

13—18 A Method of Counting the Passing People by Using the Method of the Template Matching

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Abstract

The attempts to count the passing people by the image processing have been made some time ago. But the conventional methods could not count the passing people accurately unless there were very few of the passing people through the gate at one time. In this paper, we propose an automatic method of counting the passing people by using the method of the template matching process. In proposed method, the camera is hung from the ceiling of the gate and the optical axis of the camera is set up so that the passing people could be observed from just overhead. In this system arrangement, if there are crowd people in the gate, then the data of the passing people are not overlapped each other on the obtained images. In addition, by using the color CCD camera, the human region and road region on the obtained images are able to be segmented accurately. In this paper, we show some experimental results obtained by using a simple experimental system to verify effectiveness of the proposed method.

1 Introduction

To count the passing people through the gate of the buildings or roads is considered important for the office security or the marketing research. Many of such measurements are still carried out on manual works of persons. Therefore it is necessary to develop the automatic method of counting the passing people. On the other hand, there is a machine of counting the passing people by using a revolving bar, but the use of such a machine, in general, causes the problems in the sense that the passing people are obstructed or the precise counting is difficult.

Under these circumstances, the attempts to count the passing people by the image processing have been made some time ago^{[1][2][3]}. But these conventional methods could not count the passing people accurately unless there were very few passing people through the gate at one time. The reason why these methods could not be applied to a crowd is that the segmentations of human region on the obtained images were difficult.

Therefore we have already developed the counting method by using the three dimensional data obtained from the range finder^[4]. But this method needs the complex system of obtaining the image data and long time for calculating the three dimensional data of the passing people. On the other hand, we have proposed an automatic method of counting the passing people through the gate by using a normal CCD camera^[5]. But there are some problems in the process of detecting the direction of passing people.

In this paper, we propose an automatic method of counting the passing people through the gate by using the color CCD camera. In proposed method, the camera is hung from the ceiling of the gate and the optical axis of the camera is set up so that the passing people could be observed from just overhead. Because in this system arrangement, if there are crowd people in the gate, then the image data of the passing people are not overlapped each other on the obtained images. In addition, the template matching is used by detecting the directions of passing people. The color information is used in the process of detecting the human region.

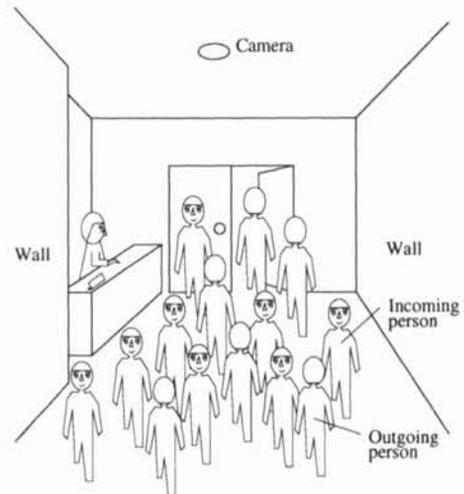


Fig.1 Scene of the gate

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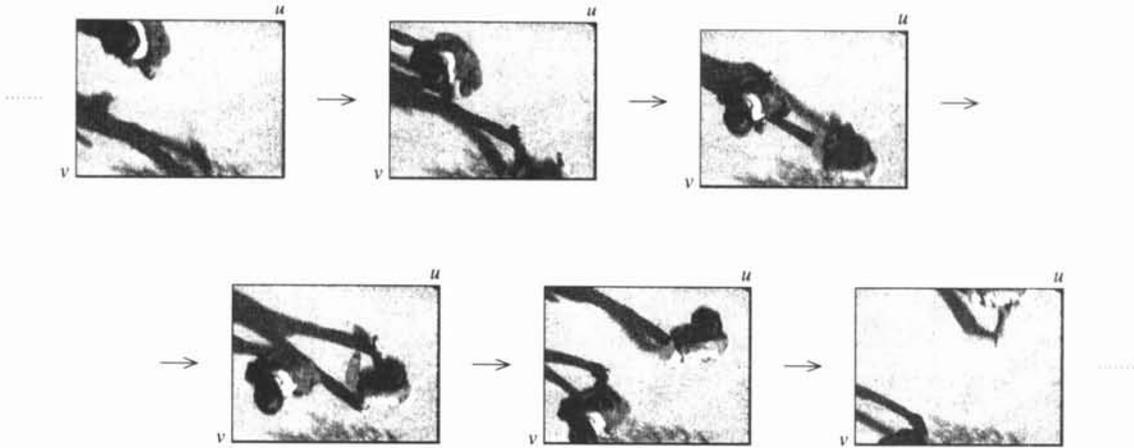


Fig.2 Examples of the images obtained by using the Color CCD camera in series

In this paper, we describe the algorithm of counting the passing people and show some experimental results obtained by using a simple experimental system to verify effectiveness of the proposed method.

2 Counting algorithm

2.1 Scene of counting

A scene of the passing people through the gate of the buildings is shown in Fig.1. There are a lot of the incoming people and the outgoing people. If the revolving bar was used in this place, the incoming and outgoing people could not go through the gate smoothly.

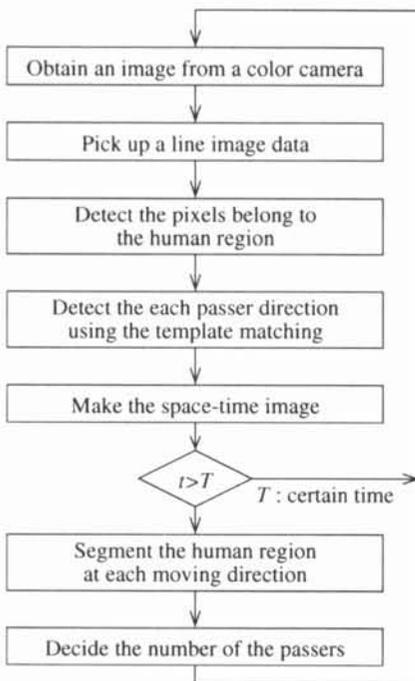


Fig.3 Flow of counting the passing people

If the conventional methods by using the image processing were applied, the passing people could not be counted accurately. Because the image data is obtained by the CCD camera installed aslant on the wall. In the proposed method, by using the CCD camera hung from the ceiling of the gate, images of the passing people are able to be obtained in series, as shown in Fig.2. These are gray level images but the obtained images have color information in fact. In these images, two persons are passing through the gate. By using this camera, the passing people could be observed from just overhead. The data of the passing people are not overlapped each other, and by using these images, the process of counting is carried out.

The flow of process of counting the passing people is shown in Fig.3. First step, pixels on the measurement lines are picked up. As a next step, each moving direction of interest pixels is detected by using the process of the template matching and transformed into the space-time image. Finally, the incoming and outgoing persons are able to be measured by counting the people data on the space-time image with the information of each moving direction.



Fig.4 An example of the gray level image



Fig.5 An example of the saturation image

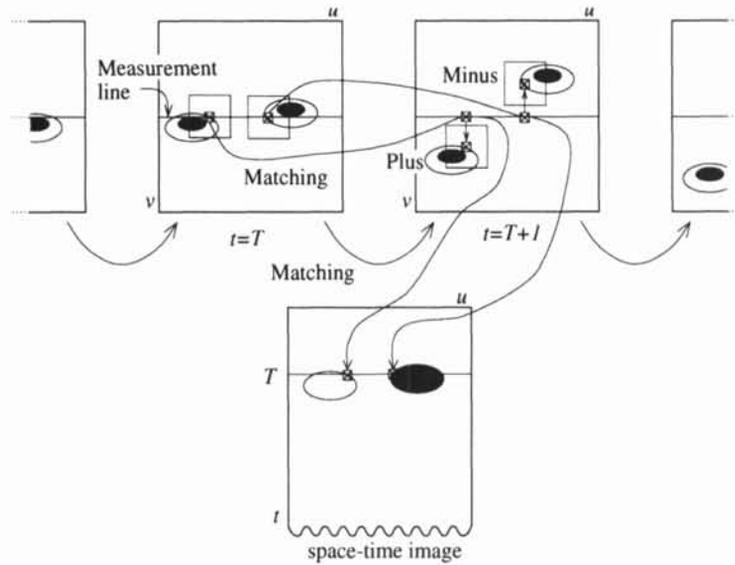


Fig.6 Detection each moving direction by using the template matching

2.2 Saturation image

In order to detect the pixels which belong to human region in the obtained image, the color information is used^[6]. An example of the gray level image is shown in Fig.4. Two persons are passing and two shadows of each person are projected on the surface of the road. The region of the people and the region of the surface of the road are not able to be segmented from the gray level image because of the shadows.

In this system, the region of the people is detected by using the value of the saturation which is one of the color information. The value of the saturation is certain on the sunny place or the shadow place of the surface of the road, so that this value indicates the color of object's own.

An example of the saturation image is shown in Fig.5. The shadows on the surface of the road are disappeared in this image.

2.3 Space-time image at the measurement line

In this system, a measurement line is set on the floor at right angle with the moving directions of the passing people. Then, the pixels just on a measurement line in the images are picked up and arranged along the time axis. As a result, a space-time image which includes just the data of the passing people over the measurement line is generated.

But from this space-time image, each moving direction of the passing people can not be recognized. Therefore, to detect each moving direction, the process of the template matching is carried out between the t image and the $t + 1$ image, as shown in Fig.6. In this process, the people data is transformed to a space-time image with the direction information.

2.4 Counting process

The number of the passing people can be measured by counting the group of people data on the space-time image with the passing direction. First, the labeling process is carried out in the space-time image. An example of the space-time image after labeling process is shown Fig.7.

The area of a person on the space-time image is different according to his passing speed. If the passer walks slowly, the area of the data is thick along the time axis, or if fast, the data area is thin. Therefore, to count the passing people is carried out allowing for the passing speed which is decided by the template matching.

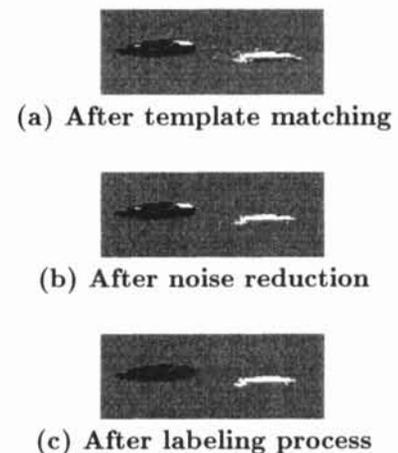


Fig.7 An example of the space-time image at the measurement line

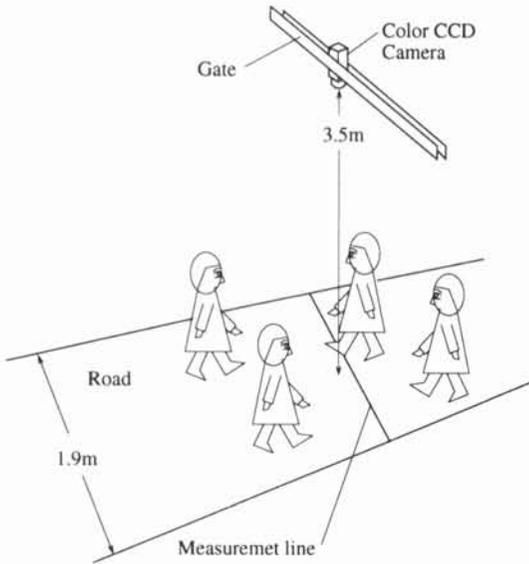


Fig.8 Parameters of the experiments

3 Experiments

The experiments by using the experimental system were performed to demonstrate the efficacy of this method. These experiments were carried out on the road inside our university. The experimental scene is shown in Fig.7 The color CCD camera was set 3.5m above the road, and the width of the gate was 3.0m.

The persons passed this place at random. 51 persons came in from the outside of the gate and 42 persons went out from the inside of the gate. Then, the results of this experiment, the incoming people are the 52 persons and the outgoing people are the 42 persons. The reason why counting was incorrect is that this passer collided with other person just on the measurement line. But except above special case, the good results were obtained.

4 Conclusion

In this paper, an automatic method of counting the passing people through the gate by using template matching have been proposed.



Fig.9 An example of the experimental scene

In the proposed method, images of the passing people are obtained in series by using the color CCD camera which is hung from the ceiling of the gate. These images on the measurement line are transformed into the space-time image which includes the data of the passing people. But each moving direction of the passing people could not be recognized from one space-time image. In this system, each moving direction of the passing people is detected by applying the process of the template matching. The space-time image is generated by the information of the moving direction. Finally, the incoming and outgoing persons could be measured by counting the people data with each direction information.

In this paper, we have described the algorithm of counting the passing people using the process of the template matching. In addition, we showed some experimental results obtained by using a simple experimental system to verify effectiveness of the proposed method.

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References

- [1] Kenji Mase: "X-t Spacetime Image and its Application for Counting Pedestrians", Proceedings of ICS90, No.62, pp.29-36, 1990.
- [2] Hideki Koike, Megumu Tsuchikawa and Fumio Adachi : "A Study of a Counting Method of People in Moving Picture", *Proceedings of the 22nd Joint Conference on Imaging Technology*, No.5-3, pp.123-126 (1991)
- [3] Tomonori Yamada, Toshinari Nonaka and Shinji Ozawa: "A Method for Counting Persons Using a Series of Images", Proceedings of the 1996 IEICE General Conference, No.D-633, pp.7-345, 1991.
- [4] Ryutaro Ito, Kenji Terada, Jun'ichi Yamaguchi and Masato Nakajima: "Counting Method of the Number of a Crowd of People using Fiber Grating Vision Sensor", *The Journal of the Institute of Image Electronics Engineers of Japan*, Vol.24, No.5, pp.550-556, 1995.
- [5] Kenji Terada, Masaki Fujikawa and Jun'ichi Yamaguchi : "An Automatic Method of Counting the Passing People through the Gate by using the Two Space-time Images", *Proceedings of IAPR WORKSHOP on Machine Vision Applications*, No.8-24, pp.321-324 (1996)
- [6] Kenji Terada, Jun'ichi Yamaguchi : "A System for Counting Passing People by Using the Color Camera", *The Transactions of The Institute of Electrical Engineers of Japan*, Vol.118-C, No.3, pp.322-328 (1998)