Detection of Belt Longitudinal Rip based on Canny Operator

Chuanwei Zhang and Junnan Zhang

College of Mechanical Engineering, Xi'an University of Science and Technology, Xi'an, Shanxi, China

*297169686@qq.com

Abstract. The longitudinal rip of belt conveyor often causes coal mine in a stoppage of production, and the fault diagnosis technology of visual processing is adopted. Because of a large amount of dust, most visual processing algorithms are often out of work. In this paper, the edge detection algorithms including Canny operator, Sobel operator and laplacian operator are compared, meanwhile, the python language is applied in image processing, the Canny operator of python programming is simulated and verified. Finally, the canny operator is proved to have good detection effect.

1. Introduction

Belt conveyor, as a carrier of the bulk mineral material, has become of equipment in coal mine, port and other industry. The belt conveyor has the advantages of convenient transportation and low energy consumption, which usually work under the condition of overload. Long time work is easy to produce longitudinal tear, wear, burr and other faults. In order to reduce the economic loss caused by abnormal shutdown, it is necessary to use the modern technology to diagnose the fault. The traditional manual inspection is gradually replaced by the machine vision, where image processing plays a vital role in diagnosis.

Work environment in coal mine is complex and changeable, with the dust floating, which cause low visibility. It is a great challenge for visual detection processing to work. Using modern control algorithm to achieve fault diagnosis, accurate detection results become the only index of troubleshooting. This paper aims to use a variety of edge detection means to identify the phenomenon of belt longitudinal rip of belt conveyor, and select the appropriate algorithm for the fault identification.

2. Edge detection principle

The edge detection of digital image is the location, orientation and measurement of the gray change of a certain pattern in digital image. Edge is the most basic feature of image, edge detection plays an important role in computer vision, image analysis and other applications. The edge of the image indicates the structure of the edge, the direction of the edge point, the fuzzy scale and the gray value on both sides.

The edge exists between the target, background and region, so it is the most important basis for image segmentation. The edge can be roughly divided into step shape edge and roof edge, for step shape edge, the second order directional derivative is zero crossing at the edge; For the roof edge, the second order directional derivative takes the extreme value at the edge.
3. Algorithm

(1) Canny operator

The Canny operator edge detection is based on the local maximum value of the image gradient, using the strong edge and weak edge two thresholds to determine the detection edge. Only when the weak edge is connected to the strong edge, the weak edge will be included in the output.

John Canny studies the characteristics of the optimal edge detection method, and gives three indicators to evaluate the performance of the edge detection performance:

1) Good signal to noise ratio (SNR), the probability of being judged as the edge point should be low, and the probability of judging the edge point as a non-edge point becomes low.
2) High positioning performance, that is, the detected edge points should be at the center of the actual edge as far as possible;
3) There is only a unique response to a single edge, that is, the probability of generating multiple responses on a single edge is low, and the false response edge should be suppressed maximum.

Canny operator to find the edge point, the specific algorithm steps are as follows:

1) The image is smoothed by Gaussian function to remove the noise in the image;
2) At each point, the local gradient and the edge direction can be calculated, and the Sobel operator and Roberts operator can be used to calculate;
3) The gradient use “non-maximum suppression”. The edge points identified in the second step lead to ridges in the gradient amplitude image. The algorithm is then used to track the top of all ridges, and all pixels without the top of the ridge are set to zero so that a thin line is given in the output;
4) The edge of the edge is detected and connected by a double threshold algorithm. Because the edge chain hole is worth it with high Fujian, it contains less false edges, but also lost some useful edge information. The min value of the edge array TL is low, and more information is retained. Therefore, the edge array TL can be used as the basis of the edge array, and the edge image can be obtained.

(2) Sobel operator

Sobel operator is a first derivative edge detection operator, in the process of the algorithm, through the $3 \times 3$ template as the core and the image of each pixel to do convolution and operation, and then select the appropriate threshold to extract the edge. Therefore, the significant change (edge) of the image gray value can be detected by the discrete approximation function of the gradient. The operation steps of Sobel operator are as follows:

1) The two directional templates are moved from one pixel to another along the image, and the center of the pixel is overlapped with a pixel position in the image;
2) Multiplying the coefficient within the template with the pixel values corresponding to the image;
3) Add all the multiplied values;
4) The maximum value of 2 convolutions is corresponded to the center position of the corresponding template;
5) Select the appropriate threshold (TH), if the new pixel gray value $\geq$ TH, then the pixel point is interpreted as the image edge point.

$$G(x,y)=|f(x,y)-f(x+1,y+1)|+|f(x,y+1)-f(x+1,y)|$$  \hspace{1cm} (1)

Sobel operator uses the gray weighted algorithm of the upper, lower, left and right neighborhood of the pixel, and carries out edge detection according to the principle of reaching extreme value at the edge point. This method not only produces better detection effect, but also has a smooth effect on noise, which can provide more accurate edge direction information. However, at the same time of anti-noise, there are also the disadvantages of detection to the false edge, the positioning accuracy is not high.

(3) Laplacian operator

Laplacian operator is the second derivative operator of the two-dimensional function, is not related to the direction, and is not sensitive to orientation, so the calculation is small. The pull operator is a second order quotient operator that depicts the gray level of the image. It is the point, line and
boundary extraction operator. Usually the image and the result combination after the implementation of the pull-type operator produces a sharpening image. If you only care about the position of the edge, but do not need to know the actual gray difference around it, generally select the operator to extract the edge of the image.

The laplacian operator is not used in the original form for edge detection because it is a second derivative, and the laplacian operator has an unacceptable sensitivity to noise. At the same time, its amplitude produces the edge, which is the complex segmentation does not want some results; Finally, the laplacian operator cannot detect the direction of the edge. Therefore, the role of laplacian in the segmentation includes:

1) Using its zero property to locate the edge;
2) Determine whether a pixel is on the edge of a dark side or on the bright side.

Laplace operator is a kind of isotropic operator, it is more suitable when only the edge of the edge is concerned without considering the gray value of the pixels around it. The response of laplace operator to isolated pixel is stronger than that of edge or line, so it only applies to there is no image. In the presence of noise, the low-pass filtering is needed before the laplacian operator is used to detect the edge.

4. Simulation result
The code and simulation of canny operator.

![Figure 1. Inspection chart of longitudinal rip.](image1)

![Figure 2. Detection chart.](image2)

Sobel operator code and simulation.
Figure 3. x direction.

Figure 4. y direction.

Figure 5. Sobel detection chart.

Code and simulation of laplacian operator.

Figure 6. Detection chart.
5. Conclusion
From the application of canny operator in image processing, it can be seen that canny operator can effectively suppress noise, enhance the signal to noise ratio, accurately determine the position of the edge, realize the basic recognition of the phenomenon of belt conveyor longitudinal tear, and have certain fault detection credibility.

References
[1] Zhang Zhen, Liu Huaixia, Zhang Yuwu. Research on fault protection system of belt conveyor in coal mine [j]. Coal engineering, 2010 (2): 103 - 104.
[2] Zhang junsheng, Guo caiping et al. application of python in digital signal processing [j]. Nanjing: journal of electrical and electronic teaching, 2015, 08, 37 (4).
[3] Zhou Rui. Analysis and countermeasures of common faults of belt conveyor [j]. Science and technology and innovation, 2014, 06: 18 - 19.
[4] Han Yan. Research on operation state monitoring and fault early warning system of belt conveyor based on reliability theory and LabVIEW [d]. Hebei: Hebei engineering university, 2013.
[5] One k Mitra digital signal processing - a computer based method [m], third edition. The MC - hill companies, Inc. 2005.
[6] De. Intelligent inspection robot based on embedded system [d]. China University of petroleum (east China), 2010.
[7] Zhang ruo fool. Python science [m]. Beijing: Tsinghua university press, 2012.
[8] Liu Ban, Wang Ding. Handling of common faults of belt conveyers [j]. Scientific and technical information, 2009, 23: 840.
[9] Gavin hack. Mylab machine learning with sci kit - learn [m]. Birmingham: packt publishing, 2014.
[10] Rafael c Gonzalez, r IC hard e woods, Steven l eddins. MATLAB implementation of digital image processing [m]. Trans. ruanqiuqi. Beijing: Tsinghua university press, 2013.