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An Automatic Method of Counting the Passing People through the Gate by Using Two Space-time Images

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Abstract

In this paper, an automatic method of counting the passing people through the gate by using two space-time images is proposed. In the proposed method, the images are obtained in series by using a camera which is hung straight from the ceiling of the gate, so that the data of the passing people are not overlapped each other in the images. First, a space-time image which includes the data of the passing people over the measurement line is generated. But in this system arrangement, each moving direction of the passing people can not be recognized from one space-time image. Therefore, two measurement lines are set on the inside and outside of the gate and two space-time images are generated. By detecting which line the person passes early, each moving direction is recognized. Finally, the incoming and outgoing persons could be measured by counting the people data on two space-time images of each moving direction.

1 Introduction

To count the passing people through the gate of the buildings or the entertainment halls 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]. 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 people on the obtained images were difficult. On the other hand, we have developed the counting method by using the three dimensional data obtained from the range finder[3]. 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.

Therefore, we propose an automatic method of counting the passing people through the gate by using a normal 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 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.

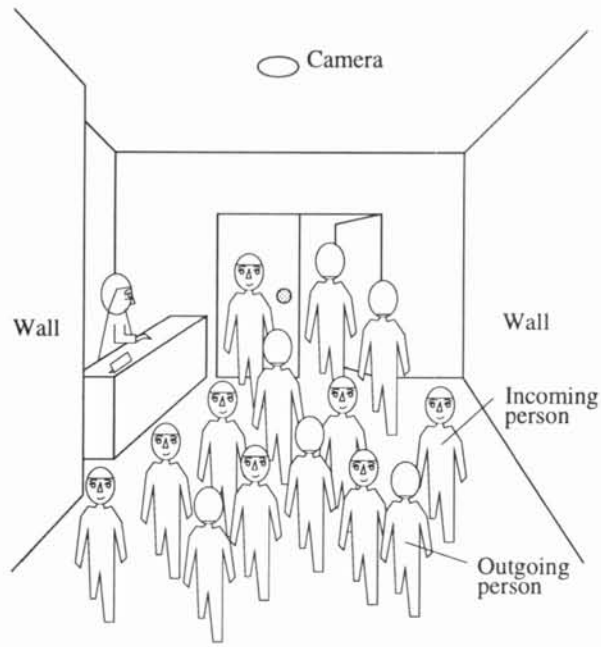

Fig.1 Scene of the gate

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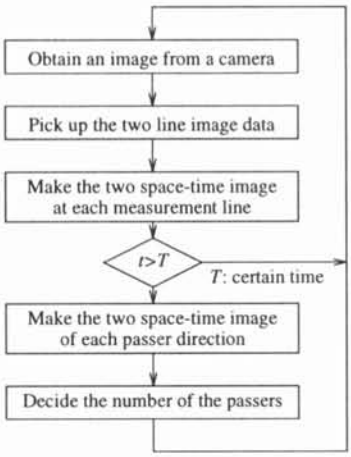


Fig.2 Flow of counting the passing people

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. If the conventional methods by using the image processing were applied, the passing people could not be counted accurately.

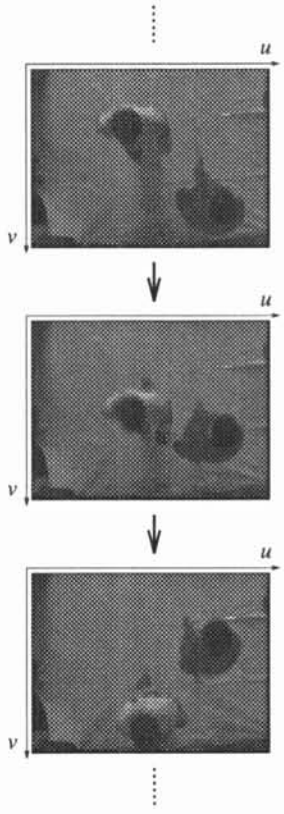


Fig.3 Examples of the images obtained in series

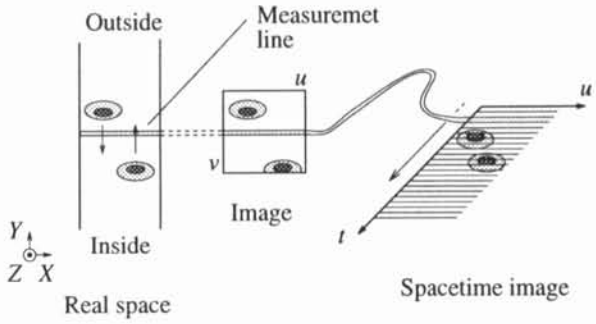


Fig.4 Transform of the line image into the space-time image

The flow of process of counting the passing people is shown in **Fig.2**. First, images of the passing people are obtained in series. As a next step, pixels on two measurement lines are picked up and transformed into two space-time images. By analyzing these space-time images, each moving direction of the passing people is detected, so that two space-time images of each moving direction are generated. Finally, the incoming and outgoing persons could be measured by counting the people data on the space-time images of each moving direction.

2.2 Space-time images at the two measurement lines

Images of the passing people are obtained in series by using the CCD camera hung from the ceiling of the gate. This camera is set up so that the passing people could be observed from just overhead. Example images obtained by using the camera in this system arrangement is shown **Fig.3**. In these images, two persons are passing through the gate and the data of the passing people are not overlapped each other.

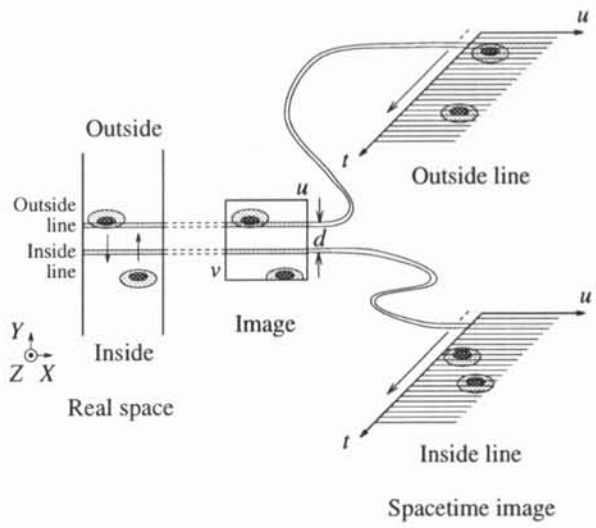
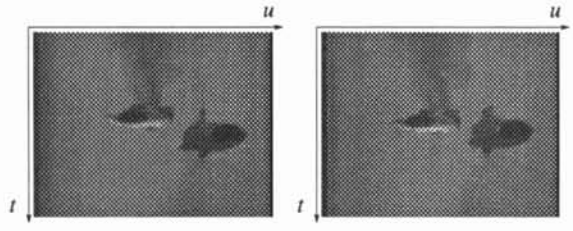


Fig.5 Transform of the two line images into the each space-time image



Outside Inside

Fig.6 An example of a pair of
the space-time images at each measurement

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 shown in **Fig.4**. As a result, a space-time image which includes just the data of the passing people over the measurement line is generated.

But from only one space-time image, each moving direction of the passing people can not be recognized. Therefore, two measurement lines are set on the inside and outside of the gate, as shown in **Fig.5**. In a similar manner, a pair of the space-time images which consist of the space-time image at the outside measurement line and the space-time image at the inside measurement line is generated.

An example of a pair of the space-time images is shown in **Fig.6**. Each direction of the passing people cannot be detected from only one space-time image. But the directions can be recognized from two space-time images by detecting which line the person passes early.

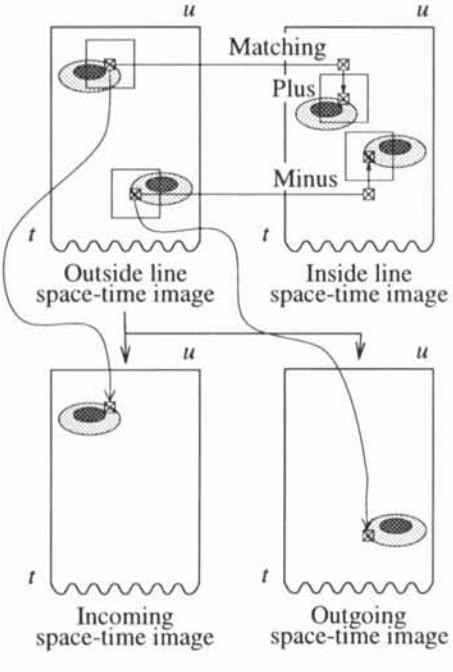
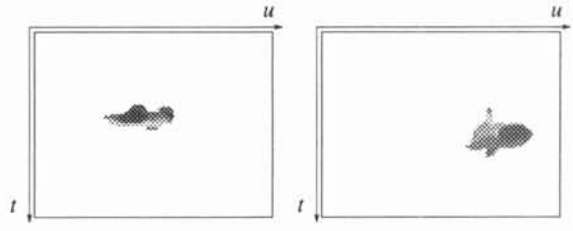


Fig.7 Transform of the two line images
into the each direction space-time image



Incoming Outgoing

Fig.8 An example of a pair of
the space-time images at each direction

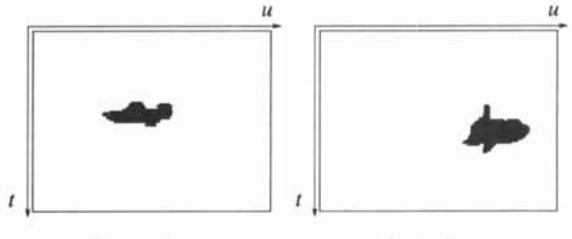
2.3 Space-time images of each moving direction

Two space-time images at each measurement line are transformed into the two space-time images of each moving direction of the passing people. To detect each moving direction, the template matching process is carried out between these images, as shown in **Fig.7**. In this process, the people data is transformed to a space-time image of the incoming persons, in case the pixel corresponding to the data on the outside image is appeared in the plus region along the time axis, or the data is transformed to a space-time image of the outgoing persons, in case the such data is appeared in the minus region. An example of a pair of the space-time images of each moving direction is shown **Fig.8**.

2.4 Counting the passing people

The number of the passing people can be measured by counting the people data on two space-time images of each passing direction. First, the labeling process is carried out in two space-time images. An example of a pair of the space-time image of each direction after labeling process is shown **Fig.9**.

But as shown in **Fig.10**, 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, the speed information which is decided by detecting the matching distance is transformed into two space-time images, as shown in **Fig.11**. Finally, Counting the passing people is carried out, allowing for the passing speed.



Incoming Outgoing

Fig.9 An example of a pair of
the space-time images after labeling process

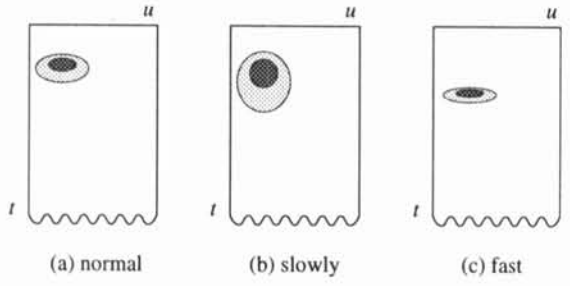


Fig.10 The area of a person data in the space-time image

3 Experiments

The experiments were performed to demonstrate the efficacy of this method. This experiment was carried out at the lobby of our building. The parameters are shown in **Fig.12**. The camera was set 3.5m above the floor, and the width of the gate was 1.6m. The distance between the outside and inside measurement line was 0.12m.

The persons passed the gate at random. The 31 persons came in from the outside of the gate and the 29 persons went out from the inside of the gate. Then, the results of this experiment, the incoming people are the 31 persons and the outgoing people are the 28 persons. The reason why counting was incorrect is that this passer ran with too high speed. But except above special cases, the good results were obtained.

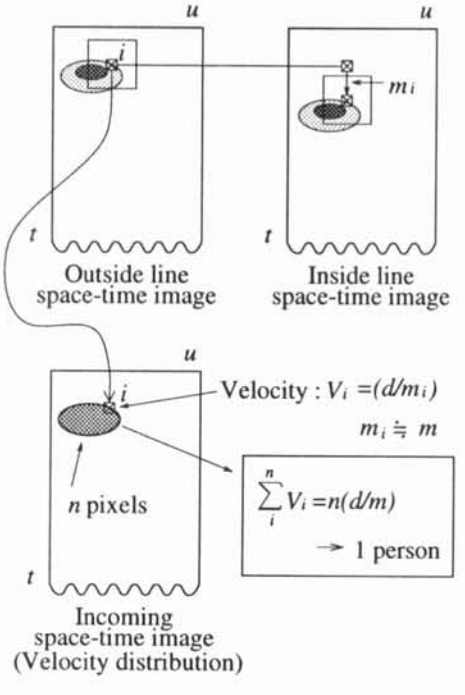


Fig.11 Transform of the speed information into the space-time images

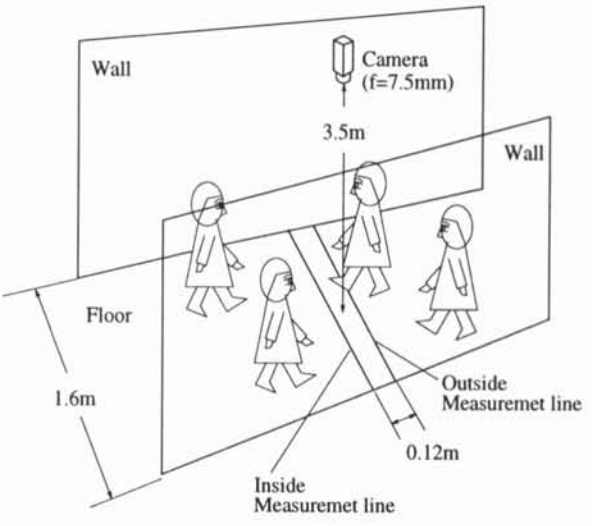


Fig.12 Experimental system

4 Conclusion

In this paper, an automatic method of counting the passing people through the gate by using two space-time images have been proposed. In the proposed method, images of the passing people are obtained in series by using a 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. Therefore, two measurement lines were set on the inside and outside of the gate and the two space-time images about each line were generated. Each moving direction of the passing people is detected from these images. 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 two space-time images and showed some experimental results obtained by using a simple experimental system to verify effectiveness of the proposed method.

References

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