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Estimating Directly Damage on External Surface of Container from Parameters of Capsize-Gaussian-Function

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ABSTRACT : *In this paper, an estimating damage on external surface of container using Capsize-Gaussian-Function (be called CGF) is presented. The estimation of the damage size can be get directly from two parameters of CGF, these are the depth and the flexure, also the direction of damage. The performance of the present method has been illustrated using an image of damage container, which had been taken from Hanjin Busan Port, after using image processing techniques to do preprocessing of the image, especially, the main used technique is Canny edge detecting that is widely used in computer vision to locate sharp intensity and to find object boundaries in the image, then correlation between the edge image from the preprocessing step and the CGF with three parameters (direction, depth, flexure), as a result, we get an image that perform damage information, and these parameters is an estimator directly to the damage.*

KEY WORDS : *damage of container, Capsize-Gaussian-Function, image processing, Canny edge detector*

1. Introduction

Estimating quality of containers is an important problem in a Port System. Automation of this process is one of needs of improvement and modernization Port Management Technology. This paper presents our research about recognition and estimating the size of damage on external surface of container.

The damage is alteration in the shape of dimensions of container as a result of the application or accident of stress to it. Information of the damage could be obtained by using camera or capture devices. Some of automatic applications are used to recognize and estimate the rate of damage.

In order to detect and estimate the damage shape, first of all, the image could be preprocessed and detected edges using Canny edge detector or another edge detection methods, and second step, we need to extract interesting features which could describe the characteristics of problem. In section two, we have briefly described some of image processing procedures used in the preprocessing data, and addressed detail to Canny edge detector which is used to extract the boundary of the image. In section three, an feature extracting method by using Capsize-Gaussian-Function in the directly estimating the damage will be introduced. In the following section four, we will show the implementation and results of our research. In section five will be discussion and conclusion.

2. Image Processing Techniques - Canny Edge detector

Observed image, which is included of informative edge of deformation shapes and another unwanted edges, should be decreasing uninteresting variations or suppressing noise and detecting the edges. These processes are called conditioning. There are many kinds of techniques used in this step, refer [8][9], such as noise cleaning, sharpening, edge detection, line detection. In section two, we have just presented Canny edge detector which is widely used in computer vision to locate sharp intensity changes and to find object boundaries in an image [1].

Canny edge detector determined edges by an optimization process, refer to [1][12], to ensure three criteria is that low error rate, the edge points be well localized (minimize the actual edge), and have a only one response to a single edge. Based on these criteria, a typical implementation of the Canny edge detector follows steps below.

1. Smooth the image to eliminate the noise and reduce desired image details by using an appropriate Gaussian mask (filter) convolute with the origin image.
2. Determine gradient magnitude and gradient direction at each pixel from the smoothed image.
3. Non-maximum suppression is used to be applied to trace along the edge in the gradient direction and suppress any pixel value that is not considered to be an edge. If the gradient magnitude at a pixel is larger than those at its two neighbors in the gradient direction, mark the pixel as an edge. Otherwise, mark the pixel as the background.
4. Remove the weak edges by hysterisis thresholding.

3. Capsize-Gaussian-Function

Capsize-Gaussian-Function is defined in eq. (1), that is a basic function constructing a class of deformation and vector describe deformation at one point.

$$y'(x') = a\left[1 - e^{\left(-\frac{x^2}{2\sigma^2}\right)} RIGHT\right] \tag{1}$$

The curve of Capsize-Gaussian-Function can rotary a angle θ about origin (called deformation pivot), change the shape by change the spread σ, an change the depth a, that is illustrated in Fig. 1.

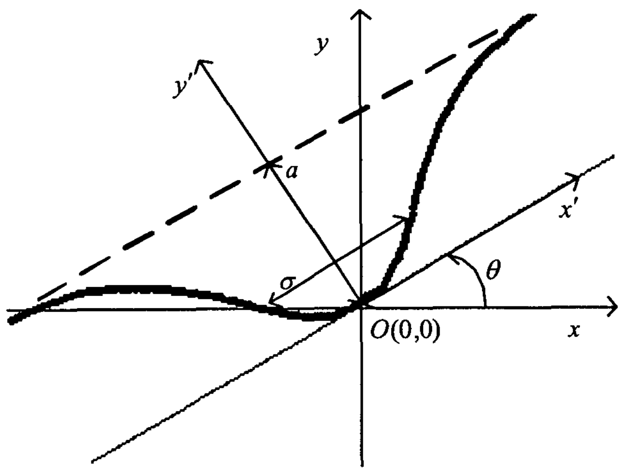


Fig. 1 Spatial feature of deformation curve at the deformation pivot O(0,0).

In general, we define a spatial mask $W(x,y,\theta,a,\sigma)$ in eq. (3) satisfy in domain $R(\theta,a,\sigma)$ in eq. (2) that used in the convolution task. At each position in 2-D image space and each set (θ,a,σ), after correlate with the mask $W(x,y,\theta,a,\sigma)$, we have a value of estimating the deformation level at the point correspond at the direction of extracting θ, the flexure σ, and the depth a, showed in Fig. 2. The correlation operator in both discrete and continuous cases in eq. (4) and eq. (5).

$$\Re(\theta,a,\sigma) = \left\{ (x,y) \middle| \left\langle \begin{array}{l} y' = a\left[1 - e^{\left(-\frac{x'^2}{2\sigma^2}\right)}\right] \\ \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{bmatrix} \begin{bmatrix} x' \\ y' \end{bmatrix} \end{array} \right\rangle \right\} \tag{2}$$

$$W(x,y,\theta,a,\sigma) = \begin{cases} 1, & \text{if } (x,y) \in \Re(\theta,a,\sigma) \\ 0, & \text{otherwise} \end{cases} \tag{3}$$

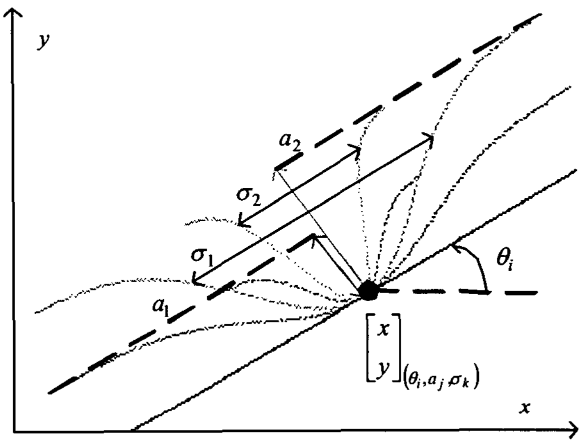


Fig. 2 Vector Integrated deformation information at a point.

Matching by correlation :

$$d(m,n,\theta,a,\sigma) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} W(x+m,y+n,\theta,a,\sigma) I(x,y) dxdy \tag{4}$$

$$d(m,n,\theta,a,\sigma) = \sum_{-\infty}^{\infty}\sum_{-\infty}^{\infty} W(x+m,y+n,\theta,a,\sigma) I(x,y) \tag{5}$$

An example to illustrate the effect of correlation operation is shown in Fig. 3. An edge image with array of line form the Capsize-Gaussian-Function after rotate -90 degree will be correlate with a mask $W\left(x,y,-\frac{\pi}{2},a,\sigma\right)$, and the result will appear white points (called centers of shape deformation) in the horizontal line.

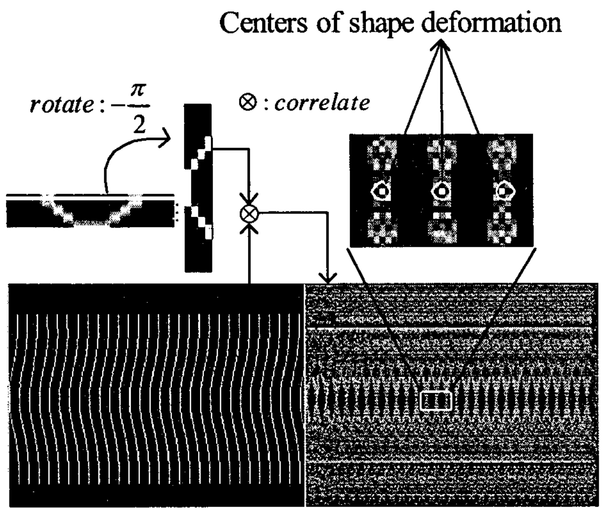


Fig. 3 Illustrate the method to detect points of high deformation.

Although the correlation operation can be normalized for amplitude changes via the correlation coefficient, obtaining normalization for changes in size and rotation can be hard. Because, in the real systems, the nature of size and rotation of deformation is unknown, so looking for the best match requires exhaustive changes of size and rotations of the mask.

Recognition based on threshold method after obtain the feature image :

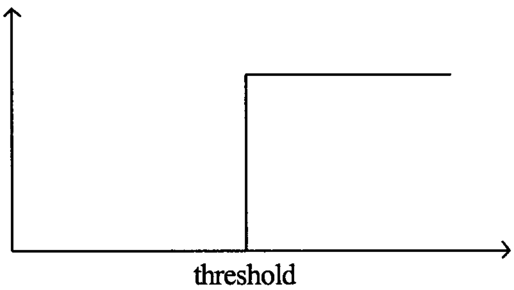


Fig. 4 Thresholding transformation.

4. Implementation and Results

To reduce the time of computation of the integral correlation calculation, for the 294×220 origin image of Fig. 5, we have just chosen a few of elements of each parameters, but it has not lost the signification of our method. Three values for each parameters are given such as :

$$\theta = \left[-\frac{\pi}{2} \quad 0 \quad \frac{\pi}{2} RIGHT\right],$$

$$a = [5 \quad 10 \quad 20\, RIGHT],$$

$$\sigma = [7 \quad 15 \quad 28\, RIGHT]$$

Fig. 6 is the edge image of origin image in Fig. 5 after apply Canny edge detector.

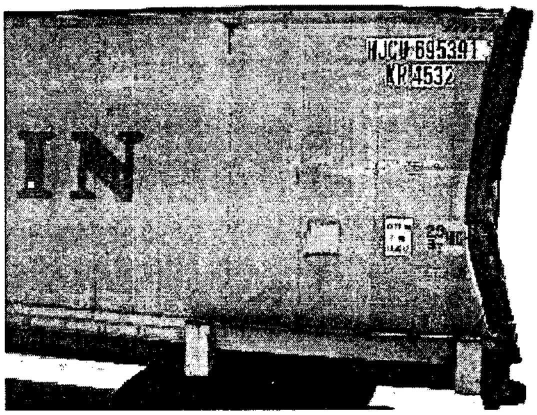


Fig. 5 Origin image: A container with deformation at the right hand side of image.

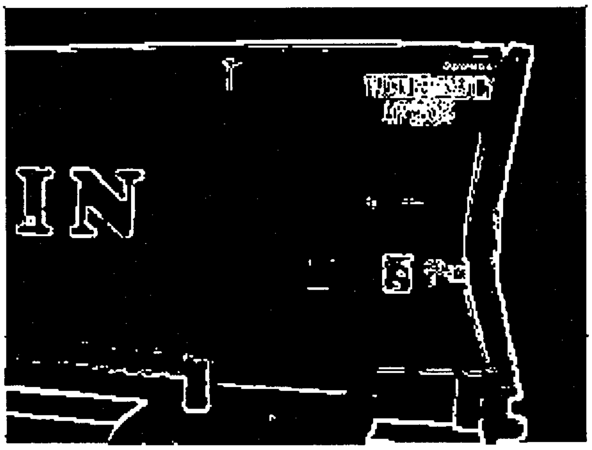
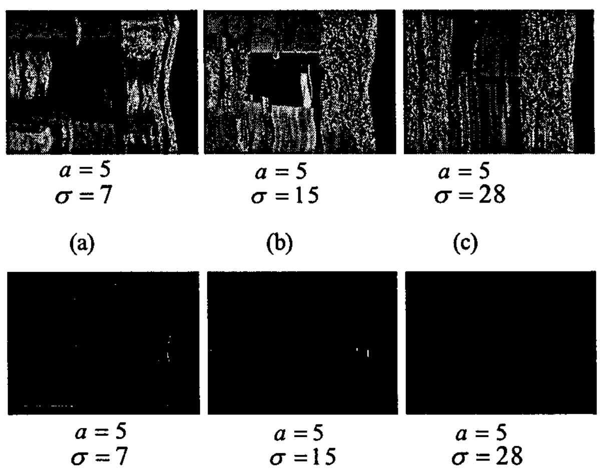


Fig. 6 Edges of the origin image determined by the Canny edge Detector.

$\theta = -\pi/2$



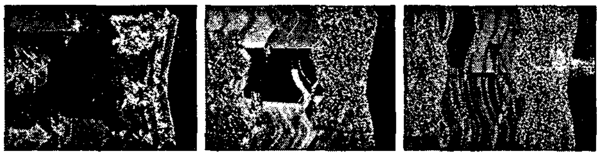
(threshold_a) (threshold_b) (threshold_c)

$a=10$ $a=10$ $a=10$
$\sigma=7$ $\sigma=15$ $\sigma=28$

(d) (e) (f)

$a=10$ $a=10$ $a=10$
$\sigma=7$ $\sigma=15$ $\sigma=28$

(threshold_d) (threshold_e) (threshold_f)



$a=20$ $a=20$ $a=20$
$\sigma=7$ $\sigma=15$ $\sigma=28$

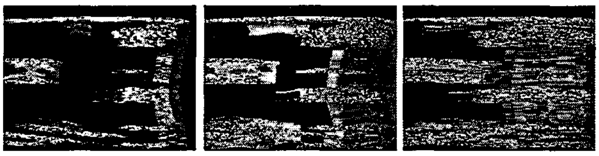
(g) (h) (i)

$a=20$ $a=20$ $a=20$
$\sigma=7$ $\sigma=15$ $\sigma=28$

(threshold_g) (threshold_h) (threshold_i)

Fig. 7 Feature Images after applied correlation and thresholding transformations at direction $\theta=-\pi/2$.

$\theta=0$



$a=5$ $a=5$ $a=5$
$\sigma=7$ $\sigma=15$ $\sigma=28$

(a) (b) (c)

$a=5$ $a=5$ $a=5$
$\sigma=7$ $\sigma=15$ $\sigma=28$

(threshold_a) (threshold_b) (threshold_c)

$a=10$ $a=10$ $a=10$
$\sigma=7$ $\sigma=15$ $\sigma=28$

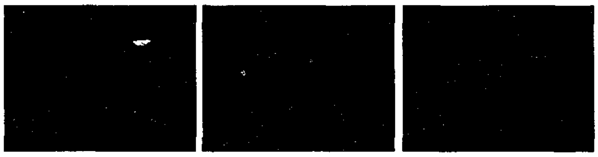
(d) (e) (f)

$a=10$ $a=10$ $a=10$
$\sigma=7$ $\sigma=15$ $\sigma=28$

(threshold_d) (threshold_e) (threshold_f)

$a=20$ $a=20$ $a=20$
$\sigma=7$ $\sigma=15$ $\sigma=28$

(g) (h) (i)

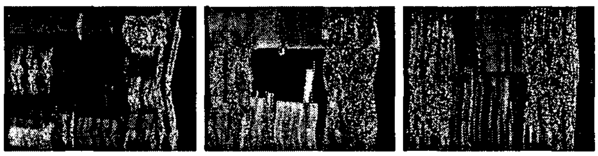


$a=20$ $a=20$ $a=20$
$\sigma=7$ $\sigma=15$ $\sigma=28$

(threshold_g) (threshold_h) (threshold_i)

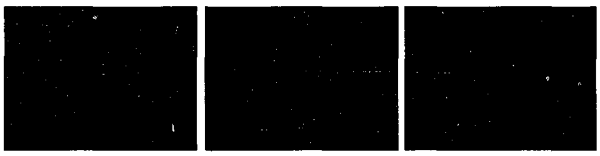
Fig. 8 Feature Images after applied correlation and thresholding transformations at direction $\theta=0$.

$\theta=\pi/2$



$a=5$ $a=5$ $a=5$
$\sigma=7$ $\sigma=15$ $\sigma=28$

(a) (b) (c)



$a=5$ $a=5$ $a=5$
$\sigma=7$ $\sigma=15$ $\sigma=28$

(threshold_a) (threshold_b) (threshold_c)

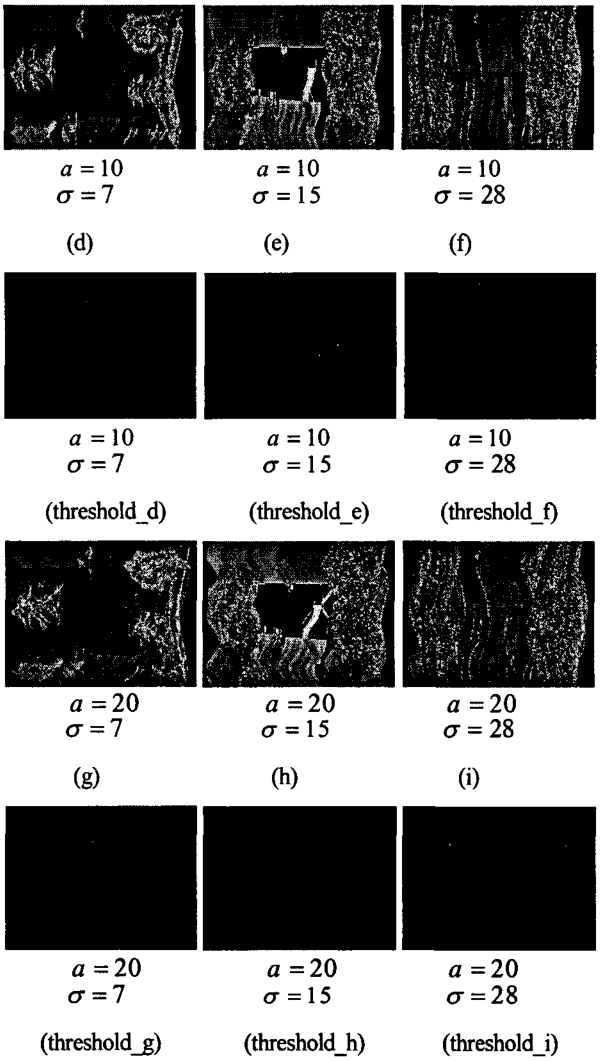


Fig. 9 Feature Images after applied correlation and thresholding transformations at direction $\theta = \pi/2$.

The deformation can be detected from white points in the feature images Fig. 7((threshold_a), (threshold_b), (threshold_f)) corresponding to the parameters

$$(\theta, a, \sigma) = \left\{\left(-\frac{\pi}{2},5,7\right),\left(-\frac{\pi}{2},5,15\right),\left(-\frac{\pi}{2},10,28\right)\right\}$$

This set of parameters is a estimator of damage of the container in image.

To ensure that the clear image of damages are obtained, Canny edge detector has been implemented. However, some of strict corner of some texts or marks on surface of container might be generate fault or error decisions, especially, when the processes are automatic.

If the distribution of the white points is not spread, high density or high the group's width of meaning, these points may be not considered as damage or deformation, we might be guess these points are belong to a particular region. Inside of Fig. 8((threshold_a), (threshold_d), (threshold_g)) has a group of white points, but that is the text region correspondingly in the origin image. And these groups have just occurred from the set parameters $(\theta, a, \sigma) = \{(0,5,7),(0,10,7),(0,20,7)\}$, we have a attention that if spreads greater than a threshold, there is not exist white group points. So we should limit the range for spread parameter and also another parameters depend on the application.

5. Conclusions

In this paper, a new ideal, which matching by correlation between edge image and Capsize-Gaussian-Function, to extract information of deformation shapes and recognize these has been presented. However, in future, we need do more experiments and looking for a decision making and measuring the size of damage or deformation shapes. And further more, we will design an automatic identity check import-export containers system in order to improve and modernize port management and technology.

References

[1] Lijun Ding, Ardeshir Goshtasby. On the Canny edge detector. The Journal of The Pattern Recognition Society 34 (2001), pp. 721-725.

[2] Suzanna Becker, Mark Pumbley. Unsupervised Neural Network Learning Procedures For Feature Extraction and Classification. International Journal of Applied Intelligence, Special Issue on Application of Neural Networks, Vol. 6, No.3,F. Pineda, 1996.

[3] K.Z. Tang, S.N. Huang, K.K. Tan, T.H. Lee. Combined PID and adaptive nonlinear control for servo mechanical systems. Mechatronics 14 (2004), pp. 701-714.

[4] Simon Haykin: Neural Networks, A Comprehensive foundation, 2nd ed., Prentice Hall.

[5] Sergios Theodoridis, Konstantinos Koutroumbas: Pattern Recognition, Academic Press.

[6] Sing-Tze Bow: Pattern Recognition and Image Preprocessing, Marcel Dekker, Inc.

[7] Abhijit S. Pandya, Robert B. Mancy: Pattern Recognition with Neural Networks in C++, CRC Press and IEEE Press.

[8] Robert M. Haralick, Linda G. Shapiro: Computer and Robot Vision I, Addison-Wesley Publishing Company.

[9] Robert M. Haralick, Linda G. Shapiro: Computer and Robot Vision II, Addison-Wesley Publishing Company.

[10] Dana H. Ballard, Christopher M. Brown: Computer Vision,

Prentice Hall.
[11] Rafael C. Gonzalez, Richard E. Woods: Digital Image Processing, Prentice Hall, 2002.
[12] Bill Green, Canny Edge Detection Tutorial, http://www.pages.drexel.edu/~weg22/can_tut.html, 2002.