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Computer- Aided Fracture Detection Of X-Ray Images

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ABSTRACT:*The usage of medical images has been increasing tremendously due to a collection of thousands of medical images every day in medical institutions. Due to the increase in medical images there is a rising need of managing the data properly and accessing it accurately. Finding the correct boundary in noisy images is still a difficult task. It introduces a new edge following technique for boundary detection in noisy images. Use of the proposed technique demonstrates its application to diverse cases of medical images. The proposed technique can detect the boundaries of objects in noisy images using the information the fracture detection on the x-ray images is founded. The proposed technique for the canny edge detector in the x-ray image locates the edges and using the boundary detection, the system which detect the fracture automatically. The boundary detection techniques also implemented in the models are Active Contour Model, Geodesic Active Contour Model and compare the accuracy of detecting is analyzed and tested by using Mat lab 2013 version.*

Keywords:- *Boundary extraction, Edge vector field model, Edge mapping model, Edge following technique.*

I. INTRODUCTION

X-ray is the one of the oldest technique to capture the bone shape. A bone x-ray are the images of the bone in the body, such as the hand, wrist, arm, elbow, shoulder, etc., [1]. Fracture is defined as the typical alignment of bones it occurs when the bone cannot withstand outside forces. Automatic detection of fractures from x-ray images can assist doctors to suggest and help for the accuracy of the diagnosis. During the fracture detection, the segmentation algorithm is used for edge detector to identify the edges, which separates the object and background and also indicate the overlapping between the boundaries. In fracture detection system, with the help of edge details, the bone region part only from extracted from the x-ray image and the fracture is detected very efficiently. From the visual inspection of the images obtained it can be seen that the canny edge detector is the efficient algorithm in identifying the edges clearly. On the other hand, region-based approaches are based on similarity of regional image data. Detection of edges in an image may help for image segmentation, data compression, and additionally help for well matching, such as image reconstruction and so on [3]. The variables involved in the selection of an edge detection operator include Edge orientation, Noise environment and Edge structure [2]. However, the performance evaluation of image segmentation results is still challenging problem as they fail to extract the correct boundaries of objects in noisy images. Effects such as refraction or poor focus can result in objects with boundaries defined by a gradual change in intensity [4]. The strategy of edge-based approaches is to detect the object boundaries by using an edge detection operator and then extract boundaries by using the edge information. The problem of edge detection is the presence of noise that results in random variation in level from pixel to pixel. Therefore, the ideal edges are never encountered in real images [5], [6]. A great diversity of edge detection algorithms has been devised with differences in their mathematical and algorithmic properties of which are based on the difference of gray levels [7], [8], [9], and [10]. The difference of gray levels can be used to detect the discontinuity of gray levels. From the visual inspection of the images obtained it can be seen that the canny edge detector is the efficient algorithm in identifying the edges clearly. On the other hand, region-based approaches are based on similarity of regional image data. Some of the more widely used approaches are thresholding, clustering, region growing, and splitting and merging. The ACMs also known as snakes are curves defined within an image domain that can be moved under the influence of the internal energy and external energy [11], [12], [13], [14]. The internal energy is designed to keep the model smooth during deformation. The external energy is designed to move the model toward an object boundary or other desired features within an image. However, the snake has weaknesses and limitations of small capture range and difficulties progressing into concave boundary regions. The GAC model is an extension of the ACM by taking into account of the geometric information of an image. Many people suffer from bone fractures. The International Osteoporosis Foundation reported that the lifetime risk of getting osteoporotic fractures in women is 30%–40% and 13% in men worldwide. In this paper, proposed a method of detecting fractures using the edge linking technique.

1.1Types of segmentation technique

The most commonly used segmentation techniques can be categorized into two classes,

a. Edge-based approach

Edge based methods is to use an edge detection operator such as Canny which is used for detecting the object boundaries and then extract the boundaries by using edge information. Edge based methods center around contour detection. The weakness of the edge based method is resulting regions may not be connected; hence edges need to be joined and prone to failure in the presence of blurring.

b. Region based approach

Region based methods partition an image into connected regions and by grouping neighboring based on image properties. The image properties consist pixels of the intensity values from the original images and values are computed based on an image operator and texture unique to each region. Region based methods are based on similarity of regional image data.

II. OVERVIEW OF THE PROPOSED APPROACH

This system proposes a new technique for boundary detection for ill-defined edges in noisy images using a novel edge following. The proposed edge following technique is based on the average edge vector field model and the edge map. Using the canny edge detection result to detect the fracture.

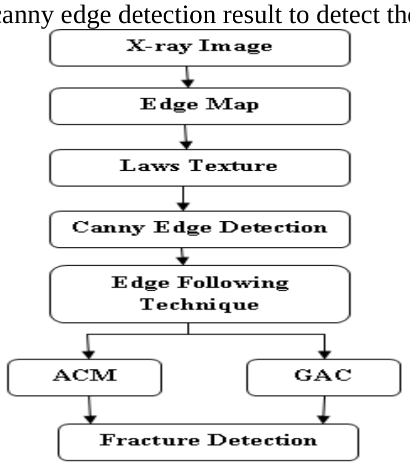

Fig 1: Work Flow of proposed Fracture Detection

III. EDGE DETECTION

Edge detection is an issue of crucial essentialness in picture examination. In ordinary pictures, edges describe object limits and are accordingly convenient for division, enrollment, and distinguishing proof of items in a scene. Edge recognition of a picture lessens fundamentally the measure of information and channels out data that may be viewed as less important, safeguarding the essential structural properties of a picture. The investigation continues in two parts: Intensity changes, which happen in a regular picture over an extensive variety of scales, are distinguished independently at distinctive scales. A suitable channel for this reason at a given scale is discovered to be the second subordinate of a Gaussian. Force changes at a given scale are best caught by discovering the zero qualities of the picture. The intensity changes discovered in each of the channels are represented by oriented primitives called zero-crossing segments. Edge detection is the detection and localization of image edges and also the first step in image segmentation.

a. Average Edge Vector Field Model

It exploits the edge vector field to devise a new boundary extraction algorithm. Edge vectors of an image indicate the magnitudes and directions of edges which gives a vector stream flowing around an object where an unclear image these vectors are distribute randomly [17]. The competence of the past edge vector field by applying a nearby averaging operation where, the quality of every vector is traded by the normal of every last one of qualities in the neighborhood. It applies a 3 × 3 window as the neighborhood N throughout the work.

Fig 2(a) Original image.
Fig 2 (b) Result from the proposed average edge vector fields and zoomed-in image.

An example of the average edge vector field is displayed in Fig. 2(a).Fig. 2(b) shows the results of the average edge vector field of the original image in Fig. 2(a). From the result, the proposed edge vector field yields more descriptive vectors along the object edge than that of the original edge vector field.

b. Edge Map

Edge map is the edges of objects in an image derived from Law's texture and canny edge detection.

c. Law's texture

The texture feature images of Law's texture are computed by convolving an input image with each of the masks. Given a column vector L= (1, 4, 6, 4, 1) ^{T}, the 2-D mask l(i, j) used for texture discrimination in this research is generated by $L \times L^{T}$. The output image is obtained by convolving the input image with the texture mask.

d. Canny edge detection

The Canny technique is implemented in five separate steps, as

1. Smoothing: Blurring of the image to remove noise.
2. Finding gradients: The edges should be marked where the gradients of the image has large magnitudes.
3. Non-maximum suppression: Only local maxima should be marked as edges.
4. Double thresholding: Potential edges are determined by thresholding.
5. Edge tracking by hysteresis: Final edges are determined by suppressing all edges that are not connected to a very certain (strong) edge.

The canny edge detector first smoothen the image, to eliminate noise and then finds the image gradient to highlight regions with high spatial derivatives. The algorithm then tracks along these regions and suppresses any pixel that is not at the maximum (non maximum suppression). The gradient array is then further reduced by hysteresis. Hysteresis is used to track along the remaining pixels that have not been suppressed. Hysteresis uses two thresholds and if the magnitude is below the first threshold, it is set to zero (made a non-edge), else it is made an edge. If the magnitude is between the two thresholds, then it is situated to zero unless there is a path from this pixel to a pixel with a gradient above T2.

e. Edge Following Technique

The edge following technique is performed to find the boundary of an object and takes the edge magnitude as primary information for edge following and this information is not enough for searching correct boundary of objects in noisy images this is the main reason that fail to extract the boundaries. To overcome this problem proposed an edge following technique by using information from the average edge vector field and edge map. The magnitude and direction of the average edge vector field give information of the boundary which flows around an object. In addition, the edge map gives information of edge which may be a part of object boundary. Hence, both average edge vector field and edge map are exploited in the decision of the edge following technique. At the position (i, j) of an image, the successive positions of the edges are then calculated by a 3 × 3 matrix.

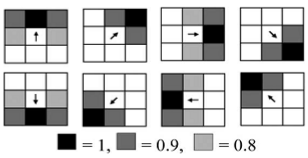

Fig.3: Edge masks used for detecting image

Let $\mathbf{C}_K$, k = 1, 2, . . . , 8, be the constraint masks of edge following to the next direction in object boundary as shown in Fig. 3. The constraint mask is selected by considering the direction of the vector model at a position (i, j). The mask which has a similarity in direction of vector is selected to suit the chosen constraint of edge following. The values of each element in each mask indicate the corresponding direction. At the position (i, j), the next direction of the edge following technique is selected as the direction that gives the maximum value of the element-wise multiplication results between $\mathbf{L}_{ij}$ and $\mathbf{C}_k$.

f. Edge Linking

Edge detectors yield pixels in an image lie on edges .The next step is to try to collect these pixels together into a set of edges. Thus, aim is to replace many points on edges with a few edges themselves. The practical problem may be much more difficult than the idealized case. Small pieces of edges may be missing; Small edge segments may appear to be present due to noise where there is no real edge etc. In general, edge linking methods can be classified into two categories:

g. Local edge linkers

Edge points are aggregated to structure edges by acknowledging each one point's relationship to any neighboring edge points.

h. Global edge linkers

All edge points in the picture plane are acknowledged in the meantime and sets of edge points are looked for as stated by some similitude obligation, for example, focuses which impart the same edge mathematical statement.

IV. FRACTURE DETECTION

To achieve an accurate diagnosis, a medical imaging examination depends on a high quality image, and also an accurate interpretation of an image by a skilled reader. Over the last hundred years, the field of radiology has grown as a result of advanced in imaging innovation, with the goal that today, to a great degree astounding pictures are handled for examination. However, the methods of interpretation have only recently begun to benefit from advances in computer technology [17]. The term computer-aided diagnosis (CAD) includes a diagnosis that is made by a radiologist who utilizes the output of a computerized analysis of the medical images as a second opinion when making the diagnosis. This assists the radiologists' image interpretation by improving the accuracy and consistency of radiological diagnosis and also by reducing the image reading time [15]. In addition, some normal and abnormal lesions can have similar characteristics, resulting in possible interpretational errors [17]. Fortunately, developments in computer vision have demonstrated the potential for computers to provide a second opinion when interpreting medical images. Good algorithms will search in a systematic manner, and may one day be capable of differentiating between normal and abnormal lesions, despite their similar characteristics. This type of computer technology is a promising and efficient source of assistance for radiologists, and should to help enhance indicative execution. using edge linking technique to detect the fractured and non-fractured image.

V. MODELS

a. Active Contour Model

It also called snakes is defined as an energy minimizing spline the snake's energy depends on its shape and location within the image. The internal spline forces serve to impose piece wise smoothness constraint. The image forces push the snake toward salient image features like lines, edges, and subjective contours. The external constraint forces are responsible for putting the snake near the desired local minimum. Representing the position of a snake parametrically by v(s) = (x(s), y(s)).

Internal Energy

The internal energy can be written

$$E_{internal} = \partial(i)\left|\frac{dv}{di}\right|^2 + \beta(i)\left|\frac{dv^2}{di^2}\right|^2 \quad (1)$$

- α(i) is a measure of the elasticity of the snake
- β(i) is a measure of the stiffness of the snake
- The first order term makes the snake act like a membrane
- The constant α controls the tension along the spine
- The second order term makes the snake act like a thin plate
- The constant β controls the rigidity of the spine
- If β=0 then the function is discontinuous in its tangent, i.e. it may develop a corner at that point
- If α=β=0 then this also allows a break in the contour, a positional discontinuity

b. Geodesic Active Contour

It is a novel scheme for the detection of object boundaries .A geodesic approach for object segmentation which connect classical 'snakes' based on energy minimization and geometric active contours based on the theory of curve evolution.

VI. EXPERIMENTAL RESULTS

Fig 4: Original Image (500 X 767)

In fig 4: shows the host image (i.e., Original image) it is a bone x-ray image.

Fig 5: Resized Image (256 X 256)

In fig 5: X-ray images are (500 X 756) size resized from (256*256) into (1024*1024).

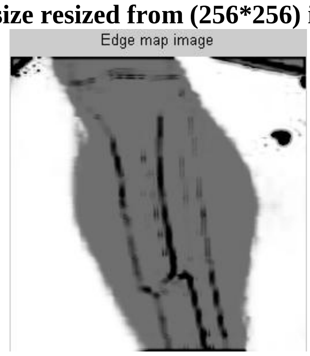

Fig 6: Edge Map Image

In Fig 6, the edges of the given x-ray image is founded, here the bone region is separated and marked the boundaries of the bone using edge following algorithm

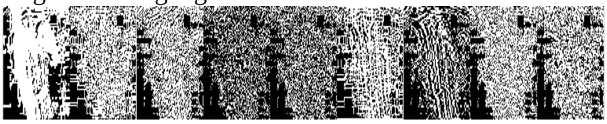

Fig 7: Laws Texture Result

In Fig 7 is extracted result of an image by convolving the input image with the texture mask.

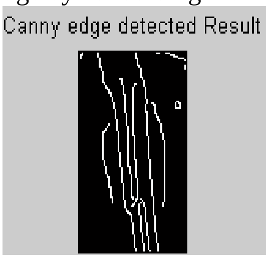

Fig 8:Canny Edge Detected Result

The Canny method finds edges by looking for local maxima of the gradient of the image. The gradient is calculated using the derivative of the Gaussian filter. The method uses two thresholds to detect strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges. This method is therefore less likely than the others to be "fooled" by noise, and more likely to detect true weak edges. Fig 8 illustrates these points which are the result of applying this method to the image of Fig 4.

Fig 9 :Edge linking Result

The edge link results in fig 9 only detected the fractured and non-fractured image,if there is any break in the following bounadaries of the edges in the image,it will considered as an break fracture system is decided the given tested image is considered as an fractured otherwise it’s an non-fractured image and displays the result in fig 10.

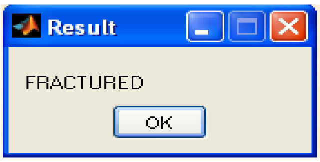

Fig 10:Fractured Result

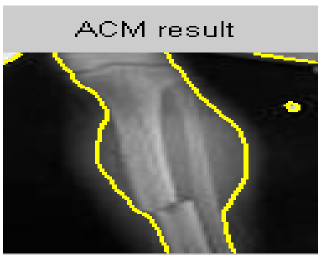

Fig 11: Active Contour Model Result

using the canny edge detection result,the models are alsoimplements such as ACM,GAC.The model also founds the extraction of an edge break in an image is illustrated with the number of iterations in fig11 and fig12 foe GAC result.

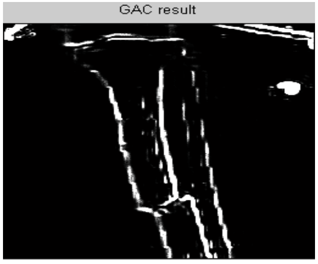

Fig 12: Geodesic Active Contour Model Result

PERFORMANCE MEASURES

Edge detection methods investigated so far are further assessed by quality measures that give reliable statistical evidence to distinguish among the edge maps obtained. The absence of the ground truth edge map reveals the search for an alternative approach to assess and compare the quality of the edge maps resulted from the detectors exploited so far. The evidence for the best detector type is judged by studying the edge maps relative to each other through statistical evaluation. Upon this evaluation, an edge detection method can be employed to characterize edges to represent the image for further analysis and implementation.

Table5.1.Calculating time comparison of varying image size

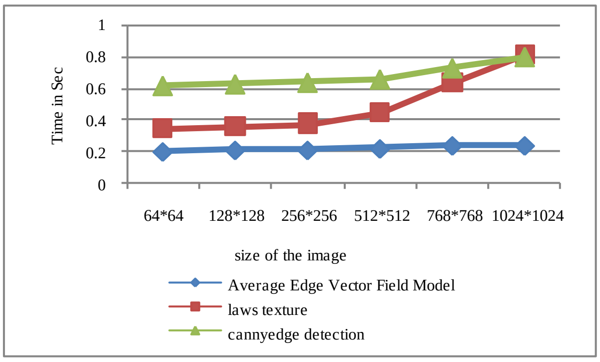

Table5.2. Calculating accuracy, sensitivity, specificity, comparison of varying images.

Image	**Accuracy (%)**	**Sensitivity (%)**	**Specifi city (%)**
Fracture	96.66	87.5	98.64
Non-fracture	93.33	99.09	84.28
Overall Performance	**94.99**	**93.29**	**91.46**

VIII. CONCLUSION

In this work designed a new edge following technique for boundary detection and applied it to object segmentation problem in medical images. Our edge following technique incorporates a vector image model and the edge map information. The proposed technique was applied to detect the object boundaries in several types of noisy images where the ill-defined edges were encountered. Several synthetic noisy images were created and tested for the sake of the known ground truths. The results of detecting the object boundaries in noisy images show that the proposed technique canny edge detection is better. The results of the running time on several sizes of images also show that our method is more efficient than the canny edge detection is better. It have successfully applied the edge following technique to detect ill-defined object boundaries in medical images and hence to identify the fracture and non-fracture x-ray images. The proposed method can be applied not only for medical imaging, but can also be applied to any image processing problems in which ill-defined edge detection is encountered.

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