Prediction of Pedestrian Detectability for Drivers by Image Processing and its Driver Adaptation

Ryunosuke Tanishige[1], Daisuke Deguchi[2], Keisuke Doman[3], Yoshito Mekada[3], Ichiro Ide[1], Hiroshi Murase[1], and Naoki Nitanda[4]

[1]: Graduate School of Information Science, Nagoya University, Japan
[2]: Information and Communications Headquarters, Nagoya University, Japan
[3]: School of Engineering, Chukyo University, Japan
[4]: DENSO CORPORATION, Japan
E-mail: tanishiger@murase.m.is.nagoya-u.ac.jp, ddeguchi@nagoya-u.jp, kdoman@sist.chukyo-u.ac.jp, y-mekada@sist.chukyo-u.ac.jp, ide@is.nagoya-u.ac.jp, murase@is.nagoya-u.ac.jp

Abstract In recent years, advances in pedestrian detection technology have resulted in the development of driving assistance systems that notify the drivers of the presence of pedestrians. However, warning of all of the presence of pedestrians would confuse the driver. Therefore, the driver should only be notified of the less detectable pedestrians to avoid confusion. To achieve this, it is necessary to develop a method to predict the pedestrian detectability. This paper proposes a method that predicts the pedestrian detectability considering the difference between individual drivers. The proposed method constructs a predictor specific to each driver, in order to predict the pedestrian detectability precisely. To obtain the ground truth of the pedestrian detectability, we conducted an experiment by human subjects using images from an in-vehicle camera including pedestrians. From the comparison between the output of the proposed method and the actual detectability, we confirmed that the proposed method significantly reduces the prediction error in comparison with the existing methods.

Keywords ITS, driver assistance system, pedestrian, detectability, personalization

1 Introduction

In recent years, advances in pedestrian detection technology using in-vehicle cameras and sensors have resulted in the development of driving assistance systems that notify the drivers of the presence of pedestrians. However, warning the driver of all visible pedestrians could be confusing and is thus prohibitive towards safe and comfortable driving. Therefore, it would be useful to de
perception performance of pedestrian detectability. Fig. 1 shows an example of the detectability of pedestrians in different conditions.

Several research groups have proposed methods for predicting the pedestrian detectability. Engel et al. [1] proposed a method for predicting the pedestrian detectability using image features and information on the structure of the road. Wakayama et al. [2] proposed a method considering Visual Search [3] and pedestrian motion. They used a saliency map [4] and motion features. The aim of these methods is to estimate the average pedestrian detectability for all drivers in general. However, in practice, the visual performance of individual drivers affects the pedestrian detectability.

In this paper, we focus on the difference between drivers, and propose a method for personalized prediction of the pedestrian detectability. To achieve this, we construct predictors optimized for individual drivers and predict the pedestrian detectability incorporating these predictors.

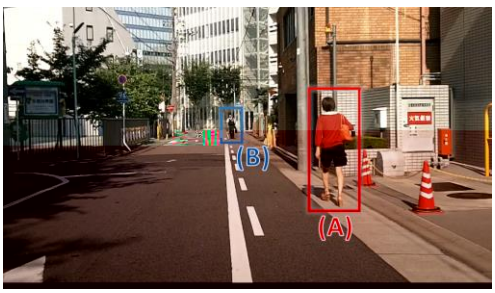

Fig. 1. Example of the difference of pedestrian detectability. Pedestrian (A) is near the camera, and is easier to detect. Pedestrian (B) is far from the camera, and is more difficult to detect.

In the following, section 2 describes the details of proposed method. Then, an experiment by human subjects using in-vehicle camera images is reported in section 3. Next, evaluation of the proposed method is reported in section 4. Finally, we conclude this paper in section 5.

Table 3. The result of the MAE of predicted pedestrian detectability. This table compares the proposed method with personal adaptation and the comparative method [1,2] without personal adaptation.

Method	Subject					
	A	B	C	D	E	F
Comparative	0.190	0.194	0.203	0.185	0.222	0.206
Proposed	0.172	0.184	0.196	0.175	0.204	0.195

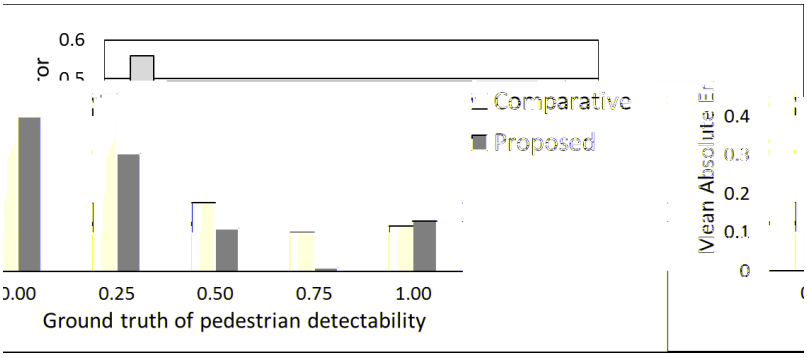

Fig. 5. Comparison of the prediction accuracy by MAE for subject **E** between the proposed method and the comparative method.

between the ground truth of the pedestrian detectability and the predicted value for subject **E**. As can be seen in the graph, the proposed method is more effective for low detectability pedestrians. From these results, we confirmed that the proposed personalization for individual drivers significantly contributed to improve the prediction accuracy.

5 Conclusion

This paper proposed a method for personalized pedestrian detectability prediction from in-vehicle camera images. To improve the accuracy, the proposed method considered differences between individual drivers. Evaluation results showed that the adaptation for a driver is effective for the prediction of the pedestrian detectability. Future works include: (1) investigation of features that can represent the difference of drivers, and (2) evaluation of the proposed method through larger experiment with many subjects.

Acknowledgement

Parts of this research were supported by JST CREST, the Kayamori Foundation of Information Science Advancement, and MEXT, Grant-in-Aid for Scientific Research. This work was developed based on the MIST library:
(http://mist.murase.m.is.nagoya-u.ac.jp/trac/).

Reference

[1] D. Engel and C. Curio, redictionin Dynamic Scenes for Enhanced Environment P Proceedingsof the IEEE Intelligent Vehicles Symposium2012, pp.178 183, Alcalá, Spain, June 2012.

[2] M. Wakayama, D. Deguchi, K. Doman, I. Ide, H. Murase, and Y. Tamatsu,
Human Performance for Pedestrian Detectability Based on Visual Search and Motion F Proceedingsof the 21stInternational Conference on Pattern Recognitionpp.1940 1943, Tsukuba, Japan, November 2012.

[3]J. M. Wolfe. In H. Pashler, editor, Attention pp.13 73. University College London Press, 1998.

[4] L. Itti, C. Koch, and E. Niebur, odel of Saliency-Based Visual Attention for Rapid Scene A IEEE Transactionson Pattern Analysis and Machine Intelligence vol.20, no.11, pp.1254 1259, November 1998.

[5]A.J. Smola and B. Sch utorial on Statistics and Computing vol.14, no.3, pp.199 222, August 1998.

[6] Histograms of Oriented Gradients for Human D Proceedings of the 2005 IEEE Computer Society Conference on Computer Visionand Pattern Recognition, vol.1, pp.886 893, San Diego, USA, June 2005.

[7] C.-C. Chang and C.- : A library for Support Vector M ACM Transactions on Intelligent Systems and Technology, Vol.2, No.27, pp.1 27, April 2011.