Ilkogretim Online - Elementary Education Online, 2021; Vol 20 (Issue 4): pp. 3868-3875
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.04.422

Analysis Of Image Segmentation Techniques For Dental Radiographs

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Abstract

Now a days, one of the most prevalent dental illnesses affecting people of all ages worldwide is dental caries. It might be difficult to identify dental caries in its early stages using dental x-ray or radiovisiography (RVG) pictures. Nearly all medical areas employ deep learning to anticipate or identify certain disorders. In this study, a K-means clustering for image segmentation was proposed and examined. This study has shown that image enhancement methods are crucial for enhancing the quality of dental radiograph pictures. The proposed k- means model algorithm has been done, with better accuracy.

I. Introduction

An image is made up of pixels, and we create segments by grouping pixels with similar characteristics together. The technique of segmenting one image into several segments is known as image segmentation. It is the process of grouping together components of an image that correspond to the same object class. Pixel-level classification is another name for it. As we divide the image into segments, these segments aid in the efficient processing of the image.

Simple bounding boxes can be beneficial in object detection problems, but they don't provide information about the object's shape. For each object in the image, the image segmentation method can be used to create pixel-wise masks. We may gain a much better idea of the object(s) in the photograph using this strategy. During this process, an object type is allocated to each pixel in the image. Instance and Semantic are the two main types of image segmentation. In semantic type, a single class label is used to identify all items of the same type, but in instance segmentation, related objects are given their distinct labels.

Different image segmentation approaches for dental x-ray pictures are studied and analyzed in this work

1.1. Need of image segmentation

The early detection of cancerous cells is critical for saving millions of lives. The severity of disease is determined by the morphology of cancerous cells. To obtain relevant findings, image segmentation allows us to determine the shape of cells in a granular manner. Image segmentation has revolutionized a variety of industries, including satellite object detection, traffic management systems, and self-driving cars. Different forms of x-rays, such as CBCT scans, CT scans, panoramic images, OPGs, and radiographs, are available to detect anomalies in dental tooth structures. Dental practitioners all over the world rely on digital radiography for extensive clinical evaluations and investigations. Due to the abysmal sensitivity rate of tooth structure and depth of caries, manual evaluation of dental x-ray images is a time-consuming task.

Computer-assisted medical diagnosis systems benefit from image segmentation. Dental imaging techniques have been proven to be useful in a variety of applications, including gender estimation, human identification, chronological age estimation, and biometrics, according to several research articles. VGG-16, AlexNet, Inception V3, GoogleNet, and other pre-trained networks have shown to be superior at image segmentation in general. CNN, on the other hand, tends to evolve from a small network to a larger, problem-specific, or complicated network.

Improving image segmentation and analysis performance with deep learning algorithms has proven to be difficult. Deep learning approaches aid in the resolution of difficult problems that have arisen in various studies

1.2. Image Segmentation Categories

Region based, edge based and Pixel-based segmentation techniques are separated into three categories: Region based, watershed, threshold and clustering boundary-based approaches.

1.2.1. Region-based Segmentation

A region is classified using this method based on the similarity of connected pixels. When an image has contrast seen between object and the backdrop, the object's and background's pixel values are different. Pixels must follow some present rules in order to be grouped into related pixel regions. When an image contains noise, region-based image segmentation is preferable than edge-based image segmentation. Region growing method is a type of region-based segmentation.

We start with the seed pixel and then inspect nearby pixels in this manner. If a neighboring pixel follows the preset rules, it is added to the seed pixel until no more similar pixels exist. If the region is expanding, a threshold value is established as a rule. If the threshold value is 5, and a specific pixel has a value of 3, that pixel is inspected in a distinct region, whereas pixels with values greater than 5 are considered in the seed pixel region, as illustrated in figure 1

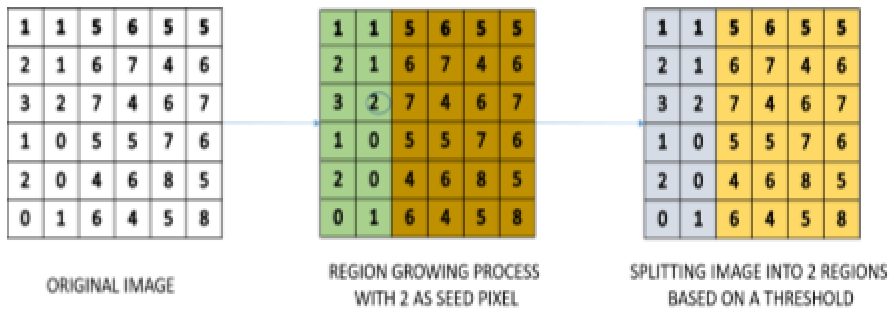

Fig. 1 Region based segmentation

1.2.2. Threshold based segmentation

We can use this method to set threshold values based on the original image's pixel intensity. To separate the pixels into sections, we'll use a threshold. For example, if the image has a range of 0 to 255, we'll set a threshold of 100. Pixel values more than 100 are assigned the value 255 (white), whereas those less than 100 are assigned the value 0. (black).

Types of thresholding techniques:

Global thresholding

The bimodal image, which has two peaks of intensities, is employed in the global thresholding approach. An object has one peak of intensity and the background has another. The global threshold value for the entire image will be calculated, and that value will be utilized for the entire image. When the image has low lighting, it performs poorly

Manual thresholding

Steps for manual thresholding are given below:

Step 1: select initial values of threshold T'

Step 2: segment image into two regions R1 and R2

Step3: Calculate mean of pixels for region R1(m1) and region R2(m2)

Step 4:- Threshold value Th= (m1+m2)/2 go back to step 2

Step 5: Continue the above steps until |Ti-Ti+1|<=T'

a) **Adaptive Thresholding**: This method divides the image into sub regions, calculates the threshold value for each sub region, and then combines the sub regions to create the segmented image. The problem of image lighting can be mitigated to some extent.

b) **Optimal Thresholding**: To reduce the misclassification of pixels caused by segmentation, an optimal thresholding technique can be applied.

1.2.3. Edge based segmentation

Edge detection operations are used in edge-based segmentation to find the edges of images. Edges with differing pixel values, such as grey levels, texture, or color, are used to separate two objects in an image. When we walk from one object region to another, these levels shift. The edges of an image can be thought of as the image's discontinuous local characteristics. We can detect that edge once we find a discontinuity in the images. The object's border can be established and used to locate different items in an image. To find edges in an image, we can apply filters and convolution operations. The purpose of edge segmentation is to produce an intermediate segmentation result that can subsequently be utilized to create the final segmented image by applying region-based or other types of segmentation

1.2.3. Watershed Segmentation

In image processing, a watershed is a change in the grayscale image. It alludes to a geological watershed or a drainage division. A watershed method would treat the image as if it were a topographic map. It searches for the lines that run along the tops of the ridges using the brightness of a pixel as its height.

1.2.4. Clustering algorithms for Image segmentation

The purpose of image segmentation is to transform an image's representation into something more meaningful and easier to examine. It's typically used to locate things and draw lines around them. Clustering algorithms are based on distance measures. Distance-based learning algorithms measure similarity to learn input data. The relative difference between two things in a problem area is captured by a distance measure. A comparison measure is a statistic which determines how similar dual objects are. A number of 0-1 indicates similarity (Range). There will be more resemblance if there is little separation between two data point is modest; if the gap is large, there will be less similarity. Distance-based models use similarity measurements from training data to test new samples

1.2.4.1 Distance Measures: Different distance measures available for distance-based clustering algorithms are: a) Cosine Similarity b) Hamming Distance c) Minkowski d) Euclidean Distance

II. Materials and Methods

The image segmentation technique K-Means clustering is an unproven learning procedure that employs iterative clustering techniques. Although it is also referred to as Lloyd's algorithm, people most frequently call it the K-Means algorithm. The global minimum cannot be determined using any practical method. As a result, the K-means problem is categorized as NP-complete in figure 2. The technique uses the nearest-centroid decision criteria to iterate between partitioning the data and recalculating centroids from a partition.

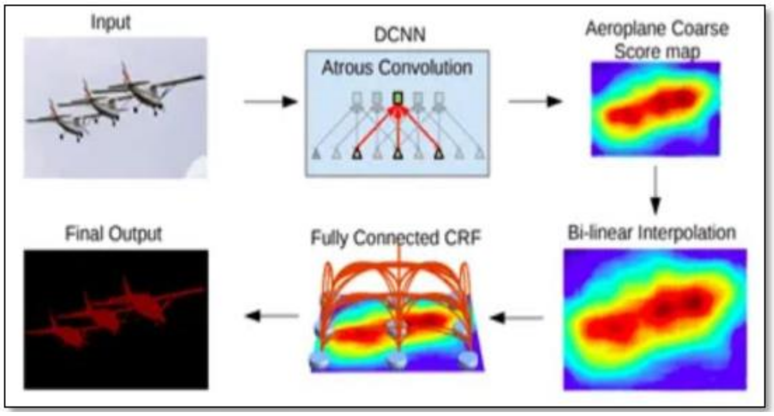

Figure 2. Deep Lab architecture

A simple unsupervised machine learning technique is the K-means algorithm. It creates a predetermined number of clusters out of an image. To start, the image space is divided into k pixels, each of which represents one of the k group centroids. The distance between each object and the centroid determines which category it is assigned to next. Once all pixels have been assigned to all clusters, the algorithm can shift and reassign the centroids.

2.1. Algorithm 2.1: Image segmentation of dental radiographs using K-Means Clustering algorithm

Kmeans (D, K) Algorithm

Input: Data D in the form of pixels of an image; K is number of clusters

Output: means values of k clusters are: a1, a2,….. ak 1.

1. Define number of clusters as K with initial mean a1, a2,….. ak
2. Reiteration

- Allocate each x ε D to arminj ED(x, aj)
- For j=1 to k do

3. Until no change in µ1, µ2,….. µk
4. Return µ1, µ2,….. µk
5. End

III. Results and Discussion

To demonstrate effect of Image segmentation methods on dental x-ray images let us consider two images panoramic and RVG X-ray image as shown in figure 3 a) and b) respectively.

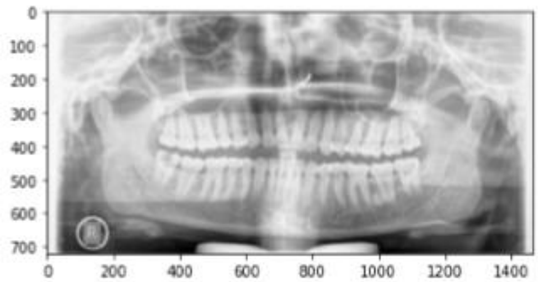

Fig. 3 Original image a) Panoramic X-ray

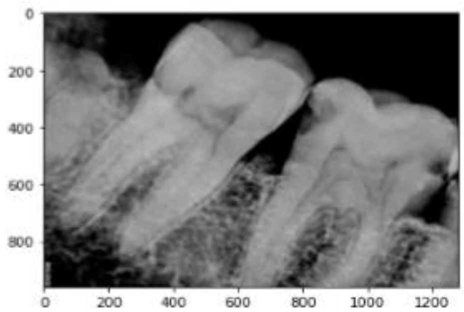

Fig. 3 Original image b) RVG X-ray

The height and width of figure 3 a) is 720 and 1464 respectively and for figure 3 b) is 960 and 1280 respectively.

The mean rate of pixel is calculated and used as threshold rate for region based segmentation. We can declare that pixel according to object if its rate is higher than our threshold. Background will be applied if pixel rate is less than threshold.

Different threshold rates there are some of advantages of using different threshold rates for image segmentation method: calculations are less complicated, high-speed operation, this method works well when item and background have high contrast. However, there are several drawbacks to this method. It's tough to acquire correct segments when there isn't large grayscale difference or when grayscale pixel rates overlap. Figure shows result of applying four threshold rates on panoramic image and RVG-xray image. From 4 (a) figure we can’t recognize patterns from image but for RVG-xray image it shows good segmentation results figure 4(b).

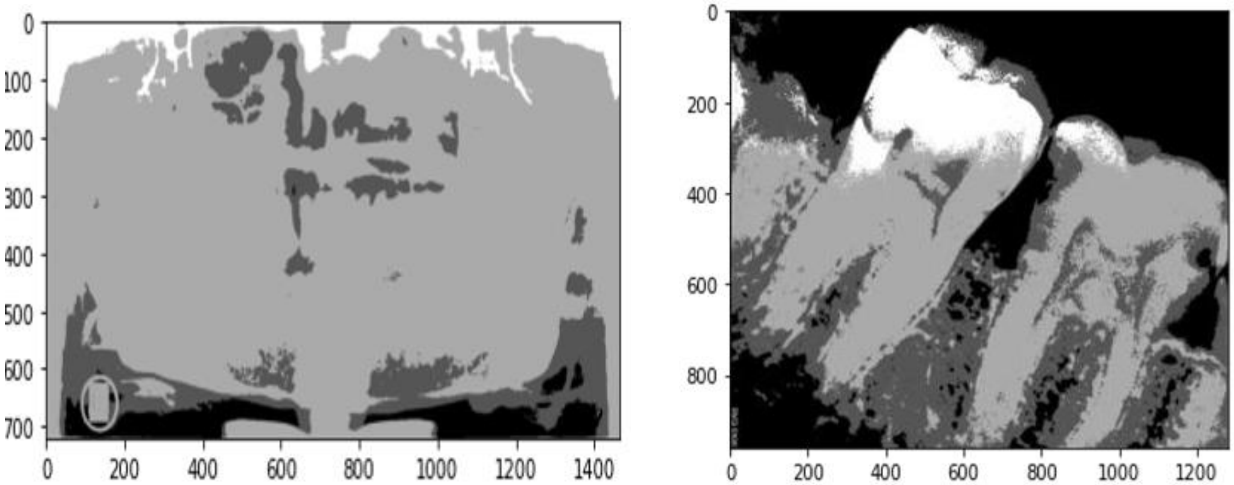

Figure 4 (a) Normal Pattern Image b) Segmentation Image

K-Mean clustering: k=6 for panoramic images and k=2 for RVG x-ray images are the number of clusters passed to k-means clustering in figure 5.

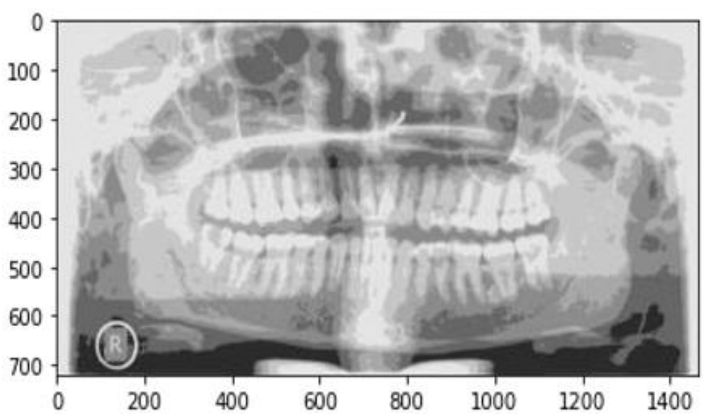

Fig. 5. K mean clustering algorithm for image segmentation for K=6

IV. Conclusion

The mean worth of pixel is determined and utilized as limit incentive for district based division. It's difficult to secure right sections when there is anything but enormous grayscale contrast or when grayscale pixel rates cross-over. For tooth division, K means bunching procedure is applied to x-ray and OPG images, yet result isn't acceptable. Further, Veil R-CNN model is utilized to OPG picture for tooth division, with acceptable outcomes. Tooth segmentation is possible with the Mask R-CNN. However, the experiment's pre-trained model is based on the MSCOCO data set, which has little in common with the dental X-ray data set. Other X-ray data sets could be included in future experiments, reducing the difficulty of fine-tuning and improving experimental outcomes.

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