

Statistical Analysis of Reliability in edge detection techniques using Optical Coherent Tomography image

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Abstract

Optical Coherence Tomography (OCT) has many uses in medicine and engineering biology. It is a non-invasive technique where Edge detection in image processing playing a significant role in characterization of boundaries and identifying the structural properties in image. In this paper, Choroidal neovascularization – OCT image is comparatively analysis by various Edge Detection techniques. Statistical analysis of Mean Square Error (MSE) is compared with multidimensional scaling methods. On the reliability of scaling, inter-correlation matrix in calculated from correction, dissimilarly and Euclidean distance model is evolved. Resultant graph described the characteristics of edge detection techniques.

Keyword: Multidimensional analysis; Correlation; Edge detection; Optical Coherence Tomography.

1. Introduction

Optical coherence tomography is an imaging modality that provides cross-sectional images of the information on the thickness of retinal layers. Identifying the defect of the diseases, Central serous retinopathy (CSR) is a fluid detachment of macula layers from their supporting tissue. This allows choroidal fluid to leak into the subretinal space. The build-up of fluid seems to occur because of small breaks in the retinal pigment epithelium.

Image Edge detection is mathematical methods and characterizes boundaries significantly reduces the amount of data, object detection and filters out useless information, while preserving the important structural properties in an image by different edge detection algorithms [1]. Edge detection involves convolving the image with an operator (2-D filter).

Multi-Dimensional Analysis is generally used in statistics Informational Analysis on data, which groups data into two basic dimension and measurement categories. Here, data are mutual relationship or connection between two or more things. Inter- dependence of variable quantities. Correlation is applied for statistical relationships and dependant variables. Reliability is a proportion of variance measure (squared variable) and intra - relation correlations, estimates of internal consistency. The average inter-item correlation is simply the mean of all these correlations.

2. Experimental Procedure

Optical coherence tomography image of Central serous retinopathy affected diseases is subjected to operate with different edge detection techniques.

Edge detection techniques are executed on the basic of operator in different techniques and threshold value is the acceptance criteria for layer and boundary detection of tissue layers and structure [2][3]. Here different edge detection techniques are applied in OCT-CSR image. They are as follows,

2.1 Zero crossing detector

In zero crossing out points in the signal stream where the digital signal of an image passes through a pre-set '0' value, and marks this out as a potential edge point.

2.2 Canny operator detector

By this method, detector is able to generate single-pixel thick continuous edges. This method is not easily disturbed by noise and can keep the good balance between noise and edge detection. For two-dimensional image, canny operator can produce two information including the border gradient direction and intensity.

2.3 Frei-Chen Edge detector

Appropriate masks are chosen and the image is projected onto it. The computation for Frei-Chen edge detector also works on a 3×3 matrix footprint but applies a total of nine convolution masks to the image. Frei-Chen masks are unique masks, which contain all of the basis vectors.

2.4 Sobel Edge detector

The Sobel operator performs a 2-D spatial gradient measurement on an image and so emphasizes regions of high spatial frequency that correspond to edges.

2.5 Laplacian Edge detector

The Laplacian is isotropic measure of the second spatial derivative of an image. The Laplacian of an image highlights regions of rapid intensity.

2.6 Non-Maxima Edge detector

The Non-Maximum Suppression module will set all pixels in the current neighbourhood window that are lower than the maximum value in that window to zero (or black) and high value (or white)

2.7 Prewitt Edge detector

The Prewitt operator is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Prewitt operator is either the corresponding gradient vector or the norm of this vector.

2.8 Roberts Edge detector

The Roberts Cross operator highlights regions of high spatial frequency which often correspond to edges by grayscale image, as is the output. Operator performs a simple, quick to compute, spatial gradient measurement on an image.

2.9 Statistical Data and image

Peak Signal-to-Noise Ratio (PSNR), is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Using this output's from edge detection, one set of eight output images is taken as Original image (OI) and other set of eight images as Distorted images (DI). One edge detection technique (OI) is compare with the other seven output image (DI) in corresponding to the statistical techniques of PSNR and MaxDiff in changing the original image with respective of distorted image. The date obtained is of multi-dimension information of correlation of eight edge detection methods.

2.10 Statistical Reliability techniques

Statistical reliability is needed in order to ensure the validity and precision of the statistical analysis. In statistics; reliability is a concept that determines the precision of measurements. Statistical reliability determines reproducible in image analysis.

2.11 Multidimensional scaling (MDS)

A set of intra-relation statistical techniques that preferences and perceptions of respondents and representing on a visual grid, in perceptual mapping form, used in information visualization for exploring similarities or dissimilarities in data[4].The correlation and inter relation correlation is applied on the data to identify the relation of the edge detection operators.The correlation(r) can be calculated as: $r = \frac{\sum (Z_x Z_y)}{N}$. Where Z_x and Z_y are 2D data of multidimensional scaling of N numbers variables.

2.12 Inter - Item Correlations or Inter – variable correlations(R)

Model of calculation is based on Select the model for calculating the intra variable or class correlation coefficient. Inter – variable correlation assess the usefulness of an item as a measure of individual differences in algorithm. George and Mallery [5] provide the following rules of thumb: “0.9 – Excellent, 0.8 – Good, 0.7 – Acceptable, 0.6 – Questionable, 0.5 – Poor, and 0.5 – Unacceptable”.

Available models are two-way mixed model. Reliability analysis algorithms are done by common Inter – variable correlation methods ie., $R = \text{Covariance} / \text{Variance}$. This is implemented by SPSS software.

3. Data Analysis and Results

On comparing the original image with distorted image by applying the PSNR in each set, multidimensional data show in below table is obtained.

3.1 Mean Square Error

The data is manipulation of original image and distorted image is shown in the Table 1 of multidimensional analysis of Mean Square Error (MSE) statistical techniques.

Table 1. Mean Square Error –Multidimensional

	ZC	Canny	FC	Sobel	Laplacian	NonMax	Prewitt	Roberts
ZC	0	488.4769	3014.9	3764.3	1493.3	1878.2	1878.2	1809.2
Canny	488.4769	0	3435.6	4210.7	1788.8	2008.7	2008.7	1889.6
FC	3014.9	3435.6	0	863.3418	3536.2	3305.2	3305.2	3094.6
Sobel	3764.3	4210.7	863.3418	0	4134.6	4263	4263	3449.6
Laplacian	1493.3	1788.8	3536.2	4134.6	0	1373.5	1373.5	568.4629
NonMax	1878.2	2008.7	3305.2	4263	1373.5	0	0	1267.6
Prewitt	1878.2	2008.7	3305.2	4263	1373.5	0	0	1267.6
Roberts	1809.2	1889.6	3094.6	3449.6	568.4629	1267.6	1267.6	0

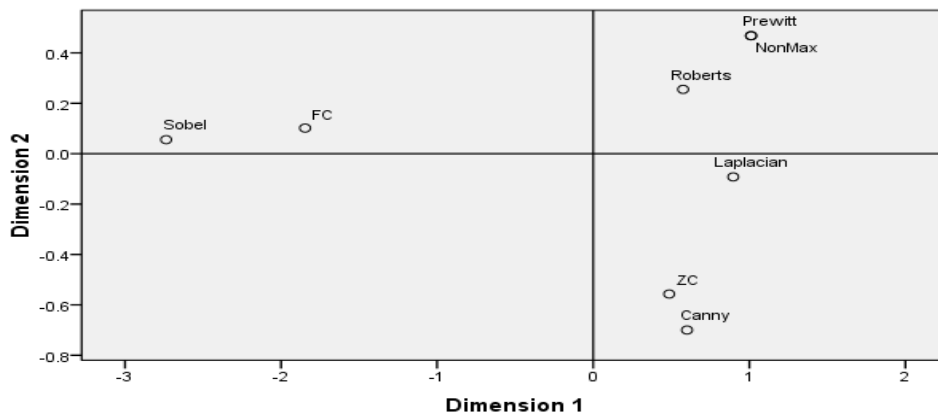


Fig. 1 MSE - Individual Difference (Weighted) Euclidean distant model (Bidimensional data)

The distant models used to represent dissimilarity/similarity data in MDS. There are other distance models; the Euclidean distance model is the most popular one used in MDS. Fig.1 represent the Euclidean distance model of PSNR value in multidimensional model.

3.2 Inter - Item Correlations

The average inter variable correlation is simply the average or mean of all these correlations. The Table 2 show Inter item correlation of PSNR values. Fig. 2 is the PSNR graphical representation.

Table 2. Mean Square Error - Graphical representation of Inter-Item Correlation Matrix

Techniques	ZC	Canny	FC	Sobel	Laplacian	NonMax	Prewitt	Roberts
ZC	1	0.978	-0.746	-0.8	0.649	0.483	0.483	0.495
Canny	0.978	1	-0.777	-0.826	0.641	0.503	0.503	0.508
FC	-0.746	-0.777	1	0.947	-0.879	-0.801	-0.801	-0.812
Sobel	-0.8	-0.826	0.947	1	-0.88	-0.883	-0.883	-0.793
Laplacian	0.649	0.641	-0.879	-0.88	1	0.78	0.78	0.957
NonMax	0.483	0.503	-0.801	-0.883	0.78	1	1	0.775
Prewitt	0.483	0.503	-0.801	-0.883	0.78	1	1	0.775
Roberts	0.495	0.508	-0.812	-0.793	0.957	0.775	0.775	1

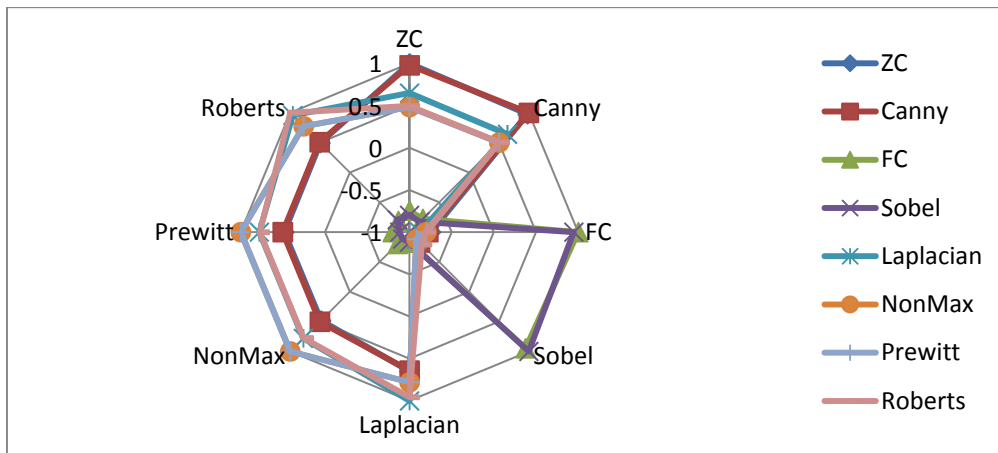


Fig. 2 PSNR - Graphical representation of Inter-Item Correlation Matrix

4. Conclusion

Here, OCT - CSR type of image is taken for identifying the efficient algorithms by comparing the images using the statistical technique i.e., PSNR. Normally 0.2 or 0.3 indicated insignificant value for correlation. Based on the criteria of critical values in Inter-Item Correlation and Euclidean distant model, Prewitt edge detection is effectively suitable followed by Canny and Laplacian edge detection methods. From the result graph, Frei-Chen and Sobel Edge detector methods are deviated by PSNR and intra item correlation values.

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