The automatic cutting algorithm of the plastic film based on image processing

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Received 1 July 2014, www.cmnt.lv

Abstract

This paper proposes an algorithm based on image processing to solve the dislocation problem when cutting the edge, which is in the light of the uneven edge and the wrong side phenomenon. First of all, the images of the plastic bag edge captured by the camera are pre-treated; then the image is enhanced by fuzzy contrast enhancement algorithm, which is aim to extract the creases contour; finally the edge of the image is detected used by the Canny operator to get the crease on the edge of plastic bag, the cutter position can be obtained by offset some distance from the creases. The research results show that this algorithm is very effective to solve the dislocation problem when cutting the plastic bag edge automatically.

Keywords: fuzzy contrast enhancement, the Canny operator, edge detection, plastic film cutting

1 Introduction

In the industrial manufacturing field, a lot of sheet products are unable to guarantee the uniformity in the process of operation, the reasons are as follows:

1) The malalignment of the drive roller, roller, idler roller and guiding rollers all produce sheet deviation.

2) In the work process, if the sheet products are uneven and partial load, the sheet side uneven stress will be caused and the sheet offset will be resulted in.

3) The unevenness caused by the operator when they place the sheets and the unevenness of the back sheets' state can all make the sheet deviation.

4) When the sheets are coiled to the end, they have no much weight and roll both ways, which can also make the sheet deviation.

From the top, there many deviation factors in the process of coiling sheets, so adding automatic edge control system is necessary in the coiling process, which realizing the automatic alignment.

The edge mismatch and the wrong side are the problems of the plastic bag cutting in the production line, to address this phenomenon; this paper proposes a plastic film automatic cutting algorithm based on image processing to realize straight edge automatically when cutting the edge in the production line.

2 The preprocessing algorithm of plastic film automatic cutting

2.1 THE SUMMARY OF THE PREPROCESSING ALGORITHM

Image pre-processing is an important part of research based on image algorithm, effective treatment for the image can improve the resolution for the key information of the system,so then the stability and accuracy of the feature extracted will be improved, the pre-treatment technology mainly includes image filtering, image enhancement and object segmentation. The image filtering is to suppress the noise in the image, so as to reduce the influence of noise on the feature of the target and improve the stability of feature extracted; image enhancement is to make the target image more clear in the image, this is the focus algorithm in this paper, which is necessary to extract the feature points; object segmentation is to eliminate the impact of background, and improve the accuracy of feature extracted.

The images obtained from cameras are pre-processed used by the median filtering, fuzzy contrast enhancement and edge detection to get clear target contour [1].

2.2 THE REALIZATION OF THE PREPROCESSING ALGORITHM

1. Image filtering.

The objects processed in this paper is the edge image of plastic film in the production line, which have no much details, the purpose for preprocessing is that the complete edge can be extracted. The median filter is especially suitable for the situation in a strong pepper interference or

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pulse type interference. Because of the interference values are very different from some of the adjacent gray-scale values of the pixels [2]. Therefore the median results after sorting is to make the interference values and some of the adjacent gray-scale values of the pixels same, which can remove the interference effect [3]. Therefore, the median filter will be taken to remove the original image in this paper.

2. Image enhancement

1) The definition of fuzzy contras t.

In recent years, many scholars devoted to introducing the contrast enhancement into the research of image processing, the concept of fuzzy contrast is introduced according to the fuzzy contrast enhancement algorithm proposed by Li Jiuxian et al.

The definition of fuzzy contrast: in the *M***N* image with *L* level grey-scales, $\mu_{ij} \in [0,1]$ ($i = 1,2,..., M$; $j = 1,2,\ldots, N$), μ_{ij} is the membership of the pixels' grey levels x_{ij} , $\bar{\mu}_{ij}$ is the membership of all the pixels gray mean values in the window, which regards the processed point as the centre, so the fuzzy contrast of the pixel x_{ij} is

$$F = \frac{|\mu_{ij} - \bar{\mu}_{ij}|}{|\mu_{ij} + \bar{\mu}_{ij}|}. \tag{1}$$

In the Equation, $|\mu_{ij} - \bar{\mu}_{ij}|$ is the absolute value of the difference between the membership of the pixels x_{ij} and the membership of its neighbour means, which can express the fuzzy contrast; F is the normalized relative fuzzy contrast, F not only considers the smoothing effects of the spatial neighbourhood averages, but also takes into account the tension of the fuzzy domain contrast [3].

2) The improved fuzzy contrast enhancement algorithm.

The improved algorithm of the image enhancement based on the fuzzy contrast is proposed on the basis of the fuzzy contrast enhancement algorithm in the paper, its realization process is as follows:

① The fuzzy enhancement algorithm based on grayscale use a fuzzy membership function that is a linear, that is:

$$\mu_{ij} = T(x_{ij}) = \frac{x_{ij}}{L-1}. \tag{2}$$

② In the Equation, *L* is the grayscale of the image pixel distribution;

③ Calculate the fuzzy image contrast with the 3*3 window;

④ Do a nonlinear transform for *F* to get

$$F' = \psi(F). \tag{3}$$

The selection of the convex function $\psi(g)$ directly affects the enhancement effect of the fuzzy contrast enhancement, if $|\psi(F) - F|$ is too small, the image details cannot be highlighted; if $|\psi(F) - F|$ is too large, the noise will be revealed.

After repeated experiments, this paper choose the polynomial function:

$$\psi(x) = 4x^3 - 12x^2 + 9x. \tag{4}$$

The following conclusion is obtained through the calculation and the verification: $\psi(x)$ is a convex function ($\psi''(x) = 24(x-1) \le 0, \quad \forall x \in [0,1]$, and $\psi(0) = 0$, $\psi(1) = 1$, $\psi(x) \ge x$.

⑤ Use F' to calculate the pixel gray membership degree and it's gray value after adjustment, the mathematical expressions is:

$$\mu'_{ij} = \begin{cases} \dfrac{\bar{\mu}_{ij}(1-F')}{1+F'} & \mu_{ij} \le \bar{\mu}_{ij} \\ 1 - \dfrac{(1-\bar{\mu}_{ij})(1-F')}{1+F'} & \mu_{ij} > \bar{\mu}_{ij} \end{cases}, \tag{5}$$

$$x'_{ij} = \mu'_{ij}(L-1). \tag{6}$$

⑥ The contrast enhancement method not only enhances the edge region but also sharpens the noise to a certain extent, therefore, the median filtering method is used to eliminate the isolated noise points [4].

In summary, the realization process is still that the image is mapped from the spatial domain to the fuzzy domain first， a local contrast operator is definited in fuzzy domain to represent the absolute value of the difference between the membership of the pixels and the membership of its neighbour means. Then, through the convex function to enhance and amplifier the difference among the neighborhood pixels; finally the image is append back to the spatial domain and is filtered, so as to complete the process of the image enhancement processing.

3) The experimental results and analysis.

Note: The red rectangular box marked in the following chart is the position of plastic film edge, the following enhanced image is enhanced used by the fuzzy enhancement two times in order to extract the feature of the edge folds solely.

FIGURE 1 Before enhancing (green)

FIGURE 2 After enhancing (green)

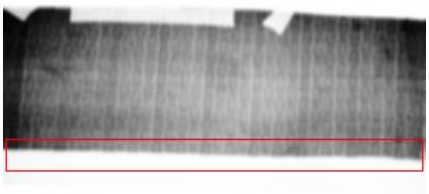

FIGURE 3 Before enhancing (yellow)

FIGURE 4 After enhancing (yellow)

FIGURE 5 Before enhancing (red)

FIGURE 6 After enhancing (red)

FIGURE 7 Before enhancing (white)

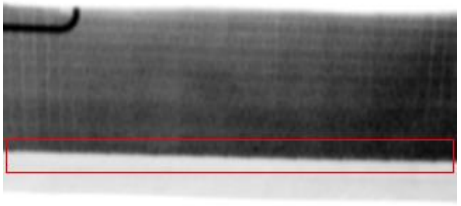

FIGURE 8 After enhancing (white)

By above knowable, after enhancing with fuzzy contrast**(**see Figure 2, Figure 4, Figure 6, Figure 8), the image contrast enhances significantly at the crease and decreases significantly at the edge and background, which lay the foundation for the crease extraction behind.

The image contrast enhancement method is that the spatial domain is enhanced everywhere by enhance the gray difference between neighborhood pixels by locally. But it not only enhances the contrast in the crease region but also sharpens the noise to a certain extent, so the image should be smoothed after enhancing, so as not to affect the quality of the feature extraction.

3. Image edge detection.

Edge detection is the fundamental topic of image processing and computer vision, the study of the human visual system show that the image edge is particularly important and an object can be identified only by a sketchy outline [7].

The essence of edge detection is to extract the boundary between a object and its background image using some algorithm. The process of general edge detection algorithm is that first the smoothing image is obtained by smoothing the original image; and then the image whose edge being enhanced using a variety of algorithms, whose gray levels is 256.

At this time, the flat grey regions disappears and the mutational grey regions remains alone in the image whose gray is enhanced, the 256 levels image is becomed to the binary image after the final threshold segmentation, the edge image is got if the mutant edges are displayed obviously [5].

According to the characteristics of the target image and the requirements of the edge feature, the edge is extracted by Canny operator in this paper, the selection of thresholds should be paid special attention to. After many experiments analysis, the ratio of the Canny operator's two parameter threshold is 2:3 in view of the identification target [6]. The experimental results are as follows:

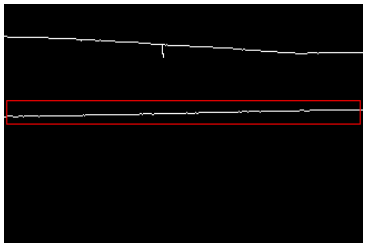

FIGURE 9 Edge detection (green)

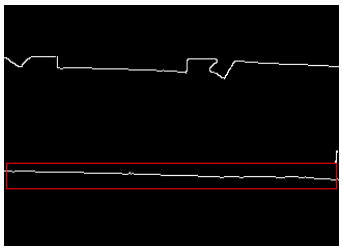

FIGURE 10 Edge detection (yellow)

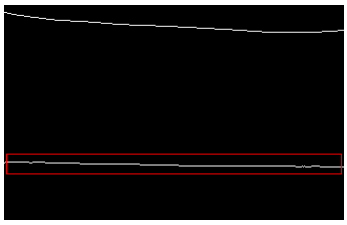

FIGURE 11 Edge detection (red)

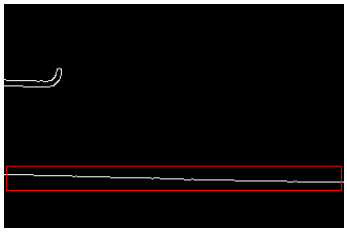

FIGURE 12 Edge detection (white)

3 The automatic cutting algorithm of the plastic film

3.1 THE SUMMARY OF AUTOMATIC CUTTING ALGORITHM

The accurate position of the cutter must be controlled timely in order to realize the automatic slitting of the plastic film. The crease contouring near the edge is obtained by the preprocessing of the plastic film image, including median filtering, image contrast enhancement, edge detection, then the cutter position will be obtained by offsetting some distance according to crease position.

3.2 THE RELIZATION OF THE AUTOMATIC CUTTING ALGORITHM

1. Select the reference position

A reference position needs to be selected as the standard in order to make the cutter regular while cutting the edge. Through the analysis of the plastic film image obtained by the backlight and the camera. The plastic film edge fold position is chose to be the standard position and then the position of the cutter will be obtained by offsetting some distance from the edge if the creases position is got in the image, so as to avoid the uneven edge [8].

2. Obtain the reference position.

A clear outline of the plastic film edge creases is obtained after pretreatment. The next is to determine the position of the crease. The average value of all feature points at the crease is selected as the crease's accurate position.

3. The steps of the algorithm:

1) A region of interest (ROI) is arranged at the crease in the image which includes all feature points in the region of interest.

2) Obtain the coordinate values of each feature point by traversing the ROI area and calculate their average value.

3) Traverse the image again and set a threshold according to the requirements. Then calculate the difference between the coordinate value of each feature point and the average value. If the difference is greater than the threshold, the feature point will be dropped; otherwise it will be remained.

4) Calculate the average coordinate value of each feature point that remained and regard it as the crease position.

5) The cutter position can be obtained by offsetting the distance after getting the standard position of the crease of the plastic film.

6) Select a scale by calibrating the camera and use the scale to transform the pixel position in the image into the actual distance of the controller.

3.3 THE RESEARCH RESULTS AND ANALYSIS

1. The experimental results:

Note: the red rectangular box is the ROI region which contains the crease, the green line is the reference position calculated by the upper algorithm.

FIGURE 13 Crease position (yellow)

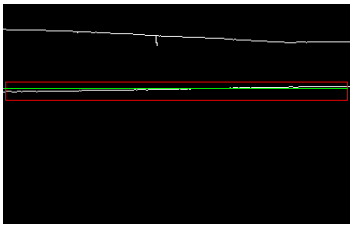

FIGURE 14 Crease position (green)

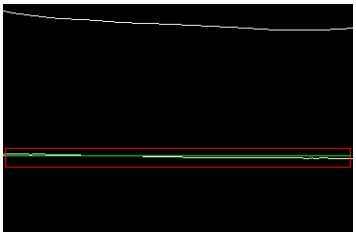

FIGURE 15 Crease position (red)

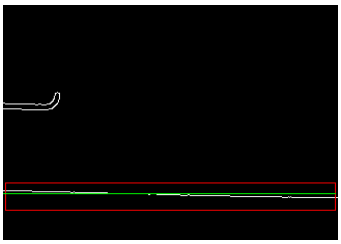

FIGURE 16 Crease position (white)

2. The analysis of the results

The crease position can accurately obtained by the algorithm proposed in this paper. It should be noted that the noise points that offset a long distance from the crease position will affect the accuracy of the algorithm, so it is necessary to eliminate the noise in the third step.

4 Conclusions

This paper aims at the deviation phenomenon of the plastic film automatic cutting in the production line, a lot of manpower and material resources are wasted because of artificial control deviations in the actual production, so the automatic cutting algorithm of the plastic film based on image processing are put forward which resolves the running deviation while cutting the edge and the wrong side phenomenon [9].It has the characteristics of high efficiency and high precision compared with manual visual method. The paper mainly completes the following work:

1. Preprocess the image of plastic film edge. Firstly, make the gray processing for the plastic film; then do smoothing for the processed image; finally the clear edge image can be obtained by the edge detection after getting relatively clear image.

2. Obtain the crease position of the plastic film edge. The clear outlines of the plastic film edge creases are got after pretreatment and the average value of all feature points at the crease is selected as the accurate position of the crease.

3. Get the actual position of the cutter by offsetting some distance from the position of the crease. The location of the cutter can be obtained by making the cutter offset the distance from the crease after getting the standard distance between the edge and the crease; the actual distance of the controller can be obtained by selecting a scale by calibrating the camera and use the scale to transform the pixel position in the image into [10].

The algorithm proposed in the paper also has shortcomings, when the noise points is too much nearby the crease of the plastic film edge image, which is easy to have a great influence on the reference position ,so the preprocessing work is very important.

Acknowledgments

This work is supported by Natural Science Foundation of Hubei Province (No. 2013CFB034)

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