Fracture Detection Using Euler Numbers

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Abstract— **This paper presents an algorithm to extract a binary image from gray scale image using auto-tuned threshold value obtained from the correlation of Image Euler Numbers. This technique can be used for bone fracture detection and also for study of Lung Cancer Detection using Chest X-ray Images. The objective is realized by constructing and designing an algorithm & software for getting a binary image out of a color image or x-ray image thus highlighting the cracks or tumors. This Computer Vision system can help screen x-ray images for suspicious cases and alarm the doctors.**

I. Introduction

HERE the input is an color or an X-ray image of the body part. This image is read initially and converted into a grayscale image. The input image can be in any format like jpeg, bmp, etc.

This technique uses a Euler number which calculates the threshold value. Euler number is basically given as:
Euler no = No. of objects - No. of holes

This algorithm is based on the fact that the other regions are brighter than the cracks, and so they show up after histogram equalization.

An adaptive scheme is used to generate the threshold for each connected region. If there is large spread, the threshold is set to fraction of the mean else the threshold is set higher to make sure that the dark part is seen.

The output of this algorithm is provided to further computer vision system which helps screen the faulty areas in the images and give proper results. In this way the system of crack detection becomes automated which reduces the number of errors.

Such a method would be very useful for prevention of the skeletal system diseases as well as for their treatment in a non-developed phase. It is postulated in this paper that texture analysis of digitized X-ray images can be considered as an alternative to standard techniques of skeletal system diagnosis.

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II. Fracture detection

A. Histogram equalization

This method usually increases the local contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast without affecting the global contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values.

The method is useful in images with backgrounds and foregrounds that are both bright or both dark. In particular, the method can lead to better views of bone structure in x-ray images, and to better detail in photographs that are over or under-exposed. A key advantage of the method is that it is a fairly straightforward technique and an invertible operator. If the histogram equalization function is known, then the original histogram can be recovered. The calculation is not computationally intensive. A disadvantage of the method is that it is indiscriminate. It may increase the contrast of background noise, while decreasing the usable signal.

Consider a discrete grayscale image, and let ni be the number of occurrences of gray level i. The probability of an occurrence of a pixel of level i in the image is

$$p(x_i) = \frac{n_i}{n}, i \in 0, \ldots, L-1$$

L being the total number of gray levels in the image, n being the total number of pixels in the image, and p being in fact the image's histogram, normalized to [0,1].

Let us also define c as the cumulative distribution function corresponding to p, defined by:

$$c(i) = \sum_{j=0}^{i} p(x_j)$$

also known as the image's accumulated normalized histogram.

We would like to create a transformation of the form that
will produce a level y for each level x in the original image, such that the cumulative probability function of y will be linearized across the value range. The transformation is defined by:

$$y_i = T(x_i) = c(i)$$

Notice that the T maps the levels into the domain of 0..1. In order to map the values back into their original domain, the following simple transformation needs to be applied on the result:

$$y'_i = y_i \cdot (\max - \min) + \min$$

The above describes histogram equalization on a grayscale image. However it can also be used on color images by applying the same method separately to the Red, Green and Blue components of the RGB color values of the image.

B. Euler Number

The Euler number is a measure of the topology of an image. Euler Number is a property of an image useful for describing a region by calculating the number of connected regions. If C is the number of connected components and H is the number of holes, then the Euler Number E is given by

$$E = C - H$$

i.e. the Euler number is the difference of the number of objects and the number of holes.

We can use either 4- or 8-connected neighborhoods. Euler number of a binary image is a fundamental topological feature that remains invariant under translation, rotation, scaling, and rubber-sheet transformation of the image.

C. Fracture Detection using Euler Technique

1) Take input color or X-ray image.
2) Convert it into grayscale image.
3) Perform histogram equalization.
4) Set an array for calculating different Euler number.
5) Calculate the maximum and minimum of Euler number.
6) Select the minimum and maximum Euler number from the matrix.
7) Calculate the mean.
8) Calculate the threshold value.
9) Convert the histogram equalized image into binary by thresholding with the above calculated threshold value.
10) Display the output image.

D. Implementation of Actual Fracture Detection

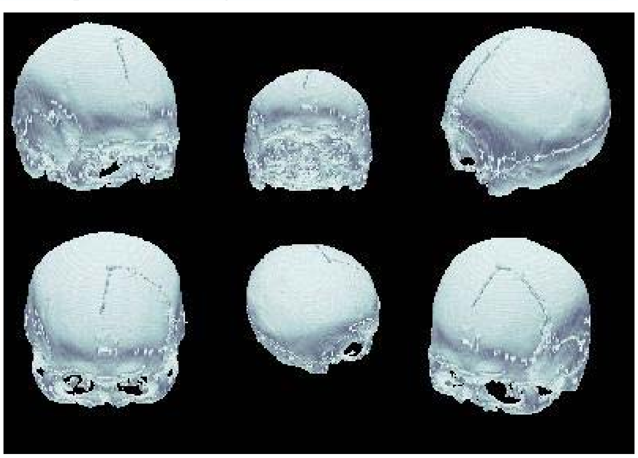

Figure 1: Input color image with fractures

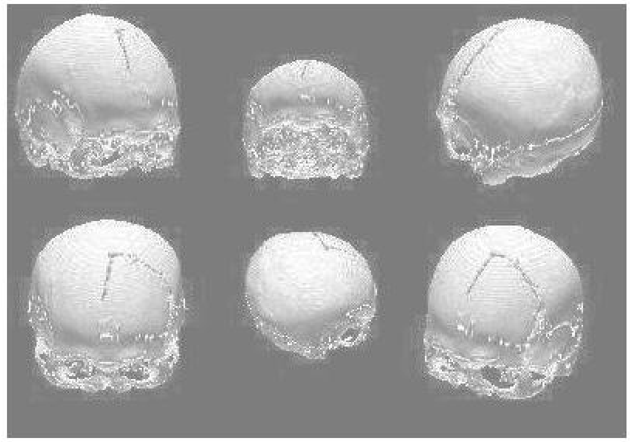

Figure 2: Histogram Equalized image

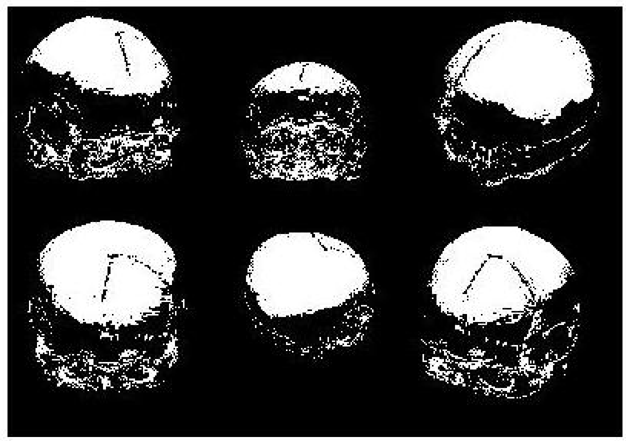

Figure 3: Output binary image with cracks highlighted

E. Implementation of Lung Fracture Detection

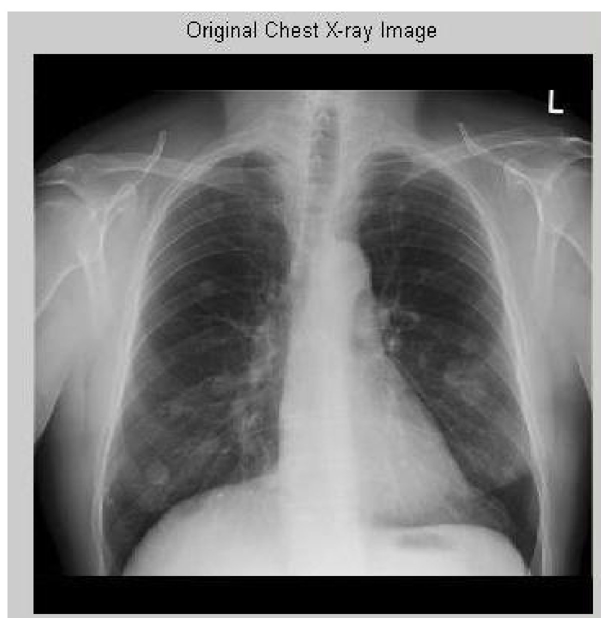

Figure 4: Input X-ray image with a cancer in the lung

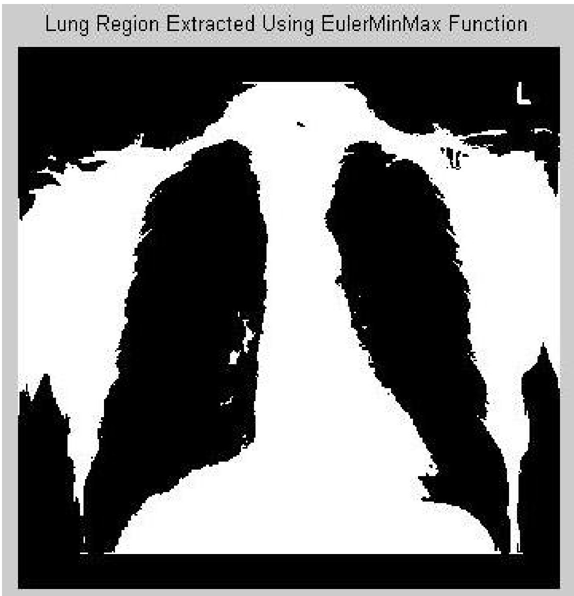

Figure 5: Output binary image with cancer highlighted

III. CONCLUSION

Since manual inspection is tedious and time consuming, a radiologist may miss a fractured image among the healthy ones. This image processing program will enable computer vision which will screen X-ray images and always give correct results.

IV. REFERENCES

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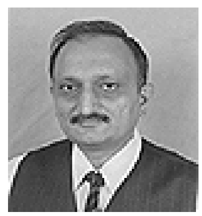

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