

## RESEARCH REVIEW ON FEATURE EXTRACTION METHODS OF HUMAN BEING'S X-RAY IMAGE ANALYSIS

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**Abstract** — Medical image processing covers various types of images such as tomography, mammography, radiography (X-Ray images), cardiogram, CT scan images etc. X-Ray is a type of image in which electronic radiation is passed in human body to capture images of injured parts. Once the X-Ray image is captured, orthopaedics doctors to detect degenerative conditions, trauma, sports injury, tumors, congenital issues etc. manually diagnose it. In automated medical diagnosis system, image processing has to go through various stages such as image acquisition, enhancement, feature extraction, ROI detection, interpretation etc. Feature extraction is one of the important steps of image processing which mainly focus on detection of the region of interest from the image. It includes various mathematical, statistical and scientific algorithms to detect characteristics from the targeted image to narrow down the image. Many researchers have worked on feature extraction from X-Ray image to contribute into automated X-Ray image processing system. In this research paper, we have presented an extensive research review on “Feature Extraction” step of digital image processing based on X-Ray image of human being.

**Keywords** – Orthopaedics; congenital issues; trauma; ROI; X-Ray; Feature Extraction; image processing.

### I. INTRODUCTION

In recent medical revolution, Computer Aided Diseases Diagnoses (CADD) plays an important role. The basic aim of CADD is to detect diseases based on human image as an input at low cost, better accuracy and patient's satisfaction. There are many bio-medical imaging technologies available such as Radiography (X-Ray image), CT-Scan, ECG, Ultrasound, MRI, etc. All these medical imaging are best suited depending on the type of diseases to be detected from human body.

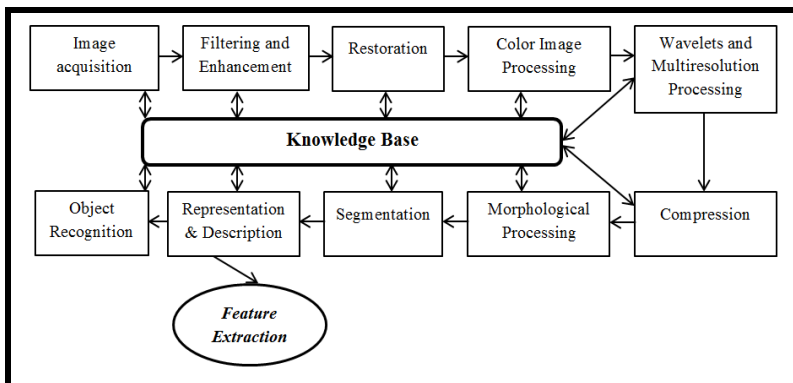
The bone injury is a common problem in human beings. It occurs due to high pressure is applied on bone, fracture, foreign object, simple accident, osteoporosis, tumors, bone cancer, heredity etc. Therefore, the truthful diagnosis of bone injury is important aspect in medical field. In this case, mainly Radiologists capture and review the X-Ray images and finally, design a report with their findings to aid in diagnosis. Further, X-Ray images and report are used by orthopaedics doctors or physicians to prescribe proper treatment to patient [1].

According to paper [2] imaging with X-rays involves exposing a part of the body to a small dose of ionizing radiation to produce images of the interior part of the body. In the human body, each bone plays an important role for example arm, leg, scalp etc. Figure 1(a) Courtesy: <https://images.google.com/> shows X-Ray imag of right arm's fingers of human and Figure 1(b) Courtesy: <https://images.google.com/> shows X-Ray imag of left arm's fingers of human.



**Fig. 1(a):** X-Ray imag of right arm's fingers of human.

**Fig. 1(b):** X-Ray imag of left arm's fingers of human.



**Fig. 2:** Basic steps in digital image processing.

From Patient's perspective X-Ray imaging is very better in terms of low cost, first look examination of bone injury, quick response and review, less time require to capture X-Ray image etc. From Orthopaedics doctor or physicians' perspective, they are always interested to analyse X-Ray image of human being's

bone for better diagnoses of the bone related issues. CADD system can be developed with the use of image processing. Figure – 2 depicts steps of digital image processing [3].

Above figure – 2 shows basic steps to perform digital image processing. Image acquisition is the process of obtaining a digitized image from a real world source using camera, cell phone or any electronic device. Images, which are acquired in the first step, may be blurred, out of focus or noisy so, in the next step, that is image filtering and enhancement is used to improve the quality of image. This step includes various filtering and enhancement algorithm. X-Ray images can be pre-processed with Gaussian filter, Average Filter and Median Filter for better enhancement and visualization improvement.

Image restoration is an area that also deals with improving the appearance of an image. However, unlike enhancement, which is subjective, image restoration is objective, in the sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation. Enhancement, on the other hand, is based on human subjective preferences regarding what constitutes a “good” enhancement result [3].

The next step that is Color Image Processing deals with feature extraction based on color. Wavelet is the foundation for image resolution. This step focuses on measurement of wavelet to improve image resolution. The next step is image compression. This step is used to decrease the size of image so that it can be stored in minimum space or can be transmitted even on low bandwidth channel. Morphological processing step includes tools for extracting image components that are useful in the step that is representation and description of image shape. The next step is image segmentation, it means dividing the image in constituent segments based on boundary, similarity, color, shape etc.

Representation and description always follow the output of a segmentation step. The first decision that must be made is whether the data should be represented as a boundary or as a complete region. Boundary representation is appropriate when the focus is on external shape characteristics, such as corners and inflections. Regional representation is appropriate when the focus is on internal properties, such as texture or skeletal shape.

A method must also be specified for describing the data so that features of interest are highlighted. Description, also called feature selection, deals with extracting attributes that result in some quantitative information of interest or are basic for differentiating one class of objects from another [3]. The last step object recognition deals with assigning the label to the object/information

extracted during feature extraction step. Finally, the result is displayed in the form of data or image.

The aim of this paper is to present an extensive research review only on feature extraction sub-step of image processing cycle based on human X-Ray images. The paper is organized as follows: Section 2 provides physical process of X-Ray image and suggestion of structure, which is beneficial for imaging. Section 3 gives a brief over of different feature extraction techniques;

Section 4 discusses on various classification methods applied on X-Ray image; Section 5 discusses work on X-Ray image feature extraction; Section 6 highlights about some findings derived from section 5; Section 7 represents our analysis on feature extraction methods; finally, the paper is concluded in section 8.

## II. PHYSICAL PROCESS OF X-RAY IMAGE

X -Rays are a form of electronic radiation with wavelengths that range from about  $10^{-7}$  to about  $10^{-15}$  meters in electromagnetic spectrum. In X-Ray, imaging X-Ray tube passes through the injured parts of human body to capture internal images. This process is described as attenuation of the X-ray beam. On the opposite side of the body, detectors or a film capture the attenuated X-rays, resulting in a clinical image [4]. The structure of the image should include following steps to benefit for imaging: X-Ray image source arrangement, Availability of primary health services to avoid side effects of electronic rays, Pass X-Ray beam in human body, Capture X-Ray image on a film, Derive print of X-Ray image on a plastic photo paper, Diagnoses of X-Ray image by orthopaedics doctor and Provide efficient treatment to patient.

## III. FEATURE EXTRACTION TECHNIQUES

A major component in analysing images involves data/dimensionality reduction which is accomplished by intelligently modifying the image from the lowest level of pixel data into higher level representations. From these higher level representations we can gather useful information; a process called feature extraction [5]. As per paper [6] Feature extraction is an essential stage that represents the final results to determine the normality or abnormality of an image.

The ultimate aim in a large number of image processing applications is to extract important features from image data, from which a description, interpretation, or understanding of the scene can be provided by the machine [7]. Feature extraction is an integral part of Image Analysis. It is quite different from other image processing operations, such as restoration, enhancement, and coding,

where the output is another image. Image analysis basically involves the study of feature extraction, and classification techniques [7].

As per [8] feature extraction techniques are broadly classified into two categories that is low level feature extraction and high level feature extraction. Low-level features deals with basic features that can be extracted automatically from an image without any shape information such as thresholding and edge detection. Naturally, all of these approaches can be used in high-level feature extraction, where we find shapes in images. Feature extraction techniques are briefly described as follows:

**Edge Detection:** It highlights image contrast. Edge is generally boundary of the image where intensity of the pixel changes abruptly [8]. There are various edge detection operators such as Canny, Sobel, Prewitt etc. Each edge detection operator is best suited on the type of image such as medical image, sports image, aerial image etc.

**Thresholding:** It selects pixels that have a particular value or arc within a specified range. It can be used to find objects within a picture if their brightness level (or range) is known. This implies that the object's brightness must be known as well. There are two main forms: uniform and optimal thresholding.

In uniform thresholding, pixels above a specified level are set to white and those below the specified level are set to black. Whereas, optimal thresholding seeks to select a value for the threshold that separates an object from its background usually seek to select a value for the threshold that separates an object from its background [8].

**Detecting image curvature (corner extraction):** Curvature is normally defined by considering a parametric form of a planar curve. This technique is used to detect corner from the image [8].

**Region/patch analysis:** Collection of pixel is usually refers to region of the image. This technique is used to detect particular region on the basis of certain algorithm [8].

**Hough transform:** It defines an efficient implementation of template matching for binary templates. This technique is capable of extracting simple shapes such as lines and quadratic forms as well as arbitrary shapes. In any case, the complexity of the implementation can be reduced by considering invariant features of the shapes [8].

**Image Motion Detection:** In the case of motion there is more than one image. If we have two images obtained at different times, the simplest way in which we

can detect motion is by image differencing. That is, changes or motion can be located by subtracting the intensity values; when there is no motion, the subtraction will give a zero value, and when an object in the image moves, their pixel's intensity changes, and so the subtraction will give a value different of zero. This technique is again divided into Scale invariant feature transform (SIFT), Speeded up robust features (SURF), Local Binary Pattern (LBP), Saliency etc [8].

**Histogram:** The intensity histogram shows how individual brightness levels are occupied in an image; the image contrast is measured by the range of brightness levels. The histogram plots the number of pixels with a particular brightness level against the brightness level. Color histogram can also be used in feature extraction [8].

**Haar wavelets:** Haar wavelets are binary basis functions. There is (theoretically) an infinite range of basis functions. Discrete signals can map better into collections of binary components rather than sinusoidal ones [8].

**Texture Extraction:** Texture is an arrangement of pattern after certain interval in the image. Many techniques are used to extract texture from the image such as Local Binary Pattern (LBP), Fourier Transform, Co-occurrence matrices etc [8, 9].

The above discussion provides brief overview of different techniques that can be used in digital image processing for the feature extraction from digital image. However, it is not an exhaustive discussion of the feature extraction techniques.

#### IV. X-RAY IMAGE CLASSIFICATION

Image classification refers to the process of extracting targeted classes or group of pixels from the image. The method that does the task of classification is called image classifier [10]. Classification can be supervised or unsupervised. Supervised image classifiers includes MDM (Minimum Distance from Mean), Parallelepiped, ML (Maximum Likelihood), SVM (Structured Vector Machine), ANN (Artificial Neural Networks) etc [10]. Whereas, unsupervised image classifiers includes k-means, ISODATA, clustering algorithms etc.

Authors of paper [11] shown that SVM provides better generalisation performance compared with other classification techniques in automatic classification of medical X-Ray images. Paper [12] have presented work on CNN (Convolutional Neural Network) with transfer learning for the image classification and detection problems posed within the context of X-ray baggage

security imagery. X-Ray image can be efficiently classified by SVM, KNN and ANN classifier algorithms.

In particular, Hansen and Salamon [13] proved that the image classification accuracy obtained by combining different classifiers can be higher than that of the best individual classifier, only if the classifiers make 'independent' errors. Selection of classifier is purely subjective matter it means it highly depends on a type of image to be classified. One classifier used in one type of image may not provide effective result on other type of image.

## V. X-RAY IMAGE FEATURE EXTRACTION

A feature extraction is a process through which region of interest (ROI) extracted for analysing image. It includes modifying the image from the lower level of pixel data into higher-level representations. From these higher-level representations, we can gather useful information; a process called feature extraction [14]. Authors of paper [5] have proposed a novel technique for extracting texture features from medical image for classification. It is based on bloc wise clustering of medical images.

It includes steps such as divide the entire image into non-overlapping sub-images, split each of these sub-images into other M blocs, for each bloc construct bloc representing set of texture features vectors, use k-means algorithm to cluster the feature vectors, for each cluster construct a sub-image representing set of texture feature vectors, build the final set of texture features representing the overall image and add class label. This technique extracts accurate and general set of textural features.

Paper [15] proposed a novel method to automatically detect the texts embedded in medical image. Authors have used Histogram of Oriented Gradients (HOG) as a statistical feature descriptor, which reflects the distribution of oriented gradients in a selected region. Further, they have adopted AdaBoost classifier to separate the text regions from non-text regions. This method achieved 84% precision rate, which is greater than edge base method (45%) and hybrid method (76%).

Paper [16] proposed an algorithm to extract local features from mammographic image. In this paper, the SIFT algorithm is combined with the sliding window to extract the ROI region, that is, the breast region, and remove most of the background region. It follows the experimental process as Background denoising, Using SIFT to extract the key point, Using the SVM and sliding window to detect the ROI position,

Extract the features of the ROI region and Design BP neural network. The experimental results show that the accuracy of neural network classifier based on SIFT is 96.57%, which is 3.44% higher than that of traditional SVM classification accuracy.

Paper [17] presents an automated approach to detect tuberculosis using chest radiographs. The proposed approach basically includes three main steps such as Pre-processing, Registration and watershed segmentation. Lung region is extracted by using registration based segmentation methods. The accuracy of proposed segmentation and global thresholding is 59.8% and 59.4% respectively.

The accuracy of active contour method is 34.4%. Paper [18] also proposed a novel mechanism to detect tuberculosis in chest radiographs. The proposed method includes a three-stage process of accurate detection of tuberculosis. In the first stage, lung segmentation using adaptive thresholding is utilized to segment the chest images, which have different illumination.

The second stage of feature extraction modifies the input image into a set of features, which extracts relevant information contained in the chest image. In the 3<sup>rd</sup> stage of process, k-Nearest Neighbour classifier (k-NN) outputs the decision that the input image is normal or abnormal. The accuracy of proposed method is 4% more than the graph-cut based TB detection system.

Authors of paper [19] have developed a software namely Visualizer which allows the viewing of individual CT/MRI image slices, slice reconstruction in various projections, detailed analysis of slices and 3D reconstruction of desired object(s) as well as localization of various anatomical structures for further evaluation of parameters. Anita Chaudary and Sonit S.S. [20] have worked on lung cancer detection from CT scan images using image-processing steps such as pre-processing, segmentation and feature extraction. In this paper, authors have used MATLAB as image processing tool and concentrated on Area, Perimeter, Roundness and Eccentricity features of image.

Paper [21] presented an image feature extraction and fusion algorithm based on K-SVD, in order to better fuse CT and MRI images. In this method, images are divided into blocks via the sliding window. The dictionary is compiled the column vectors. The K-singular value decomposition (K-SVD) algorithm learns the redundant dictionary. Then, solved the sparse coefficient matrix for each original image and finally, combining sparse coefficient of nonzero elements realizes the image feature fusion. Authors of paper [22] have proposed a method based on the exploitation of features closely related to image inherent quality. Specifically, in the novel method, Sobel operator, log Gabor filter and local

pattern analysis are employed for complementary representation of image quality. Finally, support vector regression is implemented for the synthesis of the multiple distortion indices and mapping the quantification into an objective quality score.

Paper [23] presented a survey on deep learning in medical image analysis. Authors have stated that feature extraction from medical image can also be done through efficient deep learning algorithm. Authors of paper [24] have worked on OPEN CV Environment to extract features using SURF technique. They have emphasized on the feature extraction phase of CBIR [25] and concluded that SURF is efficient image processing technique in terms of detect ability, accuracy, rotation and execution time.

According to paper [26] if prior shape and a straightened boundary image (SBI) based algorithm are applied on X-Ray image segmentation then, feature extraction will be more easy. Paper [27] proposed a tool, which, first segments the bone region of an input digital X-ray image from its surrounding flesh region and then, generates the bone-contour using an adaptive thresholding approach. Next, it performs unsupervised correction of bone-contour discontinuities that might have been generated because of segmentation errors, and finally detects the presence of fracture in the bone.

Paper [28] has presented a novel feature, which is the combination of shape and texture features. The feature extraction is started by edge and shape information of X-Ray image then, Gabor filter is used to extract spectral texture features from shape images. To evaluate the effect of said feature, a set of well-known classifiers such as Euclidian distance matching, PNN and SVM are applied. 4402 medical X-Ray images are tested and accuracy is 88.77% and 94.2% achieved using SVM and combination of new feature & other 3 methods respectively.

Authors of paper [29] have concentrated on five statistical features like mean, standard deviation, skewness, kurtosis, and entropy to find out the X-ray image features for the development of computer applications for identification of lung tuberculosis (TB) disease and concluded that features extraction can be done effectively using combination of Thresholding based ROI template and PCA (Principle Component Analysis) methods.

Paper [30] proposed a novel method to eliminate the non-ROI data from bone X-ray images based on the histogram dispersion method. ROI is separated from the background and it is compressed with a lossless compression method.

This method contains 3 steps such as Noise Reduction and Smoothing, ROI Boundary Detection and Compression. Experiment was conducted on 60 X-Ray

images and achieved the bit rate of 1.633 which was the lowest bit per pixel among the comparison methods. It is clear from the above extensive literature review that many researchers have worked on feature extraction from X-Ray image of human being.

## VI. FINDINGS

We have identified following findings from above extensive work carried out by many researchers in the field of feature extraction from X-Ray image and other types of medical images. The researchers to explore X-Ray image processing for further research can utilize these findings. Mathematical Morphological operation [2] and clustering based texture method [5] can be performed to extract features from medical images. Local Feature Extraction and Supervised Learning can be used to detect text from medical images [15]. Neural Network Based on SIFT Local Feature Extraction can be used in Medical Image Classification [16].

Registration based segmentation method can be used to detect tuberculosis from chest radiographic images [17]. Software has been proposed to view individual image (CT/MRI) slices, slice reconstruction in various projections, detailed analysis of slices and 3D reconstruction of desired object(s) [19]. K-singular value decomposition (K-SVD) algorithm can be used to extract features from medical images [21].

Adaptive Thresholding method based feature extraction [18] and pre-defined ROI shape from Thresholding method [29] can detect tuberculosis. SVR classifier can be used to extract multi-features to assess image quality [22]. Deep learning is also option for feature extraction from medical images [23]. X-Ray image boundary is extracted with a constant width using enhanced X-ray image segmentation method using prior shape [26]. Digital-Geometric Techniques can be used to detect bone fracture related features from digital X-Ray images of human being's long bone [27]. Combination of shape-texture features can be used to classify X-Ray images [28]. A novel method based on histogram dispersion has been proposed to eliminate the non-ROI data from bone X-ray images for lossless compression [30].

## VII. ANALYSIS ON FEATURE EXTRACTION METHODS

On the basis of findings of section – II, our analysis of feature extraction methods is given as follows: Authors of paper [5] have proposed a novel technique for feature extraction based on bloc wise clustering. This technique is best suitable for X-Ray images of human's hand, arm, fingers, shoulders, elbow etc.

Authors of paper [17] have presented an automated approach based on k-NN classifier which is highly recommended for detection of tuberculosis from chest radiographs. Paper [28] has suggested a novel approach to extract features from X-Ray images based on Gabor filter which is also best for X-Ray image. Apart from these scholar works, basic feature extraction methods such as Thresholding, Histogram, Hough transform etc. are primary requirement for pre-processing to detect features from X-Ray images.

Thresholding is the best method to detect feature from X-Ray image because it is used in edge detection and segmentation. Gaussian Filter is the best filtering method for X-Ray image enhancement in the pre-processing stage. However, the method and algorithm to detect features from any type of image is highly subjective.

### VIII. CONCLUSION AND FUTURE ATTEMPTS

X-Ray image is an important medical imaging component to detect bone related issues and diseases. Many researchers have shown their interest to work in the field of X-Ray image processing. The broad survey presented in the above section III proves that researchers have worked in features extraction from human being's X-Ray images. This research review is further useful for researchers to develop automatic application or decision support system to diagnose human being's X-Ray images to detect bone related diseases such as bone fracture identification, fatigue of knee joint, bone age assessment, lung module diagnoses, osteoporosis, arthritis, bone tumor, bone infection etc.

### REFERENCES

- [1] Bharodiya, A.K., and Gonsai, A.M. (2017). Research Review on human being's X-Ray image analysis through image processing, Proceedings of National Conference on Sustainable Computing and Information Technology, SCET, Surat, pp. 38-42.
- [2] Bhowmik, M., Ghoshal, D., and Bhowmik, S. (2015). Automated Medical Image Analyser, IEEE ICCSP 2015 conference, pp. 0974-0978.
- [3] Gonzalez, R., C., and Woods, R., E. (2008). Digital Image Processing, USA, PE & PH, pp. 1-34
- [4] Schmidt, C. (2018). 3-D X-Ray Imaging With Nanometer Resolution for Advanced Semiconductor Packaging FA, IEEE TRANSACTIONS ON COMPONENTS, PACKAGING AND MANUFACTURING TECHNOLOGY, Vol. 8 (5), pp.745-749.
- [5] Mohamed., M. H., and AbdeISamea., M. M. (2008). An Efficient Clustering based Texture Feature Extraction for Medical Image, IEEE

Proceedings of International Workshop on Data Mining and Artificial Intelligence, Bangladesh, pp. 88-93.

- [6] Suzuki K. et al (2005). False-positive Reduction in Computer-aided Diagnostic Scheme for Detecting Nodules in Chest Radiographs by Means of Massive Training Artificial Neural Network, *Academic Radiology*, Vol. 12 (2), pp. 191-201.
- [7] Jain, A.K. (1989). *Fundamentals of Digital Image Processing*, USA, PE & PH, pp. 342-425.
- [8] Nixon, M. S. and Aguado, A. S. (2012). *Feature Extraction & Image Processing for Computer Vision*, Third Edition, UK, Elsevier, pp. 137-212.
- [9] Rogers, L.F., Talianovic, M.S. and Boles, C.A. et al (2008) *Grainger & Allison's Diagnostic Radiology: A Textbook of Medical Imaging*, New York, Churchill Livingstone, Chap 46.
- [10] Giacinto, G., Roli, F., Fumera, G. (2000). Selection of Image Classifiers, *IEEE Electronics Letters*, Vol. 36(5), pp. 420-422.
- [11] Zare, M.R., Mueen, A., Awedh, M. et al. ( 2013). Automatic classification of medical X-ray images: hybrid generative-discriminative approach, *IEEE IET Image Processing*, Vol. 7 (5), pp. 523-532.
- [12] Akcay, S., Kundegorski, M.E., Chris, G. et al. (2018). Using Deep Convolutional Neural Network Architectures for Object Classification and Detection within X-ray Baggage Security Imagery, *IEEE Transactions on Information Forensics and Security*, Vol. 13 (9), pp. 2203-2215.
- [13] Hansen, L.K., Salamon, P. (1990). Neural network ensembles, *IEEE Trans.*, 1990, PAMI-12, (10), pp. 993-1001.
- [14] Kodogiannisa, V.S., Boulougourab, M., Wadgea, E. and Lygourasc, N. (2007). The usage of soft-computing methodologies in interpreting capsule endoscopy, *Elsevier Engineering Applications of Artificial Intelligence*, Vol. 20 (4), pp.539-553.
- [15] Ma, Y. and Wang, Y. (2015). Text Detection in Medical Images Using Local Feature Extraction and Supervised Learning, *IEEE 12th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD)*, pp. 953-958.
- [16] Shuqi, C., Shen, C. et al (2017). Application of Neural Network Based on SIFT Local Feature Extraction in Medical Image Classification, *IEEE 2nd International Conference on Image, Vision and Computing*, pp.92-97.
- [17] Poomimadevi, C. S. and Sulochana, H. C. (2016). Automatic detection of pulmonary tuberculosis using image processing techniques, *IEEE WiSPNET conference*, pp.798-802.

- [18] Joykutty, B., Satheeshkumar, K. G. and Samuvel, B. (2016). Automatic Tuberculosis Detection using Adaptive Thresholding in Chest Radiographs, IEEE International Conference on Emerging Technological Trends.
- [19] Barabas, J., Capka, M., Babusiak, B. et al (2012). Analysis, 3D reconstruction and anatomical feature extraction from medical images, IEEE International Conference on Biomedical Engineering and Biotechnology, pp.731-735.
- [20] Chaudhary, A. and Sukhraj, S. S. (2012), Lung Cancer Detection on CT Images by using Image Processing, IEEE International Conference on Computing Sciences, pp.142-146.
- [21] Chen, H. and Huang, Z. H. (2014). Medical Image Feature Extraction and Fusion Algorithm Based on K-SVD, IEEE Ninth International Conference on P2P, Parallel, Grid, Cloud and Internet Computing, pp. 333-337.
- [22] Ding, Y., Zhao, Y. and Zhao, X. (2017). Image Quality Assessment Based on Multi-Feature Extraction and Synthesis with Support Vector Regression, Elsevier Signal Processing: Image Communication, Vol. 54, pp. 81-92.
- [23] Litjens, G., Kooi, T., Babak, E. B. et al (2017). A Survey on Deep Learning in Medical Image Analysis, Elsevier Medical Image Analysis, Vol. 42, pp. 60-88.
- [24] Kaur, B. and Jindal, S. (2014). An implementation of Feature Extraction over medical images on OPEN CV Environment, IEEE International Conference on Devices, Circuits & Communications.
- [25] Swati, V. S. and Vrushali, G. N. (2011). Design of Feature Extraction in Content Based Image Retrieval (CBIR) using Color and Texture, International Journal of Computer Science & Informatics, Vol-I (II), pp.57-61.
- [26] Hossein, M. M. and Jacques A. D. (2017). Enhanced X-ray image segmentation method using prior shape, IET Computer Vision, Vol. 11(2), pp. 145-152.
- [27] Oishila, B., Arindam, B. and Bhargab, B.B. (2016). Long-bone fracture detection in digital X-ray images based on digital-geometric techniques, Elsevier Computer Methods and programs in Biomedicine, Vol. 123, pp.2-14.
- [28] Seyyed, M. M., Mohammad S. H. et al (2012). Novel Shape Texture Feature Extraction for Medical X-Ray Image Classification, International Journal of Innovative Computing, Information and Control, Vol. 8 (1-B), pp. 659-673.
- [29] Ratnasari, N. R., Adhi S., Indah, S. et al (2013). Thoracic X-ray Features Extraction using thresholding-based ROI template and PCA-based Features

Selection for Lung TB Classification Purposes, IEEE 3rd International Conference on Instrumentation, Communications, Information Technology, and Biomedical Engineering (ICICI-BME), pp. 65-69.

- [30] Kazemina, N., Karimi, S.M., Soroushmehr, R. et al (2015). Region of Interest Extraction for Lossless Compression of Bone X-Ray Images, 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), pp. 3061-3064.

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