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Detection of Fractures in Orthopedic X-Ray Images

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***Abstract*:** Computer detection of fractures in orthopedic X-ray images is very difficult and stimulating process. Bones can crack in multiple ways having a variety of degrees of severity. The Severe fractures effect drastically to the shape of the longest bones, mild fractures do not affect gammon's shape and only elusive indications are observed in orthopedic X-ray images. A Large number of image processing procedures have been tested with orthopedic X-ray images having several types of fractures. The proposed work is to designate the fractures in orthopedic X-Ray images using edge detection, intensity based segmentation and frequency transformation based methods. An analysis has been performed using proposed algorithm on various orthopedic X-ray images depending upon the image characteristics and fracture type. The proposed work discovered an image processing algorithm that first performs orthopedic X-ray image enhancement, then performs the segmentation of region of interest of bone along with edge detection and feature extraction of broken area of bones. Then by applying morphological filtering, determines the expected region of fracture in test orthopedic X-Ray image. The analysis reveals improvement in timeliness and accuracy in clinical diagnosis. Results outshined both quantitatively as well as qualitatively when compared with other existing techniques. Also the clinical validation of Results has been performed.

***Keywords*:** Orthopedic, Fracture, Segmentation

1. INTRODUCTION

Bones would inflexible, yet they do bend alternately "give" will A percentage degree At an outside compel is associated. Be that Likewise it may, if the compel may be exorbitantly incredible, the bones will break, virtually as a plastic ruler breaks The point when it may be bowed a really far. The reality of crack Likewise a standard depends for upon the compel that brought on the break. In the occasion that the bone's breaking point need been surpassed barely somewhat, after that the bone might part as opposed to break totally through. On the off possibility that those drive is great, to example, clinched alongside a pile up or a discharge, the bone might break. In the off chance that those bone breaks for a way that bone ends emerge through those skin, alternately a harm infiltrates down of the broken bone, the crack will be known as a "open" crack. This sort crack is particularly real clinched alongside light of the certainty that once the skin will be broken, tainting done both those harm and the bone could happen [1]. The bones break contrastingly atthe mellow incredibly rapidly the thing that happens up component fractures brought with respect to Toward helter skelter velocity alternately secondary vitality stacking – e. G. Impact. Toward the side of the point when a bone may be broken quickly, in a situation including a considerable measure of engine vitality, the resulting crack is exceptionally comminuted [7].

1.1 Diagnosing a Fracture

An X-ray is those practically normal best approach to diagnose a crack. An X-ray camwood give acceptable a thorough picture of the bone and uncover any breaks. With an X-ray, your doctor might determine a fracture's sort Also correct area. Previously, a percentage instances, attractive reverberation imaging (MRI) or figured tomography examine (CT alternately feline scan) might be utilized for further examination[2].

1.2 Types of fractures according to various characteristics

There are different routes about describing fracture, generally identified with those severity, those kind about anxiety bringing on those crack Also states that build those probabilities from claiming crack. Fractures watched in archeological or measurable setting need aid for the most part portrayed Concerning illustration basic alternately multi-fragmented Furthermore further ordered as stated by its geometric properties (i. G. Winding or linear), the position alternately area of the crack (long bone alternately skull fractures), those introduction of the crack relative of the bone in length hub (i. G. Straight alternately transverse) or the culmination of the break [3][6].

1.2.1 Completeness

In the break doesn't experience the whole bone What's more bone pieces need aid at present incompletely joined, it may be called a inadequate break e. G. Gap crack that influence special case cortical surface about bone alternately "greenstick fractures" in Youngsters bone the place the breakage Furthermore]. Bowing for bone is combined, fig. 8). Though the break passes quite through the bone Furthermore separate pieces completely, it may be known as a complete crack [8].

1.2.2 Outline

A finish break that separates those bone Exactly done two bits will be called a basic break while an break that brings about three or that's only the tip of the iceberg bone pieces will be called An multi-fragment alternately comminuted crack (fig. 8). A distinct crack lines need aid interconnected in that crack Also might need transverse, angled alternately winding character. Those straight fractures run parallel of the in length hub of the bone, in this way along those barrel shaped osteon tubes same time transverse fractures run over the bone hub toward a right edge (fig. 8). These fractures need aid initiated basically Eventually Tom's perusing bowing strengths. Transverse fractures might be generally

smooth birch or rough, frequently bring a profound teethe on the crack surface [3]. The angled crack dives diagonally and crosses the long bone hub in roughly a 45° point (fig. 8). Those edges for an angled crack would Typically smooth; those cortical edges are instead level over sharp. These fractures for the most part bring about shortages from bowing for superimposed pivotal layering. A winding crack is described Toward an helical break that spirals along the in length hub of the bone (fig. 8). It will be normally created Toward torsional bending or rotational drives The point when no less than you quit offering on that one and only those bone need been turned alternately turned. Bowing from claiming bone is combined, fig. 1.1). Though the break passes totally through those bone Also differentiate pieces completely, it may be known as a complete crack [9].

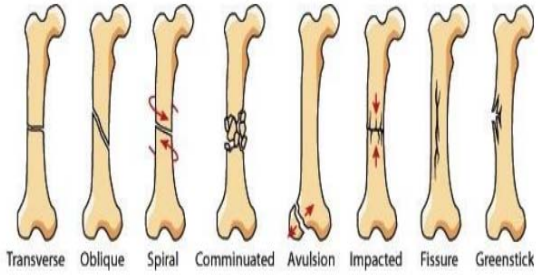


Figure 1.1: Different long bone fractures [4]

The affected break (fig. 8) may be created when bone fragments, for the most part cortical, need aid compelled or affected under crossed out bone alternately under one another. This sort commonly happens in those finishes of long bones. Layering fractures would comparative to affected ones, yet the term may be normally used to depict fractures to which crossed out bone collapses and compresses upon itself, normally in vertebra figures taking after trauma of the spine [5]. The most recent two sorts from claiming fractures need aid a greater amount incessant clinched alongside skull over in in length bones. The separation crack happens when a part of bone may be differentiated from those primary impostor (fig. 8). The transmitting fractures commonly begin from the purpose of anxiety Furthermore augment Concerning illustration drive dissipates through the bone At concentric alternately “hoop” fractures happen circumferentially around those purpose from claiming sway [3].

2. Methodology

1. To understand the concept of Bone Fracture by using edge detection in Digital Image Processing.
2. On review those written works identified with bone crack identification.
3. Will uproot the commotion exhibit in the X-RAY pictures.
4. Will outline Furthermore execute the progressed crack identification procedure.
5. To compare the proposed technique with the already existing technique.

3. Results and discussions

We have gathered various bones broken images and take it as info information for our algorithms. Ourproposed algorithms actualized in the MATLAB reproduction stage. Here in the screen shot of execution of code in MATLAB.

3.1 Evaluation Criteria

In the proposed work, above all else we select a image for acknowledgement of breakage in the bone. In the proposed work firstly we locate the heavy bone region area shape the rest part of the image. This is done by the segmentation of the image .In which we make the few segments of the image and find out the area having bones in the selected image [10] .e.g following is the input image for the recognition.

For the segmentation of the bone part of the image we apply adaptive histogram equalization on the image. This procedure is utilized to increase the contrast to the several parts of the image, which are valuable to recognize the breaking area with in the bone. Following is the output of the selected image after applying the adaptive histogram equalization on the image [11].

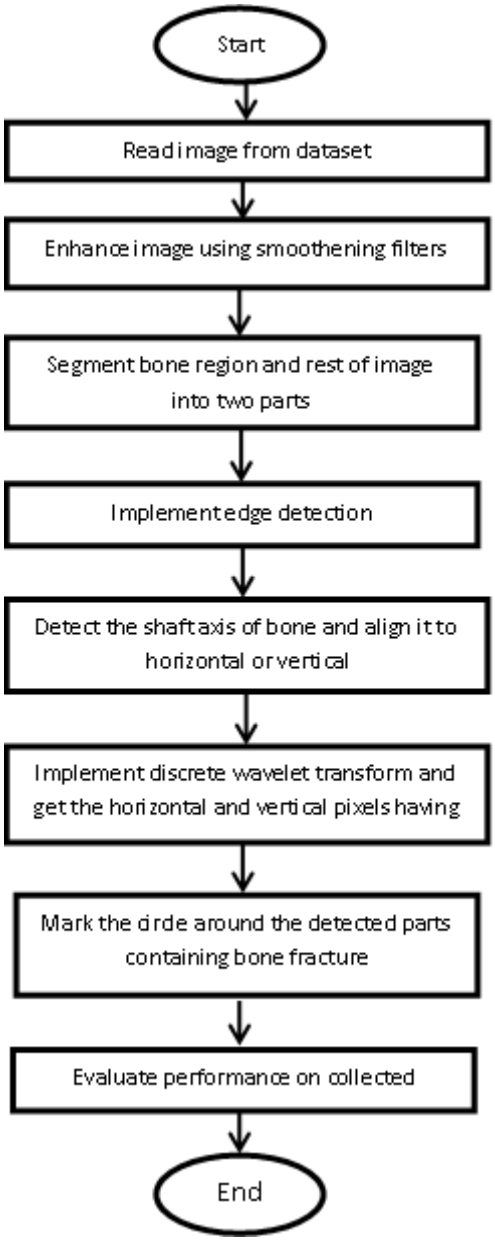


Fig 2.1: Flowchart of Methodology

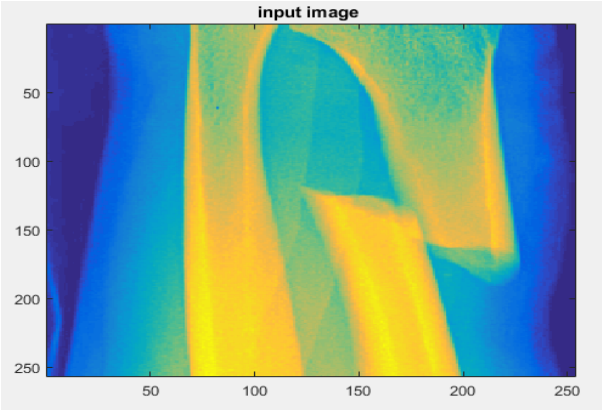


Fig 3.1: Input image of Bone fracture

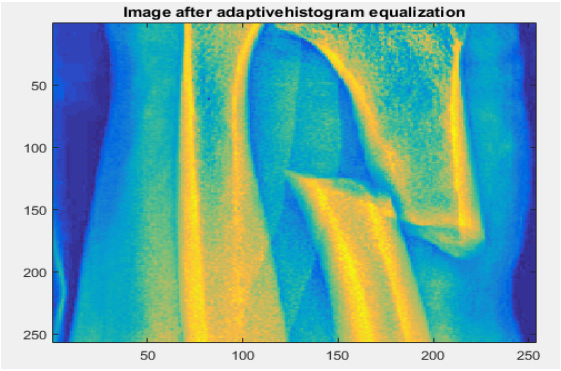


Fig 3.2: Selected image after adaptive histogram equalization

Presently we have the image after adaptive histogram equalization. Now we apply the median filter to remove the noise within the image. Really median filter is a nonlinear digital noise filtering technique, which is used to reduce the noise within the image. Following is the output of the image after applying the median filter to image [11].

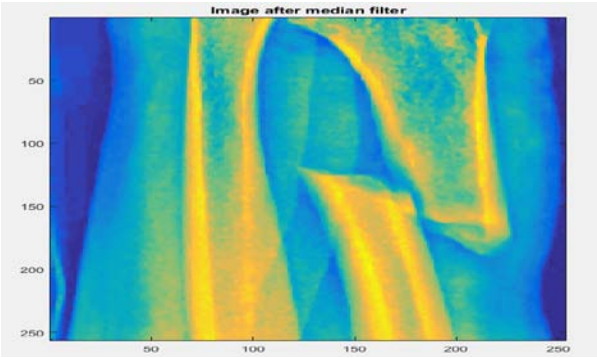


Fig 3.3: Selected image after applying median filter

After applying the median filter, we apply wiener filter, which is utilized to create an estimation of required and craved arbitrary procedure by linear time- invariant filtering. Following is the output of selected image after applying the wiener filter and it is a maximum noise free image [11].

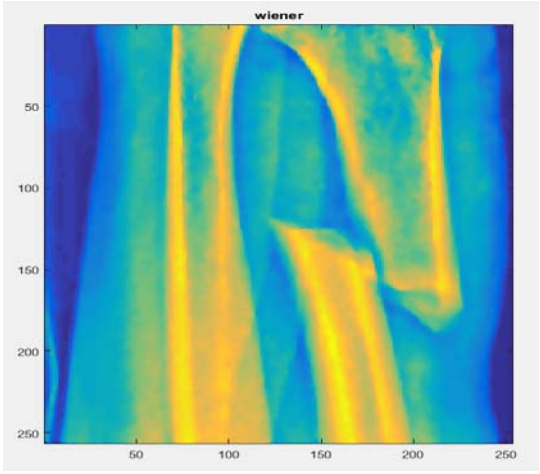


Fig 3.4: Wiener image of selected image

We apply median filter and wiener filter to remove the maximum noise from the input image. For the representation results we represent the histogram of noise free image. Following is the histogram output image of the noise free selected image.

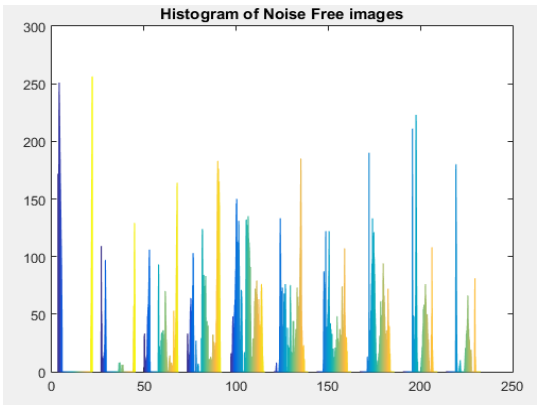


Fig 3.5: Histogram of Noise Free images

Now after removing the noise from selected image, now we apply probability and cumulative function to smoothen the selected image. Due to which it is easy to get the desired results. Following is the figure, which is showing the image after applying the probability and cumulative function on the image [11].

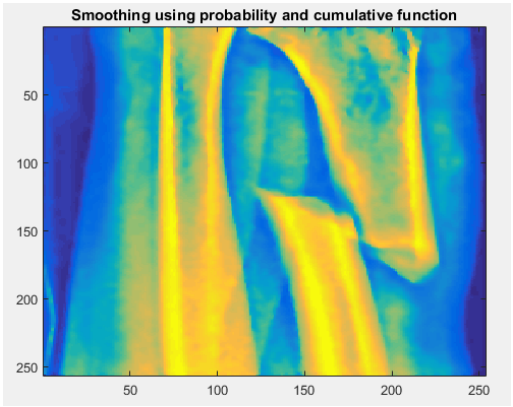
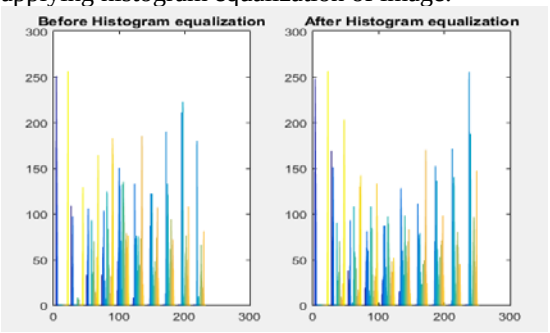


Fig 3.6: After smoothing image after using probability and cumulative function

Now after smoothing of image, we apply histogram equalization on the selected image. This is to adjust the intensity of the image and due to which contrast of the

selected image is enhanced. Following is the figure showing the difference between outputs of the selected image after applying the histogram equalization on it and before applying histogram equalization of image.



(a) (b)

Fig 3.7: (a) Before histogram equalization (b)After Histogram equalization

Now after the histogram equalization we apply the threshold technique for the segmentation of the selected image. Threshold technique is to way to convert the various pixel of the image into black pixels as the intensity value of the pixels is less than the required intensity value. Following is the output image after applying the threshold technique to the selected image [11].

Fig 3.8: Image after segmentation using threshold

After the segmentation of the selected image, now we apply the morphological operation on the image. Morphological operations are of two types i) Dilation ii) Erosion. First we apply the erosion technique in which the value of the pixel is the minimum value from its neighbor pixels. Then dilation type is applied on the selected image, in which the value of pixel is the maximum value of the selected image. Following is the output of the selected image after applying morphological operations on the selected image [11].

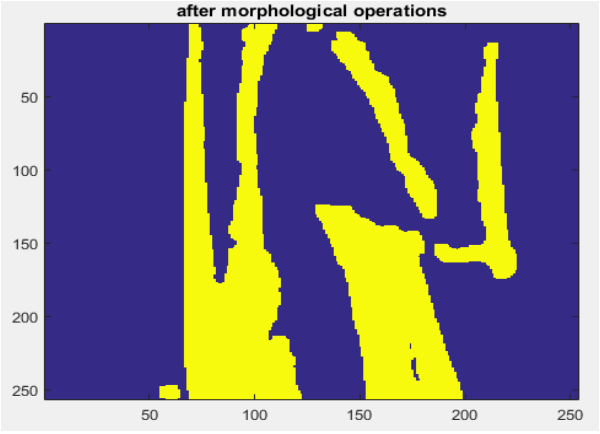


Fig 3.9: Selected image after erosion and dilation operation

After the morphological operations, the selected image is converted to the binary image. Following is the selected image after the binarization [11].

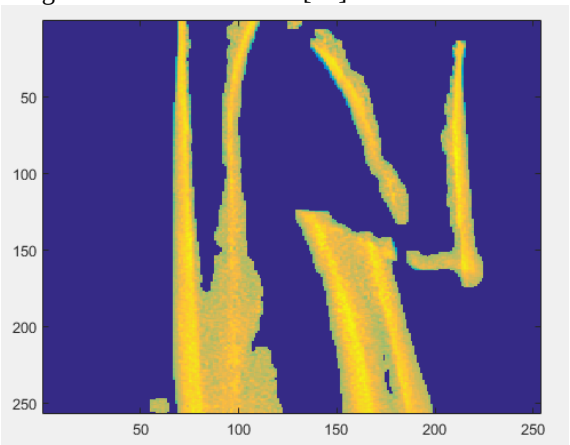


Fig 3.10: Selected image conversion from gray scale to binary image

After the binarization of image, Fuzzy C-mean clustering technique is applied on the image. Fuzzy C-mean clustering is way to make the cluster or classes of the image pixels based on distance, intensity and connectivity between them. Following is the output image of selected image after applying FCM on the image.

Fig 3.11: Binary image after applying the FCM

Now we have applied the FCM on the image, and the image pixels are clustered in this technique. This is done to so that we can find the edges of the bones within the image. Following is the selected image after finding the edges of it.

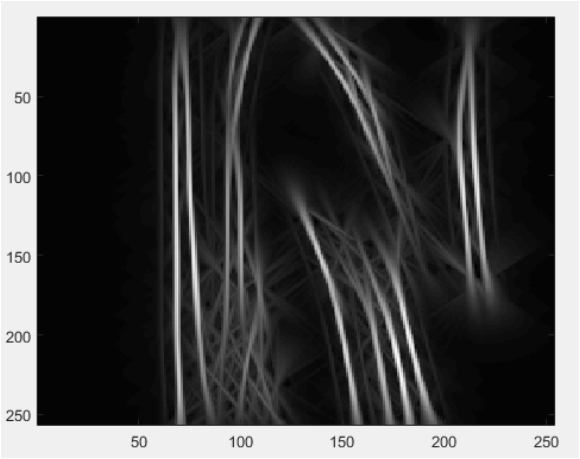


Fig 3.12: Image after finding the edges.

After finding the edges of the image, we selected the only pixels which are required for out outcome. For this we apply intensity measures to remove the unwanted pixels so that the output is of only required pixels. Following is the output of the selected image [12].

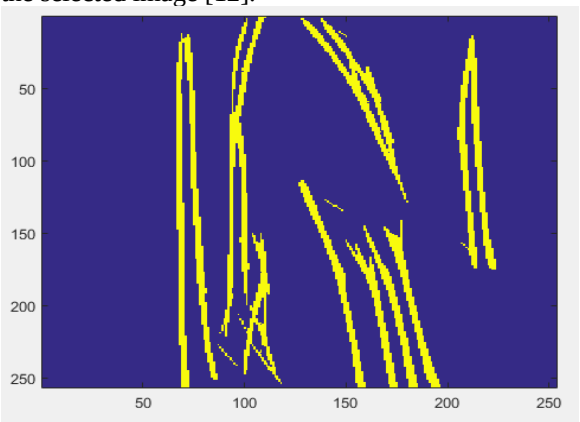


Fig 3.13: After selected pixels based on intensity

After finding the edges on based of intensity of the selected image. Again apply morphological operation for thinning of image and also convert it in black and white color so that the outcome can be easily get and unwanted pixels can be removed. Following is figure showing thinning image after morphological and black and white operation.

Fig 3.14: Image showing the edges of the selected figure

Now after these operations we have to find the longest line segments with in the image so as to recognize the breakage area in the broken bone image. For this we plot pixels and mark on the line segments and know about the lines between them. Following is output image after marking the longest line segments between them [12].

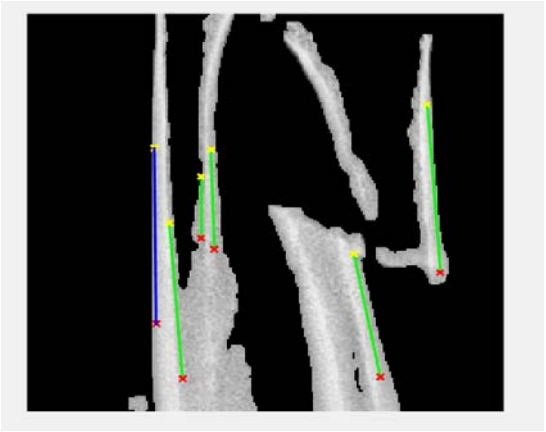
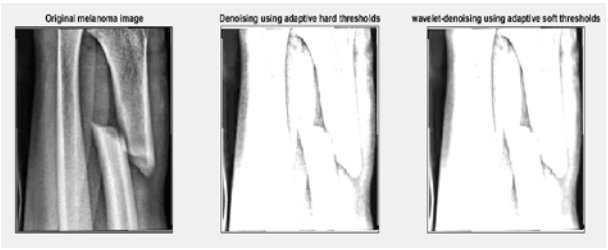


Fig 3.15: Figure applying transform in order to show the longest lines and plotting signs to them and highlighting the longest line segment

Now we have plotted the marks on the longest lines and have to know the slopes of marked and recognized line segments. For this we slightly rotate the image, so as to know the slopes of the required line segments with in the selected broken bone image.
Here slope taken = 0.0088, angle1 = -89.4930, angle1 = 0.5070 is the outcome on the selected image after finding the slope of the image.

Following is the image after applying the rotating operation on the image.

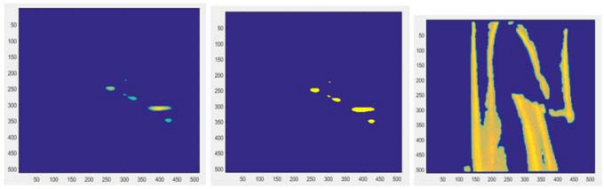
Fig 3.16: After rotating and getting the slope of the image



(a) (b) (c)

Fig 3.17: (a) Figure showing the original melanoma image. (b) Figure showing the selected image after de-noising using adaptive hard thresholds. (c) Figure showing wavelet-de-noising of selected image as soft thresholds.

Now after de-noising of image, we have to find the breakage area of bone. For this we check the maximum possibility of breakage as checking it on different intensities of the images.



(a) (b) (c)

Fig 3.18: Figure showing the maximum possible areas of finding the breaking area in the image.

After checking the image on different intensity the following is the outcome of the image with maximum possible area of image.

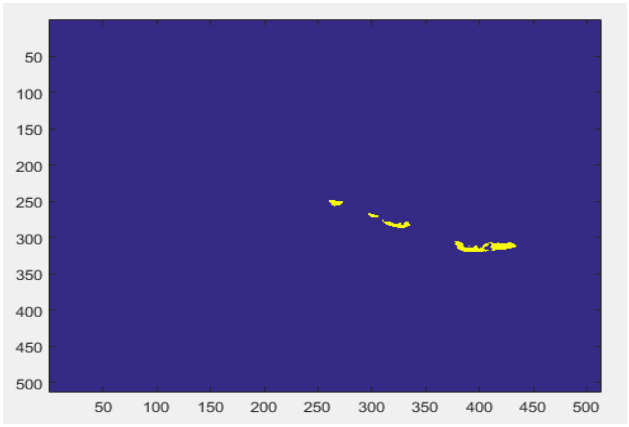


Fig 3.19: Maximum possibilities of breakage area of bone

Now we have found the maximum possible area of breakage with in the image. And now we compare the recognized area with original selected image and following is the output image with marked circle plotted on it.

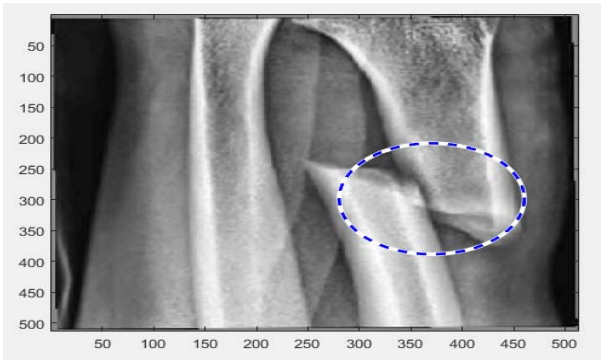


Fig 3.20: Final image of breakage of bone.

4. QUANTITATIVE RESULTS

4.1 Overall Classification Accuracy

It is defined as the mean of the summation of sensitivity and specificity values. For the measuring of accuracy of our present algorithm we get the result of output of 35 images, out of which 2 images are non-fractured image and 33 images are fractured. In which our algorithm is showing correct result on 33 true images.

Table4.1: Classification accuracy Table

Accuracy Method	Previous method outcome	Previous method %age	Proposed method outcome	Proposed method %age
Sensitivity	12/15	80	31/33	93.93
Specificity	14/15	93.33	2/2	100
Predictive value	12/13	92.13	31/31	100

Negative predictive value	14/17	82.35	2/4	50

4.2Overall accuracy comparison:

Table 4.2: Overall accuracy comparison Table

	Sensitivity	**Specificity**	**Overall accuracy**
Previous method	80	93.33	86.67
Proposed method	93.93	100	96.96

As seen in the above table the resulting figures are showing the accuracy of proposed method as compared to the previous method. The overall accuracy of the methods is calculated by sensitivity and specificity of the outcomes. So overall accuracy of previous method is 86.67 percent whereas overall accuracy of our present algorithm is 96.96 percent.

5. CONCLUSION AND FUTURE SCOPE

In Proposed work, a procedure to perceive the fracture of bone from an input image has been presented. Forthis, first a dataset of various sorts of images of fractures of bones was made. Then various types of noiseswere removed from it by using median filter and wiener filter, and smoothened it using probability and cumulative function. Then Threshold technique was applied on to select thepixels for required intensity and also morphological operation were applied on it. After this, Fuzzy C-mean clustering algorithm was applied, which was required to segmentation of the bone area with in the image. By which wewere helpful torecognize theedges of the bones in the image, which was further helpful in finding the segments of the bones so as to know the breaking bone segment. Thisbreaking bone segment was used to know the slope of desired area. Thenvarious intensity methods were applied for recognizing the maximum possible area of fracture with in the image. As aresult, the method was successfully recognizing the fracture area of the bone and was marked under a circle with in the resultedimage.

As there were also several techniques to recognize the fracture area of bones using image processing.But these were not sufficient. The proposed algorithm is capable to find the several types of breakage within bones of several types.

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