Fast Road Sign Detection using Hough Transform for Assisted Driving of Road Vehicles

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Abstract. A system for real-time traffic sign detection is described in this paper. The system uses restricted Hough Transform to detect circular traffic sings. Some results obtained on a set of real road images are presented in order to illustrate the robustness of the detection system.

1 Introduction

Traffic sign detection and recognition has experimented increasing research interest in the last times, this is due to the importance of improve safety in road vehicles. Drivers sometimes miss signs because of distractions or lack of concentration. Our system must alert the driver using voiced warning. There are four types of traffic signs in the traffic code: prohibition, warning, obligation and informative. The most important traffic signs are prohibition ones; therefore they have priority to be detected in this work.

To detect a traffic sign in an image, the algorithm follows these steps:

1. Obtaining edge image using Canny method [1].
2. Looking for contours into the edge image.
3. Contours-filtering using aspect constraints.
4. Applying Hough transform [2] to filtered contours.

2 Contours Information

The method used for edge detection is Canny method; this method has been extremely influential in many applications. Numerous implementations of edge-detectors based on Canny's idea have been developed. Canny described a method for generating an edge-detector using an optimization approach and showed how to use the technique to generate a robust-edges-detector. Canny's method preserves contours, what is very important for detecting traffic sign using shape information, because they are closed contours. The contours are filtered using aspect constraints. In this sense, circular contour has similar width and height, prohibition traffic signs are circular, and therefore their contours will fulfill the aspect constraints. The Hough Transform is

applied to filtered contours, thus the computation-time is reduced. The search area of traffic signs is focused in the right side of the image as it is showed in Fig. 1.

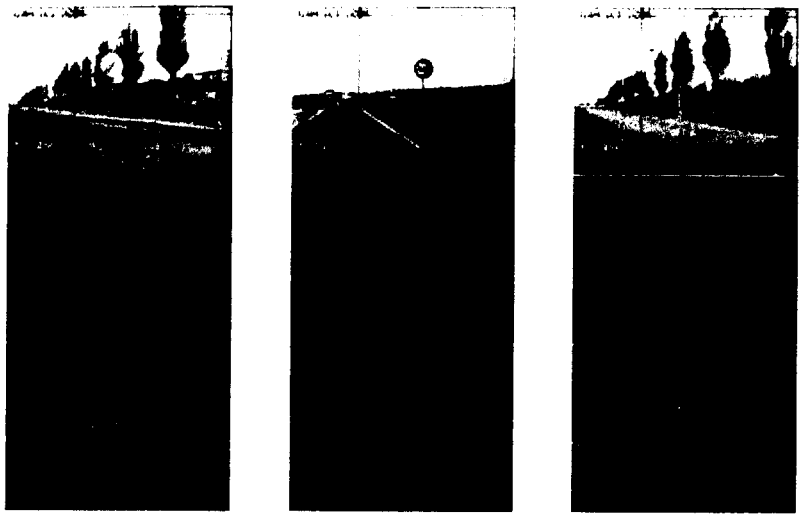

Fig. 1 Sequence of real road image, filtered edge image into the area of search and Canny image.

3 Hough Transform

The classical Hough algorithm [3] can be easily extended to find any curves in an image that can be expressed analytically in the form $f(x, p) = 0$ [4]. Here, x is a point in the domain of the image and p is a parameter vector. We use the Hough algorithm for circle location. A circle in the xy-plane with center (X, Y) and radius r can be expressed as:

$$f(x, p) = (x - X)^2 + (y - Y)^2 - r^2 = 0 \quad (1)$$

Where the parameter space, $p = (X, Y, r)$, must be quantized. The accumulator matrix a is the representation of the quantized parameter space. For circle detection the accumulator a will be a three-dimensional matrix with all entries initially set to 0. The entry $a(X_r, Y_s, r_t)$ is incremented by 1 for every feature point (x_i, y_i), in the image-domain, contained in the circumference with centre (X_r, Y_s) and radius r_t, with a precision margin by ε, used to compensate quantization error when digitize the image [5]. This condition is expresed:

$$|(X_r - x_i)^2 + (Y_s - y_i)^2 - r_t^2| < \varepsilon \quad (2)$$

In order to reduce the computation time we use contour information, so, every feature point (x_i, y_i) is searched inside a restricted area in every filtered closed-contour.

3 Results

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3 Results and Conclusion

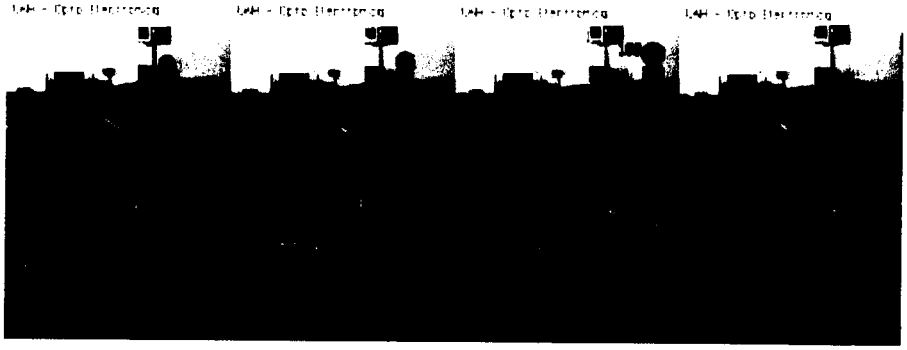

Fig. 2 Sequence of real road images under adverse weather conditions where speed limit is detected.

An algorithm for real-time detection of traffic signs is carried out based on Hough Transform. The algorithm has been empirically tested under adverse weather conditions. We detect the road sign when its closed contour increases the accumulator matrix *a* over one threshold, this condition is easy to fulfill for circular shapes. If several circular shapes are detected it will not be a problem since a neural network will make a fine classification and validation of the detected road signs. As a future work this method for circular sings detection can be easly extended to searching triangular traffic sings using the Hough Transform for lines expressed as:

$$x \cos(\beta) + y \sin(\beta) = r \quad (3)$$

A triangular traffic sing is delimitated by three straight lines. A straight line is expressed analytically in the form $f(x, p) = 0$, where $p(r, \beta)$ is the parameter vector. The accumulator matrix *a* will be a two-dimensional matrix. The rest of this method is very similar to circular traffic-signs detection. Our system works between 5 and 50 frames/s, depending of the amount of shapes detected.

References

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