

Proposal of Estimating Number of Passengers Using Images of Drive Recorder Inside Buses

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Abstract. In this paper, we investigated the method of counting the number of people getting on/off the bus. As a result, there are currently research and products that estimate the number of people getting on/off using dedicated cameras and sensors, but the additional cost is required to install dedicated equipment. Therefore, we investigated the facilities of the existing bus, and found that there are mainly a drive recorder and a digital tachograph (equipped with many sensors). A method of estimating the number of people by using the machine resource of digital tachograph from the image of the drive recorder is effective from the viewpoint of cost. As a result, the operation manager can inexpensively improve the route plan and provide information to the passengers.

Key words: Image Processing, IoT, Intelligent Transportation System

1 Introduction

In recent years, the route bus business has been in a difficult management situation due to the motorization mainly in local cities, the declining birthrate and aging population, and the progress of depopulation in Japan. The management of such deficit routes has been compensated by the black surplus of the other routes. However, due to the amendment of the Road Transport Law which relax a new bus companies' barrier to entry, excessive competition causes, then many bus companies are unable to maintain the deficit routes. Therefore, the demand for bus companies to know the number of passengers for reviewing the route plan is increasing. In addition, it is also required to grasp the number of passengers getting on/off in real time. It is expected that the operation manager can perform flexible operation management such as changing the vehicle arrangement and let the passengers who are planning to ride on the bus know the congestion situation.

The conventional method for real time counting passengers is manually counting by investigators. This method has two problems. Firstly, it is costly for hiring investigators for several days and entering into a spreadsheet software. The other is less information because a bus company cannot hire investigators every day. Generally, only one or two days of data can be collected a year. Since living

Table 1. Comparative table

Research	Purpose	Equipment	Cost	Privacy	Realtime
GIKEN Trastem[1]	counting	ceiling camera	High	Good	Good
AK System[2]	counting	ceiling camera	High	Good	Good
Chao-Ho Chen et al.[3]	counting	ceiling camera	High	-	-
Boon Chong Chee et al.[4]	monitoring	drive recorder	Low	Bad	Bad

traffic such as hospital visits and shopping is not done steadily every day, it is impossible to accurately grasp the actual condition of passengers.

Some bus companies introduce passenger counting system using bus cards transaction, sensors, or GPS. However, most of the bus companies which depend on some subsidy from the government cannot install above system because it is not subject to subsidies.

Therefore it is necessary to construct a system that informs the operation manager of the number of passengers on the bus in real time with cheapness that can be introduced by a bus company at the community bus level.

2 Related work

Details and discussions of four related works are following and Table 1 shows a comparison of them.

GIKEN Trastem’s Bus Passenger Count Sensor ”PASSENGER COUNTER”[1] and AK System’s ”Bus GO ! Bus Location System”[2] performs counting passengers by image processing images of two dedicated ceiling cameras. Image processing is performed by a dedicated controller, and the controller outputs the riding pulses and getting off pulses in real time if passengers pass under the camera. Because the output is a pulse, privacy is taken into account. However, additional dedicated cameras, controllers for processing images are required. Though the camera is not a special and not expensive, it can not be used for other purposes because it is installed on the ceiling.

Chao-Ho Chen et al. proposed a method to capture the flow of passengers bi-directionally using the images of the ceiling camera installed in the bus[3]. The difference of the frames of the video is calculated, and it is recognized as the moving object as the motion vector. The number of the moving objects is counted as the number of passengers who get on/off the bus in real time. Experiments show that high counting accuracy of 92% on average can be provided. However, this method also requires ceiling cameras installation for counting only, which is costly. Whether privacy can be secured depends on implementation.

Boon Chong Chee et al. proposed an elliptical head detection algorithm as a method to detect passengers onboard public transport vehicles[4]. Passengers on the bus are detected, but privacy and real-time property are not secured.

Many products those are currently on sale count the number of people by dedicated cameras, and there is no counting method using an already installed

camera such as drive recorder and other sensors. Therefore, many methods require additional costs for installing additional cameras and sensors. There are research to monitor passengers using only a drive recorder[4], but it might has a problem that the number of people is not counted and privacy is not taken into consideration there. In addition, these products and research have the problem that there is no mechanism to inform the operation manager in real time.

3 Proposal

The installation of tachographs on buses has been mandatory by law for a long time. In recent years, digitization has progressed, and more systems are increasing in which sensors are connected and communication functions are provided, and the operation information is conveyed to the operation manager in real time.

In addition, the bus company has installed a drive recorder to capture the driver and the inside of the bus from the vicinity of the roof mirror for safety management and analysis at the time of trouble occurring at both inside and outside the bus. Generally, the drive recorder mounted on the bus is mainly stored with 4 channels stored as full HD (in fact, each camera image is recorded as $960\text{px} \times 540\text{px}$ resolution.) Two of these cameras shoot inside of the car, one shoots a driver and another shoots passengers.

Although it is possible to estimate the number of passengers by transmitting the camera image to the outside of the vehicle, permission for secondary use of such privacy contents is required when using the images showing the passenger's face. It is unrealistic to get permission from every passenger in public transportation.

In this paper, we pointed out a method of counting passengers using image processing on the digital tachograph from the video of the drive recorder and transmitting in real time. The system overview is shown in Fig.1.

There are three points of this proposal.

- Adopt edge computing architecture to achieve privacy protection and real-time compatibility
- No need to newly install communication equipment and image processing resources since using the existing digital tachograph
- No need to newly install dedicated sensing equipment since using the existing drive recorder

4 Conclusion

In this paper, we pointed out that the demand for bus companies to know the number of passengers for real time for reviewing the route plan is increasing. It is expected that the operation manager performs flexible operation management such as changing the vehicle arrangement and let the passengers who are planning to ride on the bus know the congestion situation.

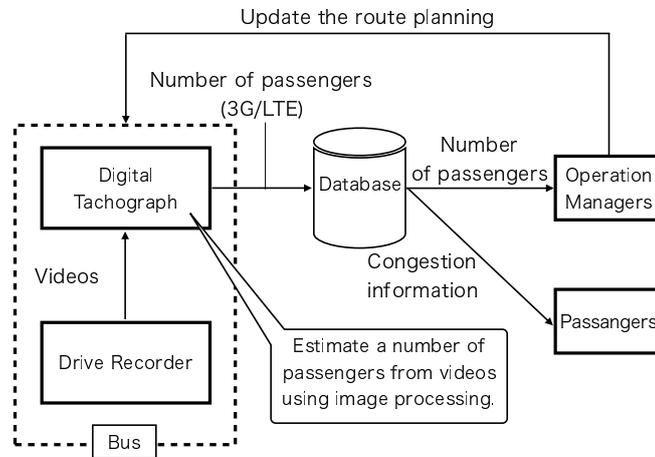


Fig. 1. System architecture

Therefore, we proposed a method of counting the number of passengers using the video of drive recorder and digital tachograph already installed in the bus. As a result, it is possible to count passengers at low cost, and it is expected to apply such as renewal of the route plan and information supply to customers. Also, the video used for estimation is utilized only in the system, and the information transmitted outside the vehicle is only the number of the passengers. This makes the data anonymous and ensures privacy.

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