature extraction and classification using deep learning architectures. Here the input has been processed and segmented for noise removal, image resize and smoothening. The features has been extracted using Convolutional histogram of oriented gradients (CHOG) and ROI extraction is used to improve the accuracy identification of abnormal part around the affected region. Then to classify the exact spotting and to grade the bone tissue as normal and abnormal using extreme Convolutional Deep learning machine (ECDLM). The results of the classification performance show that the neural network has a 92.50% success rate in classifying bone tumours. Keywords: Bone cancer, deep learning, CHOG, ROI extraction, DC-ELM.

1. Introduction:

Bone cancer is seen as a complex condition that can be brought on by a variety of genetic and physiological factors. By identifying and diagnosing the kind and stage of cancer early on and beginning the proper treatment, the death rate can be decreased [1]. In the human body, bone cancers of various sorts have been found. Sarcomas are another name for bone malignancies [2]. The process of segmenting an image involves dividing it into different areas and then taking the relevant information out of each region. Healthy cells are where a bone cancer begins to develop into a tumour. As a result, the surface of a malignant bone appears rough. A doctor must manually identify bone cancer, which adds time and the potential for error [3].

2. Related works:

Researchers have conducted related studies in this area to create an automated system to help a doctor. Automated systems are quick and have low error rates. algorithm for machine learning An automated method has been developed using SVM and digital image processing techniques, pre-processing, edge detection, and feature extraction [4,5]. In the other study, [5] created an automated method for human bone diagnostics. To prevent bias performance, k-fold cross validation can be performed. The GLCM function has been employed by [6,7] to locate broken bones. The hog feature in photos provides the pixel's shape and orientation. To distinguish between healthy and malignant bones, [7,8] combined a number of methods and textural factors [9,10].

3. Proposed Methodology:

This section discuss the proposed technique in bone cancer detection. The pre-processing, feature extraction, training, and testing phases make up the proposed system. Anisotropic diffusion filter (ADF) is first used to filter the bone MR image provided as an input to the system, and connected component labelling is then used to segment the filtered picture. Then to extract features using Convolutional histogram of oriented gradients (CHOG) and ROI extraction is used to improve the accuracy identification of abnormal part around the affected region. The extracted features has been classified to locate exact spotting and to grade the bone tissue as normal and abnormal using Deep Convolutional extreme learning machine (DC-ELM). The overall proposed architecture is shown in figure-1.

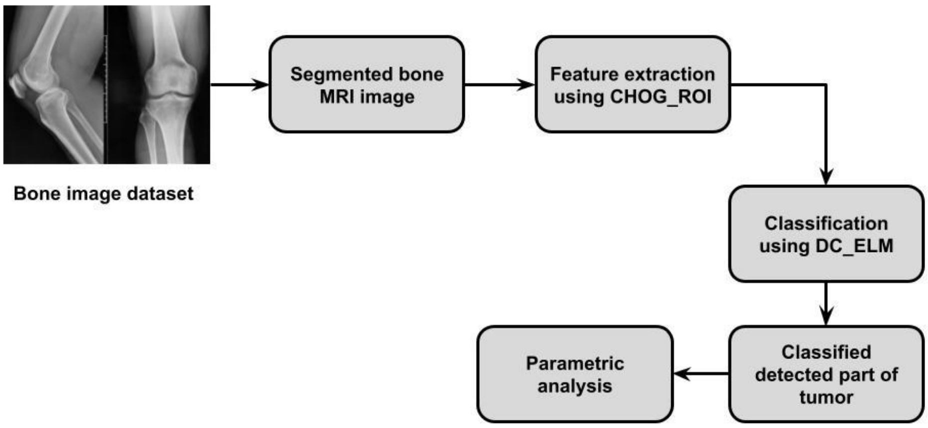

Figure-1 Overall Proposed architecture

3.1 Extraction of tumor features using Convolutional histogram of oriented gradients (CHOG) and ROI extraction:

By creating a local histogram of the picture, the CHOG (Convolutional Histogram of Oriented Gradients) feature extraction approach may extract features from every position of the image. We can finally locate the HOG derived image by swiping 1616 cells across the entire image. Image gradient calculates the intensity change. In mathematics, the derivatives with respect to x and y can be used to calculate the gradients for a two-dimensional function f(x, y). The gradient can be calculated as follows for the pixel location (x, y)eq. (1):

$$G_x = I(x+1, y) - I(x-1, y)$$

$$G_y = I(x, y+1) - I(x, y-1) \qquad (1)$$

Applying the center-surround operation to these Gaussian pyramids will yield the intensity and colour saliency feature maps. As described by Siagian and Itti, the center-surround operation is as follows [8, 23]. Six intensity feature maps may be obtained from (2), and twelve colour feature maps can be obtained byeq. (2)

$$I(c,s) = |I(c) \odot I(s)|,$$
$$RG(c,s) = |(R(c) - G(c)) \ominus (G(s) - R(s))|. \qquad (2)$$

34 saliency feature maps are produced in total, including six for intensity, twelve for colour, and sixteen for orientation. Six intensity gist feature vectors, twelve colour gist feature vectors, and sixteen orientation gist feature vectors made up the 34 gist feature vectors. A 544-dimension feature vector is created by adding together all of the gist feature vectors. Therefore, this 544-dimension feature vector can be used to represent each building image.

3.2 Deep Convolutional extreme learning machine (DC-ELM) based classification:

We can distinguish between two main CELM usage groups based on the primary studies: I studies that employ a CNN for feature extraction and the ELM for quick learning using the extracted features, and (ii) studies that employ the ELM for quick training of CNN architectures. Large amounts of data can be used to train a deep CNN model, and the learned model can be used as a pretrained model. Using a training set from a certain database, the pretrained model parameters are adjusted. The testing makes use of this refined model. An ELM-based classifier is utilised in the suggested system. The ELM is a shallow network with various benefits, including quick learning, simple convergence, and reduced randomness. The output weight vector, abbreviated as, which joins the hidden layer to the output layer is Nh × No, where No is the quantity of output classes. The following is the ELM's output by eq. (3):

$$f(\mathbf{x}_i) = h(\mathbf{x}_i)\alpha, i \in \{1{:}N_h\}.$$
$$\min_{\alpha} \parallel \boldsymbol{\alpha} \parallel_F^2 + \rho \sum_{i=1}^{N_h} \|\mathbf{e}_i\|^2$$
$$\left[u_\ell^{fg}\right]_n := \left[h_l^{fg} * x_{\ell-1}^g\right]_n = \sum_{k=0}^{K_{l-1}} \left[h_l^{fg}\right]_n \left[x_{\ell-1}^g\right]_{n-k} \qquad (3)$$

The l-th layer features, however, are calculated by aggregating the intermediate features, ulfgassociated with each of the xl1 g, in the previous equation after the convolutions have been evaluated (4).

$$u_\ell^{fg} := \sum_{g=1}^{F_{\ell-1}} u_l^{fg} = \sum_{g=0}^{F_{\ell-1}} h_l^{fg} * x_{\ell-1}^g \qquad (4)$$

4. Experimental analysis:

In the proposed work, two experiments—one with hog feature sets and the other without—were carried out using the random forest and SVM machine learning models. The models' effectiveness is further assessed using 5-fold cross-validation.

The Indian Institute of Engineering Science and Technology, Shibpur (IIEST) and The TCIA are two providers of the publicly accessible data sets for study on the bone X-ray picture (Cancer Imaging Archive).

4.1 Confusion matrix for cancer detection using proposed method:

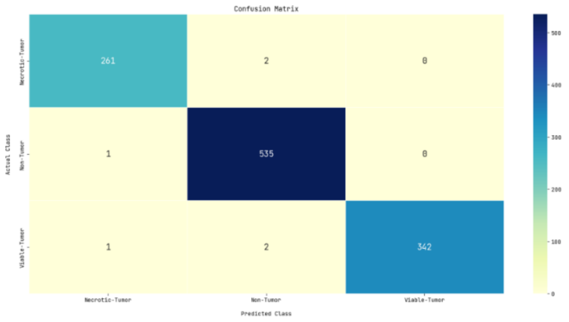

Figure-2 Confusion matrix

The above figure-2 represents confusion matrix for proposed bone cancer detection techniques based on deep learning. Here the confusion matrix has been taken for predicted class and actual class of bone cancer detection. The table-1 shows overall parametric comparison based on tumor classes.

Table-1 overall parametric comparison based on tumor classes

Tumor class	Accuracy	Sensitivity	Specificity
Necrotic-Tumor	0.9965	0.9924	0.9977
Non-Tumor	0.9956	0.9981	0.9934
Viable-Tumor	0.9974	0.9913	1.0

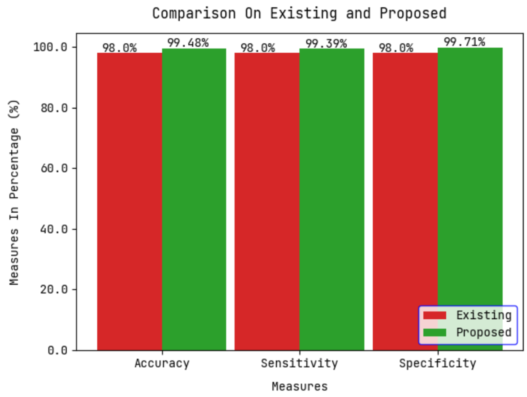

Figure-3 Overall parametric comparison

The above figure 3 shows overall parametric comparison in terms of accuracy, sensitivity and specificity. The accuracy obtained by proposed technique is 99.48%, sensitivity obtained is 99.39% and specificity obtained is 99.71%. the ROC curve has shown in figure-4.

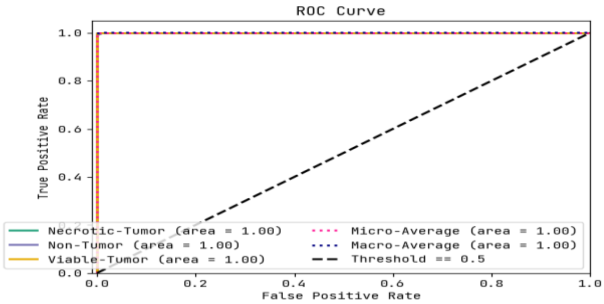

Figure- 4 ROC curve for proposed technique

5. Conclusion:

The suggested approach combines feature extraction with a classification model to identify and classify the liveliness of malignant and healthy bones. The noise is eliminated using a median filter with a 3x3 pixel size. This research propose novel technique in detection of bone cancer based on feature extraction and classification using deep learning architectures. Here the input has been processed and segmented for noise removal, image resize and smoothening. The features has been extracted using Convolutional histogram of oriented gradients (CHOG) and ROI extraction is used to improve the accuracy identification of abnormal part around the affected region. Then to classify the exact spotting and to grade the bone tissue as normal and abnormal using Deep Convolutional extreme learning machine (DC-ELM). The results of the classification performance show that the neural network has a 92.50% success rate in classifying bone tumours.

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