AN APPLICATION OF DIGITAL IMAGE PROCESSING TECHNIQUES IN DETECTING DAMAGE OR DEFORMATION SHAPE ON EXTERNAL SURFACE OF CONTAINER.

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ABSTRACT

This paper presents the number of techniques for digital image processing which can be used to detect damage or deformation shape on the external surface of container. These techniques include the edge detect operators and the feature extraction methods. In this paper, we will show the effect of Canny edge operator to detect the boundaries of extraordinary shapes on external surface of container. Also, we present a new ideal of using Capsize-Gaussian-Function to detect edges of damage or deformation. Lastly we analyze useful features to recognize these. However, the choice of these in real systems needs to adjust several of parameters or choose a suitable operator and feature extraction method, so it is far from being an easy task itself. And there is significant scope for improvement and modernization port management technology.

Keywords: edge detection; Canny edge detector; Capsize-Gaussian-Function; damage or deformation.

1. INTRODUCTION

Damage or deformation is alteration in the shape of dimensions of an object as a result of the application or accident of stress to it. Information of the deformation could be obtained by using camera or capture devices. Some of automatic applications are used to recognize and estimate the rate of damage or deformation. In general, detection and recognition of this objects is a complex procedure require a variety of steps that successively transform the iconic data to recognition information. These processes may be implemented of the following three steps: conditioning the image in which contains the damage or deformation shapes, extracting features of these, and estimating or measuring size or shape of these. In this paper we do not address the problem of estimating or measuring, although, in our approach, it has parameters relate on the size or shape such as amplitude and spread of deformation description function (will be presented later in section three). And we do address the first two steps.

In the first step, the 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].

In order to detect the damage or deformation shape, first of all, the image could be detected edges using Canny edge detector or another edge detection methods. In the second step, we need to extract interesting features which could describe the characteristics of problem, in this case that is damage or deformation shape. There are many techniques to extract feature, refer to [5][6][7], but all most of the transforms process on spread of all elements of 2-D space (also image space), even wavelets, so they bring about complex understanding of edge deformation features. Conversely, in our problem, at each point of image space, relatively we can estimate directly the bending of deformation curve, the depth of damage level at a particular direction, so it is easy to imagine the picture of damage or deformation level. Our extraction just concentrates in the points spot on characteristic line based on Capsize-Gaussian-Function. This function will be presented at section three.

In the following section 4, we will show the implementation and results of our research. In section 5 will be discussion and conclusion.

2. A REVIEWED CANNY EDGE DETECTOR

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. FEATURE EXTRACTION AND DEFORMATION RECOGNITION

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

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

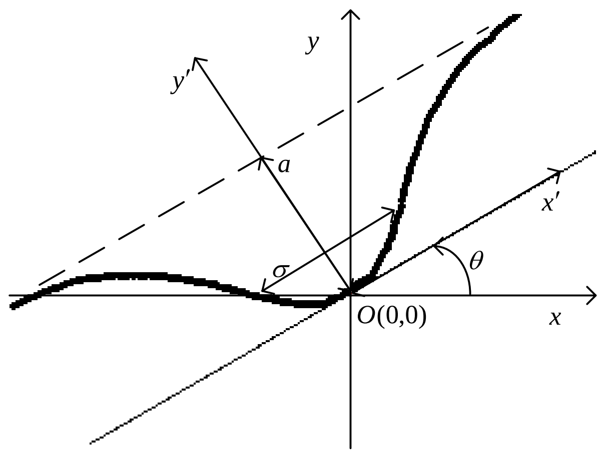

Fig. 1 Spatial feature of deformation curve at the deformation pivot O(0,0).

In general, we define a spatial mask $W(x, y, \theta, a, \sigma)$ in (3) satisfy in domain $\Re(\theta, a, \sigma)$ in (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 (4) and (5).

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

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

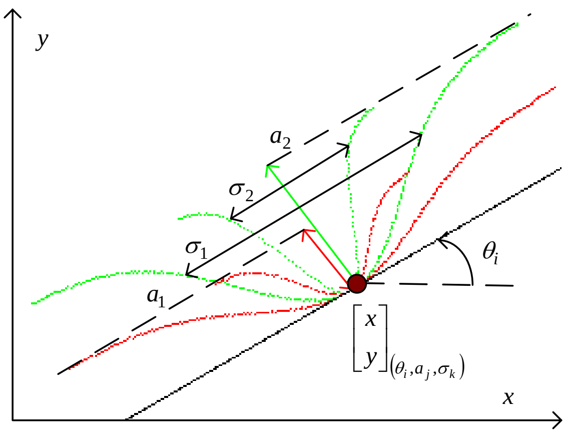

Fig. 2 Vector Integrated deformation information at a point.

Matching by correlation :

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

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

An example to illustrate the effect of correlation operation is shown in Fig. 3. An edge image with array of line form the Capsize-Gausian-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.

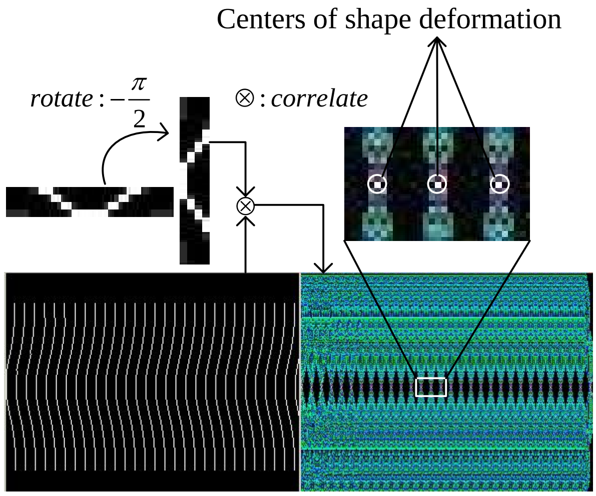

Fig. 3 Illustrate the method to detect points of high deformation.

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 :

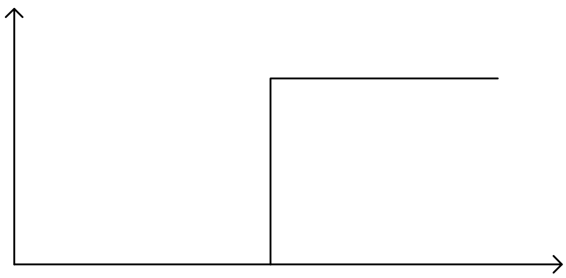

Fig. 4 Thresholding transformation.

4. IMPLEMENTATION AND RESULTS

To reduce the time of computation of the integral correlation calculation, for the 294x220 origin image of Fig. 4, 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 :

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

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

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

Fig. 5 is the edge image of origin image in Fig. 4 after apply Canny edge detector.

Fig. 4 Origin image: A container with deformation at the right hand side of image.

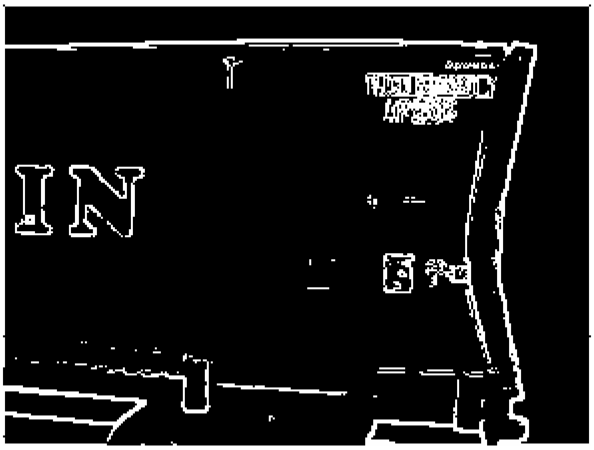

Fig. 5 Edges of the origin image determined by the Canny edge Detector.

Fig.6,7,8 are all the image features of deformation at all the points in the edge image.

$\theta = -\pi/2$

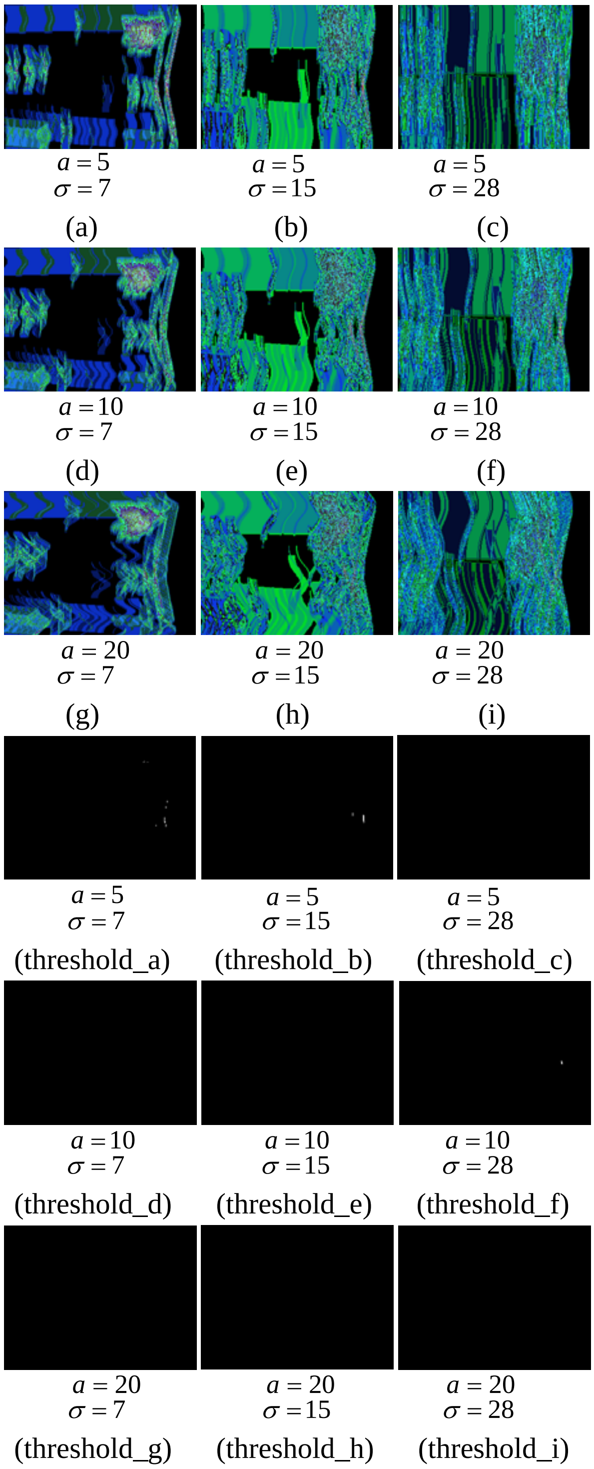

Fig. 6 Feature Images after applied correlation and thresholding transformations at direction $\theta = -\pi/2$.

$\theta = 0$

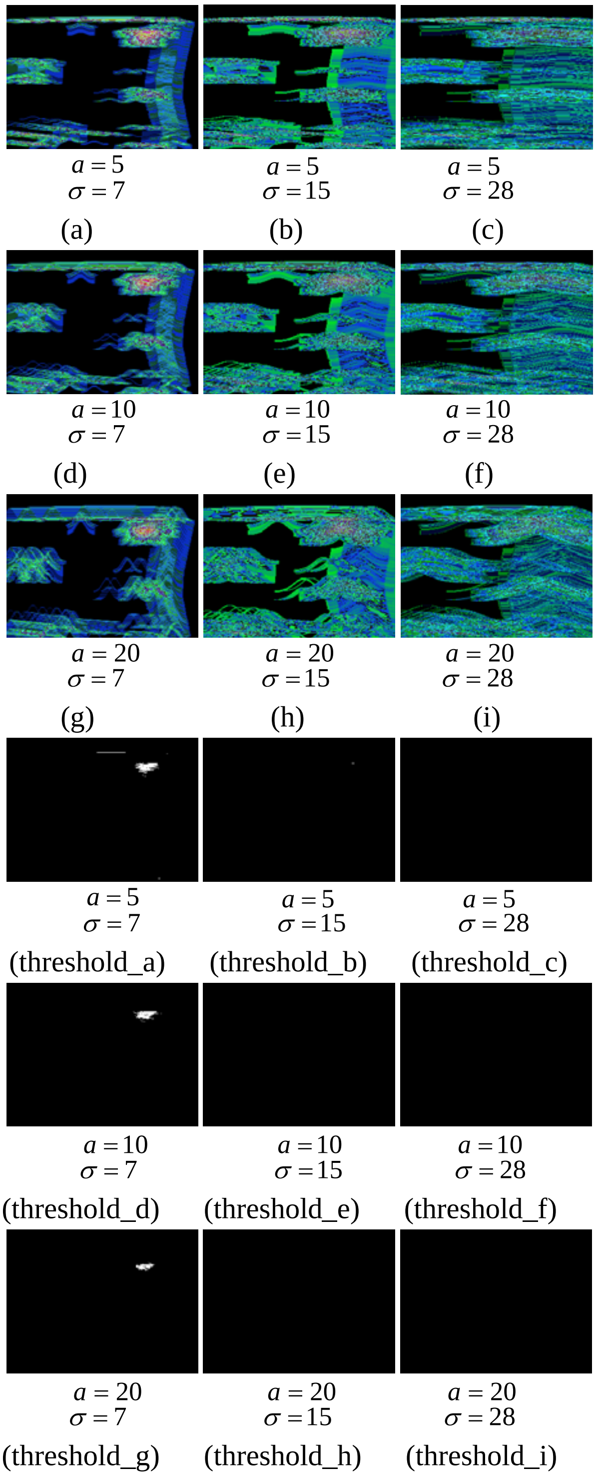

Fig. 7 Feature Images after applied correlation and thresholding transformations at direction $\theta = 0$.

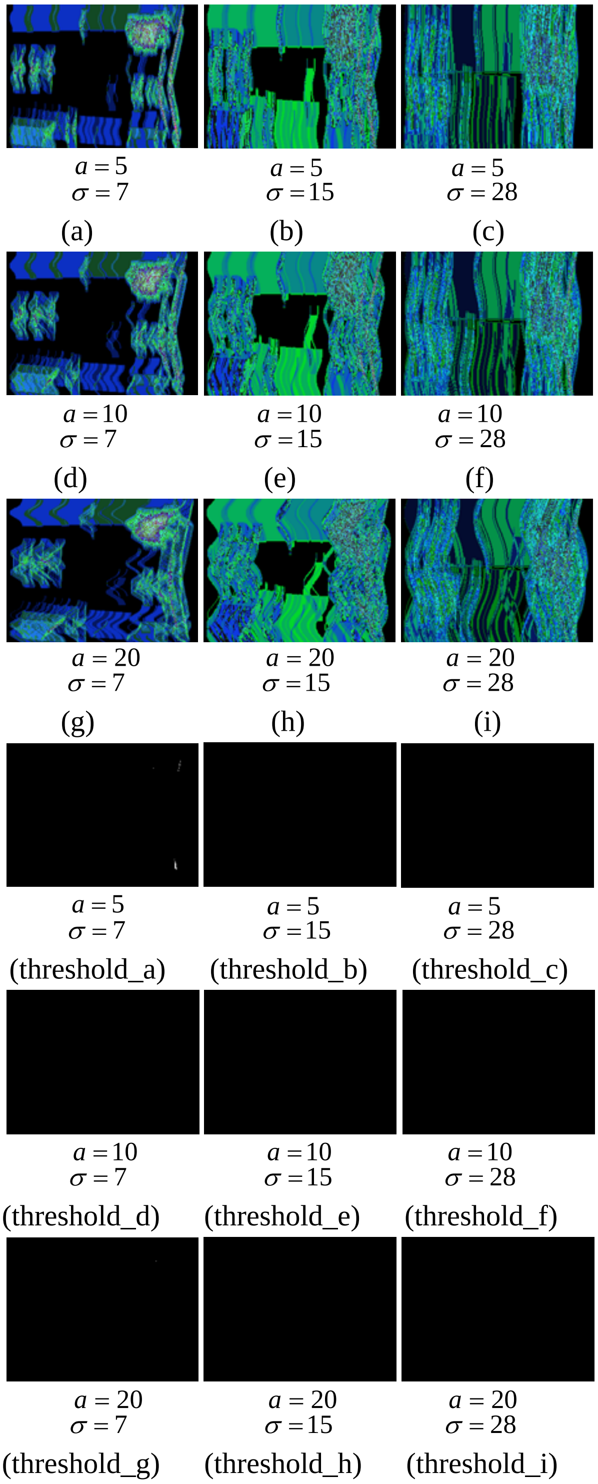

Fig. 8 Feature Images after applied correlation and thresholding transformations at direction $\theta = \pi/2$.

$\theta = \pi/2$

The deformation can be detected from white points in the feature images Fig. 6((threshold_a), (threshold_b), (threshold_f)) corresponding to the parameters

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

5. DISCUSSION AND CONCLUSION

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. 7((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.

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.

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