Image Pre-processing in Vertical Traffic Signs Detection System

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***Abstract*—The aim of this paper is to present the first steps of the systems design that will be able to detect vertical traffic signs and to provide descriptions of the applied data processing methods. This system includes various functional blocks that are described in this paper. The basis of Vertical Traffic Signs Detection System is a pre-processing of a captured traffic scene ahead of vehicle. Main part of this paper contains a description of user friendly software interface for an image pre-processing.**

***Keywords*—Cambridge optical correlator; image pre-processing; shape detection; traffic signs detection**

I. INTRODUCTION

Nowadays, road safety and comfortable drive are very popular topics. The driver assistance systems are more integrated into vehicles. Many of these systems use the digital video camera to capture the scene ahead of the vehicle. The extraction of relevant features from capture scene is very important for next data processing. The pre-processing is based on these systems. It is used for extraction of relevant features [2-4].

The goal of this paper is to present the Vertical Traffic Signs Detection System based on Cambridge optical correlator. Cambridge optical correlator is used for the comparison of the vertical traffic signs captured from road with reference vertical traffic signs from a reference database. Compared traffic scenes are captured by the video camera and pre-process by software. The image pre-processing is very important for detection of traffic signs [1-5].

In Chapter II, the hardware scheme of Vertical Traffic Signs Detection System is shown and the individual components are described. Chapter III contains a description of detection based on shape detection and a description of the user friendly software interface. The user friendly software interface is created by using C# programming language. The software was primary designed for image pre-processing. Experiments and results are involved in Chapter IV. Experiments were done with static images captured in real traffic scenes. Conclusions of designed system are summarized in Chapter V.

II. VERTICAL TRAFFIC SIGNS DETECTION SYSTEM

The Fig. 1 shows hardware scheme of Vertical Traffic Signs Detection System (VTSDS). This system includes a digital video camera, a computer, Cambridge optical correlator and a display.

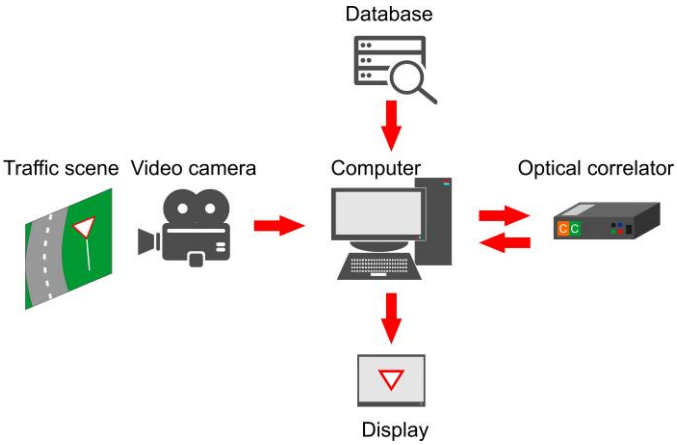

Fig. 1. Hardware scheme of Vertical Traffic Signs Detection System.

The digital video camera is installed in front of a vehicle. The role of the digital video camera is to capture a traffic scene. The digital video camera constantly records the scene ahead of the vehicle. The camera communicates with a computer and sends data to the database.

The computer is the main part of system. Its task is to process an obtained traffic scene by software. Software is used to remove unnecessary information from a traffic scene and keeps only the information that is relevant for traffic sign detection. The purpose software is a pre-processing of a captured traffic sign. The pre-processing contains many block, each of than performs certain part of an image processing. The computer has a database with reference traffic signs which are used in a matching process. The computer sends results of pre-processing with information from a database to Cambridge optical correlator for the next processing.

The Cambridge optical correlator is a technology which is used in an image recognition process. It automatically detects and identifies the content of the image by combining the input image with the reference image. The input image represents the results of pre-processing and the reference images are reference traffic signs stored in a database. The result of a matching process is information which kind of a traffic sign is located ahead of vehicle. The reference traffic sing will be shown on a screen [3-7].

III. IMAGE PRE-PROCESSING IN VERTICAL TRAFFIC SIGN DETECTION SYSTEM

The software which modifies the captured traffic scene ahead of vehicle is used for detection of the vertical traffic signs is used. Basic traffic signs contain three main colours: red, blue and yellow. Typically traffic signs are having a triangle, a circle, a square or an octagon shape based on this information. There are three ways of traffic signs detection:

- Detection based on colour filtering.
- Detection based on shape detection.
- Detection based on combination of colour filtering and shape detection.

A. Detection based on shape detection

The process of the pre-processing of the captured a traffic scene is based on shape detection. Fig. 2 illustrates the block diagram of a pre-processing. The pre-processing consists of six blocks.

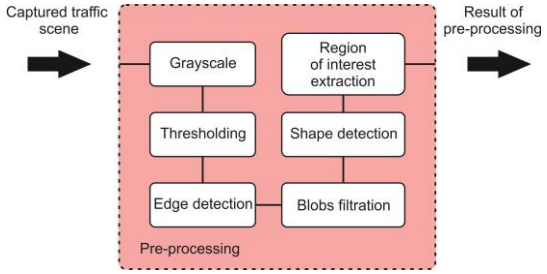

Fig. 2. Block diagram of pre-procesing.

1) Grayscale: In this first block there is the captured traffic scene transform to a grayscale image. A grayscale image carries brightness information only. There is no information about a colour. Fig. 3(a) shows an example of a captured traffic scene. Fig. 3(b) shows grayscale image created form this image.

Fig. 3. (a) A captured traffic scene (b) Grayscale image.

2) Thresholding: The grayscale image is converted to a binary image by a thresholding process in this block. Thresholdng is the simplest method of image segmentation. White pixels represent the pixels of the an image which value is within the threshold range. Black pixels represent out of the threshold range values. Fig. 4 is refers to a binary imange created from a graycscale image.

Fig. 4. The image after a thresholding process.

3) Edge detection: The Canny edge detector is applied to an image after a thresholding process in this block. The Canny edge detector is an edge detection operator. it uses a multi-stage algorithm to detect a wide range of edges in a particular image. Fig. 5 illustrates an image after using the Canny edge detector.

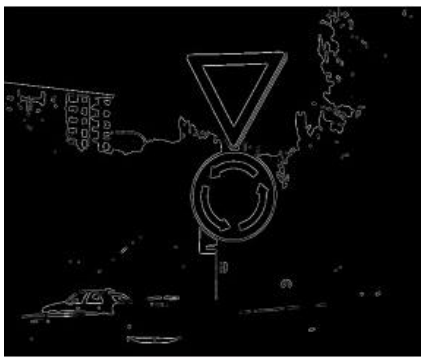

Fig. 5. An image after edge detection.

4) Blobs filtration: Blobs filtration is used to remove all blobs – object which are smaller or bigger than specific limits for an actual image. Fig. 6 shows an image after blobs filtration.

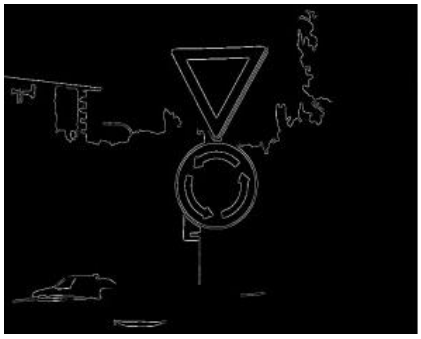

Fig. 6. An image after blobs filtration

5) Shape detection: The actual image (after blobs filtering) may contain some objects that do not represent any traffic signs. Block shape detection uses algoritms to search for some well known traffic sign´s shapes such as triangel, square, circle and octagon shapes.

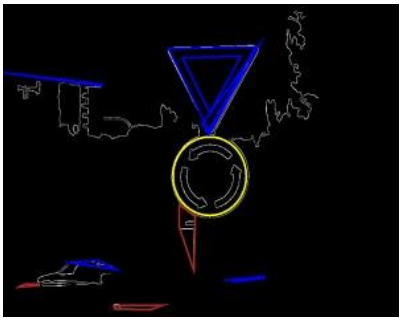

Fig. 7. Shape detection

6) Region of interest extraction: In this block the region of interest (ROI) is extracted from an original captured traffic scene. The region of interest is basically a region where a traffic sign should be located. Fig.8 shows an example of ROI extraction[2-7].

Fig. 8. Example of ROI extraction

B. *Shape Traffic Signs Detection System software implementation*

Shape Traffic Signs Detection System was created in Visual Studio 2012 (C#). This software is used for vertical traffic sign detection (shape detection). The user interface consists of two windows.

1) Detection window: This window detects of vertical traffic signs. As we can see in Fig. 9. The Load button is used to select a captured traffic scene. Loaded captured traffic scene is shown in Fig. 9 as well.

Fig. 9. Window Detection

There are three additonal buttons with some specific functions. Obsiovsly, the Triangle Sign button is used for triangle traffic signs detection. The Square Sign button is used for square signs and for circle signs the Circle Sign button. Fig. 10 shows some examples which have been disscussed in this paragraph.

Fig. 10. Exaples of result

2) Pre-processing window: This window is made of six blocks. Each block represents individual steps of pre-processing – grayscale, thresholding, edge detection, blobs filtration, shape detection and extraction of ROI. Fig. 11 illustates Pre-proccesing window.

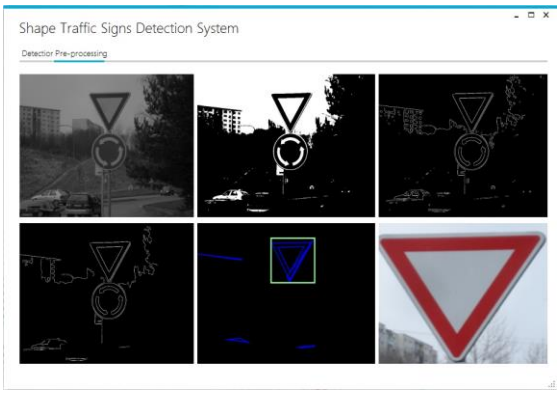

Fig. 11. Window Pre-processing

IV. Experiments and Results

Our experiments were realized with static images. These were captured in real traffic scenes in Slovakia. Some traffic scene examples used in this experiment are shown in Fig. 12.

Fig. 12. Captured Traffic Scenes

All images captured in a real traffic (Slovakia) were run through our Shape Traffic Signs Detection System. Extracted regions of interest are results of this software processing. All the images (ROIs) we have got as a product of an image pre-processing were additionally processed by Cambridge optical correlator. This can be seen in Fig. 13. Finally, extracted ROIs were with traffic signs from a reference database.

Fig. 13. Detected Traffic Signs

V. Conclusion

Vertical Traffic Sign Detection System is a complex system for a vertical traffic signs detection. This software pre-processes images (captured traffic scenes) in different phases and steps. These have been described in previous chapters in detail. Our system takes an advantage of so called Vertical Traffic Sign Detection System. Vertical Traffic Sign Detection System is capable of difficult geometric shapes such as triangle, circle and square. Our further research is containing the combination of colour filtering with the present approach (a shape detection). It turns out that this approach could increase an overall recognition success.

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References

[1] Cambridge coorelator, http://www.cambridgecorrelators.com/optical.html, September 2015.

[2] Š. Toth, "Recognition of the Europen Traffic Signs," in TRANSCOM 2011: 9-th European conference of young research and scientific worker, Žilina, Slovakia, ISBN 978-80-554-0372-4., pp. 233-236, June 2011.

[3] D. Soendroro, I. Supriana, " Traffic sign recognition with Color-based Method, Shape-arc estimation ond SVM," in International Conference on Electrical Engineering and Informatics (ICEEI), pp. 1-6, 17-19 July 2011.

[4] C. Bahlmann, Y. Zhu, R. Visvanathan, M. Pellkofer, T. Koehler, " A system for traffic sign detection, tracking, and recognition using color, shape, and motion information," Proceedings. IEEE Intelligent Vehicles Symposium, 2005, pp. 255–260, 6–8 June 2005.

[5] Z. Song, B. Zhao, Z. Zhu, M. Wang, E. Mao, " Research on Recognition Methods for Traffic Signs," FGCN '08. Second International Conference on Future Generation Communication and Networking, 2008, pp. 387–390, 13–15 Dec. 2008.

[6] Š. Toth, E. Kršák, " Traffic Sign Recognition and Localization for databases of Traffic Signs," in Acta Electrotechnica et Einformatica, Vol. 11, No. 4, 2011, 31-35, DOI: 10.2478/v10198-011-0039-2.

[7] D. Solus, Ľ. Ovseník, J. Turán, "Inventory System of Vertical Traffic Signs," in 25th Conference Radioelektronika 2015, April 21-22, Pardubice, Czech Republic.

Biographies

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