WAS Science Nature
WASSN

ISSN: 2766 - 7715
WAS PRESS

Article

Efficient Traffic Sign Detection Based on High Dynamic Range Preprocessing Module

Mohammed El Amine Moumene[1] *

[1] Department of Mathematics and Computer Science, faculty of exact sciences and informatics, University of Abdelhamid Ibn Badis Mostaganem, Algeria; elamine.moumene@univ-mosta.dz.

*Corresponding author. E-mail address: elamine.moumene@univ-mosta.dz .

Received: 01-08-2021; Accepted: 02-09-2021; Published: 20-09-2021

Abstract: Traffic sign recognition systems are primordial for intelligent vehicles. Various vision based detection systems have been proposed to detect road panels, but few of them tackle adverse conditions of acquisition such as bad weather or high dynamic range scenes. In this paper, we introduce efficient traffic sign detection when facing difficult illumination conditions. First, a high dynamic range preprocessing module based on Neural Network exposure fusion is used. After that, shape or color based detection phase is performed to detect regions of interest. Evaluation and comparisons using some relevant works showed that the added preprocessing module enhances the detection rate facing adverse illumination conditions.

Keywords: Intelligent Transportation Systems; Traffic Sign Recognition; High Dynamic Range Imaging; Artificial Neural Network.

---

1. Introduction

Advanced driver assistance systems reduce the number of accidents by handling some driving actions such as the traffic signs recognition. Road panels contain essential information that could be overlooked by drivers due to inexperience, inattention or fatigue. This is why traffic sign recognition is considered a main component of intelligent vehicles. Most researches utilize computer vision methods for traffic signs recognition. Detecting road panels in images delivered by a camera mounted in front of the vehicle has become a common practice.

Traffic sign recognition in images goes through two main phases: detection and classification. In this paper, we address a detection problem that is critical for a complete traffic signs recognition system. The main objective of detection methods is to locate regions of interest containing road panels. Those methods are mostly color based or shape based methods. The color-based detection methods are dominant because the traffic signs are characterized by specific colors. Md. Abdul et Al [1] generated probable road signs from the input images using a segmentation phase, which is based on color. After the conversion of an RGB image into HSV, a thresholding is applied to the image to extract red color. Hilario Gómez-Moreno et Al [2] detected panels in YUV space by applying a colorimetric thresholding. Yi Yang et Al [3] proposed a color probability model that transforms the input image color into a traffic sign probability map, where pixels of traffic signs will have high intensities. The other approach for panels detection consists of using shapes. Road signs are detected from the edges of the image. Shape based methods are generally robust and they can handle grayscale images. However, they are costly in computing time. Hough transform is the most adopted technique to detect panel shapes. Garcia-Garrido MA et Al [4] used Hough transform to detect edges and closed contours. A circle detection algorithm EDCircles, introduced by Akinlar C et Al [5] is also used by several works to detect circular traffic signs [6]. Circular arcs are extracted from edges and arcs having a similar radius are grouped together to form candidate circles.

Drivers pay less attention to road signs when driving in difficult lighting conditions or in bad weather. Therefore, increasing driving safety as well as improving automatic road sign detection during these critical situations becomes essential to help reduce the number of road fatalities. In this paper, we introduce a new traffic sign detection method which is suited for adverse lighting conditions such as driving facing the sun. We use a Neural Network exposure fusion as a preprocessing step before the usual color or shape detection methods. The obtained results show that adding the HDR preprocessing module enhances the detection rate and reduces the rate of misses when facing adverse lighting conditions. The remainder of this paper is structured as follows: Section II introduces the proposed traffic sign method. Section III and IV show respectively the obtained results and the conclusion.

2. Proposed Traffic Signs Detection

The cameras are equipped with features that regulate the amount of light falling on the photographic sensor. When facing a high dynamic range scene such as the one shown in the Figure 1, the auto exposure algorithm of the camera reduces the exposure time to avoid a saturated image. In this case, low lights of the scene (The road panel on Figure 1) cannot be properly captured. A scene containing dark regions along with very bright regions can cause significant loss of detail in the captured image, regardless of the exposure settings chosen. The traffic signs recognition system needs to be reliable in extreme conditions. Unfortunately, in such scenes, sensors may produce misleading or missing data for decision making, which will decrease the safety level of the Autonomous Vehicle.

Facing a High Dynamic Range Scene, the camera is unable to capture all details in one single image. One promising solutions to this problem is to capture exposure bracketing and merge it into one enhanced image containing all scene details. The first step to our proposed sign recognition system is to perform neural network exposure fusion [7]. It is a real time exposure fusion method that takes three exposures as input and delivers suitable images facing High Dynamic Range Scene. A Neural Network is fed with different samples of HDR scenes containing exposure bracketings which are labeled with their Mertens's Exposure Fusion image [8]. The model requires samples transformed into two vectors. The first one is the input which contains three RGB values of the same pixel position across three different exposures. The second one is the RGB values of the fused images by Mertens's Algorithm. The learning dataset contains millions of samples, captured from different types of scenes (Indoor, outdoor, day and night scenes). It is constructed from the HDR photographic survey database [9]. The resulting model from the learning determines how to produce a more detailed images starting from any exposure bracketing. The resulting image is passed to usual color or shape based detection techniques [2],[4].

(a) (b) (c)

Figure 1. Exposure Fusion Neural Network facing High Dynamic Range Scene: (a) Auto exposed image; (b) Saturated image; (c) Exposure Fusion + Canny Edge Detection.

3. Results and Comparisons

The used traffic signs image dataset for experiments contains 273 image bracketings of different road scenes. Those images are captured while driving and facing adverse lighting conditions (Figure 1). The exposure bracketings consist of three images differently exposed (Auto exposure, under-exposed image, and over-exposed image). The exposure bracketings are passed on to the real time Neural Network exposure fusion algorithm, then to the shape or color-based detection methods [2],[4]. As shown in Table 1, adding the HDR preprocessing module to both shape and color-based methods enhances considerably the detection rate. The delivered images by the original auto exposure system of the camera facing high dynamic range scenes undergo the backlighting effect. Loss of road panel details on those images produces a high rate of misses.

Table 1. Traffic signs Detection facing adverse lighting condition.

Method	Detection Rate	Average Processing Time (S)
Color based Method	21%	0.42
Color based Method + HDR module	**79%**	0.47
Shape Based Method	33%	0.63
Shape Based Method + HDR module	**88%**	0.69

4. Conclusions

In this paper, we introduce the use of the neural network exposure fusion algorithm as a preprocessing step to usual traffic signs detection algorithms. Experiments on captured images facing adverse lighting conditions show that the proposed technique enhanced considerably the good detection rate without significantly increasing the processing time.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Sheikh, M. A. A., Kole, A., & Maity, T. (2016, October). Traffic sign detection and classification using colour feature and neural network. In 2016 International Conference on Intelligent Control Power and Instrumentation (ICICPI) (pp. 307-311). IEEE.
2. Gómez-Moreno, H., Maldonado-Bascón, S., Gil-Jiménez, P., & Lafuente-Arroyo, S. (2010). Goal evaluation of segmentation algorithms for traffic sign recognition. IEEE Transactions on Intelligent Transportation Systems, 11(4), 917-930.
3. Yang, Y., Luo, H., Xu, H., & Wu, F. (2015). Towards real-time traffic sign detection and classification. IEEE Transactions on Intelligent transportation systems, 17(7), 2022-2031.
4. Garcia-Garrido, M. A., Sotelo, M. A., & Martin-Gorostiza, E. (2006, September). Fast traffic sign detection and recognition under changing lighting conditions. In 2006 IEEE Intelligent Transportation Systems Conference (pp. 811-816). IEEE.
5. Akinlar, C., & Topal, C. (2012). A real-time circle detector with a false detection control. IEEE International Con-ference on Acoustics, Speech and Signal Processing. Kyoto, 1309-1312.
6. Berkaya, S. K., Gunduz, H., Ozsen, O., Akinlar, C., & Gunal, S. (2016). On circular traffic sign detection and recognition. Expert Systems with Applications, 48, 67-75.
7. Moumene, M. E. A., & Benkedadra, M. (2021). Enhanced Road Lane Detection Facing Sun Glare. Journal of Mobile Multimedia, 773-788.
8. Mertens, T., Kautz, J., & Van Reeth, F. (2007, October). Exposure fusion. In 15th Pacific Conference on Computer Graphics and Applications (PG'07) (pp. 382-390). IEEE.

9. Moumene, M. E. A., & Benkedadra, M. (2021). Enhanced Road Lane Detection Facing Sun Glare. Journal of Mobile Multimedia, 773-788.