

# An image overall complexity evaluation method based on LSD line detection

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**ABSTRACT.** In the artificial world, whether it is the city's traffic roads or engineering buildings contain a lot of linear features. Therefore, the research on the image complexity of linear information has become an important research direction in digital image processing field. This paper, by detecting the straight line information in the image and using the straight line as the parameter index, establishing the quantitative and accurate mathematics relationship. In this paper, we use LSD line detection algorithm which has good straight-line detection effect to detect the straight line, and divide the detected line by the expert consultation strategy. Then we use the neural network to carry on the weight training and get the weight coefficient of the index. The image complexity is calculated by the complexity calculation model. The experimental results show that the proposed method is effective. The number of straight lines in the image, the degree of dispersion, uniformity and so on will affect the complexity of the image.

## 1. Introduction

At present, image complexity has been widely used in many fields, including: military field for battlefield environmental assessment, military combat situation prediction; medical aspects for disease diagnosis, pathological analysis. In many academic articles, scholars use geometric information to analyze the image, the general will refer to edge information and geometric elements and other terms, usually with the information to describe the characteristics of these things. Geometric elements usually include linear, round, triangular and other shape features, in real life, these elements constitute the material world, increasing the diversity of objects. In this paper, the complexity of the image information from the linear aspects of the relevant research.

## 2. Image complexity characteristic parameter

There are many algorithms for straight line detection. In recent years, many scholars have been working on the algorithm of straight line detection. This paper will realize and contrast the classic Hough transform line detection and LSD (a Line Segment Detector) line detection algorithm. It is found that the Hough transform algorithm is not very accurate in locating the end points of the straight line, and it is easy to produce false line segments. The detection result is not very ideal. Fortunately, LSD linear extraction algorithm not only avoids the drawbacks of Hough transform algorithm, but also has the advantages of low computational complexity, good real-time performance and low storage



space requirement. Therefore, considering this problem, this paper adopts LSD line detection algorithm to carry out experiments.

### 2.1 Based On LSD Linear Detection Algorithm

(1) The scale factor of 80% ( $S=0.8$ ), is the smallest image reduction that reasonably solves the staircase problem while producing almost the same result as a full scale analysis on images without artifacts. (A 80% scaling means here that the x and y axis are each reduced to 80%; the number of pixels is thus reduced to 64%.)

$$\sigma = \sum / s, \sum = 0.6 \quad (1)$$

(2) Gradient Computation:

$$g_x(x, y) = \frac{I(x+1, y) + I(x+1, y+1) - I(x, y) - I(x, y+1)}{2} \quad (2)$$

Note that the computed value corresponds to the image gradient at coordinates  $(x + 0.5; y + 0.5)$  and not  $(x; y)$ . This half-pixel offset is then added to the output rectangles coordinates to produce coherent results. Pixel  $(x, y)$  gradient detection is defined as follows:

$$\theta_l = \arctan\left(\frac{g_x(x, y)}{-g_y(x, y)}\right) \quad (3)$$

the gradient magnitude as:

$$\theta_l = \arctan\left(\frac{g_x(x, y)}{-g_y(x, y)}\right) \quad (4)$$

$$G(x, y) = \sqrt{(g(x)^2 + g(y)^2)} \quad (5)$$

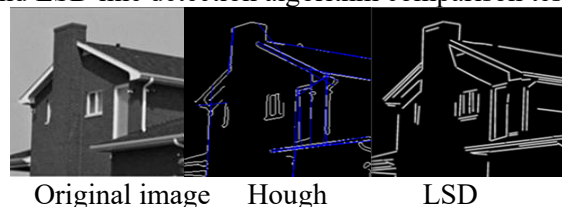
(3) Rectangular estimate that in the initial conditions, the support area as a single pixel, and sets the line direction of the support area to the pixel gradient direction, tags get straight line support area of the pixel, and then the linear area is rectangular simulation.

(4) NFA Computation:

$$NFA(r) = (MN)^{5/2} * \sum_{j=k}^n \left(\frac{n}{k}\right) p^j (1 - p^j)^{n-j} \quad (6)$$

The rectangles with  $NFA(r) < \mathcal{E}$ , are validated as detections.

Hough change algorithm and LSD line detection algorithm comparison test results are as follows:



### 2.2 Straight Line Characteristic Parameter

In order to establish the mathematical relationship between the detected linear feature and the image complexity. In this paper, the straight lines extracted in each image are normalized without loss of generality. The length of straight line segment is straight to ignore. This article will each image is

extracted by a straight line within the length in do not break under the condition of generalized linear normalization processing, line length is:

$$l = \text{len}(l_i) = \sqrt{(x_{mi} - x_{li})^2 + (y_{mi} - y_{li})^2} \quad (7)$$

Where  $x_{mi}$ ,  $y_{mi}$ ,  $x_{li}$ ,  $y_{li}$  is the horizontal and vertical coordinates of the two end points of the  $i$ th straight line segment.

Line length of the normalized treatment, the formula is:

$$L = \frac{l}{l_{\max}} \quad (8)$$

$l_{\max}$  is the longest line detected in the image.

Then after the normalization processing range is divided into such as straight line [0, 0.2), [0.2, 0.4), [0.4, 0.6), [0.6, 0.8), [0.8, 1] five interval. Then the image complexity evaluation index X1, X2, X3, X4, X5 undertake unity to dimension, using interval value method to dimension :

$$W_i = \left( \frac{x_i(1) - \min(X_i)}{\max(X_i) - \min(X_i)}, \frac{x_i(2) - \min(X_i)}{\max(X_i) - \min(X_i)}, \dots, \frac{x_i(n) - \min(X_i)}{\max(X_i) - \min(X_i)} \right) = (x_i^0(1), x_i^0(2), \dots, x_i^0(n)) \quad (9)$$

That was five parametric image complexity of the model  $W_{[0-0.2)}$ ,  $W_{[0.2-0.4)}$ ,  $W_{[0.4-0.6)}$ ,  $W_{[0.6-0.8)}$ ,  $W_{[0.8-1]}$ .

### 3. Image complexity evaluation model

This paper adopted in the process of the construction of the model can reflect the change of the index weight, and can improve the scientific, effectiveness and evaluation of the effectiveness of the BP neural network training method [5-6].

Evaluation index for each neural network unit number: 5, the BP neural network input layer node number is five, the number of output layer neurons identified as 1, number of hidden layer neurons for four.

Network accuracy is achieved when all the sample training and, by right of the connection between the input layer to hidden layer matrix V, calculate the input layer node to the sum of the absolute value of the right of all the connection between the hidden layer nodes, and normalization, m the weight of indicators. The specific formula is as follows:

$$w_j = \frac{\sum_{l=1}^k |v_{jl}|}{\sum_{i=1}^m \sum_{l=1}^k |v_{il}|} \quad j = 1, 2, \dots, m \quad (10)$$

$V_{ij}$  is the input layer to hidden layer between the connection weight matrix.

### 4. The experimental results and analysis

This paper established an image database of 800 images within 800 image contains four different levels of complexity (easy, complicated, very complicated) image, the experiment selected method is

based on human visual image from the image database, chose 16 is representative of the image as a test sample, the figure 1 (figure 1 (a) ~ (l)) method based on human visual from the simple to the complex situation of sorting.

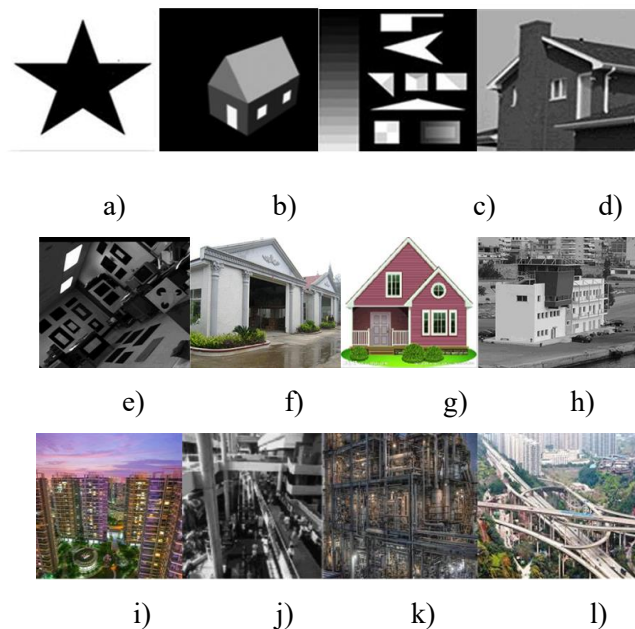


Figure 1 The method based on human visual image (figure b (a) ~ (l)) from simple to complex

800 images extracted from image library, using LSD linear detection algorithm for straight line detection, each image is calculated by the image complexity evaluation index X1, X2, X3, X4, X5 data stored in the database. All the line number within the range as shown in figure 2:

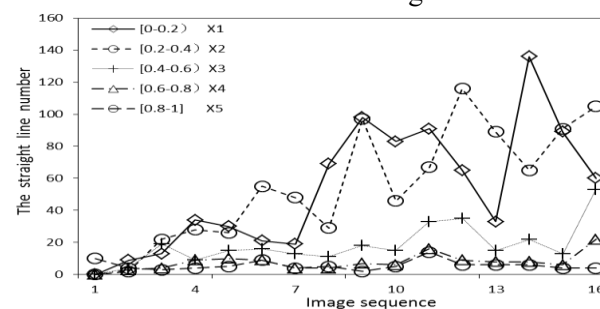


Figure 2 Image of each interval in the straight line number case diagram

From randomly selected 500 groups of data as training data network, 300 groups of data as test data, test network classification ability, parameter is obtained by the method of BP neural network training weight coefficient.

Table 1 Evaluation Index Weight Image Complexity

Index	Weight
X1	0.2670
X2	0.2700
X3	0.2381
X4	0.1417
X5	0.0832

Image complexity calculation model for:

$$C = A_1 W_{[0-0.2)} + A_2 W_{[0.2-0.4)} + A_3 W_{[0.4-0.6)} + A_4 W_{[0.6-0.8)} + A_5 W_{[0.8-1]} \quad (11)$$

In the formula,  $A_i$  is the weight coefficient of every index,  $i=1,2,\dots,5$ .

In order to verify the validity of the results, the method calculated results and the method of reference literature [4] comparing calculated results, comparing the situation as shown in figure 3:

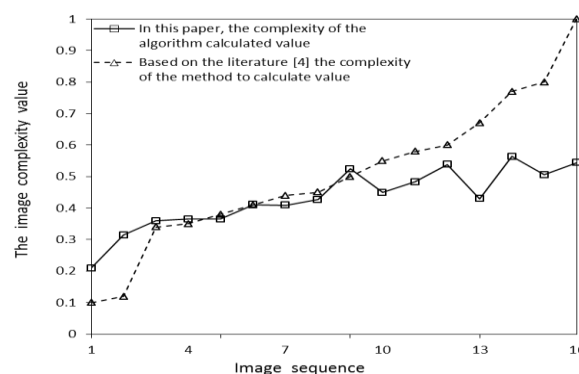


Figure 3 Complexity value contrast figure of each image

In this paper, compared with the images of the human visual complexity method is more objective and avoid the human subjective awareness of errors, from the perspective of other linear features susceptible to light, the influence of surface texture characteristics of condition, so the method from the perspective of the image complexity has opened up a new train of thought.

## 5. Conclusion

Geometric features on the analysis of the image of the role is of more and more important, geometric feature unique characteristics is based on the image, if it can be very good to extract the image geometric features, it will be the image research and has important significance. , of course, this article also has some shortcomings, such as linear interval dividing standards remains to be improved, the author will be added to modify in a follow-up study. The experimental results show the image to detect the straight line, and it can efficiently describe the image structure characteristics, and can express the complexity of the image.

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