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BONE CANCER IDENTIFICATION USING RANK CORRELATION BETWEEN TWO INTERVAL VALUED INTUITIONISTIC FUZZY SETS

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Abstract:

Bone tissues are sometimes affected by different stress, pressure which leads to form the tumor in the bone that is called as the bone malignant. The developed bone cancer is diagnosed by using the various screening methodologies, image processing and soft computing technologies. At the time of this screening process, it consists of different risk such as swelling, weaken risk, night swears, chills that is difficult to identified in the bone tumor starting stage. So, in this work focuses to detect the bone tumor in the beginning stage by utilizing the Rank correlation between Two Interval Valued Intuitionistic fuzzy Sets method. Initially the bone images are captured and noise, inconsistent data is removed by using the median filter. Then the affected part is segmented with the help of the proposed method and region features are extracted. After that the extracted features are classified using the above proposed Rank correlation between Two Interval Valued Intuitionistic fuzzy Sets approach. At last the efficiency of the system is evaluated with the help of using experimental results in terms of the accuracy, sensitivity and specificity.

Key Words: Bone Malignant, Swear Symptoms, Swelling, Bones Weaken Risk, Rank Correlation Between Two Interval Valued Intuitionistic Fuzzy Sets.

1. Introduction:

As per the overview of the national foundation in the United States led in the year 2016, 1490 people groups are passed on because of the bone tumor which has been broke down from 3300 cases [1]. The bone disease is one of the threatening tumors that happen in the bone which has been partitioned into two structures, for example, essential and auxiliary bone growth in which the essential malignancy happened in the bone cells, though the optional bone tumor occurred in the entire body [2]. These diseases are produced because of the different issues, for example, injury, aggravation, irregular development of the tissues exhibit in the bone and anomalous improvement different changes which is occurred in the age of 30 [3]. A portion of the bone tumors showed up in the germ cells of the bone which is situated in the tailbone. The accompanying figure 1 demonstrates that the essential and auxiliary influenced some portion of the bone malignancy. The bone malignancy has a few side effects, swelling, bone shortcoming, weight reduction, mass felt, fever, night sweats and chills [4]. These indications are occurred because of the accompanying reasons, for example, leading standard radiation treatment, history of paget's infection, innate retinoblastoma, hereditary conditions and umbilical hernia [5]. Along these lines the genuine bone disease has been distinguished and determined to have the assistance of a few screening philosophies, for example, MRI image, CT scan and X-rays. Among the few screening process, X-rays set a critical part because of the precision likewise it identifies the disease from the earliest starting point development of the tumor cell [6].

Figure 1: Sample Structure of Bone Cancer

Depending on the above processing techniques, the bone tumor has been detected by applying the mathematical process along with the image processing techniques. Thus, the image processing techniques such as Gaussian filter, median filter, non-local median filter is applied for removing the noise present in the captured image. After that the particular affected region is segmented by using the mathematical techniques such as fuzzy

set approach, probability metrics, Bayesian methods are used. From the derived region, again statistical features are extracted by applying the image processing techniques such as Fourier transform, wavelet transform and so on. Then again mathematical approach is used to recognize the particular bone tumor related features successfully. According to the above discussions few authors discussing about the bone cancer detection process. Mallikarjunaswamy et al.,) [7] enhancing the bone break location rate up to 85% by utilizing the image handling strategies. Creator at first caught the X-ray or CT image which is encouraged into the image handling ideas, for example, preprocessing, division, edge discovery, include extraction and acknowledgment prepare. The picture preparing based bone break location framework perfection is analyzed utilizing the MATLAB 7.8 apparatus. The viability of the framework is additionally enhanced by applying the streamlining methods. Shikha Agrawal et al., 2015[8] recognizing the abnormal growth of tissues in bone by utilizing the neural systems in different medicinal research regions, for example, radiology, urology, oncology and cardiology. The neural system expends the component from the past element extraction organize which is prepared with the assistance of the different enactment work. At that point the prepared elements are perceived utilizing the successful coordinating procedure. At that point the effectiveness of the framework is assessed by utilizing the MATLAB trial comes about. The author created framework guarantees the powerful tumor identification venture alongside that it is more practical additionally created framework exceptionally easy to use when contrasted with the other customary classifiers. Depending on the discussions, the bone cancer has been identified using the fuzzy based [9] mathematical image processing technologies using from the bone cancer images. The detailed derivation of the bone cancer processing methodologies is discussed in the following sections. Then the rest of the section organized as follows, section 2 analyzes elaborate mathematical explanation of the Rank correlation between Two Interval Valued Intuitionistic fuzzy Sets approach and working definition. Section 3 discussing the proposed bone cancer detection process using the Rank correlation between Two Interval Valued Intuitionistic fuzzy Sets method. Section 4 examining the efficiency of the proposed system and concludes in section 5.

2. Proposed Bone Cancer Detection Process Using the Rank Correlation Between Two Interval Valued Intuitionistic Fuzzy Sets:

The next process is bone cancer detection which is done by using the Rank correlation between Two Interval Valued Intuitionistic fuzzy Sets. Then the processing steps of the bone cancer identification process are shown in the figure 2.

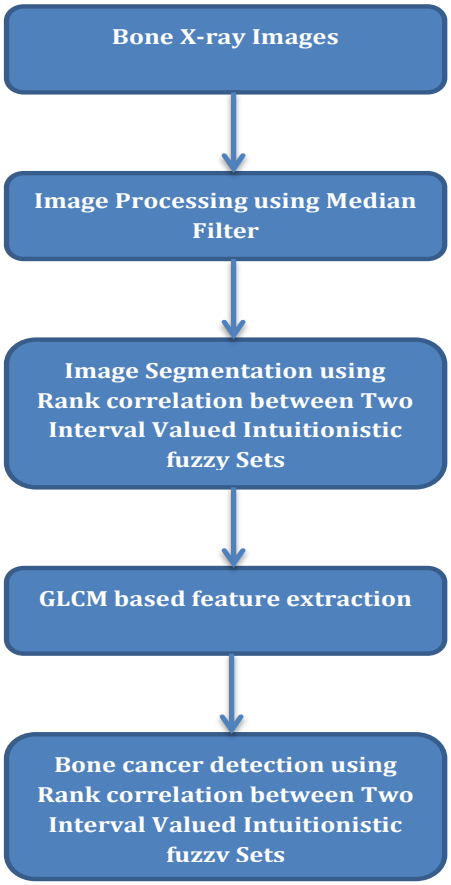

Figure 2: Proposed Bone Cancer Detection Flow

The proposed bone cancer detection system consists of different stages such as image preprocessing, segmentation, feature extraction and cancer identification. The working process of the bone cancer detection is explained as follows,

Median Filter based Noise Removal Process:

Initially the noise in the bone X-ray images are eliminated by using the median filter [14] which investigated each and every pixel present in the image. Each pixel is compared with the maximum and minimum threshold value, if it is considered as the noisy pixel than it has to be replaced by median value. The median value is calculated by arranging the sorting order and the center value, this process is repeated continuously and eliminated noise pixel successfully. after that the affected region is segmented by applying the mathematical rank correlation between intuitionistic fuzzy rank correlation method which is explained as follows.

Two Valued Rank Correlation between Intuitionistic Fuzzy Set based Image Segmentation:

The foremost important process is image segmentation that is done by using the two valued rank correlation between intuitionistic fuzzy set [15] approach with particular fuzzy membership value $\mu_A$and non-membership value γ_A that is lies between [0,1]. But the conventional rank correlation value is belongs to the [-1,1], so, the intuitionistic fuzzy set has been defined as $A = \{\langle x, \mu_A(x), \gamma_A(x)\rangle\}$ and $B = \{\langle x, \mu_B(x), \gamma_B(x)\rangle\}$ which takes the input value as 1,2,3…..n. After that the correlation between each pixel data has been estimated as given in the below.

$$(\overline{\mu_A} - \overline{\mu_B}) = (\overline{\gamma_A} - \overline{\gamma}_B) = \frac{n+1}{2}\sigma_\mu^2 - \frac{1}{2}\sum_{i=1}^{n}[(\mu_A - \mu_B) - (\overline{\mu_A} - \overline{\mu_B})]^2 \quad (2)$$

Based on the above eqn (7) the noise removed X-ray images pixels are arranged in the intuitionistic fuzzy set, the correlation between the pixels are calculated as follows,

$$\rho = 1 - \frac{6\{\sum[d\boldsymbol{\mu}_L + d\boldsymbol{\mu}_U] - \sum[d\gamma_L + d\gamma_U]\}^2}{2n(n^2-1)} \quad (3)$$

Based on the above process, the two valued rank correlation is determined, the rank correlation value is used to identify the similar pixels which are grouped into together with effective manner. From the extracted regions various statistical features are extracted which is listed in the following section.

Statistical Feature Extraction:

The third most stage is statistical feature extraction which is done by using the Gray Level Co-occurrence Matrix (GLCM) [16]. The method derived the features from the two valued rank correlation intuitionistic fuzzy set based segmented region in terms of both texture, shape and intensity features which is listed out in the table 1. According to the table 1 eqn's different features are extracted with effective manner.

Table 1: GLCM Based Features and Related Formulae

Features	Related Formula
Entropy	$\sum_{i,j=0}^{n-1} -\ln(P_{ij})\,P_{ij}$
Correlation	$\sum_{i,j=0}^{n-1} P_{ij}\,\frac{(i-\mu)(j-\mu)}{\sigma^2}$
Energy	$\sum_{i,j=0}^{n-1} (P_{ij})^2$
Contrast	$\sum_{i,j=0}^{n-1} P_{ij}\,(i-j)^2$
Cluster Shade	$\sum_{i=0}^{n-1}\sum_{j=0}^{n-1}(i+j-\mu_x-\mu_y)^3.p(i,j)$
Variance	$\sum_{i=0}^{n-1}\sum_{j=0}^{n-1}(i-\mu)^2.p(i,j)$
Mean	$\sum_{i=0}^{2(n-1)} i.p_{x+y}(i)$
Cluster Prominence	$\sum_{i=0}^{n-1}\sum_{j=0}^{n-1}(i+j-\mu_x-\mu_y)^4.p(i,j)$
Inertia	$\sum_{i,j=0}^{n-1}(i-j)^2.p(i,j)$

Skewness	$\sigma^{-3}\sum_{i=0}^{n-1}(i-\mu)^3 . p(i)$
Kurtosis	$\sigma^{-4}\sum_{i=0}^{n-1}((i-\mu)^4 . p(i)) - 3$

The extracted GLCM features are widely used to analyze the bone cancer by using two valued rank correlation intuitionistic fuzzy set approach.

Two Valued Rank Correlation Intuitionistic Fuzzy Set based Bone Cancer Detection System:

The final step is bone cancer detection that is performed by using the two valued rank correlation intuitionistic fuzzy set approach [17]. Before classifying the features, which are trained with the help of the Adaboost technique. The Adaboost technique strength the weak features else it avoids the weak features while classifying features. Then the Adaboost training process is done by using as follows,

$$f(x) = \sum_{j=1}^{J} \alpha_j h_j(x) \qquad (4)$$

α_j is the non-negative weak features in the pooling layer, h_j is the better features. Based on the above eqn (9) the extracted features are trained which are compared with the testing features for recognizing the bone cancer with effective manner. After that the testing features are fed into the two valued rank correlation intuitionistic fuzzy set approach [18] that uses correlation between testing and training features. The correlation between these features are estimated as follows,

$$\rho = 1 - \frac{6\{\sum[d\boldsymbol{\mu}_L + d\boldsymbol{\mu}_U] - \sum[d\gamma_L + d\gamma_U]\}^2}{2n(n^2-1)} \qquad (5)$$

based on the above equation (5), the correlation has been estimated, if the testing feature correlation value matched with trained feature correlation value, if the computed values are equal then it is considered as the normal bone feature else it treated as the bone cancer related features. This process is repeated continuously, and the output of the bone cancer has been detected according to the training features with effective manner. Thus the proposed two valued rank correlation intuitionistic fuzzy set successfully recognizes bone cancer. Then the efficiency of the system is evaluated with the help of the experimental results and discussions.

3. Experimental Results of Bone Cancer Detection Process:

The excellence of the proposed two valued rank correlation intuitionistic fuzzy set approach based bone cancer detection process is implemented with the help of the MATLAB tool. At the time of implementation process, bone images are collected from the Open-Access Medical Image Repositories [19] that consists of collection different parts of bone images which help to analyze the proposed two value ranked based intuitionistic fuzzy set based bone cancer detection system efficiency. After collecting the images the noise present in the images are eliminated by replacing the median value and the affected region is successfully extracted with effective manner. From the extracted region, various features are extracted which are trained by using the Adaboost method which is stored as template in database. The new testing features are compared with the trained features using the deep neural netwo value ranked based intuitionistic fuzzy set. Then the efficiency of the system is examined using the following performance metrics[20].

$$True\ Positive\ rate\ (TP) = \frac{Numbers\ of\ features\ detected \times 100}{Number\ of\ features\ in\ the\ dataset} \qquad (6)$$

$$False\ Positive\ rate\ (FP) = \frac{Number\ of\ false\ detections \times 100}{Number\ of\ features\ detected + Number\ of\ false\ detection} \qquad (7)$$

$$False\ Negative\ Rate\ (FN) = \frac{Number\ of\ features\ missed \times 100}{Number\ of\ features\ in\ the\ dataset} \qquad (8)$$

$$Precision = \frac{TP}{TP+FP} \qquad (9)$$

$$Recall = \frac{TP}{TP+FN} \qquad (10)$$

$$Accuracy = \frac{number\ of\ true\ positive + number\ of\ true\ negative}{number\ of\ true\ positive + false\ positive + false\ negative + true\ negative} \qquad (11)$$

According to the above performance metrics, the excellence of the proposed bone cancer detection process is evaluated while segmenting the image and classifying the extracted features from the dataset. The effectiveness of the proposed intuitionistic fuzzy rank correlation based segmentation process is compared with the traditional segmentation methods such as canny edge detection [21], soble edge detection process [22] and fuzzy clustering process [23] which is shown in the figure 3. Thus the proposed two valued rank correlation based intuitionistic fuzzy set segmentation method achieves the 99.54% accuracy, 98.53% of precision and 99.15% of recall which is shows that the proposed segmentation method effectively identifies the affected region from the dataset that helps to retrieve the features successfully.

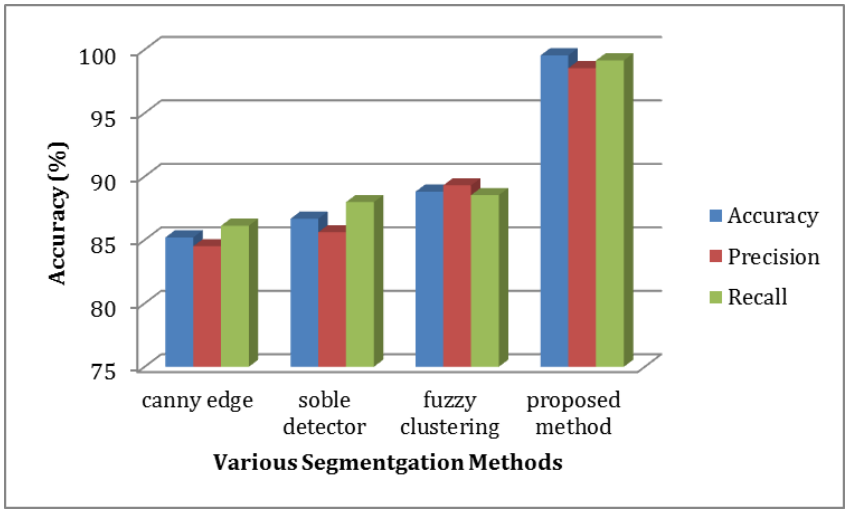

Figure 3: Efficiency of two valued rank correlation based intuitionistic fuzzy set Segmentation Methods

Based on the above image segmentation methods, the retrieved features are fed into the Adaboost method which successfully trains the features with minimum time. Then the Adaboost based trained features are compared with the traditional training methods such as support vector machine (SVM) [21], Radial basis Function (RBF) [22] which is shown in figure 4.

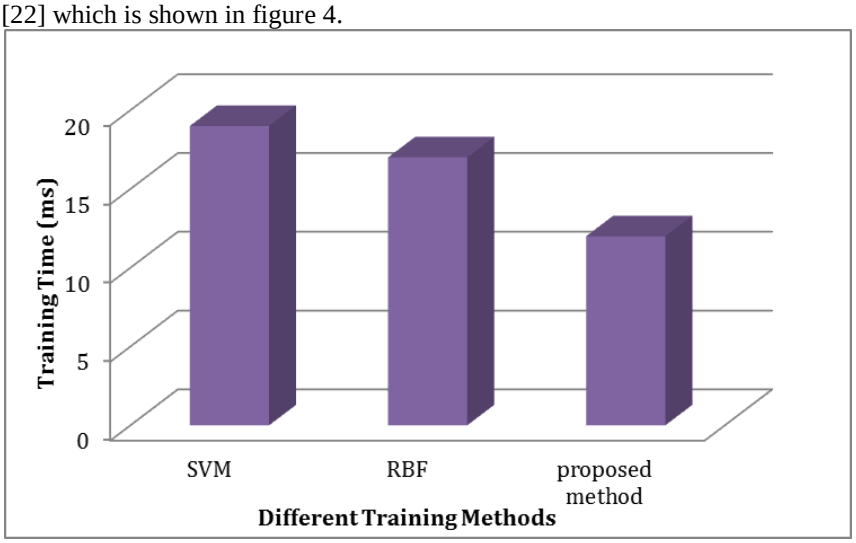

Figure 4: Training Time for Training Methods

The above figure 4 depicted that the proposed Adaboost method effectively trains the extracted features with minimum time when compared to the other training methods. In addition, the training method ensures the high accuracy that shows that the proposed method selects the correct feature while matching process. Then the accuracy of the training process is shown in the figure 5.

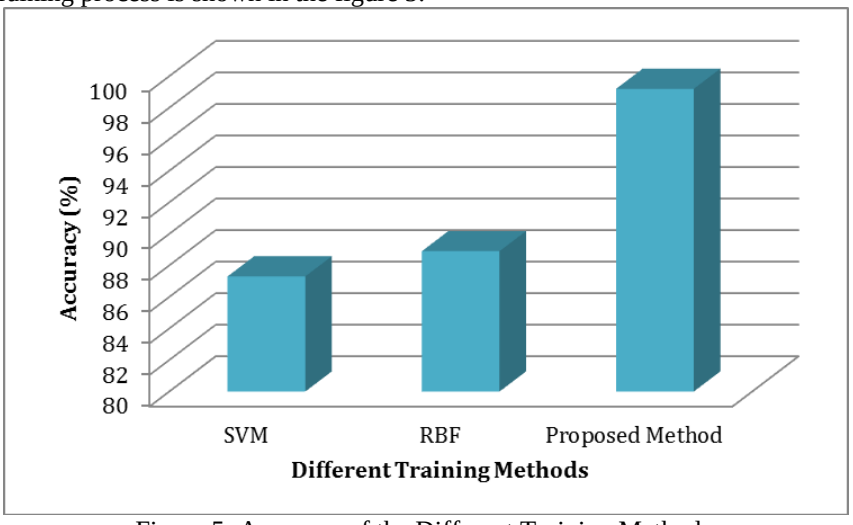

Figure 5: Accuracy of the Different Training Methods

The above figure 5 depicted that the proposed method successfully train the feature with effective manner and the trained features are stored in the database in terms of the template. Then the Adaboost method based trained features are matched with the testing features using the two valued rank correlation based intuitionistic fuzzy set which consumes the minimum error rate when compared to the traditional methods such as K-Nearest Neighbor (KNN) [24], Neural Networks (NN) [25], Back propagation Neural Network (BPN) [26] which is shown in figure 6.

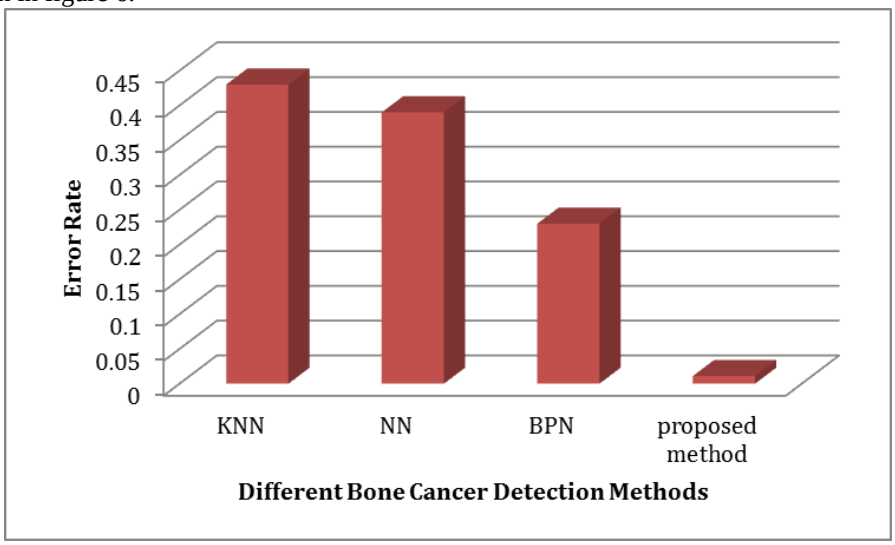

Figure 6: Performance of the Means Square Error Rate

Thus the above figure clearly shows that the proposed method consumes the minimum error rate while classifying the bone cancer related features. This minimized error rate increased the classification accuracy which is shown in figure 7.

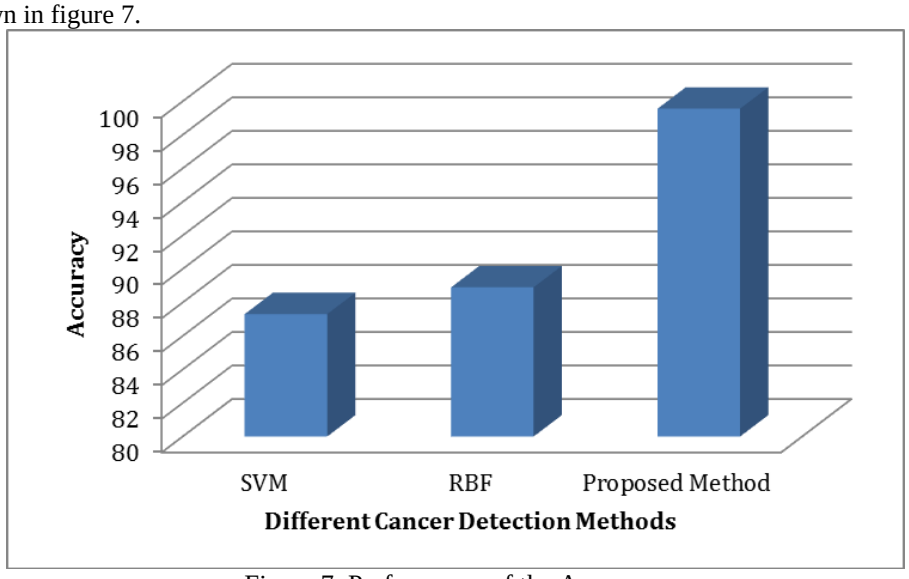

Figure 7: Performance of the Accuracy

Thus the proposed system successfully recognizes the bone cancer features from the extracted features with 99.56% accuracy when compared to the other traditional methods due to the minimum error rate also the effective region segmentation and detection method. Thus the efficiency of the proposed method well worked in the image medical database. Also the proposed Adaboost trained two valued rank correlation based intuitionistic fuzzy set ensures the high accuracy while classifying the bone cancer features with effective manner.

4. Conclusion:

This paper analyzes the bone cancer detection process using the two valued rank correlation based intuitionistic fuzzy set approach and the efficiency is examined using the Open-Access Medical Image Repositories data set. Initially the images are collected and noise has been eliminated with the help of the median filter, which analyze each and every pixel present in the image. After that the correlation between the pixels are estimated by using the two valued rank correlation based intuitionistic fuzzy set approach which examines two pixels at time and the similar pixels are grouped together. According to the affected regions are clustered and statistical features are extracted which are trained by Adaboost algorithm. Then the new testing features are compared with trained features in the concept of same two value rank correlation based

intuitionistic fuzzy set. Then the effectiveness of the system is evaluated with the help of the medical image dataset. Thus the proposed system ensures the high accuracy while recognizing the bone cancer due to the minimum error rate along with the effective mathematical based segmentation and detection process.

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