To Predict the Gender and Fracture from Skull X-ray Image from Various Image Analysis

B.J. Bipin Nair, Mathews Jose, S. Harikrishna

Abstract--- In our proposed work we are going to predict the gender and detect fracture from archeological skull image using various image analysis techniques. Due to the huge technological advancements in forensics as well as healthcare, determining the gender and predicting the fracture is easy with X-rays images. However, the major drawback of existing work is that conclusions are drawn based upon the prediction made by doctors manually. But from our system, using various medical image processing techniques like Histogram Equalization, Prewitt, Sobel and Canny Edge Detection algorithm we can predict the skull bones fracture, and by feature extraction we can predict gender using ROI. Our system works on the various efficient methods and algorithms developed to perform various operations on skull images, but these operations make life easy for the surgeons.

Keywords--- Histogram Equalization, Sobel, Prewitt and Canny Edge Detection, Region of Interest (ROI).

I. INTRODUCTION

Digital image processing is the interpretation of images in digital computers. It is one of the field in signals and networks but it concentrates on images. DIP focuses on progressing a computer system which is suitable to perform operating on images. The intake of that computer system is digital images and the system operate on that images using effective algorithms, and gives images as output. Medical Imaging is the method of generating visual depiction of the inside body for medical analysis.

The skull fracture is common problem in human beings due to accidents or other causes like bone cancer etc. The fractures can happen in any bone of our body like wrist, heel, ankle, hip, rib, leg, skull, chest etc. It is not possible to see fractures by our naked eyes, that's why X-ray or CT images are used to find it. But sometimes these images lack sufficient details needed to diagnose. So we try to overcome this by image processing. Skeleton of humans act as the very important proof during criminal investigation because it helps in predicting factors like gender etc.. Different body parts can be used to predict this, but we are using the skull x-ray used by the doctors to predict gender. This tool act as a second opinion to the doctors and thus more accuracy can be achieved. We are using craniometry, image processing methods, machine learning for more accuracy.

Manuscript received February 01, 2019

B.J. Bipin Nair, Department of Computer Science, Amrita School of Arts and Sciences, Mysuru, Karnatka, Amrita Vishwa Vidyapeetham, India. (e-mail: bipin.bj.nair@gmail.com)

Mathews Jose, Department of Computer Science, Amrita School of Arts and Sciences, Mysuru, Karnatka, Amrita Vishwa Vidyapeetham, India. (e-mail: tmathewsjose@gmail.com)

S. Harikrishna, Department of Computer Science, Amrita School of Arts and Sciences, Mysuru, Karnatka, Amrita Vishwa Vidyapeetham, India. (e-mail: hariskrishna39@gmail.com)

II. LITERATURE SURVEY

Dhiraj B et-al[1] describes - To develop a software system for surgeons which is far better in evaluating the X-rays and MRI than the existing technique. The procedure that the doctors have been using till today can help them find even more fractures using image processing algorithms. The suggested system The limitation in this method in some CT scans and some X-ray images it is difficult to find area of fracture, later it is fully applied to CT scan images and also can classify the type of fractures will happens. Girish Saraf et-al[2] describes-Nowadays curve of the frontal bone helps in determining the gender of human beings. It is done by using X-Rays, CT scan, MRI etc. However, results are drawn based upon the determination made by doctors manually. However, a second opinion from a computer will be good by evaluating and understanding the information from the image by using proper techniques and then interpreting the results by making effective use of the various image processing tools. The algorithms used here is double thresholding algorithms to find attached edges. The determination of the gender can be done using the system. However, to get more accurate results other parameters such as the chin bone, pelvis and more can be examined together with the frontal bone. Tanudeep Kaur et-al[3] describes Now a days skull fracture is usually diagnosed by x-ray, because fractures can't be seen by our naked eyes, a doctor will experience difficulty in reading and understanding the X-ray images because of the presence of different noise. By building proposed system, we can expect that the system will help the doctor to detect bone fracture correctly. Pre-processing of datasets, segmentation, edge detection of preprocessed image and fracture detection of image and classification are the proposed system. Canny Edge Detection algorithm is used here. In future we can use different type of segmentation algorithm to improve the fracture prediction and also implement another classifier. Rajitha Bakthula et-al[4] tells- various methods for age prediction from left hand x-ray images. These medicinal pictures must be well worked for good evaluation by the use of various Image Processing Methods. X-ray images are the datasets used. Image Enhancement, Rotation of bone pixels to proper angles, Segmentation, Measurement, Decision making and finding of region of interest [ROI] for analysis is obtained by different Segmentation methods.

By that ROI's the lengths and angles, Left Hand Image Analysis for BAA, GP, Tanner and Whitehouse Method (TW), Point Distribution Model are proposed. Many finders have used the preprocessing methods, enhancement technique, segmentation techniques, fuzzy logic, neural network, active shape models and clustering methods for automaticage prediction. In future one can use morphological image processing, color image processing, frequency and spatial domain enhancement methods etc. for better age evaluation and bone length measurement. Kamil Dimililer et-al [5] tells about to develop classifier that will be able to determining and categorizing the fracture by using separate image processing technique. Haar Wavelet transforms, (SIFT) Scale-Invariant Feature Transform algorithm are used here. The suggested algorithms could be improved for biorthogonal and daubechies wavelet transforms and their effects on detection of fractures to improve the accuracy in coming works photos. Finding correct structure of bone and cracktracki. Swathika et-al[6] describes- This paper is about automatic prediction of bone fracture by the use of X-raying is obtained by the use of a novel morphological gradient based edge detection methodology, after finding the morphology gradient canny edge detection is utilized. Pre-processing methodology and edge detection technique like canny are used here. Bone X-ray images are the dataset. Tanudeep Kaur et-al[7] describes -In this Paper they proposed fracture determination by the use of Fuzzy c-means and by Multilevel wavelet algorithms. Input an image, Remove the noise, Smooth the image, use Threshold Fuzzy C-Means (FCM), Gabor filter, Hough Transform to find bone, Wavelet decomposition Detection of fracture. x-ray images are the datasets. In future algorithms could be altered or can be applyon various dataset and also is used for detecting the hand, back bones and hip etc. Diyana et-al[8] describes- A new methodto predict head fracture and take out features, for this they use-Wan Mimi based retrievals of skull fracture cases in CT scan photos. Suggested method includes image equalization, centroid identification, multilevel global segmentation and skull skeletonization. Data sets used here is fractured CT skull images. Mangesh Sawadkar et-al[9] says – They suggested a system for gender predictionby using image processing and machine learning. The proposed work consists Neural Networks (NN) and Support Vector Machine (SVM) and image processing and Back Prop Algorithm is used here. The dataset is taken as cranial metrics x-ray image, Skull x-ray image and MRI. Shweta M Madiwal et-al[10] describes- In this study the skeletal age is calculated by the morphological research x-rays of left handand discrete wavelet or image transformations, energy based segmentation, Jacobi method, EMROI and CROI for feature extraction, ISEF edge detector and k-mean classifier. Dataset used here is x-ray of the left hand. Ismail Hmeidi et–al[11] describes-In this paper they proposed a system, that automatically detect fracture in the hand bones x-ray images using the methodologies like Image Pre-processing, Sobel edge detector, Feature Extraction and Selection x-ray images are the dataset used here. B. Gajjar et-al[12] describes-In this paper preprocessing, Segmentation, ROI searching and detection methodologies were used. Canny edge detection and double thresholding algorithms are used andHand long bone x-rays are taken as dataset. In the future, more robust algorithms to detect fractures in hand will be used. Amandeep Kaur et–al[13] describes –First they are preprocessing then doing the foundation of the edge boundary, creating the contour shape based model, Evaluation of the segmentation algorithm, point distribution algorithm using contours are used. Datasets are bone X-rays. Zhiyun Xu e et-al[14] describes -In this study their goal is to classify the spine x-rays by image characteristics that predicts gender. Customized Sequential CNN Model, ROI Image Cropping, Experimental Test, FINE-ENSENET TUNING, Experimental Test were the methodologies used. The Spine x-rays are the dataset used here. N. Shobha Rani et-al[15] Says about the recognition of machine printed Telugu documents. Segmentation of touching characters in machine printed Telugu documents like newspapers, text books achieved by them. Many segmentation techniques and Touching character segmentation is used here. Bipinnair B J et-al[16]says that about the K-mean algorithm for clustering data by their phenotype similarities. The prediction of genetic disease is by analyzing phenotypic features is also introduced in this paper.

III. PROJECT METHODLOGY

Preprocessing Technique

The fractured skull x-ray images needs to be preprocessed to increase the clarityof the images. While doing preprocessing, reducing noise, correcting shades and contrast enhancements are performed on the dataset. We used Histogram Equalization which removes the noise and increase the contrast of the image.

Sobel, Prewitt and Canny Edge Detection

The Sobel and Prewitt operator are used for edge detection from images. Both operators are also used for detecting edges of two types

- Vertical direction
- Horizontal direction

First it will calculate differences among the pixel intensity of an edge. The center row of mask contains zeros so it doesn't include the original value of edges in the images but it calculates the differences of above and below pixels intensity of the edge. This increase of change in intensities and creation of the edges is more visible. The image is smoothened by the use of Gaussian filter to decrease noise. Here two values are used as threshold. When the pixels are taken as an edge then its gradient is higher than maximum threshold value. If the pixel value has a gradient less than the minimum threshold value, then the pixel is taken as a background image. If the pixel value has a gradient between the highest threshold and lowest threshold, then the pixel will be considered as an edge only when the nearby pixel has a gradient which is an increased value than the highest threshold. Here, for detecting the Edges of cracked region two algorithms are used which include Sobel and Canny Edge Detection algorithm.

Feature Extraction

Feature extraction is used to extract the useful features from the image. Here we are finding ROI that is shape of the forehead in the skull x-ray image. After cropping the shape of the forehead region. We are detecting whether it is vertical or slopped is carried out. If shape is vertical then gender is female else gender is male.

FLOW DIAGRAM

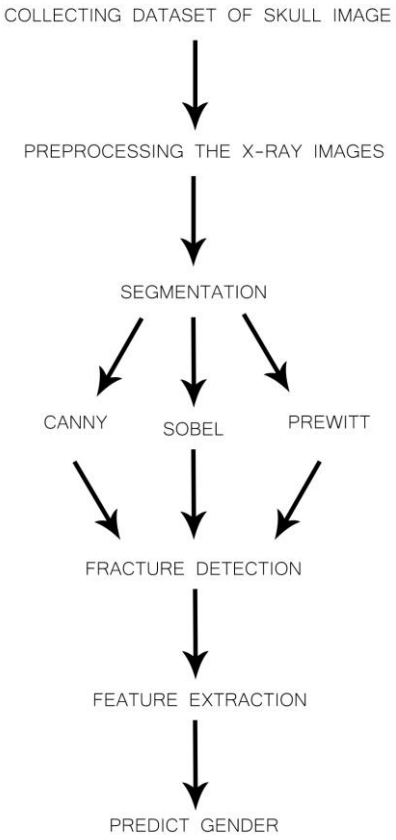

Fig. 1: Flow diagram

Data set

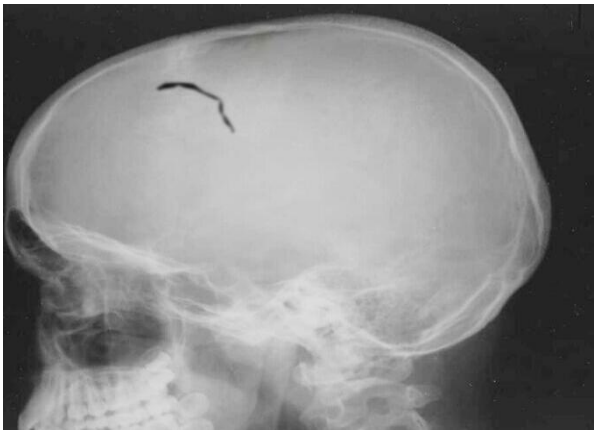

Fig. 2: Sample x-ray image

We Collected 50 dataset of skull x-ray images from hospital for our study as well as experimentation.

IV. MATHEMATICAL MODEL

Preprocessing

We are using histogram equalization for removing the noise from skull x-ray to increase the intensity of the pixel:

a) *Histogram Equalization*

It is a method aimed at altering image intensities to improve contrast.

$R_m = m / tp$

m – Number of pixel intensity

tp – Total number of pixels

Let $f$be assumed as a $\boldsymbol{A_r}$ by $\boldsymbol{A_c}$ matrix. The intensities ranging 0 to L – 1 (integer pixel). The histogram equalized image $\boldsymbol{k}$ definite by

$$\boldsymbol{k}_{a,b} = floor\,((L-1)\sum_{m=0}^{Fa,b} Rm)$$

anywhere floor() slices dejected to the adjacent digit.

Segmentation

Detecting the Edges of cracked region using Sobel and Canny Edge Detection algorithm

- **Morphological gradient analysis**

Difference images are attained by subtracting the eroded images from the dilated images

Diffe(p,q)=fa(p,q,A)-fb(p,q,A)

Where A denotes disc shape structuring element of mask size (3 x 3). Diffe(p, q) shows the variations in picture. diffe(p, q) denotes the difference image .fa(p,q,A)-denotes the dilated image. fb(p,q,A)indicates the eroded image.

Gradient picture is achieved from subtracting the difference from th preprocessed image and dilation of the gradient images are performed by using the diamond shape of structuring elements of mask size.

- **Sobel edge detection**

The Sobeledge detector is used to detect the edges from an image. It work**s** by estimating the gradient of picture intensity at each pixel in that image.

At each pixel in the picture, the gradient estimations given by Pa and Pb are rolled into one to afford the gradient magnitude, by

$P=\sqrt{Pa^2 + Pb^2}$

The gradient's path is calculated using:

$$\emptyset = arctan\frac{Pb}{Pa}$$

0 will indicates a vertical edge

- **Canny Edge Detection**

By using canny edge detection, the edges or boundaries can be achieved very accurately and fractured region from the image is also extracted.

1. Smoothening the image with Gaussian filter

where

$k(p,q)=K\sigma(p,q)*f(p,q)$

$k\sigma = \frac{1}{\sqrt{2\pi\sigma^2}}\exp(-\frac{p^2+q^2}{2\sigma^2})$

2. Compute the gradient

$D(q,q)= \sqrt{k^2 m(p,q) + g_q^2(p,q)}$

and

$$\theta = (p,q) = \tan^{-1}[k_q(p,q)/k_p\ (p,q)]$$

Threshold D:

$$D_T(p,q) = \begin{cases} D(p,q), & if\ D(p,q) > L \\ 0, & otherwise \end{cases}$$

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

where L is edge element

$\theta(p,q)$ −two value along the gradient direction

D_L - Suppress non-maxima pixels

L1 and L2-Threshold the past result by two different threshold values

Feature Extraction

- **Prewitt Edge Detection**

The operator is used to detect the boundaries or edges of the image.

P_a and P_b are two pictures which at each point contains the vertical and horizontal derivative estimations

$$P=\sqrt{p_{a^2}+p_{b^2}}$$

Using this, we can also calculate the gradient's path:

$$\theta = atan2\,(p_{a/}p_{b)}$$

where, **Θ** is 0 for a vertical edge

- **Finding ROI(Region of interest)**

Finding ROI, that is the shape of forehead. Next step is to crop the region of interest. Thus the frontal bone part of the image is obtained. Next we have to find whether the forehead is slopped or vertical in shape. If it is detected as slopped gender is male or else if it is vertical, then gender is female.

V. EXPERIMENTAL RESULT

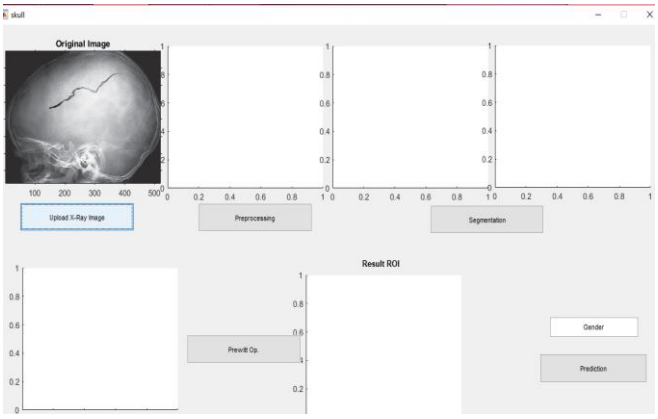

Fig.3: Inputting X-ray image

Collected dataset of fractured skull x-ray images and given as input to the system.

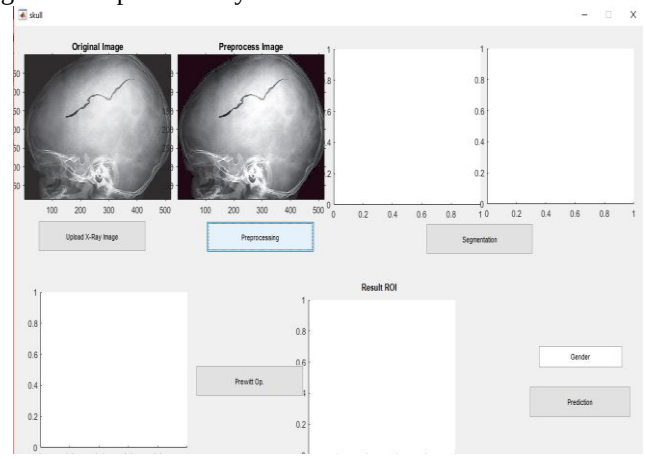

Fig.4: Preprocessing x-ray image

Preprocessing using Histogram Equalization technique in order to reduce noise and increase intensity of the image.

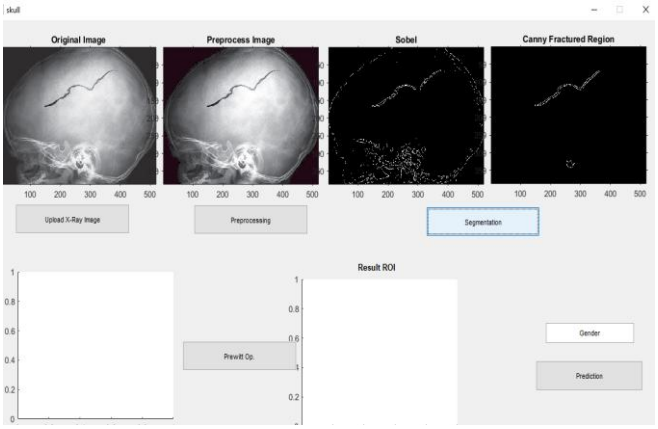

Fig.5: Segmented X-ray image(Fractured Region)

Segmented using segmentation algorithms like sobel and canny edge detection algorithms and predicted the fractured region from the fractured skull x-ray image.

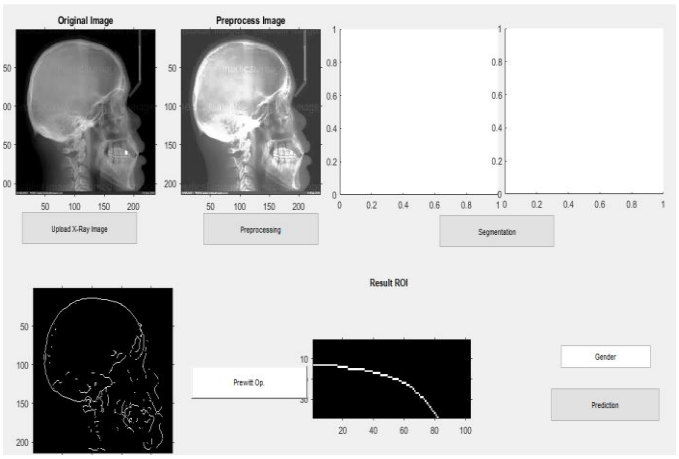

Fig.6: Selecting ROI(Region of interest)

Finding the RIO(Region Of Interest) that is shape of the forehead in the skull x-ray image. After that cropping the shape of the forehead region.

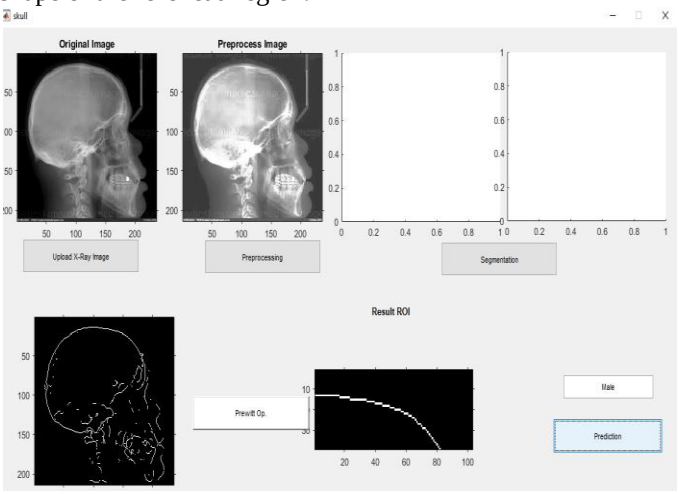

Fig.7: Predicting Gender

After cropping ROI, detecting whether it is vertical or slopped is carried out. If shape is vertical then gender is female else gender is male.

VI. CONCLUSION

Our project handles prediction of gender and detection of fracture from skulls obtained from X-ray images. As the existing methodologies cannot automatically predict the gender, the proposed method will surely help in increasing the accuracy of the prediction. X-ray images are tested manually but it is takes more time and is attracted to errors. In future we can predict age also from X-ray image and we can analyze minute fracture also using deep learning technique. As x-ray images are too much attracted to noise we use preprocessing methods to remove noise and blur from images[fig.4]. Noise is removed and transformed to clearer image so that it becomes easy for the system to detect fracture. We are using image processing technique to track bone. Unwanted things and the smallest objects are removed by the system. The fractured region is successfully extracted using segmentation techniques [fig.5].The determination of the gender is done based on the shape of the frontal bone. So after finding Region of interest (fig.6) and finding the shape of frontal bone, if it is detected as vertical then the gender is female or else if it turned out to be slopped then the gender is male. Thus successful prediction of gender is carried out(fig.7).

REFERENCES

1. Gludovatz, B., Hohenwarter, A., Catoor, D., Chang, E. H., George, E. P., & Ritchie, R. O. (2014). A fracture-resistant high-entropy alloy for cryogenic applications. *Science*, *345*(6201), 1153-1158
2. Tejaswi, H. L., & Dakshayani, K. R. (2014). of the Article: Anatomical Variations in the Arterial Supply of Gall Bladders in South Indian Cadavers. *Indian Journal of Forensic Medicine & Toxicology*, *8*(1), 1208
3. Rani, C. D. S., Cheema, C. C. D. G. S., Singh, A. K. G. E. A., Kumar, K. O. S. M. M., Divesh, G. E. S. K. E., Randhir, K. E. A. S. E., & Singh, S. D. A. K. Advancements in Engineering and Technology
4. Bakthula, R., & Agarwal, S. (2014). Automated human bone age assessment using image processing methods-survey. *International Journal of Computer Applications*, *104*(13)
5. Dimililer, K. (2017). IBFDS: intelligent bone fracture detection system. *Procedia Computer Science*, *120*, 260-267.
6. Segmentation, M. G. B. I. Radius Bone Fracture Detection Using Morphological Gradient Based Image Segmentation.
7. Mungona, S. S., &Sawarkar, M. N. M. (2018). Diagnosis of X-Ray Using Gabor Wavelet Transform
8. Zaki, W. M. D. W., Fauzi, M. F. A., &Besar, R. (2009, November). A new approach of skull fracture detection in CT brain images. In *International Visual Informatics Conference* (pp. 156-167). Springer, Berlin, Heidelberg
9. Sawadkar, M., Keni, N., & Agarwal, R. (2016). Machine Learning Based Gender Detection Using Craniometric Analysis. *International Journal of Engineering Science*, *1773*.
10. Pietka, E., Pospiech-Kurkowska, S., Gertych, A., & Cao, F. (2003). Integration of computer assisted bone age assessment with clinical PACS. *Computerized medical imaging and graphics*, *27*(2-3), 217-228
11. Al-Ayyoub, M., Hmeidi, I., &Rababah, H. (2013). Detecting Hand Bone Fractures in X-Ray Images. *JMPT*, *4*(3), 155-168.
12. Gajjar, B., Patel, S., &Vaghela, A. (2017). Fracture detection in X-ray images of long bone
13. Kaur, A., & Mann, K. S. (2018). Segmenting Bone Parts for Bone Age Assessment using Point Distribution Model and Contour Modelling. In *Journal of Physics: Conference Series* (Vol. 933, No. 1, p. 012004). IOP Publishing.
14. Xue, Z., Rajaraman, S., Long, R., Antani, S., &Thoma, G. (2018, June). Gender Detection from Spine X-ray Images Using Deep Learning. In *2018 IEEE 31st International Symposium on Computer-Based Medical Systems (CBMS)*(pp. 54-58). IEEE
15. Rani, N. S., CH, P., & Sharan, J. (2015). Segmentation and Recognition of Touching Characters In Machine Printed Telugu Documents Using Average Character Widths and Central Moments Features. *International Journal of Applied Engineering Research*, *10*(8), 19575-19583.
16. Bipinnair B J, Bhuvana P and PriyankaG(2015) Prediction Of Genetic Disorder By Using Phenotypic And Genotypic Information Using Clustering Approach. International Journal of Applied Engineering Research, *10*(4), 10783-10793

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication