Canny Operator Parameter Selection Effect on the Overhead Wires Ice Thickness Identified

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Abstract. In the field of image processing, edge is the basic feature of image. The so-called edge is a collection of the gray scale pixel step like changes or changes in the roof, it exists in the target and the background, objectives and goals, region and region, primitive and primitive. How to use the principle of Canny operator to adjust the parameters to the simple image recognition in the picture edge has become the research focus of this article. The Canny operator to extract algorithm uses a second-order derivative 2D Gauss function in either direction for the noise filter, through the convolution on image filtering, and then look for filtering the image gradient of the local maximum, to determine the image edge. The Canny operator to extract the target image obtained by the algorithm, has advantages of high precision and high signal to noise ratio and the detection, so it has been widely applied. Automatic extraction of double threshold Canny algorithm and threshold selection according to the specific situation of the image, this method has adaptive ability more, ensure the accuracy of image edge extraction.

Keywords: Iced conductors; edge detection; Canny operator; adaptive

1. The basic theory of Canny operator edge detection

First I will introduced to define the edges of the image, and then introduces the basic principles of image edge detection, and finally a detailed description of the basic principles of Canny operator edge detection, as well as the problems Canny operator.

1.1 Define the edges of the image

Intuitively, one edge is connected to a set of pixels. Those pixels located at the boundary of the two regions. Therefore, we will define the edges of the pixels located on the border of the two regions of the collection, which image edges [1] (later referred to as the edge). Image processing is a simulation based on human visual characteristics, introduce the concept of visual images edges. Definition of the human eye to strip image detail image formed gray distribution hopping edge visual images, the paper focuses on the visual image edge are after referred to as image edges.

Most of the main information of images are present in the edge of the image. Edge mainly for local image features discontinuities, is more intense gray change the image of the place, which is where we usually refer to signal the occurrence of singular change. Singular signal intensity change along the edges toward the violent, often we will be divided into step-like edge, pulse shape and roof-shaped three types. Gray values on both sides of the step edge in significant changes; while gray ridge edge located at the junction of the increase and decrease. Derivatives can be used in mathematics to describe the changes in the gray edge point, the step edge, pulse edge and ridge edge were seeking first-order and second order derivative. Schematic derivative to strike the edge of the grounds of Fig.1.

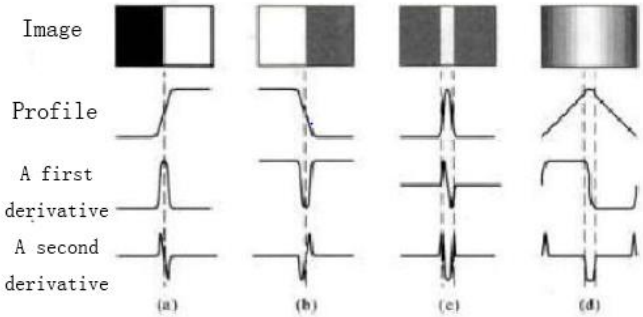


Fig.1 Edge and derivative

1.2 The basic principle of edge detection

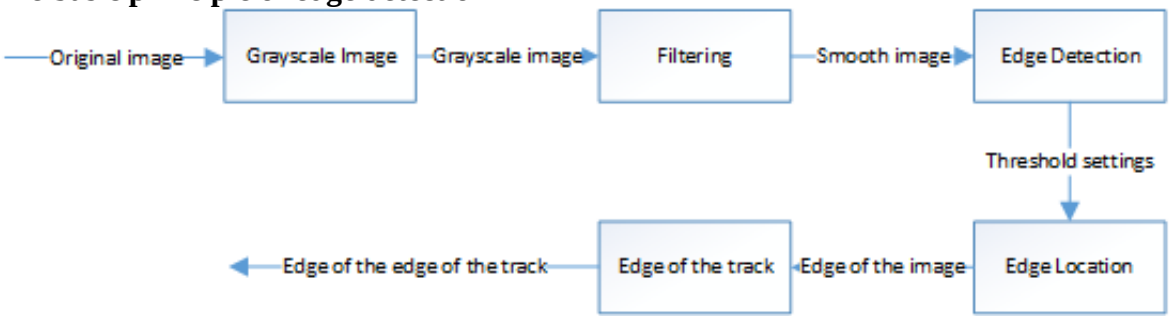


Fig.2 Step of Edge Detection

2. Canny operator edge detection

The basic principles of Canny operator are: first-order directional derivative of a two-dimensional Gaussian function in either direction for the noise filter, filtering by convolution of the image, and then look for local maximum of the filtered image gradient to determine the edges of the image.

1. with a Gaussian smoothing filter;

Gaussian function is:

$$G(x,y)=\frac{1}{2\pi\sigma^2}\exp\left(\frac{1}{2\sigma^2}(x^2+y^2)\right) \quad (1)$$

Where, G (x, y) is a circularly symmetric function, based on which the smoothing effect is to control the size of the G (x, y) and the image f (x, y) for the convolution operation of a smooth image can be obtained namely:

$$g(x,y)=G(x,y)*f(x,y) \quad (2)$$

Gaussian function G (x, y) is generally a fixed size block.

2. With the first derivative of the finite difference to calculate the magnitude and direction of the gradient. Gaussian function in one direction first derivative is:

$$G_n=\frac{\partial G}{\partial n}=n\nabla G \quad (3)$$

where $n=\begin{bmatrix}\cos\theta\\ \sin\theta\end{bmatrix}$, and $\nabla G=\left[\left(\frac{\partial G}{\partial x}\right),\left(\frac{\partial G}{\partial y}\right)\right]$, n is the direction vector, ∇G for the gradient vector.

Non-gradient amplitude maximum suppression. Just get the gradient is not sufficient to determine the overall edge, must retain a local point of maximum gradient, and while the non-maximum suppression (non-maximum suppression, NMS). Gaussian components of the image f(x, y) convolution to obtain the output:

$$Ex=\frac{\partial G}{\partial x}*f(x,y),\ Ey=\frac{\partial G}{\partial y}*f(x,y) \quad (4)$$

$$A(x,y)=\sqrt{Ex^2+Ey^2},\ \alpha(x,y)=\arctan\left[\frac{Ey}{Ex}\right] \quad (5)$$

Reflecting the edge strength of the image, the direction of the normal vector of the image, representing the edges. Edge gradient direction is divided into four kinds: horizontal (0^o), vertical (90^o), (45^o) direction (135^o) direction [2].

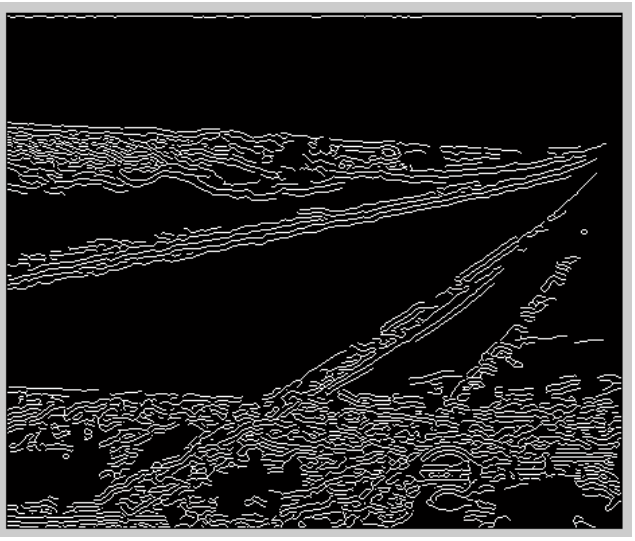
Performed using the center pixel and the neighboring pixels in four directions comparison, if the gradient value of a pixel before and after, and the gradient directions of pixel values of the two phases, and if the gradient is not the maximum value of the pixel, then the pixel is not an edge.

3. Automatic extraction of double threshold

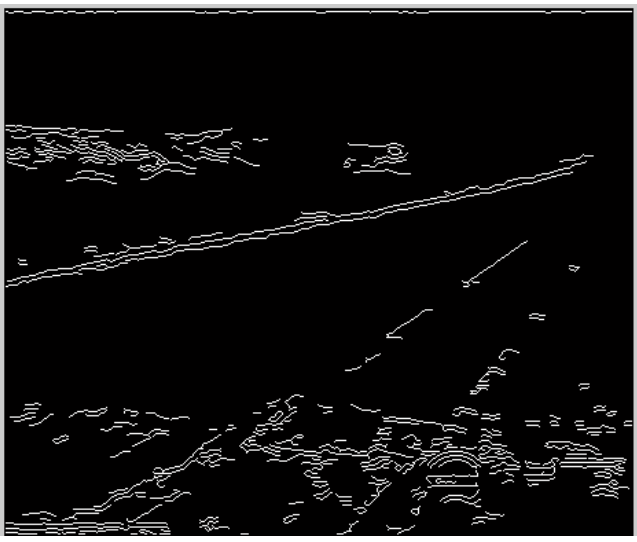
Automatic extraction of dual-threshold of Canny algorithm histogram get high and low thresholds based on gray [3]. First, the image histogram is obtained after filtering, and then calculate the cumulative histogram, and then by setting two parameters, Perc and Th determine the size of the high and low thresholds. Perc ratio parameter indicates the value of the gradient threshold value of the maximum value of the number of pixels representing the number of pixels in the gradient ratio. Th represents the threshold parameter proportion of low-threshold = Th*high threshold. Enabling dynamic selection of high and low threshold values for edge extraction effect depending on the image characteristics. Figure 2-5: (a) The picture shows the conductor overlying ice map, (b) Pictured right Th threshold (0.4), (c) Pictured Th threshold is too high (0.9999), (d) the picture shows the traditional edge detection method.

4. Test results and analysis

(a)

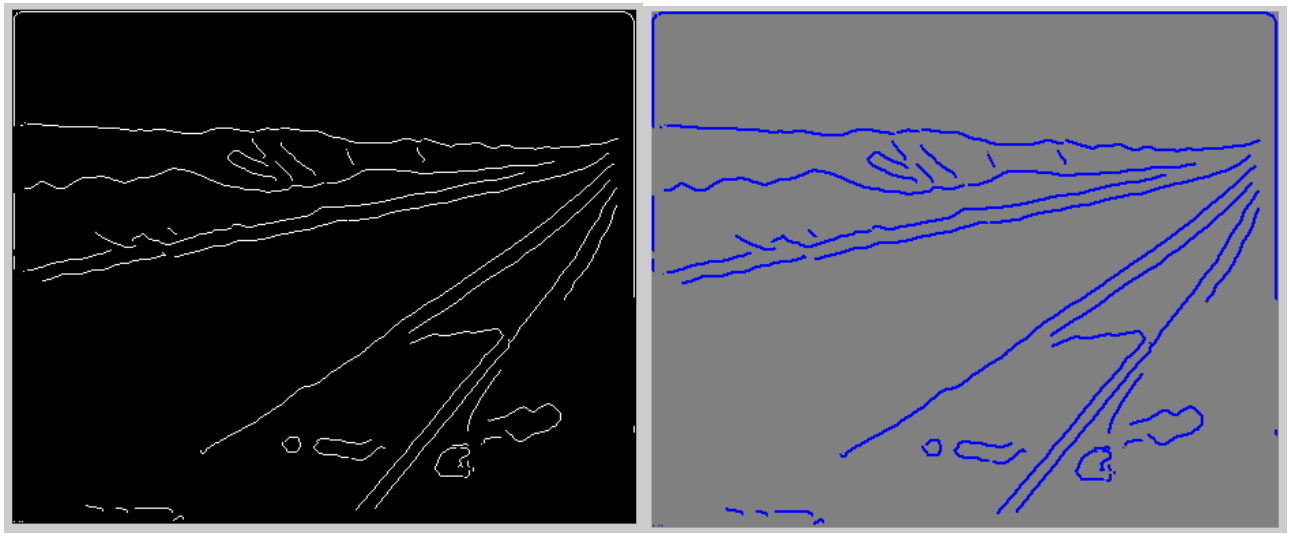


(b)



(c)

(d)



(e) (f)

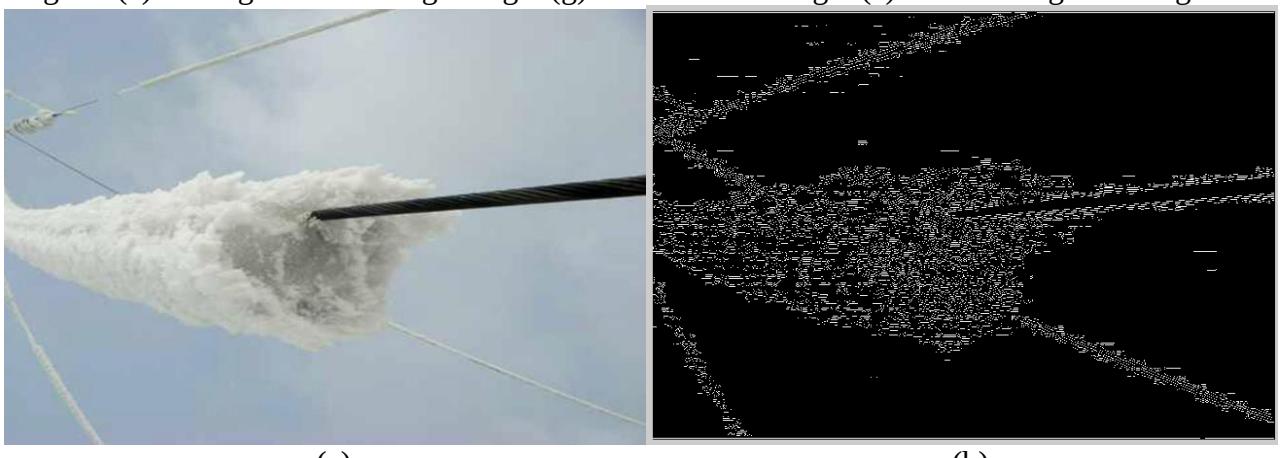
Fig. 3 Iced wire picture1 for test

Algorithm extracted image given below by directly using the edge function and a fixed threshold, and dual-threshold to automatically extract the edge map. Figure 3-1 (a) of the original image, Figure 3-1 (b) for the use of edge boundary map function does not set the threshold obtained directly, Figure 3-1 (c) using a fixed low threshold deserves to boundary map (where the fixed threshold 0.017), Figure 3-1 (d) using a fixed high threshold worth out of the boundary map (including fixed threshold value of 0.2), Figure 3-1 (e) the use of dual-threshold automatically extract derived boundary map, Figure 3-1 (f) the results of Fig. (e) tracking the bounds obtained.

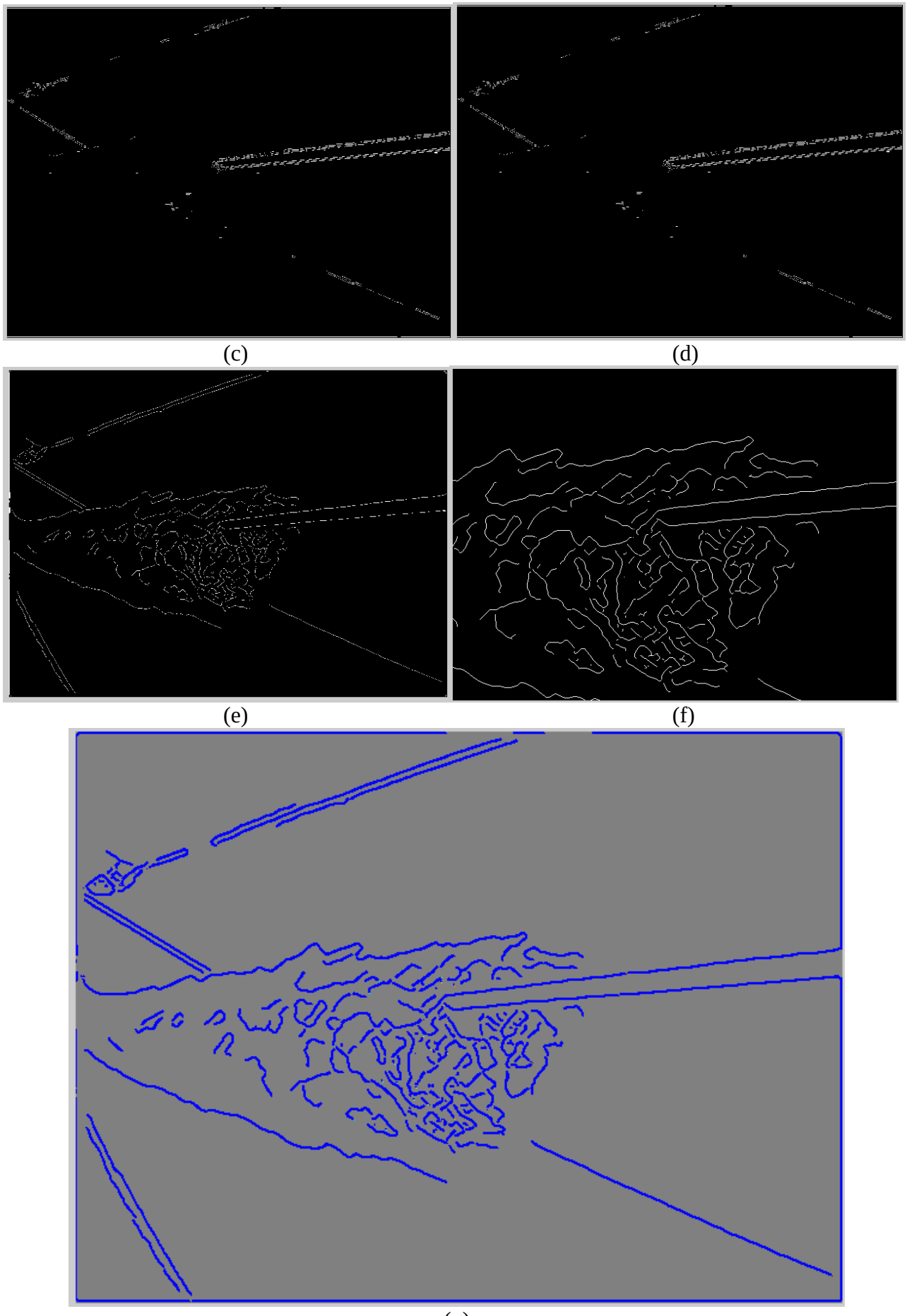
Fig. 3(e) and (f) shown in the image taken by the automatic dual-threshold boundary extraction algorithm is relatively intact, but there is a relative degree of information missing. In the area of the image changes gently, the boundary extraction is relatively sparse, high texture regions, extracting the boundaries is relatively dense[4].

Fig. 3(b) shown in the image information, although relatively intact, but the image presented over state secret, making the edges of the information is not clear, a lot of images impurities. As shown in Fig. 3(c) 0.017 in the case of the threshold image denser impurities more complicated. In (d) the drawing, when the threshold value of 0.2, the image information is a serious omission, a serious shortage of the boundary information.

Here are images by directly using the edge function and a fixed threshold, and dual-threshold algorithm to extract the edge of the map automatically extracted. Fig. 3(a) of the original image, Fig. 3(b) for the use of edge boundary map function does not set the threshold obtained directly, Fig. 3(c) using a fixed low threshold deserves to boundary map (where the fixed threshold 0.007), Fig. 3(d) using a fixed high threshold worth out of the boundary map (including fixed threshold value of 0.2), Fig. 3(e) the use of dual-threshold automatically extract derived boundary map, Fig. 3(f) is an image diagram (e) the edge of the enlarged Fig. 3(g) is the result of Fig. 3(e) after the edge tracking.



(a) (b)



(c) (d)

(e) (f)

(g)

Fig. 4 Iced picture 2 for test

Fig. 4(e), (f) and (g) as shown in the image taken by the automatic dual-threshold boundary extraction algorithm is relatively intact, but there is a relative degree of information missing. In the area of the image changes gently, the boundary extraction is relatively sparse, high texture regions, extracting the boundaries is relatively dense[5].

Fig. 4(b) shown in the image information, although relatively intact, but the image presented over state secret, making the edges of the information is not clear, a lot of images impurities. Fig. 4(c) in the case of threshold 0.007 images too dense, too many impurities, the image can not be resolved. In (d) the drawing, when the threshold value of 0.2, the image information is a serious omission, a serious shortage of the boundary information.

5. Experimental summary

Through the above two sets of image edge extraction and comparison shows that man-made preset threshold threshold is not suitable for the ever-changing images. For a set threshold threshold extract some images will appear too sparse and discontinuous boundary, the boundary of some images too dense for subsequent processing are not much significance. Clearly, automatic dual-threshold extraction algorithm given after a proper grayscale image based on the specific circumstances, to choose a more suitable threshold to arrive at a better low thresholds, the resulting boundary is relatively complete basic boundary to reflect the image of the object.

Canny operator to extract the boundary image algorithm has the advantage to noise ratio, high detection accuracy, has been widely used. Among this article, as long as, given a suitable gamma value makes the image gray appropriate in dual adaptive threshold Canny algorithm to select the upper and lower thresholds based on the image of the specific case, the method has a wider adaptability and better ensure the accuracy of the image edge extraction.

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