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Pixel Count in Dental Radiograph Compared to Various Edge Detection Techniques

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Abstract—*Image processing is widely used in medical image analysis. Using edge detection techniques, it is now much easier to detect anomalies and irregularities in medical diagnostics. In this paper, various edge detection techniques have been applied on dental radiographs on two sets. The radiographs or X-ray converted to jpeg image are compared with different techniques to find the best possible algorithm for finding irregularities in tooth format.*

Keywords: X Ray, Image, Edge Detection

1. INTRODUCTION

Image processing is a way to convert an image or a photograph into a processed image. Through image processing we get an enhanced image or extract some features or useful information from the image. The purpose of image processing is to visualize, image sharpening and restoration, image retrieval, measurements of patterns and image recognition. Image processing can be done in three steps: get the digital image, manipulate and analyze the image and its output will be the extracted feature or an altered image. Image processing can be done in two ways: analog and digital[4]. Analog image processing is applied on photographs, printouts etc. while digital image processing can only be done on digital images and manipulation on digital images can be done by computers. Raw digital image contains some deficiencies and to overcome this and get the extracted information, various processing phases are applied. [9]Three phases are: Preprocessing, enhancement and information extraction. It has many applications in the field of medicine, security (Biometrics), biology, astronomy, satellite imagery etc. Now-a-days, it is the major area of research.

Edge detection is used in image segmentation. It is the process to identify and locate lack of continuity in an image. This discontinuity describes the sudden changes in the pixel intensity or first derivative of the image intensity. [8] Discontinuities in image intensity can be Step edge, Line edge. These discontinuities are rare in real images because of instant changes are rarely occurred. The changes occurred in an image intensity over a time therefore, step edges is changed to Ramp edges and Line edges changed to Roof edges.

As elaborated by Dr. S. Vijayaraani and Mrs. M. Vinupriya [11] in their research paper used Canny and Sobel edge detection algorithm to find edges of facial images and shown that Canny works better than the sobel edge detection method.

Deven N. Trivedi1, Ashish M. Kothari, Sanjay Shah and Shingala Nikunj [12], in their research applied canny algorithm to dental images and presented graphs using hhistogram in mathematical morphology.

Raman Maini and Dr. Himanshu Aggarwal [15] compared various edge detection techniques and showed that Canny edge detection algorithm performs better but expensive of all the other methods.

The paper focuses on the comparison of major edge detection techniques. Section 2 focuses on the Image segmentation process, Section 3 focuses on Edge Detection techniques. Comparison of various edge detection techniques with X-ray image is discussed in section 4, section 5 focuses on conclusion, findings and future work.

2. IMAGE SEGMENTATION

Image segmentation is the process of dividing a digital image into multiple segments i.e. set of pixels, pixels in a region that are similar according to some homogeneity criteria such as colour, texture or intensity, to locate and identify objects and boundaries in an image. Image segmentation divides the image into multiple meaningful structures. [7]Based on two properties of image, image segmentation approaches are divided into following categories:

Detecting Discontinuities - Detecting discontinuity means partition an image based on sudden changes in intensity of grey levels in the image. It includes edge detection as image segmentation algorithm.

Detecting Similarities - Detecting similarities means partition an image into regions based on some similar properties. It includes image segmentation algorithms like region growing, region splitting and merging, thresholding.

Thresholding Technique: It is simple but powerful technique for segmenting an image. To convert a grayscale image into binary image thresholding can be used. It is based on image-space regions i.e. on characteristics of image. If the intensity of pixel is greater than T i.e. threshold value then it belongs to the object otherwise it belongs to background.[5]

a) Global thresholding : In this value of T is constant. It is used when there is a large distinction between the objects of background and foreground and a single value of threshold can be used to differentiate between both of the objects.

b) Local thresholding : In this value of T is variable because of uneven illumination. This method divides the image into many regions and for each subregion it choose various threshold Ts values.

Texture based Segmentation: Texture segmentation is based on segmenting a textured image into several regions those having similar patterns.[3] It is very effective and efficient technique used in analysis of medical images, seismic images.

- *Statistical approach*: Statistics like the moments of gray-level histogram or co-occurrence matrix are computed to distinguish different textures.
- *Structural approach*: In this, basic element is texture primitive which is used to form more complex textures patterns. Different grammar rules are applied to generate texture patterns.
- *Spectral approach:* In this, textured image is transformed into frequency domain.

Edge Based Segmentation: It shows a large group of methods based on the information about edges in the image. In this, object can be detected very easily if there is a good contrast between object and background. There are three types of discontinuities in an image: points, lines and edges.

Steps for edge based segmentation:

i. Compute all the edges of original image.
ii. Process the edges of the image so that only closed object boundary remains.
iii. Fill the object boundaries and transform it into ordinary segmented image.

Region Based Segmentation: Region based segmentation is simple but more immune to noise. It is based on connecting similar pixels in a region. There are two ways for region-based segmentation: region splitting and region merging (growing).

The approach to segmentation using splitting is:

i. Obtain an initial (under) segmentation of the image.
ii. Split each segment which is not same in some respect
iii. Go to step 2 until all segments to be homogeneous.

The approach to segmentation using merging is:

i. Obtain an initial (over) segmentation of the image.
ii. Merge the adjacent segments which are similar (homogeneous) in some respect to form a single segment.
iii. Go to step 2 until no segment should be merged to remain.

3. EDGE DETECTION TECHNIQUES

The following edge detection techniques are:

3.1 Sobel Method

The Sobel operator is used to perform a 2D spatial gradient measurement on an image and to emphasizes regions of high spatial frequency which corresponds to edges. It is used to find the approximate absolute gradient magnitude at each point in a grayscale image. This operator consists of a pair of 3x3 convolution kernels. One kernel is simply the other rotated by 90^0.[6]

3.2 Robert's Cross Operator

The Roberts Cross Operator performs a simple, fast to compute, 2D spatial gradient measurement on an image. Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input at that point. It highlights the regions of high spatial frequency which corresponds to edges. The operator consists of a pair of 2x2 convolution kernels. One kernel is simply the other rotated by 90^0. It is very similar to Sobel operator.

3.3 The Prewitt Detection:

It is an appropriate method to estimate the magnitude and orientation of an edge. While differential gradient edge detection takes much time in calculating the estimate orientation from the magnitudes in the x and y- directions. The prewitt operator is limited to 8 possible orientations , shows the most direct orientation estimates are not much accurate. This gradient based edge detector is estimated in the 3x3 neighborhood for eight directions. All the eight convolution masks are calculated. One convolution mask is selected, namely the largest module.

3.4 Canny Edge Detection:

It is known as optimal edge detector. His focus was on to enhance the edge detectors already out during his time. He followed a list of criteria to improve current methods of edge detection. Some criterias are given below:

a) Low error rate- edges in images should not be missed and no response to non-edges.
b) Edge points should be well-localized- distance between edge pixel found by detector and actual edge of image should be minimum.

c) Only one response to single edge- it is used to eliminate the possibility of multiple responses to an edge.

3.5 Laplacian of Guassian:

The Laplacian is a 2-D isotropic measure of the 2nd spatial derivative of an image. It highlights regions of rapid intensity change and hence used for edge detection. It is firstly applied to an image to filter noise from it by applying Gaussian Smoothing filter. The operator's input is gray level image and its output is another gray level image.

4. COMPARISON BETWEEN X-RAY IMAGE, SOBEL, PREWITT AND CANNY

Dental X-ray are converted to jpeg image and is taken as input. Various edge detection techniques such as SOBEL, PREWITT & CANNY edge detection algorithms are applied that gives their respective images. The number of white and black pixels are calculated on SOBEL image, PREWITT image and CANNY image. The table below depicts the comparison between number of pixels obtained.

Table 1: Number of Black and White pixels in X-Ray, Sobel, Canny, Prewitt Images.

Number of Black and White pixels in X-Ray, Sobel, Canny, Prewitt Techniques								
Tooth No	**X-Ray**		**Sobel**		**Prewitt**		**Canny**	
(.jpg)	**no. of black pixels**	**no of white pixels**	**no. of black pixels**	**no. of white pixels**	**no. of black pixels**	**no. of white pixels**	**no. of black pixels**	**no. of white pixels**
1	91191	72816364	1654290	4710	1654271	4729	1593289	65711
2	82276	71499181	1653874	5126	1653907	5093	1598133	60867
3	212197	39479954	1653652	5348	1653668	5332	1621309	37691
4	129940	44738279	1654329	4671	1654359	4641	1614303	44697
5	122253	45458314	1653948	5052	1653989	5011	1614303	44697
6	149195	47597437	1654502	4498	1654515	4485	1609869	49131
7	140057	37071411	1653824	5176	1653793	5207	1623816	35184
8	94806	36508055	1654397	4603	1654433	4567	1625303	33697
9	86973	44916952	1652901	6099	1652917	6083	1621286	37714
10	42282	46631362	1653490	5510	1653605	5395	1615613	43387

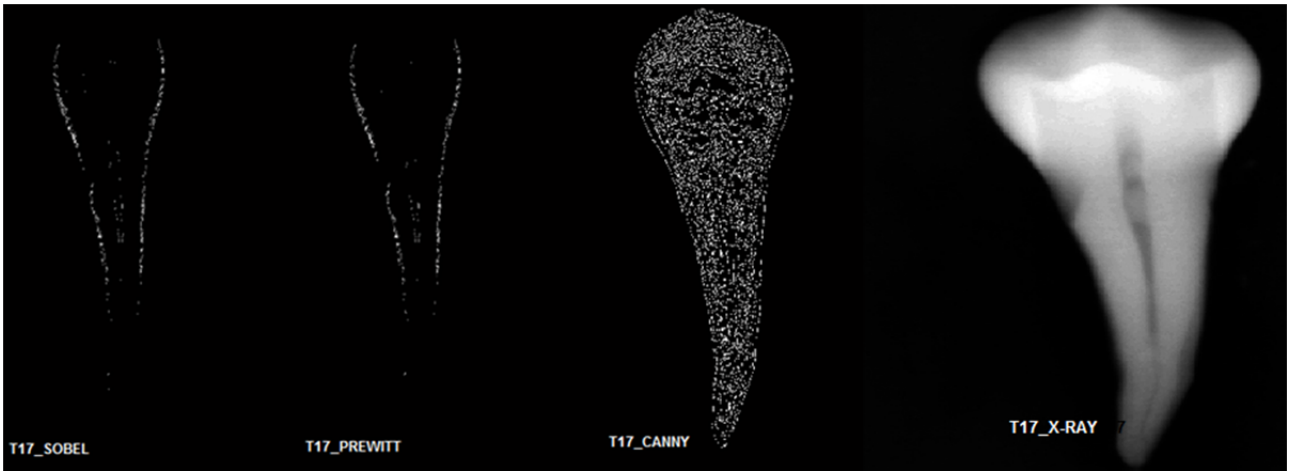

Fig. 1: Comparison of Sobel, Prewitt, Canny and X-ray Image

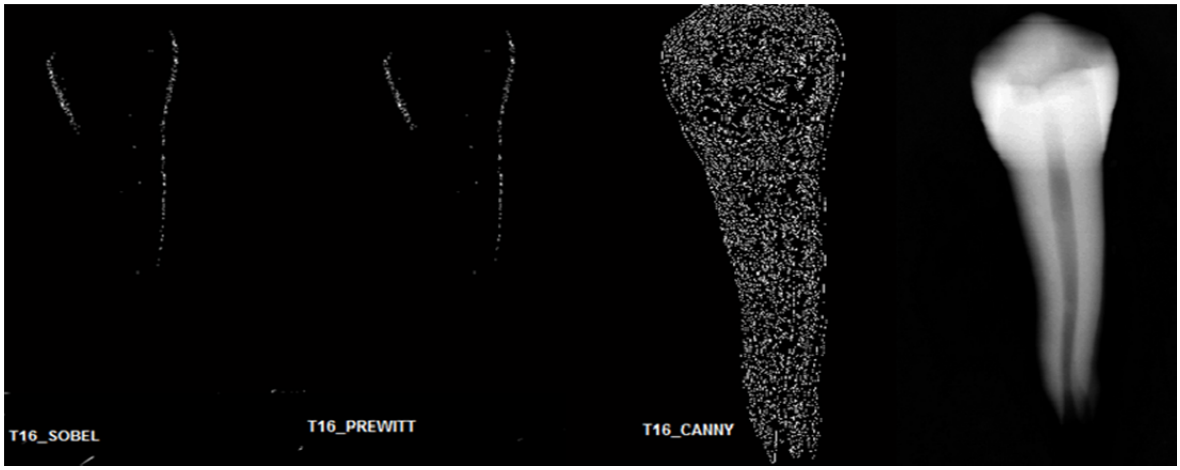

Fig. 2: Comparison of Sobel, Prewitt, Canny and X-RAY Image

5. CONCLUSION & FINDINGS

Edge detection is the important step in image processing and it is used to calculate the difference between various edge detection techniques. After applying various edge detection techniques on Dental radiographs, it has been observed that the images are more prominent and clear and the size of image is less as compared to original image. Various edge detection techniques have been applied to dental radiographs for pixel count and it was found that Canny algorithm works best in comparison to other techniques. While SOBEL and PREWITT techniques provide only the outer boundary of the object, CANNY method provides a much broader view of the dental image. It is also observed that the difference in the number of pixels in CANNY technique is much larger than SOBEL and PREWITT technique while the difference between the pixels obtained in SOBEL and PREWITT technique is much nearer. Thus, Canny algorithm works best with medical imaging and has high accuracy in all edge detection technique.

Future Work would focus on feature extraction implemented on Canny algorithm for image segmentation.

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