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Region of Interest Extraction using K-Means and Edge Detection for DEXA Images

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ABSTRACT: Region of interest in the world of medical images, there is a region in each image that contains unique features that distinguish each image from the other or distinguish one group of the image from another group. This paper proposes a new method for extracting the region of interest for DEXA images via the K-means and edge detection. firstly, the noise is reduced by the mean filter then segment the image into two clusters by k-means, followed by edge detection to identify object boundaries and erosion operation to clarify boundaries and get the correct coordinates of ROI. The results show that the accuracy of the proposed system is 99%. where 174 images cropped correctly out of 176. the dataset used in this work is 'Osteoporosis DEXA Scans Images of Spine from Pakistan'.

Keywords: Region of interest, K-means, Edge detection, Erosion, DEXA, Medical image.

1. INTRODUCTION

A crucial tool for decision-making and treatment procedures in healthcare is now digital medical images [1]–[3]. Determining the area of interest in medical images is one of the most important basic operations in diagnostic systems [4], [5], and the reason is due to the fact that most images contain useless areas [6], [7]. For example, the size of the background and the object differ from one image to another, as the image that is close to the scanner occupies the largest part. But if the image is relatively far from the scanner, the largest part of the image will be for the background [8], [9]. The importance of defining the area of interest lies in getting rid of the useless parts of the image while preserving as much as possible information-rich parts [10],[11]. All this depends on the nature of the image and the purpose of the selection process [12], [13].

In this paper the DXEA image of the spine is used, The main objective of cropping the region of interest is to remove the background and pelvic parts as well as the ribs and keep only the spine to prepare the image for a later stage, such as a diagnostic or verification system, etc. Thus, the accuracy of the system is higher and the time is less.

The outline of the paper is as follows. In Section 2, previous work in a region of interest extraction. The proposed system is described in Section 3. The results will be given in Section 4. We conclude in Section 5.

2. RELATED WORK

There are previous works on this subject, most notably:

Leung and Malik, 1998" due to Ref.14], gave instructions on how to include curvilinear grouping in region-based picture segmentation. Through orientation energy, soft contour data is gathered. By using contour propagation, weak contrast gaps and arbitrary contours are filled in and use normalized cut method for segmentation.

Dhanachandra et al, 2015" due to Ref. [15], the K-means clustering algorithm should be used. But initially, a partial stretching improvement is made to the image to enhance its quality before the K-means method is used. The initial centres are then produced using a subtractive cluster, and the k-means algorithm uses these initial centers. The segmented image is ultimately given a medial filter to remove any undesired areas from it.

To segment computed tomography (CT) and magnetic resonance (MR) medical images, a novel mix of image segmentation techniques, including K-means clustering, watershed transform, region merging, and growth algorithm, was developed by Salman et al , 2015" due to Ref. [16].

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Khan et al, 2017" [17], provides an improved K-means method to address the limitations of traditional K-means in the context of image segmentation. By using an adaptive histogram-based initial parameter estimate process to improve the K-Means clustering technique for image segmentation.

Sun and Zhang, 2017" [18], used the attributes of the medical image to extract the ROI from the surrounding environment. In order to clearly identify the nidus, the article splits the medical image by combining an iteration technique and a region-growing algorithm.

Zheng et al, 2018" [19], adaptive K-means image segmentation technique has been presented, which avoids interactive K value input and produces accurate segmentation results with easy operation. This technique first converts the colour space of the image into LAB colour space. Additionally, a specific value is chosen for the brightness components to lessen the impact of light on image segmentation. The image is then adaptively segmented using the equivalent relation between K values and the number of connected domains after the threshold is set. The final segmentation results are generated after morphological processing, maximum connected domain extraction, and matching with the source picture.

Salman and Mohammed, 2021" [20], for image segmentation, an improved K Means clustering technique is suggested; it is based on Li's technique, the proposed method determines the initial centres using Particle Swarm Intelligence (PSO). The K-Means technique is then used to place each pixel in the appropriate cluster after receiving these initial centroids. A region-expanding technique is then applied to the segmented image to isolate regions and create edge maps. The testing findings demonstrate that the suggested method produces segments of good quality in a short amount of time.

3. PROPOSED SYSTEM

Fig 1 presents the diagram of the proposed system, it implies four basic stages of a region of interest extraction system: firstly the original image is loaded from the dataset, followed by preprocessing stage to remove noise and prepare the image for the next stage the K-means to segments the image into two clusters. and edge detection stage to define the spine border, finally define a region of interest coordinate and crop the image accordingly.

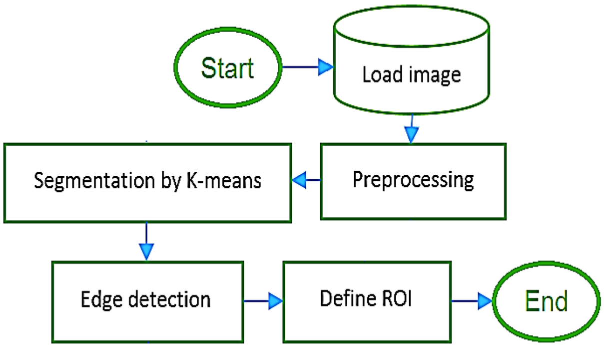

FIGURE 1. The layout of the proposed system diagram

3.1 PREPROCESSING

After reading the image, it is entered into preprocessing phase, which prepares the image for the subsequent phases (k-means segmentation, edge detection and defining ROI): Since the image are taken in different conditions, the image contains an amount of noise, which must be reduced. One of the most famous filters that are used to get rid of noise is the mean filter. After loading the image from a database directly, it is entered into a mean filter with a window mask [3 3]. Fig. 2 shows the original image, and Fig. 3 presents the enhanced image.

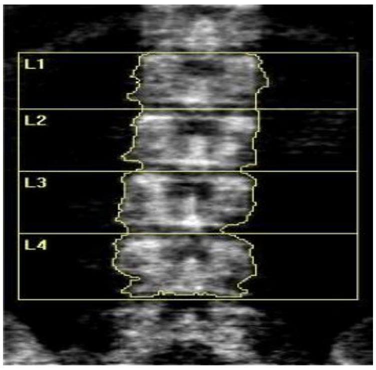

FIGURE 2. Original image

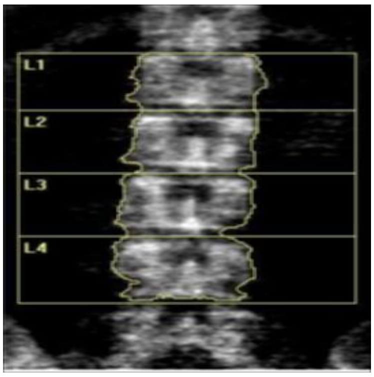

FIGURE 3. Enhanced image by mean filter

3.2 K-MEANS

The objective of this algorithm is to divide the number of elements (n data) into k number of sections in which each element is subdivided into the section with the closest central point (mean), where the centre point is the basis on which the data is divided and categorized and that is why the name k-means clustering. The result of the classification is the division into voronic regions. in this paper k-means is used to divide the image into different regions, this step is very important in clarifying the edges for the process that follows. Algorithm 1 presents the k-means algorithm

Algorithm1: K-means algorithm

Start:

1 Choose k point as an initial centroid

2 loop

3 Generate 2 clusters (assigning all points to the closest centroid)

4 Recalculate new centroid for every cluster

5 Until centroid don’t change

End:

By using k-means, the enhanced image segment into two clusters (object and background) as shown in fig. 4.

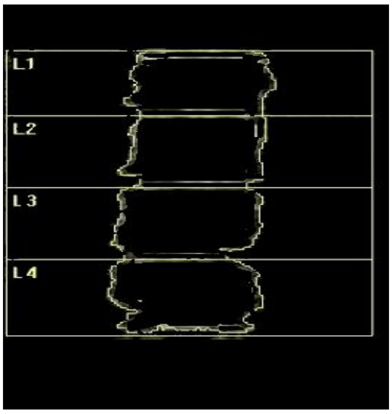

FIGURE 4. Segmented image by k-means with two clusters.

3.3 EDGE DETECTION USING CANNY FILTER

Edge detection is a technology that dramatically minimizes the quantity of data that needs to be processed while extracting relevant structural information from a variety of optical objects. They are frequently employed in many different computer vision systems. Common standards for edge detection Include Edge detection with a low error rate requires that every edge in the image be recorded as precisely as possible. The true edge's centre must precisely match the location of the detected edge. Wherever possible, the picture noise should not create false edges and the selected edges in the image should only be marked once. The edge detection algorithm is carefully chosen and can offer one of the good and most reliable detection methods among the edge detection techniques currently in use. It has become one of the most well-liked edge detection algorithms because it satisfies the three criteria for edge detection and has a straightforward implementation process.

The Flow of Canny Processing

- Determine the position and gradient strength of each pixel in the image.
- Non-maximum suppression is used to get rid of the erroneous response that edge detection causes.
- The genuine and prospective edges are identified via double threshold detection.
- The last step in edge detection is to block individual weak edges.

In this paper, canny edge detection is employed to determine the boundary of a primary region of interest based on the outcome of k-means. Fig. 5 presents boundaries and Fig. 6 shows the primary ROI.

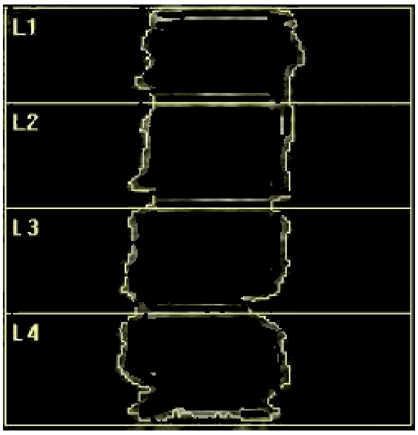

FIGURE 5. edge detection by canny

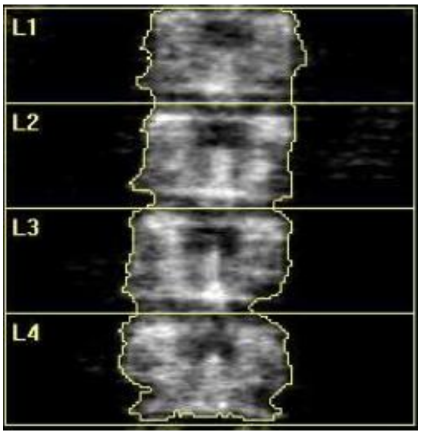

FIGURE 6. Primary ROI

3.4 DEFINE FINAL ROI

In order to get rid of the extra edges, and cut off a part of the useless edges, 50 pixels were neglected from the beginning and end of the image. Then use erosion operation with [2 1] rectangular window size to remove white lines as shown in Fig. 7, followed by the Edge detection process for the second time to get final coordinates and crop ROI as shown in Fig. 8.

FIGURE 7. Remove extra edge by erosion operation

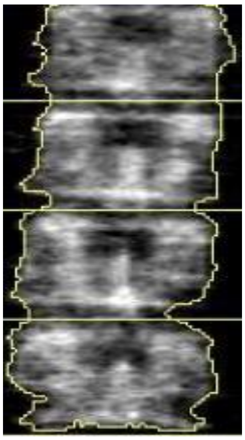

FIGURE 6. Final ROI

4. RESULTS

The proposed method showed good results in obtaining the region of interest, as it was applied to Osteoporosis DEXA Scans Images of Spine from Pakistan dataset consisting of three classes:(normal has 60 images, 57 images in osteopenia and 59 osteoporosis). As the outputs of the proposed system are excellent in terms of accuracy and speed. the accuracy reached 99%. where 174 images are cropped correctly from 176. as well as the system was tested with another database collected by the author from Medical City Health Department / Radiology Institute and Orthopedics surgery Specialty Center. and got very good findings as shown in ta.

Table 1. - The results of obtaining the region of interest for other datasets.

dataset	Total number of the collected images	Number of images cropped correctly	number of images not cropped correctly	Accuracy = cropped correctly / Total number of images
Radiology Institute	200	196	4	98%
Orthopedics surgery Specialty Center	250	247	3	98.8%

5. CONCLUSION

The method that we proposed not only has good results but also it's simple and effective When applied to the DXEA scan of the Spine from Pakistan dataset and two other datasets collected by the author. Where the proposed method improves the image using a mean filter, followed by K-means for segmenting the image into two clusters to isolate the object from the background, and an edge detection filter which defines the edges of the spine. then morphological erosion process that contributed greatly to get rid of the noise to define clear edges. Finally, the Edge detection process for the second time plays an important role in defining the final coordinates of and crop Region of interest.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest

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