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# A Prototype Model on CBMIR Using Canny Edge Detection and Neural Network for Visual Search

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**ABSTRACT:** The advancement in the area of medical imaging method has lead industries to conceptualize a complete automated system for the medical procedures, diagnosis, treatment, and prediction. Content-Based Image Retrieval (CBIR) is a process to retrieve a stored image from the database by supplying an image as a query instead of text. The success of such system largely depends upon the robustness, accuracy, and speed of the retrieval systems. CBIR system is valuable in medical systems as it provides retrieval of the images from the large dataset based on similarities. This paper proposes a model for Content-Based Medical Image Retrieval (CBMIR) using Canny Edge Detection and Neural Network for visual search on hand radiography. The initial Stage of Image Retrieval namely pre-processing is used in order to get a better image; it eliminates the noise present in the query image. Edge detection by Canny method is performed on the hand radiography. The Canny Edge detector finds linear and continuous Edges. A rule for comparing the images using Neural Network is defined for retrieving images that match the given query from a large database. This Comparison is done by Convolutional Neural Network (CNN), Probabilistic Neural Network (PNN) and Extreme Learning Machine (ELM). CNN is a deep Neural Network. It is based on Multilayer feed-forward Neural Network. PNN is also a multilayer feed-forward Neural Network and classifies faster than the CNN. Euclidean distance is used for calculating the distance between each pair of Region Of Interest (ROI) for similarity measurement. The Proposed technique allows users to retrieve similar query image from the database, higher retrieval performance can be achieved and also compares CNN and PNN classifiers on hand radiography images.

**KEYWORDS:** CBIR, CBMIR, Canny Edge Detection, CNN, PNN, ELM.

### I. INTRODUCTION

Content-Based Image Retrieval (CBIR) has been one of the most dynamic areas in computer science in the most recent decade as the numbers of digital images obtainable remain increasing. CBIR is kind of Image Retrieval Technique. CBIR uses the image contents such as colour, shape, texture, and spatial layout to represent and index the image. It is also denoted as Query by Image Content (QBIC) and Content-Based Visual Information Retrieval (CBVIR). Searching for digital images in large databases is a big problem and hence this image retrieval problem is resolved with the help of CBIR. CBIR finds its applications in many fields such as medical diagnostics, GIS and military applications, pattern recognition, computer vision and many others [1]. There are different techniques to retrieve the images in CBIR. The oldest process is text annotation for images in the database. Image annotation is a tedious task and requires tagging which is time consuming. Hence in order overcome these significant limitations, researchers have turned their attention to CBIR. CBIR has become an energetic and fast- improving research area in image retrieval in the last few years. Due to this, CBIR has been improved in recent years by techniques for region-level feature extraction, relevance feedback approach, semantic-based approach etc. The proposed CBIR system developed consists of four stages, which include (i) Pre-Processing (ii) Feature Extraction (iii) Classification and (iv)



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Similarity Matching. These four stages are consecutively performed between training and query medical images for extracting the most relevant images.

- Pre-processing - Pre-Processing refers to the initial steps in Image Processing that are applied to the raw image in order to remove noise in an image.
- Feature Extraction - Feature Extraction is the process of extracting information from images based on color, shape, texture.
- Classification - Image Classification is one of the significant steps in image retrieval method because it saves more time while searching the images from the large database. Classification is identification of different regions of the images by which the retrieval efficiency of the system will be improved.
- Similarity Matching – A similarity measure plays an important role in image retrieval. Similarity measurement is one of the key issues in content-based image retrieval. The Similar images from the database can be retrieved by using Similarity Measure.

## A. Content-Based Image Medical Image Retrieval

Content-Based Medical Image Retrieval (CBMIR) has become a major necessity with the growing technological advancements. In the Medical Field, images and especially digital images are produced in ever-increasing quantities and used for diagnosis and therapy. Medical image plays an important role in surgical planning, medical training, and patient diagnosis. Content-based access to medical images is following the medical decision making has been designed that would ease the administration of medical data and scenarios for the combination of content-based access methods into Picture Archiving and Communication Systems (PACS) [2]. Every day large volumes of different types of Medical images such as dental, endoscopy, skull, MRI, ultrasound, radiology are produced in various hospitals as well as various medical centres.

Medical image retrieval systems are special from regular image retrieval in several ways. Medical image retrieval has many significant applications, especially in medical diagnosis, Education, and research fields. The retrieval of digital medical images can also be done in the form text-based and content-based techniques. Medical image retrieval for diagnostic purposes is significant because the chronological images of different patients in medical centres have valuable information for the upcoming diagnosis with a system which retrieves similar cases, makes more accurate diagnosis and to decide on appropriate treatment.

## II. RELATED WORK

The image pre-processing analysis proposed by Pietka E et al. [3], performed a computerized Bone Age Assessment process. The system uses computed Radiography (CR) images and digitized images. Two pre-processing steps were carried out. The image orientation correction and background elimination for increasing the accuracy of ROI segmentation. ManjulaGururaj H, Dr. G. S. Nagaraj [4] suggested a standard Deviation based Skeletal for Bone Age Assessment (BAA) based on feature Extracted from Phalanx. BAA System using Euclidean Distance and Standard Deviation Method is a good analytical method to discover the age in children. Image smoothing is done to cut the disturbance inside the image or to produce a less pixilated image. Most smoothing methods are based on low pass filters. The proposed work uses smoothing to reduce interference by using a Gaussian filter. The Gaussian filter reduces the magnitude of higher frequencies proportional to the lower frequencies, but at the price of more computation time. Thangam & T.V Mahendran [5] proposed the design and implementation of the tetrolets based system for Automatic Skeletal Bone Age Assessment. Tetrolets are used in combination of Particle Swarm Optimization (PSO) for segmentation. Principle Component Analysis (PCA) is employed as a feature selection tool to reduce the size of the feature vector. The selected features are fed into ID3 decision tree classifier, which outputs the class to which the radiograph is categorized, which is mapped on to the final bone Age. They made use of Sobel edge detector to detect the edges. The Sobel edge detector uses a pair of 3 x 3 convolution masks, one estimating the gradient in the x-direction (columns) and the other estimating the gradient in the y-direction (rows). As an outcome, the mask is slid over the image, operates a square of pixels at a time. A Fully automatic technique depends on the CBIR using Extreme Learning Machines (ELM) was developed and adopted for assessing the Skeletal Maturity [6]. The estimation results of the ELM models were then compared with those of the Genetic Programming (GP) and Artificial Neural Network (ANN) models. Further, the results showed that the ELM model can be utilized with confidence in further work on the formulation of new models of skeletal age assessment techniques.

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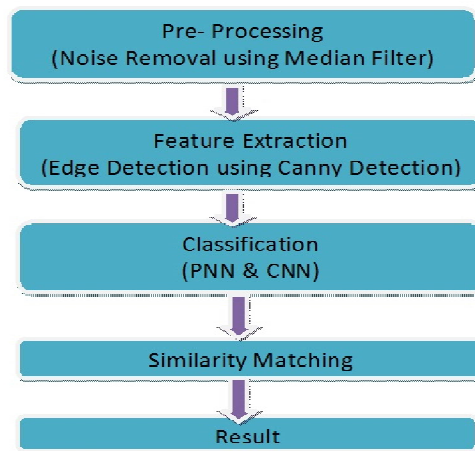
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## III. PROPOSED WORK

The Proposed Methodology comprises the general phases of CBIR such as Pre-processing, feature Extraction based on edge, classification and Similarity Metric analysis. The purpose of this work was to improve the accuracy of a CBMIR application by allowing the system to retrieve the similar images.



Architecture of the Proposed Work CBMIR PNN – CBMIR CNN

Fig. 1. Architecture of the Proposed Work CBMIR PNN – CNN

The input query image is taken for the process of retrieval of the similar image from a lot of medical images in the database. Medical Image, left hand radiography was taken as input to the system.

### A. NOISE REMOVAL USING MEDIAN FILTER:

Pre-processing is performed in order to remove the noise in the medical images. Most of the X-ray images are passed through many sources. Therefore, noise should be removed before extracting the features. The Proposed Methodology uses the Median Filter for removing Noise. The median filter is a nonlinear filter and it has widely used in digital image processing because of its good edge keeping characteristics and reducing impulse noise ability. The median filter is a rank-order filter. Its noise-reducing effects depend on the size and shape of the filtering mask. Median Filter is used for noise removing because it removes the noise as well as preserved the edge information in images. When Noise affects a point in a grayscale image, the result is called salt & pepper noise. The Median Filter is very useful for removing the Salt & Pepper Noise. The median filtering output is

$$g(x,y) = \text{med} \{ f(x-i, y-j), i, j \in w \} \quad \text{eq. (1)}$$

Where  $f(x, y)$ ,  $g(x, y)$  are the original image and the output image respectively,  $W$  is the two-dimensional mask: the mask size is  $n \times n$  (where  $n$  is commonly odd) such as  $3 \times 3$ ,  $5 \times 5$ , etc. Because the median filter is a nonlinear filter, its mathematical analysis is relatively complex for the image with random noise. For an image with zero mean noise under normal distribution, the noise variance of the median filter approximately.

$$\sigma_{\text{med}}^2 = \frac{1}{4n f^2(n)} \approx \frac{\sigma_i^2}{n + \pi/2 - 1} \cdot \frac{\pi}{2} \quad \text{eq. (2)}$$



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Where  $\sigma^2$  is input noise power (the variance),  $n$  is the size of the median filtering mask,  $f(n)$  is the function of the noise density. And the noise variance of the average filtering is

$$\sigma_0^2 = \frac{1}{n} \sigma_i^2 \quad \text{eq.(3)}$$

Comparing the equation (2) and (3), the median filtering effects depend on two things: the size of the mask, and the distribution of the noise. The median filtering performance of random noise reduction is better than the average filtering performance, but to the impulse noise, especially narrow pulses are farther apart and for the pulse width less than  $n/2$ , the median filter is very effective.

## B. EDGE-FEATURE DETECTION USING CANNY METHOD:

Feature Extraction is used to extract inherent features in images such as shape, colour, and texture. It helps to diagnose and determine the accurate segmentation of images. Feature extraction can be done in three levels, the pixel, the local and the global. The simplest visual image feature extraction are based on pixel. Local features are extracted from sub-images from the original image. Global features are extracted to describe the whole image in an average.

**Color:** Color is the common features extracted in CBIR, because of the simplicity in extracting the color information from images.

**Texture:** Texture is the most important feature of an image. It is used to represent visual patterns in images and to determine and specify how they are spatially defined. The process of identifying something in specific textures in an image is a variation. The brightness of pairs of pixels are calculated as the degree of contrast, regularity, coarseness, and directionality which may be estimated.

**Shape:** Shape feature extraction normally includes the extraction of edges, corners, and curvature scale space and chain codes. Shape contains the most absorbing visual information for easy understanding. It does not define the shape of an image, but it defines the shape of a particular area.

For detecting edges Canny Edge Detection Algorithm is used and for connecting the edges to form the shape of the image. Canny edge detection is a multi-step calculation that can recognize edges with noise covered up in the meantime. The Canny edge indicator was created in 1986 by John F. Shrewd. It is still broadly utilized today was one of the default edge locators in Image Processing. The Canny edge detector is based on computing the squared gradient magnitude [7]. Local maxima of the gradient extent that are more than some threshold are then recognized as edges. The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect an extensive range of edges in images. The Canny aim was to realize the optimal edge detection algorithm. In this situation, an "optimal" edge detector means

- **Good detection** – It should mark as many real edges in the image as probable.
- **Good localization** – Edges marked should be as close as possible to the edge in the actual image.
- **Minimal response** – A given edge in the image should only be marked once, and where possible, image sound should not create copied edges.

The Canny edge location calculation can be separated into 5 stages:

**Step 1:** Smooth the image utilizing a Gaussian/Median filter to evacuate high recurrence noise.

$$g(m, n) = G_\sigma(m, n) * f(m, n) \quad \text{eq. (4)}$$

where  $G_\sigma$  is calculated as

$$G_\sigma = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{m^2 + n^2}{2\sigma^2}\right) \quad \text{eq. (5)}$$

Step 2: Compute the gradient intensity representations of the image.

$$M(m, n) = \sqrt{g_m^2(m, n) + g_n^2(m, n)} \quad \text{and}$$

$$\theta(m, n) = \tan^{-1}[g_n(m, n)/g_m(m, n)] \quad \text{eq. (6)}$$

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Where M is the Threshold, M can be calculated as

$$M_T(m, n) = \begin{cases} M(m, n) & \text{if } M(m, n) > T \\ 0 & \text{otherwise} \end{cases}$$

Where  $T$  is so chosen that all edge elements are kept while most of the noise is suppressed.

Step 3: Apply non-maximum suppression to remove “false” responses to edge detection.

Step 4: Apply thresholding using a lower and upper boundary on the gradient values.

Step 5: Track edges using hysteresis by suppressing weak edges that are not connected to strong edges.

## C. CONVOLUTIONAL NEURAL NETWORK:

Convolutional Neural Network (CNN, or ConvNet) is a class of deep, feed-forward artificial neural network that have successfully been applied to analysing visual imagery. Convolutional Neural Networks (ConvNets or CNNs) are a gathering of Neural Networks that are very effective in fields such as image recognition and classification. The Deep learning algorithm of CNN in the multilayer feed forward network introduced the outstanding neural network structures [8], it is broadly utilized as a part of extraordinary scientific fields. Ordinarily, a neural framework contains three levels:

- (i) an input level;
- (ii) A middle or hidden level;
- (iii) An output level.

To calculate the gradient of classification of the input to the  $l$ -th layer and the hidden layer of the image is calculated as

$$\delta(l) = (W(l))^T \delta(l+1) \cdot f'(z(l)) \quad \text{eq. (7)}$$

And the output level gradients are

$$\begin{aligned} \nabla W(l) J(W, b; x, y) &= \delta(l+1) (a(l))^T \\ \nabla b(l) J(W, b; x, y) &= \delta(l+1). \end{aligned} \quad \text{eq. (8)}$$

Each output map is given its own multiplicative bias  $\beta$  and an additive bias  $b$  of the image.

## D. PROBABILISTIC NEURAL NETWORK

A Probabilistic Neural Network (PNN) is a feed-forward neural network, which was got by the Bayesian network and a statistical algorithm called Kernel Fisher Discriminant analysis. It was presented by D.F. Specht in the mid-1990s. In a PNN, the operations are organized into a multilayered feed forward network with four layers:

- Input layer
- Hidden layer
- Pattern layer/Summation layer
- Output layer

**Input Layer:** The input vector, denoted as  $p$ , its dimension is  $R \times 1$ .

**Radial Basis Layer:** In Radial Basis Layer, the vector distances between input vector  $p$  and the weight vector made of each row of weight matrix  $W$  are calculated. Here, the vector distance is defined as the dot product between two vectors. Assume the dimension of  $W$  is  $Q \times R$ . The dot product between  $p$  and the  $i$ -th row of  $W$  produces the  $i$ -th element of the distance vector  $\|W-p\|$ , whose dimension is  $Q \times 1$ . The minus symbol, “-”, indicates that it is the distance between vectors. Then, the bias vector  $b$  is combined with  $\|W-p\|$  by an element-by-element multiplication. The result is denoted as  $n = \|W-p\| \cdot *p$ . The transfer function in PNN has built into a distance criterion with respect to a center. In this paper, we define it as

$$\text{radbas}(n) = e^{-n^2} \quad \text{eq. (9)}$$

Each element of  $n$  is substituted into the above formula, and produces corresponding element of  $a$ , the output vector of Radial Basis Layer. We can represent the  $i$ -th element of  $a$  as

$$a_i = \text{radbas}(\|W_i - p\| \cdot *b_i) \quad \text{eq. (10)}$$

Where  $W_i$  is the vector made of the  $i$ -th line of  $W$  and  $b_i$  is the  $i$ -th component of predisposition vector  $b$ .

PNN is got from Radial Basis Function (RBF) Network, which is an ANN utilizing RBF. RBF is a bell shape work that scales the variable non-linearly. PNN is adapted for it has many advantages [9]. Its testing speed is ordinarily quicker than CNN. Moreover, it

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is effective to noise examples. The most important advantage of PNN is that training is easy and instantaneous. Weights are not “trained” but assigned. Existing weights will never be exchanged however, just new vectors are embedded into weight grids when preparing. So it can be utilized in real-time. Since the training and running technique can be implemented by matrix manipulation, the speed of PNN is very quick. The execution of the PNN classifier was evaluated in terms of training, performance and classification accuracies. Probabilistic Neural Network gives fast and accurate classification and is a promising tool for classification.

## F. SIMILARITY MEASUREMENT

Measures can be evaluated using distance functions, and it is important to determine the most suitable function for each type of ROI. Euclidean distance is used to evaluate distances in n dimensional vector spaces. The Euclidian method is used to calculate the distances between the query image and extracted images. The Euclidian method is utilized to calculate the distances between the query image and extracted images. Euclidean distance is the square root of the sum of squared differences between corresponding elements of the two vectors. The distance between vectors X and Y is characterized as

$$d(x, y) = \sqrt{\sum_i^n (x_i - y_i)^2}$$

## IV. RESULTS

The proposed CBIR Based image retrieval System for Medical image CBMIR PNN-CNN, are implemented with the left hand Wrist X-ray samples collected from the IRMA database. The radiographs were classified and scanned in an X-ray format with 256 x 260 pixel size. The Proposed Work is implemented in Python and the Packages are installed in Python to work with images. The Installed Packages are PIL, OpenCV, Numpy, and matplotlib. Neural Network classifiers are applied in the Proposed Model CBMIR PNN-CNN. Convolutional Neural Network (CNN) and Probabilistic Neural Network (PNN) are used to classify the ROI of the images. PNN provides the fast and Accurate to classify the ROI in Medical Images. The estimation results of PNN are compared with those of CNN and ELM. ELM based calculations are carried from the existing method. To demonstrate the merits of the presented approach on a more definite and tangible basis, the accuracy of PNN model estimation is compared with the accuracy of estimation of the CNN and ELM methods, which served as a benchmark. PNN approach has much faster learning speed compared to CNN and ELM.

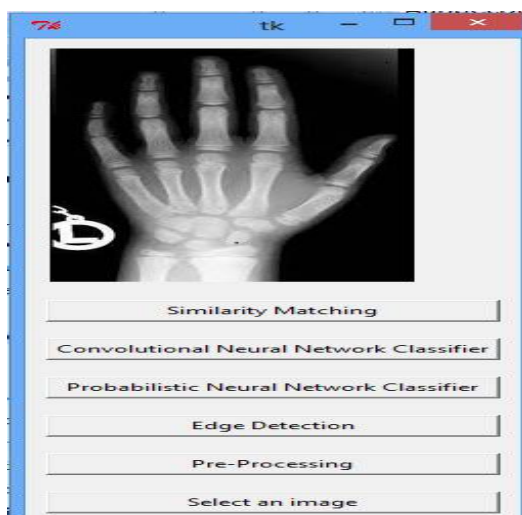


Fig. 2. Proposed System CBMIR PNN-CNN for ImageRetrieval Fig. 3. Pre-processed Image using Median Filter

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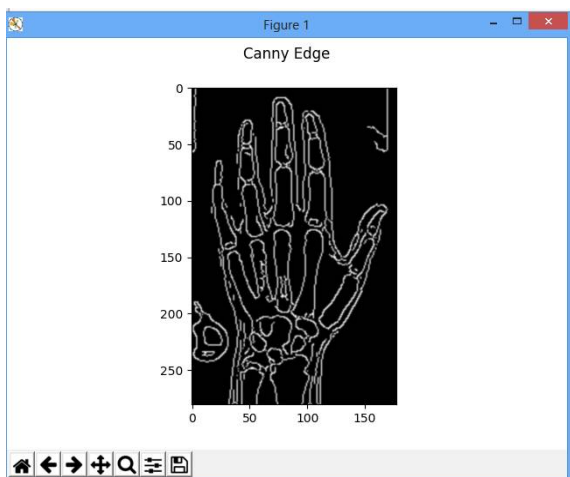


Fig. 4. Edge Detection using Canny Edge Detection

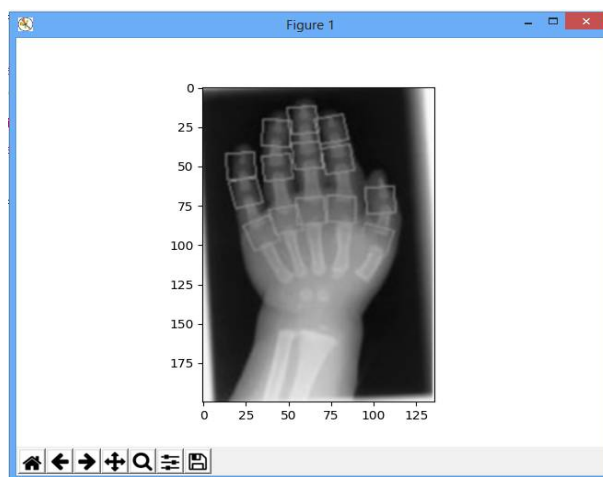


Fig. 5. eROI in the Proposed Model.

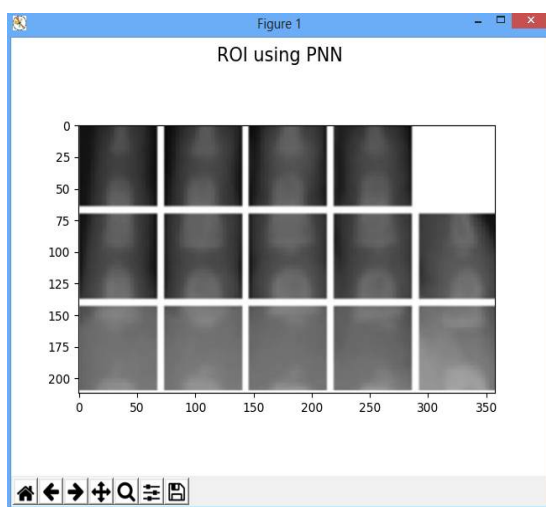


Fig.6.ROI Matching using PNN

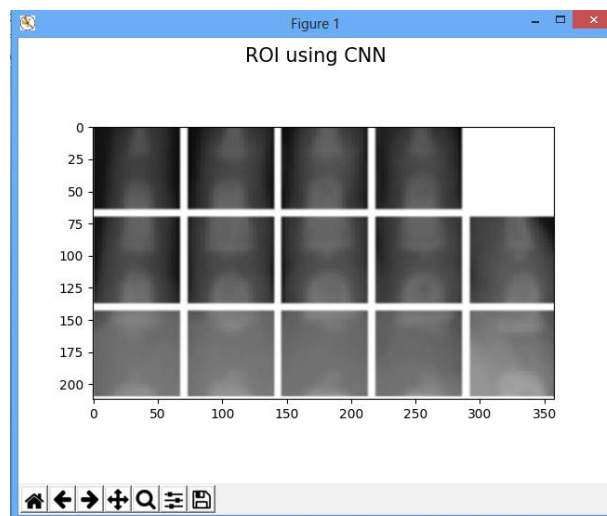


Fig.7. ROI Matching using CNN

CBIR is helps to assist in the image retrieval problem. Two of the most popular evaluation measures are the Precision and Recall. The Precision, Recall and retrieval Accuracy are noted for each Query. For evaluating the performance of the classification stage of our CBMIR PNN -CNN, the Precision, recall, sensitivity, specificity, is measured for the classification accuracy for each image.

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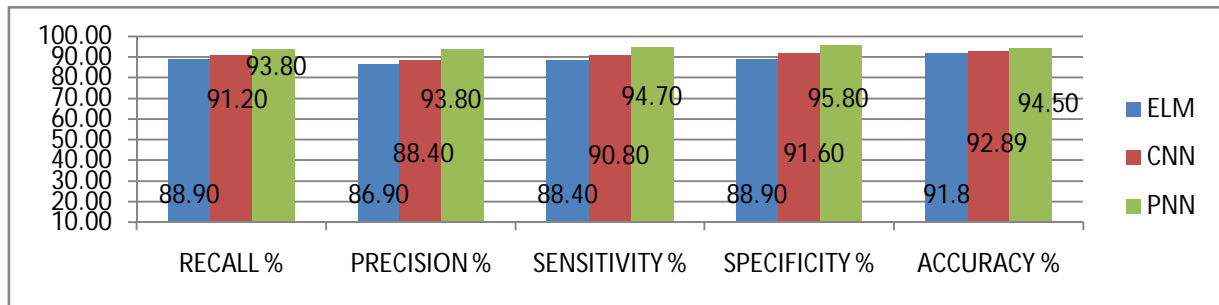


Fig.8. Results and Analysis of the Proposed CBMIR PNN-CNN Model

## V. CONCLUSION AND FUTURE WORK

In this Proposed Work CBMIR PNN-CNN, An efficient system is designed to extract the features of images and classify using Probabilistic Neural Network for Content Based Image Retrieval for Medical Images. The query image can be read from the database and then eliminate the noise using median filter. Median filtering based pre-processing step was carried to de-noise the image, for feature extraction uses shape extraction & texture extraction. Edge Detection uses the canny Edge Detection Method to detect the selection of medical image edges and the feature that contains Region of Interest (ROI) processing, Choice of ROI – Choosing ROI based on quality, density, size, shape, smoothness, thickness of border, etc., and the Probabilistic Neural Network (PNN) Classifier and Convolutional Neural Network (CNN) is used to classify the ROI. PNN is often used in classification problems and for similarity measure the proposed model uses the Euclidean Distance, When Implemented the Proposed System can easily retrieve a similar images from the PNN classifier. Performance of the PNN classifier was evaluated in terms of training performance and classification accuracies. Probabilistic Neural Network gives fast and accurate classification and is a promising tool for classification of the X-ray of left hand wrist images. The main disadvantage of CNN is high computational cost and also CNN use to need a lot of training data, the speed of PNN is very fast when compared to other Artificial Neural Network Convolutional neural network (CNN). As image collections grow in size of the proposed system may take a lot of time and eventually reduce the query retrieval process. Increasing the speed and the user interaction with the image retrieval systems can be done as future work. The Future Work will also involve the Bone Age Assessment accuracy by expanding the database of images. The Future Work will also be focused on extending the system to work for different Medical images like Brain, Liver, Breast, Ear, Spinal Cord etc. and to be implemented over the World Wide Web.

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