Proceedings of the 12th
KACC, October 1997

A Traffic Flow Measurement System at Night by Using Image Processing

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Abstract:
In this paper, we propose a simple alogorithm to calculate the number of passing cars at night by using an image processing sensor for digital black and white images with 256 tone levels. To recognize cars, we capture their head lamps. The reflection of the head lamps is one of the most troublesome factors in recognizing cars. The main problem in this paper is how to recognize cars under the influence of the reflection of the head lamps especially in rainy days. In general, the image of a head lamp is nearly circular and the reflection is long and narrow. On the difference of these forms, we can exclude the reflection in our proposed algorithm. For real-time operation and simple calculation, we recognize the existence of cars using fifteen lines with 256 tone levels. In the experimental application on a road, the recognition rate of a real-time operation is more than 90%. Moreover, we will also explain briefly how to recognize passing cars for 24 hours.

Key words:
Real-time operation, A simple algorithm, The elimination of reflection of head lamps

1.INTRODUCTION

In this paper, we will describe a traffic flow measurement system at night. This is a continued research of the previous paper[2]. In this system, a simple algorithm should be applied, because the system operates in real-time. The sampling period of the system must be less than 100 msec.

The following features of night traffic image are assumed:

- The head lamps of cars are light on.
- The brightness of the enveronment is const.
- The tone-level of head lamp is different from back-ground, but that of car is not so different.
- Cars are moving in one way.

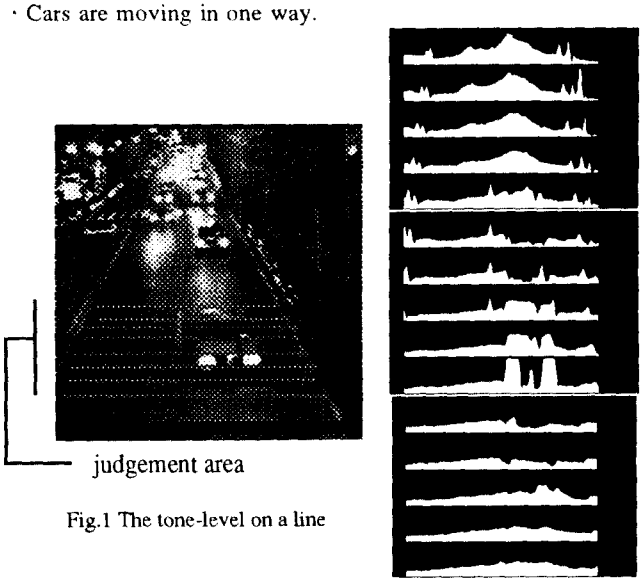


Fig.1 The tone-level on a line

According to the above features, we propose *a line-sensor system capturing head lamps* . The tone-level on a line becomes as in Fig.1. Fifteen sensing lines are settled. The existence of a car is recognized by the tone-level paterns on the sensing lines.

2.AN ELEMENTARY JUDGEMENT OF EXISTENCE OF A CARS

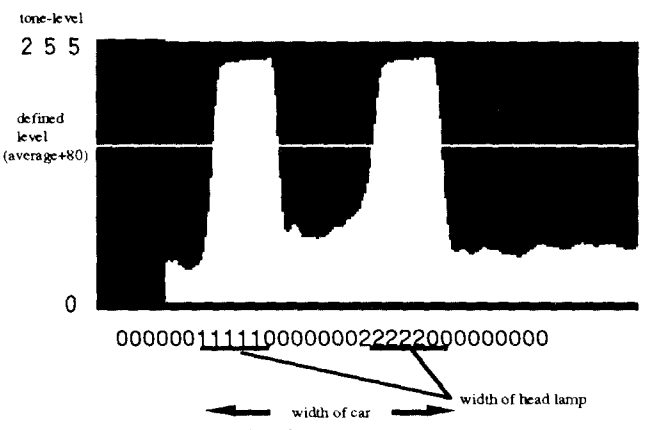


Fig.2 Judgement of head lamps

An example of the tone-level on a sensing line including head lamps is shown in FIg.2. We can judge that a car exists on a line, in case that the tone-level on the line satisfies the following three conditions:

1. The shape of the tone-level has two peaks and the distance of them agrees with car's width.
2. The width of the two peaks is almost the same at the defined level.

3.The difference of the maximum tone-level of the two peaks is less than 40.

We have 15 sensing lines. In many cases, the possibillity of a car's existence is recognized on some lines. We decide the line existing a car by finding a line with the minimum tone-level between left and right head lamps.

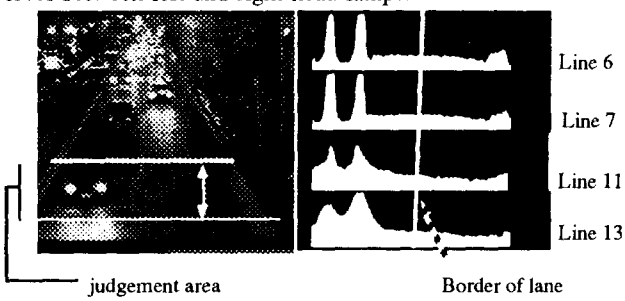


Fig.3 An example of finding the true line.

In Fig.3 there are four lines with possibility of existence of head lamps. The difference between the max and the min tone-level is less than 120. Under this condition we consider the true line as a line with smallest "valley" between two "peaks". We can conclude that the head lamps exist on a line 6 which is true result.

3. THE ELIMINATION OF REFLECTION OF HEAD LAMPS

Especially in rainy days, the difference of tone-level between head lamps and their reflections is not clear.

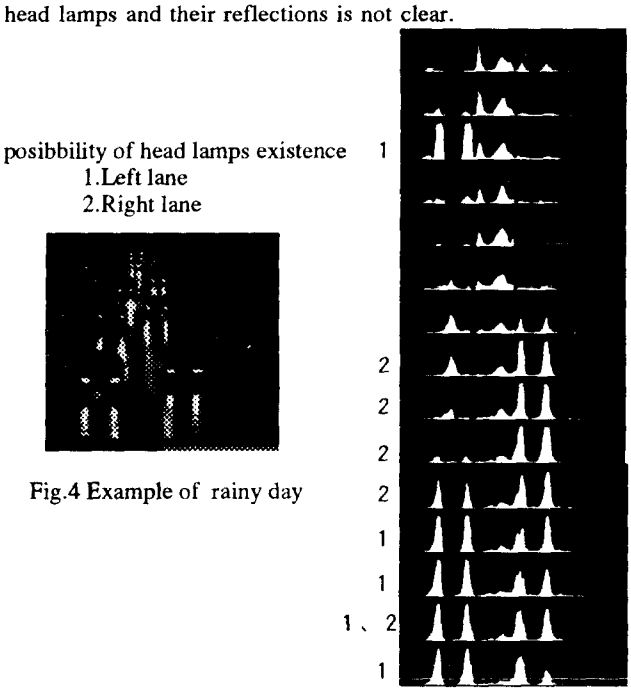


Fig.4 Example of rainy day

As shown in Fig.4, the line on which head lamps exist can't be recognized by the conditions mentioned above. But we can find the difference of the head lamps and their reflections by the following features. We detect the edge of the bright area in the region assumed existence of the head lamps. When the true head lamp exists, the two bright parts are appeared at upper and bottom of sensing line in the edge detected picture. On the other hand the reflections exist continuosly over some lines in the bright area in the region assumed existence of the head lamps.

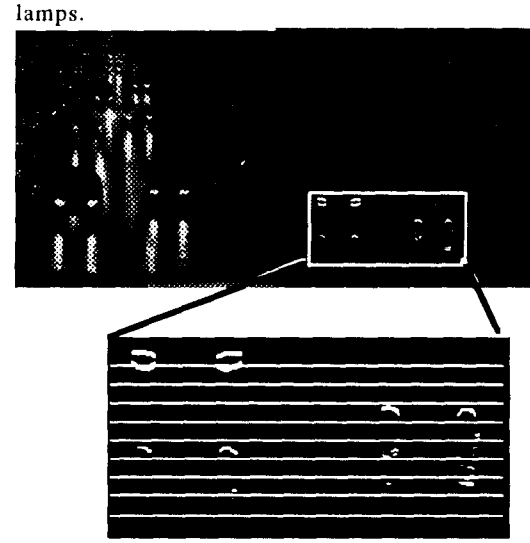


Fig.5 Detected edge

By using this differences we can eliminate the reflections. Figure 6 shows an example of the eliminated results.

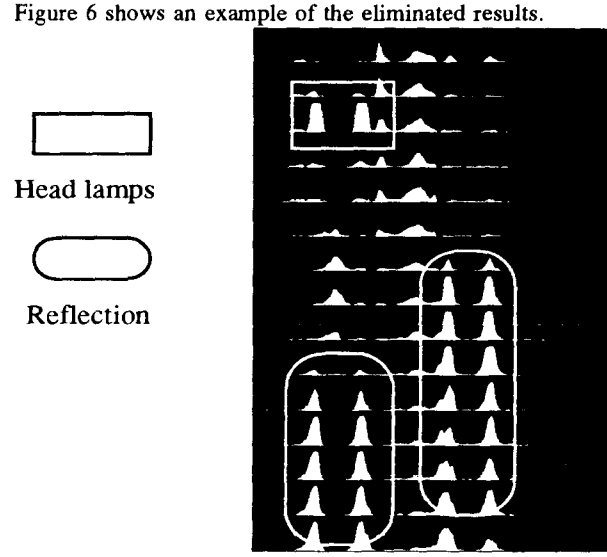


Fig.6 Elimination of reflection

The procedures to find car's existence including rainy weather case become as shown in Fig.7.

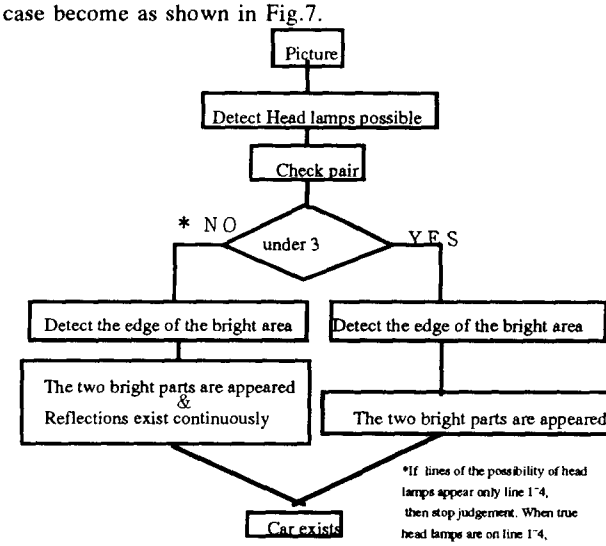
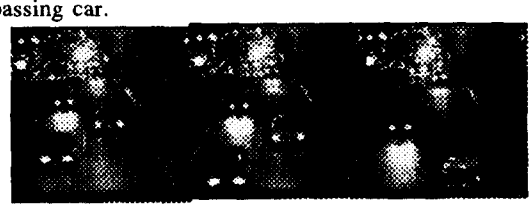


Fig.7 The procedures of all weather

4. THE METHOD OF COUNTING CARS

Using this recognition system including the procedures described above, we can judge wheather a car exists or not on each lane. In successive sampling times, existence of a car is recognized and it is disappeared in the next sampling time, we count a passing car.



Line that car exists	8	None	15	3	None	None
Number of passing cars	0	0	0	0	1	1

Fig.8 The way of counting the number of passing cars

5.THE CASES OF MISTAKES

The mistakes occur in the following case:
(1)A car with many lights is passing as shown in Fig.9.
(2)The brightness of the two head lamps is different as shown in Fig.10.

For these cases we have not found the correct recognition method.

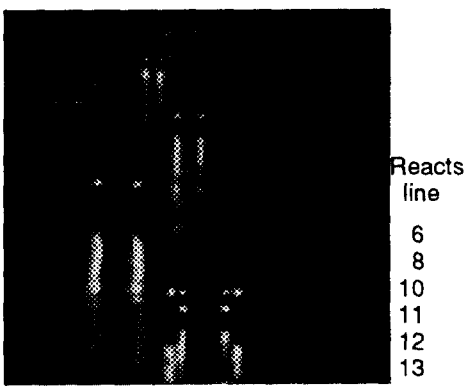


Fig.9 Example of a car having many lights

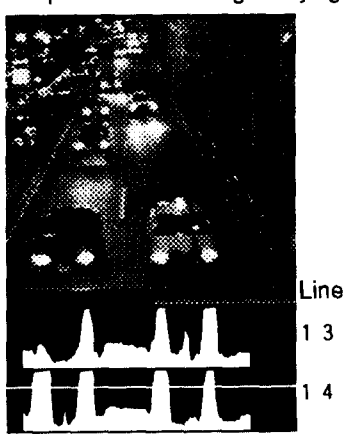
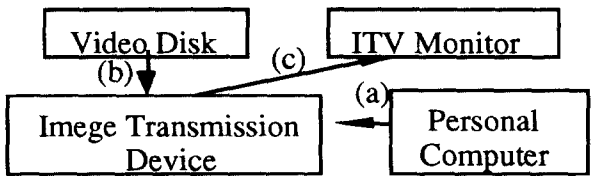


Fig.10 Example of delicacy difference

6. THE REAL-TIME OPERATION

We use the following system for real-time operation.

The name	The maker	The type
Personal Computer	NEC	PC-9821Ne2
Image Transmission Device	JRC	NDC-925
Video Disk	SONY	EV-S2200
ITV Monitor	SONY	KV-14MD1



(a) Feed the program which counts the number of passing cars.
(b) Fetch a real-time image.
(c) Output the result and the real-time image.

Fig.11 The real-time operation system.

We test the real-time operation at Meiji-dori in Japan.(see Fig.12). In Fig.12, the number "1" means "passing car". The number at the bottom part of this image shows the total number of passing cars at each lane.

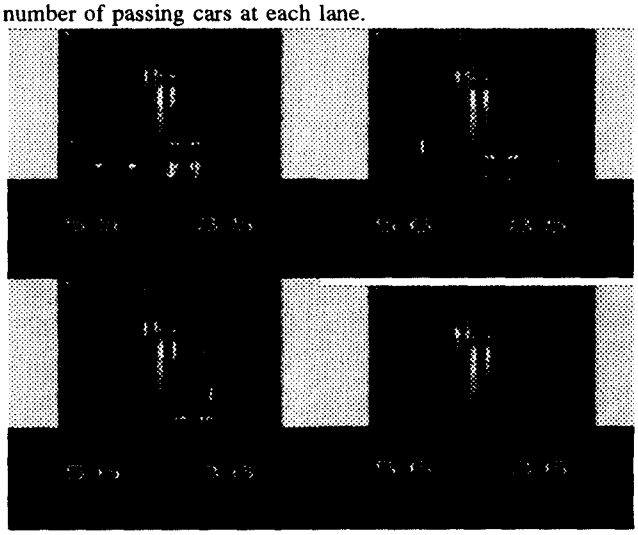


Fig.12 The operated image

Table 1 The result of real-time operation.

Weather	Passing cars	Counted cars	Oversight cars	Over-counted cars
Fine	586	562	26	2
Rain	413	407	28	22

In this real-time operation both of oversight and over-count were taken place. But we consider this result to be very good, since we can achieve the recognition rate of more than 90%

including rainy weather case.

7. OPERATION FOR 24 HOURS

The proposed recognition system works only at night, because the system is based on finding the car's head lamps. In the previous paper we proposed a recognition system for daytime[2]. To combine with the two system is difficult. Another system operating for 24 hours is considered as aplication of a method detecting the edge of a car. As shown in Fig.13, we detect the longitudinal and the lateral edge. The projection of the edges are shown in Fig.13.

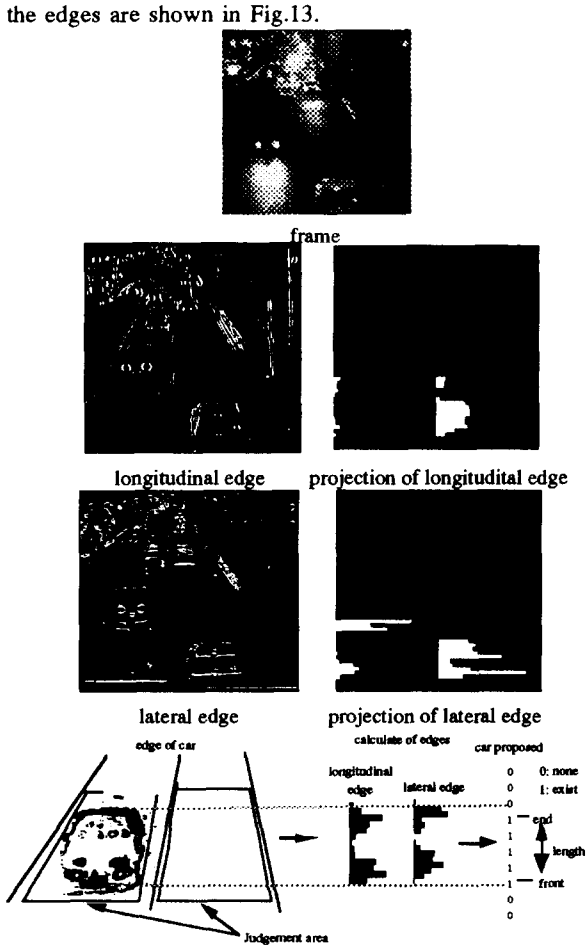


Fig.13 projection of edges

From the detected edges frame, we find car's front and end part and confirm the car's passing by capturing its movement in judge area. The width of judge area is taken as a length of a car. So we can judge car's existence in the following cases:

1. Only front part exists in judge area.
2. All of a car exists in judge area.
3. Only back part exists in judge area.

As shown in Fig.14, when the reflections of head lamps exist, we have to eliminate the reflections by the procedures mentioned in sec.3. Although this recognition method is very useful, but the operation takes too much time, it is impossible to apply the operation to real-time mode.

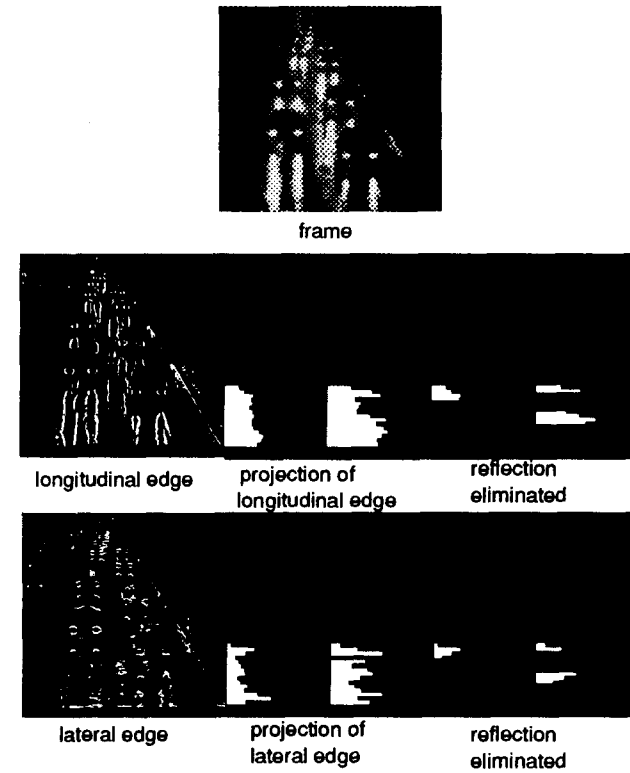


Fig.14 Reflection eliminated

Table 2 The result

numbers of frames	passing cars	counted cars	oversight cars
150	38	38	0

7. CONCLUSION

We constructed a simple recognition algorithm for passing cars which was able to operate in real-time at night, and got the recognition rate of more than 90%. For 24 hours operation, we can apply the edge detection method. But it is not suitable for real-time operation, because it takes too much time. The proposed recognition system is only applicable at night, but the recognition algorithm is very simple. So we can say this system is useful in real-time operation at night.

REFERENCES

[1] Translated by Makoto Nagao, Digital Picture Processing, kindai-kagakusha

[2] Takaaki Hara and Kageo Akizuki"Traffic Flow Measurement System Using Image Processing", KACC'96 pp426-429

[3] Tadashi Akimoto and Kageo Akizuki"A Waching System of a person entering a restricted area by Image Processing" , KACC'94 IS-01-2 pp6-12