BINOCULAR STEREO VISION MEASURING SYSTEM BASED ON STRUCTURED LIGHT EXTRACTION ALGORITHM

Lingli ZHAO,Haicheng XU, Junsheng LI
School of Engineering, Honghe University,
Mengzi, P.R.China,661100
e-mail: zll_csu@126.com CAI QUN

Qun CAI
School of Science，Honghe University Mengzi,
P.R.China,661100

***Abstract*—With the rapid development of computer technology and photogrammetry, the binocular 3D measurement has been widely used in many fields such as quality inspection and reverse engineering. Depending on the application, there are different requirements for 3D measurement systems. Structured light image feature extraction is an important part of the binocular measurement system to achieve three-dimensional reconstruction. So, the paper puts forward a kind of approach for edge detection and edge tracking, using the edge tracking algorithm proposed by the paper to extract structured light stripes, and the method using chain code track record of the extracted features, and something useful is obtained.**

Keywords- Binocular stereo vision; Light extraction; Measuring

I. INTRODUCTION

With the rapid development of computer technology and photogrammetry, the binocular 3D measurement [1] has been widely used in many fields such as quality inspection and reverse engineering. Depending on the application, there are different requirements for 3D measurement systems. The dimension measurement for industrial products inspection requires high accuracy and flexibility [2].

Usually, a third or fourth camera is introduced into the stereo imaging setup to reduce the correspondence ambiguities [3]. As a result, the observable volume becomes rather small and the configuration of a multi-camera system may pose financial and technical challenges. For the configuration consisting of a two-camera system, there are only a few algorithms in the open literature for stereo particle pairing [4–6] and the epipolar line nearest neighbor analysis is the most commonly used method.

Measurement for the object itself and its environment often have these characteristics, such as the use of conventional engineering methods of measurement or photogrammetry, the difficult, high investment and low efficiency. According to this scenario, you can manually add structured light, so that the texture of the object has no artificial texture, and using destructive, non-contact close range photogrammetry reconstruction of three-dimensional measurements. Therefore, we can use a digital camera and binocular measurement system composed of projectors.

Projectors - digital camera system is composed of a digital camera, a projector. Projector can object to provide clear, stable texture, this texture feature extraction and matching is relatively easy to implement. Digital camera is mainly used for collecting two-dimensional image data and the real texture of objects. Thus, the entire projector - digital camera image acquisition system schematic shown in Figure 1.

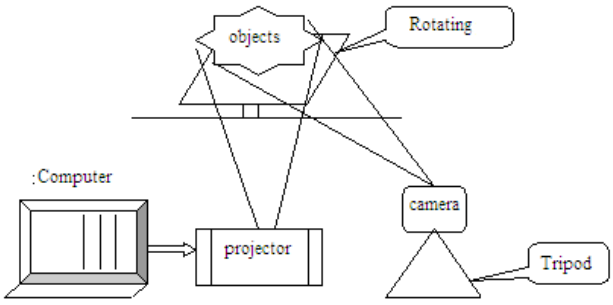

Figure 1. image acquisition system

Structured light image feature extraction is an important part of the binocular measurement system to achieve three-dimensional reconstruction. So, the paper puts forward a kind of approach for edge detection and edge tracking, using the edge tracking algorithm proposed by the paper to extract structured light stripes, and the method using chain code track record of the extracted features.

II. EDGE DETECTION OPERATOR AND EDGE TRACKING

A. Edge Detection Operator

Roberts, Sobel, Laplacian algorithm are sensitive to noise, the noise in the actual image is difficult to avoid, so these methods can not achieve satisfactory results. Canny edge extraction are summarized in three general principles, and expressed using mathematical methods to systematically determine the function of edge detection performance of three mathematical expressions, the noise suppression has a good effect.

Figure 2 shows the original image and it shows Robert, Sobel, Laplacian, Canny edge detection results and comparison .

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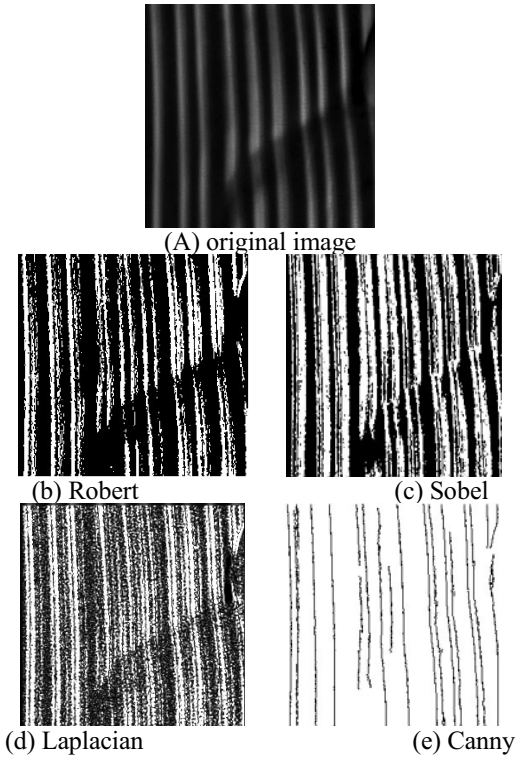

Figure 2. Detection of the four edge detection operators

B. Edge tracking

General, the traditional detection method consists of detecting the edge of the gradient value and post-Plastic handle two aspects. Gradient value detection is calculated based on local operations ,constitute the edge of the point, after the detection of plastic processing, it is based on gradient filtering, to enhance its value or the gradient value of the gradient combination, resulting in long and smooth the edge of the line.

The basic principles of edge tracking method based on image features are that big step away from the starting point to find the edge, and then start from the starting point, small step away from the progressive point to find out the various elements, the last point then these elements together into smooth curve.

The main advantage of the edge tracing method is fast and requires only a part of pixels on the image for processing, not each pixel is processed, so it's much faster than the commonly used calculation of edge detection algorithm, it is more suitable for long simple smooth curve, in particular for line segments. For short and complex ones it is poor.

Edge detection and edge tracking method are similar , it can be said that edge detection edge tracking method is an application, and its essence is based on the principle of edge detection for line tracking. Comparison of the edge tracking method , it is easier on the edge detection method to detect long and smooth curves, for linear feature extraction side.

C. Comparison of two methods

Detection of several edge detection operators can be seen that fom figure 2 In contrast, edge tracking method is more suitable for the system. Using this approach to structured light stripe image tracking, it is simple easy to implement, and good to avoid the extra edge extraction. But the algorithm itself has limitations, because the original image gray value of each band is not uniform, and therefore exists in the choice of threshold, thus is not unity. This is a great influence on the entire image processing, if it is determined a single threshold, a lot of information is lost bands. Therefore, the system to take the edge tracking algorithm for image processing.

III. THE ALGORITHM PROPOSED BY THIS PAPER AND CONCLUSION

A. Edge tracking of structure optical

This paper takes on the structure of edge tracking algorithm to track the light, the basic idea is: First, follow the edge the whole image and then extract the edge of the original image after tracking the site of redundant information, follow the edge again to get better effect. The next two parts of the image will merge operations, come test images, the final track on the second test image again to remove redundant information, to receive good quality image processing.

The realization of the algorithm is as follows:

(1) input the original image after image preprocessing, test edge tracking;

(2) observed intensity distribution after pretreatment of the image, combined with edge tracking to determine the actual situation after the separate blocks of the image edge tracking, and extracted them;

(3) separate the image of the extracted block, and edge tracking;

(4) edge of the track after the image (the former) and the edge of the track after the image block (the latter) to merge. Systems are two images read out line by line, when the detected pixel values of the latter is not empty, the former location of the pixel values of the same set value for this pixel, and so continue until the two images are scanned to complete.

(5) The combined image is done for second test. Detection is mainly used to remove the bulk of secondary legislation redundant information.

Figure 3 is the small diagram of the image edge tracking, in which the threshold is 35 split, take small steps away from the threshold to 1.

Figure 3. Schematic diagram of edge tracking

B. Refinement

It can be seen from Figure 3, after edge detection and edge tracking image, obtained with a thick strip， which is a binary image lines. To its feature extraction, we must refine them (Thinning). Refinement is carried out preparatory work before feature extraction.

Refinement is the scope of mathematical morphology operations. Morphology (Mathematical Morphology) is to analyze the geometry and structure of mathematics, algebra is built on the basis of the collection, use set theory quantitatively describes the geometric structure of science. It has become a tool of the image geometry. Mathematical morphology is a set of algebraic operators morphological composition. The basic morphological operators are: Erosion, Delation, Opening and Closing. Using a combination of these operators and their shape and structure of the image analysis and processing, including image segmentation, feature extraction, edge detection, image filtering, image enhancement and restoration work.

An image of the "skeleton" refers to the bone part of the center of the image. It is to describe the nature of the image geometry and topology of the important features. The process of seeking an image skeleton image is often referred to as "thinning" process.

Refinement algorithm is as follows:

An image of a 3 × 3 region, the tag name of each point$P_1, P_2, \cdots P_8$, which is located in center, shown in Figure 4.

P_3	P_2	P_9
P_4	P_1	P_8
P_5	P_6	P_7

Figure 4. marked point P_1 and its neighbor

If $P_1 = 1$ (the black spots), if both of the following four conditions are removed.

（1） $2 \le NZ(P_1) \le 6$;

（2） $Z0(P_1) = 1$;

（3） $P_2 * P_4 * P_8 = 0$ or $Z0(P_2) \ne 1$;

（4） $P_2 * P_4 * P_6 = 0$ or $Z0(P_4) \ne 1$;

Every point on the image to repeat this step until all points are not delete it.

Thinned image should satisfy the following two conditions: first, the refinement process, the main image should be a regular reduced; second, gradually narrowing in the main image in the process, should be connected to nature remains unchanged.

Figure 5 shows the results map after refinement.

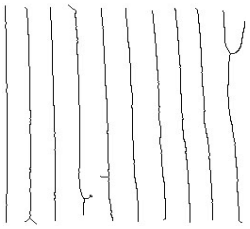

Figure 5. The image after thinning

C. The chain code tracking

After edge detection and thinning, the image shows a collection of a strip line, the lines that we want to extract the linear features, and its essence is a collection of a set of feature points.

Lines based on chain code generation connectivity inside each other, connected by four or eight adjacent neighbor definition, shown in Figure 4. Four adjacent two points is only when the time is up and down or left and right adjacent to the connection, for the figure point, the neighbors were contacts is P_2, P_4, P_6, P_8 . Means that in addition to eight adjacent up and down, but also can have four diagonal connection, the figure is around eight point eight adjacent points. Four adjacent chain code can only be said that the four symbols, usually 0 to 3, eight adjacent chain code requires eight directions from 0 to 7 symbols.

Chain code used in this paper is actually the edge of the track with the part 3.1 is similar. First of all to find a starting point. In accordance with the four or eight adjacency track lines point by point, while the output of each step in the direction of movement until it is no longer possible to move, thereby ending a trace.

The specific algorithm for tracking the chain code as follows:

(1) Scan the first row, all values recorded for the empty spot are not the starting point;

(2) For the starting point ,scan its eight neighbors, respectively (in fact only need to scan the three points below the neighborhood: P_5, P_6, P_7), face value of 1 point on record, and the starting point for the connection with the mark;

(3) Scan the next line, experience is not the point to set the record as a starting point, the case of recording sites is scanning the neighborhood, meet the point value is not null to record its location, and make it with the previous connected to a recording point;

(4) Repeat (2), (3) steps, until the records of all records connected to the starting point, the algorithm scans the image until the last pixel to stop.

This algorithm can extract the images without missing paragraphs in the lines, and faster, just scan the image again, which can well meet the system for feature extraction in this part of the demand.

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