Analytical Comparison And Selection Methods For Deformation Analysis By Edge Detection Using Image Processing

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ABSTRACT

Edge detection is one of the most commonly used technique in the field of image processing. They characterize boundary information and filters out unnecessary data therefore preserving important structural properties of image. This paper mainly compares various edge detections applied in strain analysis of soft aluminum. Various edge detection techniques include Prewitt, Sobel, Canny, LoG-(Laplacian of Gaussian)and zero cross detectors . Image analysis is performed by using Matlab 2012(a). The experimental results shows that the Sobel and Robert's operators shown better results when compared to Canny operator for deformation analysis. A standard 4000 x 2248 resolution image is taken from a 5Megapixel camera for image analysis Deformation analysis for aluminum specimen is performed in universal testing machine(UTM).

Keywords –Edge, Edge detection, necking, strain analysis, universal testing machine

I. INTRODUCTION

Edge detection is the process of identifying sharp discontinuities over an image. The abrupt changes in the pixel intensity gives the boundary of the image [1][3]. Classical edge detection methods involves convolving the image with an operator which returns a zero value for uniform regions and a nonzero value for nonuniform region. In ideal case edge detection leads to a set of curves which contains the boundary information of an image [2]. Edge detection for noisy images is more difficult as the frequency components are more, the efficient edge detection algorithm depends on the noise sensitivity [3].

1.1 Strain Analysis

Strain analysis is a branch of engineering which deals with the amount of bearing capacity of specimen when it is subjected to force or a load[4]. Generally the input for the strain analysis is a complex material and maximum and minimum forces that are to be applied and the output data gives the amount of deformation caused by the force applied[5]. Strain analysis can be performed through mathematical modeling, computational simulation and experimental testing. Out of all these methods experimental testing is the most efficient way of deformation analysis . There are four ways of performing strain analysis

1.2 Tensile testing

1.3 Strain gauges

1.4 Photo elastic method

1.5 Dynamic mechanical analysis method

Out of which universal testing machine belongs to dynamic mechanical analysis method

1.6 Universal Testing Machine (UTM)

Universal testing machine is a fast accurate and a simple experimental setup for strain analysis. The output of this system is a load displacement graph of a specimen [6]

Figure 1 -Experimental setup of universal testing machine

II. PROBLEM DEFINITION

The main problem of strain analysis in universal testing machine is to find the percentage of deformation of a specimen. It is difficult to find the percentage of deformation by normal methods[7]. Edge detection is the suitable and comfortable procedure in this case. This paper analyses the percentage of deformation by digital image processing using matlab

Matlab is easier and comfortable when compared to other computing languages [8]. Here the data is taken in the form of matrices. Many inbuilt functions are present for easy computations [9].These special functional blocks are called toolboxes and each toolbox have their own significance and these are used for a specific application. Main toolbox that is used for this application is image processing toolbox[10].

2.1 *Image acquisition*

Basic image acquisition for analysis is taken from a 5megapixel camera with a standard resolution of 4000x2248 image


Figure2(a) Figure2(b)

a. Soft aluminum specimen before strain analysis
b. Soft aluminum specimen after strain analysis

III. FLOW CHART

IV. Study and Comparison of Various Image Edge Detection Techniques

START

Read the standard 2d image from the image acquisition device i.e camera

Apply edge detection algorithms to the input image

Count the number of pixels contained in deformed regions (W.C), and background count by(B.C)

Calculate total pixel count in the image . Assign it to the variable y (T.C)

Calculate percentage of deformation by using the formula - (W.C) /(T.C)*100 , and percentage of efficiency by- (B.C)/(T.C)*100

stop

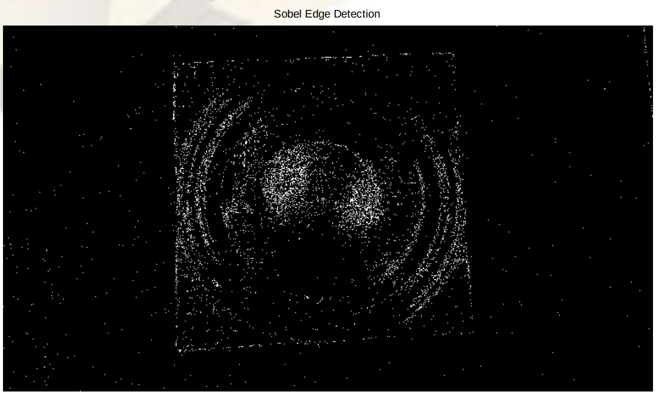
IV EDGE DETECTION TECHNIQUES

4.1 Sobel edge detection

Sobel operator is called as discrete differentiation operator [11]. It performs gradient to image intensity functions. Sobel operator is formed by passing a simple mask over an image[12]. The sobel operator performs a 2D spatial gradient measurement over an image and high spatial frequency components are treated as edges so it is computationally very efficient [13]. The 3x3 kernels of sobel edge detection are shown in figures .Here one kernel is simply the other which is rotated by 90degrees

-1	0	+1
-2	0	+2
-1	0	+1

+1	+2	+1
0	0	0
-1	-2	-1



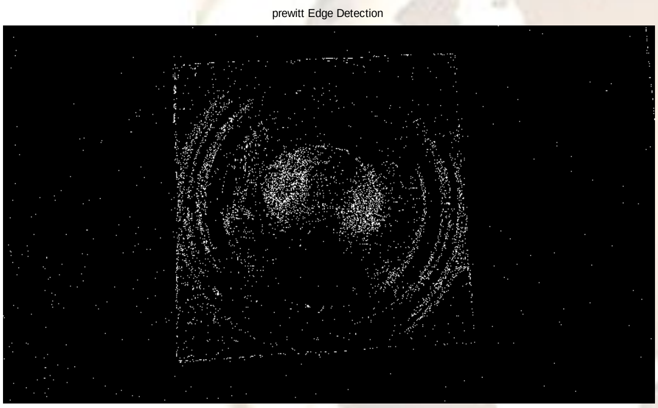
Figure(3)- sobel edge detection applied to input image

4.2 Prewitt edge detection

Prewitt operator is same as sobel operator and is used to find horizontal and vertical edges[14]. The gradient of image intensity varies from darker region to brighter region. This results in more smoothing effect at the edges [15].It is an efficient way to identify the magnitude of an edge. The kernel of Prewitt is

-1	0	+1
-1	0	+1
-1	0	+1

+1	+1	+1
0	0	0
-1	-1	-1



Figure(4)- Prewitt operator applied to input image

4.3 Robert's edge detection

It is the first edge detection algorithm and was introduced by Lawrence Roberts in the year 1963.The differential gradient of the image is obtained by computing the sum of squares of differences between adjacent pixels .It highlights the components of high spatial frequency which corresponds to edges[16]. It is used for simple and quick computation of spatial gradient. Here one mask is simply the other rotated by 90 degrees. It is similar to that of sobel operator .the 2x2 Roberts mask is shown

+1	0
0	-1

0	+1
-1	0

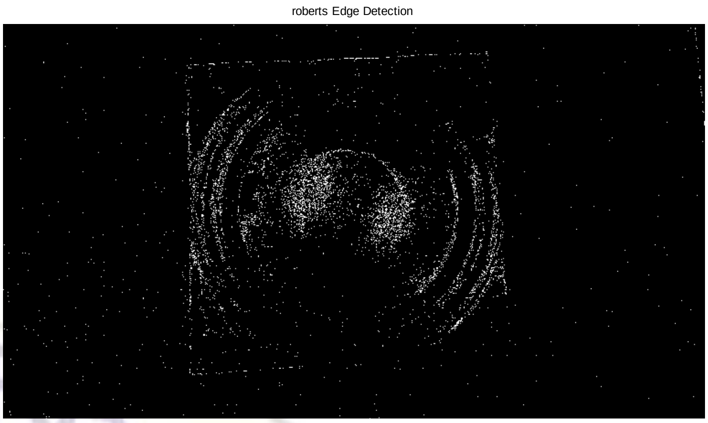


Figure (5)- Robert's operator applied to input image

4.4 Laplacian of Gaussian (LoG)

LoG is a 2D isotropic measure of a 2D spatial derivative of an image. It highlights the rapid intensity changes in an image so it is used for edge detection[15]. It smoothens the image and reduce the noise content of an image. It takes a single grey level as an input image and produces another grey level at output .The mask of LoG is given as

0	-1	0
-1	4	-1
0	-1	0

-1	-1	-1
-1	8	-1
-1	-1	-1

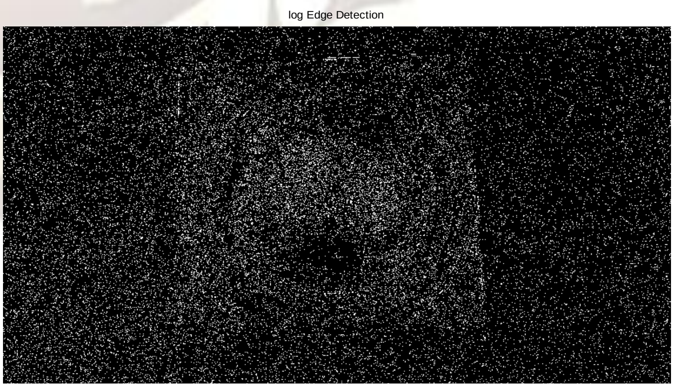
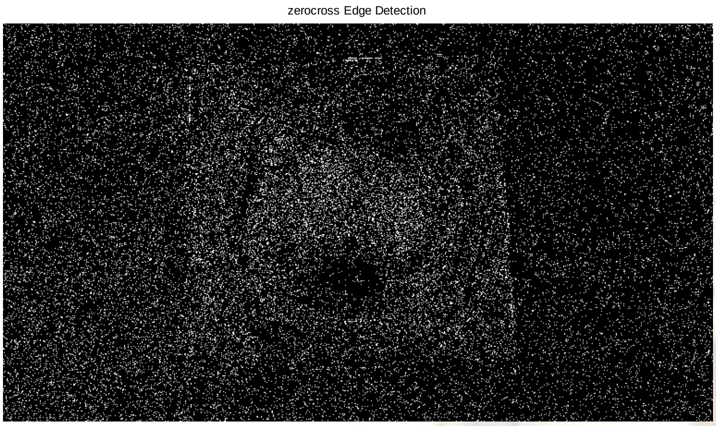


Figure (6) –LoG operator applied to input image

4.5 Zero cross edge detector

Zero cross edge detector depends on Laplacian sign changes and treat them as edges in images[17]. It is generally mentioned as a future detector rather than edge detector. The output of a zero cross detector is generally a binary image with single pixel thickness showing positions of zero crossing points [18].



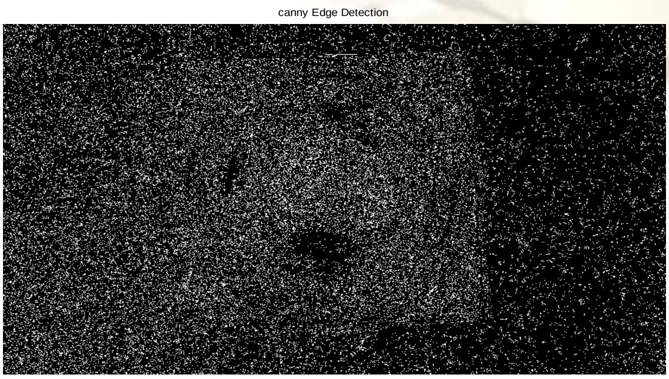
Zero cross detector applied to input image

4.6 Canny edge detector

Canny edge detector is also called as optimal edge detector. Canny edge detection depends upon gradient magnitude of smoothened image [19]. Local maxima of gradient magnitude high are defined as an edge. The optimal function in canny is described by sum of four exponential terms but can be approximated as first derivative of Gaussian. The 3x3 kernel of canny edge detection is

-1	0	+1
-2	0	+2
-1	0	+1

-1	-2	-1
0	0	0
+1	+2	+1



Canny edge detector applied to input image

I. Results

s. no	Name of edge detector	Total count(in pixels) T.C	Black count(in pixels) B.C	T.C – B.C =White count W.C	% of deformation(error) (W.C/ T.C)* 100	% of efficiency (B.C/ T.C)* 100
1.	Sobel	562000	479901	82099	14.6084	85.39
2.	Prewitt	562000	479578	82422	15.012	87.12
3.	Roberts	562000	504799	57201	10.1781	89.82
4.	LoG	562000	269125	292875	52.1130	47.88
5.	Zero cross detector	562000	292875	292875	47.8870	48.00
6.	Canny	562000	293460	293460	48.7829	49.79

Figure(8) – Performance analysis of Edge detections in deformation analysis

V Conclusions and observations

5.1 It is observed that canny edge detector shows maximum amount of deformation, the entire deformation is of 49% of image .Here the strain deformations along with surface irregularities are represented as edges resulting in lesser efficiency.

5.2Robert's edge detector shows the minimum deformation and has the maximum efficiency of about 89%

5.3 So the deformation analysis and the strain analysis is more efficient for Robert's edge detector than when compared to Canny edge detector or LoG detector

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