Computer vision in the exploitation of vehicle contour dimension automatic measurement system of technology and its application

Xingliang Li*

Nanjing Forest Police College, Nanjing, 210023, China

Received 1 October 2014, www.cmnt.lv

Abstract

This paper researched and realized a measuring system of the vehicle gabarite based on the computer vision, in order to meet the requirements of vehicle management department to measure the vehicle gabarite automatically. The accurate measurement of the vehicle gabarite with non-contact and speediness was realized.

Keywords: computer vision, vehicle gabarite, measuring system

1 Introduction

With the rapid development of the society and economic of our country, infrastructure construction of road in each level is completed gradually and the car ownership is increasing rapidly, and it brings a great convenience to the production and living of people by the developing convenient transportation and communication [1]. On the other hand, the development of communication and transportation brings a lot of social and economic problems, such as frequent occurrence of traffic accidents, environmental pollution, serious damage of road, etc. Compared with developed countries, the laws and regulations in the aspect of traffic regulation and comprehensive governance in our country are still imperfection, and the technological means are lag behind them relatively [2]. Traffic management department and related departments in our country are begin to formulate, implement, improve the relevant laws and regulations in order to improve this condition, and they are begin to research and build the intelligent traffic management systems based on the modern technology

Nowadays, the study about vehicle automatic measurement technology already has a mature research in developed countries, and it has been generalized and applied in the practical production and life; manpower and material resources is saved effectively, and the work efficiency of relevant departments and personnel has been improved enormously [3]. In comparison, research of vehicle automation measurement in our country starts relatively late. The related technology has a large gap compared with international advanced technology level, and it has not been effectively applied in the practical production and life. The car ownership increases rapidly with the development of our social economy, and relevant departments have strong need of realizing the vehicle automatic measurement in order to face the increasingly complex vehicle measurements. As an important part of vehicle automatic measurement system, the research of vehicle gabarite system with automation, simple operation, easy to promote is very necessary [4].

2 Several insufficient of artificial measurement method [5]

1) The measurement process is tedious, and the efficiency is low. Measurement process requires many manpower and material resources to prepare, and it often need to use tools such as ladder when meet higher vehicle; survey crews need to work together to measure the oversize vehicle, and the data need to be recorded categorically by manual work after measurement. Automated measurement error is large, and the accuracy cannot be guaranteed.

2) The measuring time is long. The personnel need to pull tape, climb escalator manually in the process of measurement; precision cooperation of personnels is needed in the process of measurement, and it should be remeasured with mistake of one link. The measurement of a common truck gabarite usually costs 20 minutes.

3) The measured results are susceptible to human factors. The tool like measuring tape is easy to deform and incline, and measured result is read by human, thus the accuracy of measured result is unable to guarantee. On the other hand, the measured cars' photos cannot be saved in the process of measuring, and measurement results are easy to cause controversy.

In order to solve the problems of artificial measurement, the relevant departments and companies begin to develop automatic measurement equipment of the vehicle. Nowadays, it can be divided into the following categories:

* ***Corresponding author's*** e-mail: lxlsljcxy@163.com

three coordinate measuring machine (CMM), theodolite measuring system, multistatic distance intersection measuring system [6].

To display the real three-dimensional objects in the 2D screen coordinates is the most basic objective in the computer vision system, and three common coordinate system is usually involved in this process, that is, image coordinate system, camera coordinate system and world coordinate [7], as shown in Figure 1.

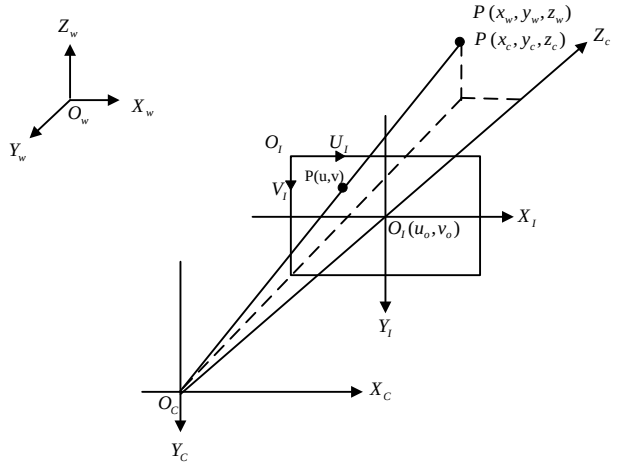

FIGURE 1 Pinhole imaging model and commonly used coordinate system

3 Measurement of car physical dimensions

Suppose m_R is the image coordinate of one spot(usually choose the midpoint) on the edge of headstock in panoramic view of body side. m_L is the image coordinate of one spot on the edge of tailstock which is on the same horizontal line of it. H_{IB} is homography between reference plane and side camera imaging plane in the process of calibration, thus the homogeneous coordinates of corresponding points of m_L, m_R in the reference plane is $\tilde{M}_L = H_{IB} = \tilde{m}_L$, $\tilde{M}_R = H_{IB} = \tilde{m}_R$, l_R is the physical length of the car body, the projected length of the car body in the reference plane is $l_B = \|M_R - M_L\|$, as shown in Figure 2.

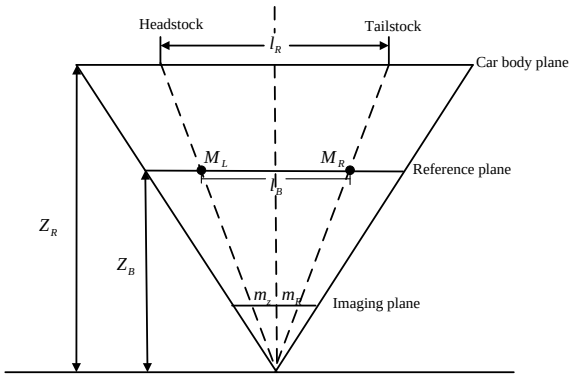

FIGURE 2 Measurement principle of vehicle body length

According to the principle of simple triangle similarity, that has:

$$\frac{l_R}{l_B} = \frac{Z_R}{Z_B} \Rightarrow l_R = \frac{Z_R}{Z_B} l_B .$$

where l_B is the distance between car body and camera, and Zs is the distance between calibration target and camera.

At last, converting the body side pixel size on image to actual physical size of body length.

The body height measurement can directly obtain according to the binocular distance measurement mentioned above: $h = H_C - D_R$. General training module, H_C is the erection height of the topcamera, D_R is the distance between car roof and camera measured by binocular, h is the car height.

4 Measurement of the actual car width

Suppose m_L is the image coordinate of one spot on the left edge of headstock, might as well let $m_L = \left(-\frac{C_L}{A}, 0\right)$, and the point of intersection is $m_R = \left(-\frac{B^2 C_L + A^2 C_R}{A^3 + AB^2}, \frac{BC_L - BC_R}{A^2 + B^2}\right)$ of the line through m_L perpendicular to the right edge lines. H_{IB} is the homography between estimated reference plane and the top of the camera imaging plane in the calibration process. Thus homogeneous coordinates of corresponding points of the m_L, m_R in the reference plane is $\tilde{M}_L = H_{IB} = \tilde{m}_L$, $\tilde{M}_R = H_{IB} = \tilde{m}_R$, the projection width w_B of the car roof in the reference plane is $w_B = \|M_L - M_R\|$.

According to the inference above, it is known that the actual width w_R of car roof is $w_R = \frac{z_R}{z_B} w_B$, where Z_R is the distance between car roof and top camera measured by binocular, Z_B is the distance between reference plane and top camera in the calibration process.

We detect the peripheral point of car roof by simple pixel difference method, fit two edge lines by these peripheral points, and obtain the pixel distance between two edge lines. Then the actual physical size of car width can be received based on the similar method of body length measurement.

5 Conclusion

This paper designed and exploited a vehicle gabarite measurement system based on researching the principles and methods of the computer vision measurement system, and it aimed at the demand of vehicle management department to apply the vehicle gabarite automation measurement. In this paper, considering about the environmental characteristics of actual measurement field, the outer contour features of the measured vehicle and the request of system for measure performance, different

methods are used to measure the length, width, height of the car [8]. The designed hardware environment is regarded as basis and developed software is regarded as the core of the system, and a complete set of vehicle gabarite measurement scheme has been finished. Practical application results show that this system can accomplish the measurement of vehicle gabarite rapidly, accurately and automatically, which can provide a technological mean for effective identification of and customized car and comprehensive management of oversize and overload.

References

[1] Sonka M, Hlavac V, Boyle R 2011 Processing and Analyzing of the Image and Machine Vision *Beijing: Tsinghua University Press* 111-2

[2] Tang B, Wang Z 2003 Comprehensive Considerations of Transport Efficiency and Transportation Safety GB1589 Discussion the Castigatory of Gabarite, Axle Load and Limitted Quality of Road Vehicle> *Automobile & Parts* (25) 36-9

[3] Cheng Y, Du Y, Yang H, Ma W 2013 Analysis about Adhibition of Vehicle Gabarite Dynamic Automatic Measurement Device *Technology and Market* (03) 33-6

[4] Li L 2012 The General Situation of Automotive Testing Technology *Transport World* (07) 80-1

[5] Dong H 2014 Design and Application of Locomotive Comprehensive Information Monitoring System. *Electronics World* (11) 110

[6] Wang B, Chen Z, Xu X 2009 Design and Analysis of Signal Detecting Circuit for the Vehicle Body's Height Sensor *Instrument Technique and Sensor* (08) 85-7

[7] Xie X 2012 Control Measures Analysis of Road Transportation Vehicles Overrun and Overload *China Urban Economy* (03) 210-1

[8] Deng Z, Chen C 2009 An Image Matching Algorithm Based on Epipolar Line Restriction *Journal of Engineering Graphics* **5**(8) 104-7

Authors

Xingliang Li, 1979, Jiangsu Province, China.

Current position, grades: lecturer.
University studies: master's degree in software engineering, Dalian University of Technology in 2008.
Scientific interests: criminal science and technology.