Traffic sign detection as a component of an automated traffic infrastructure inventory system

Karla Brkić[1], Axel Pinz[2], Siniša Šegvić[1]

[1]Faculty of Electrical Engineering and Computing, University of Zagreb, Croatia

[2]Vision-based Measurement Group, Institute of Electrical Measurement and Measurement Signal Processing, Graz University of Technology, Austria

Abstract

We study the problem of traffic sign detection for the purpose of automated traffic infrastructure inventory. Traffic sign images extracted from videos filmed on the Croatian roads are presented. Constraints present in the images, along with a review of recent approaches, lead us to employ the Viola-Jones object detector for triangular warning signs detection. The detector performs well, achieving correct detection rates better than 90%. which is sufficient for our problem domain. However, the false positive rate is a concern, in some cases being higher than 160%, so the causes of false positive detections are analyzed in detail. We suggest fusing the Viola-Jones detector with a priori knowledge, in the form of a sign model and geometric constraints, in order to increase the correct detection rate and decrease the false positive rate.

Road inventory in Croatia

The road filming is done using a car equipped with a camera and a GPS receiver. The video is georeferenced in real time using an on-board computer.

Croatian regulations define five sign categories: warning signs, explicit order signs, information signs, direction signs and supplemental panels. The category of explicit order signs contains both prohibitory signs and priority signs, as defined by the Vienna Convention. Mandatory signs, information signs and special regulation signs, as defined by the Vienna convention, are contained in the category of information signs.

Appearance of a sign belonging to one legal category can vary tremendously: above are examples of information signs.

Training and test data for sign detection

A sign is annotated in four distinctive frames. Our collection currently contains 2352 annotated images of signs belonging to all five legal categories.

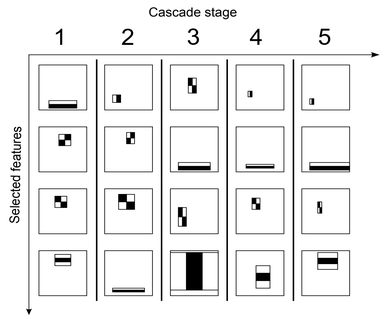
Triangular warning signs

Each group of similar signs, not necesarrily belonging to the same legal category, will have to have a dedicated detector. In this work we focus on developing a **detector for warning signs**, which are always triangular in shape with white or yellow background and a thick red edge. We work with a total of 983 images containing 1071 warning signs.

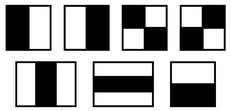
Problems in the data include interlacing, motion blur, color inconsistency, shadows, occlusion.

Employing the Viola-Jones detector

Examples from the training set. The training set images contain a total of 898 warning signs.



The first four features used by the early stages of the trained Viola-Jones cascade detector. The cascade has a total of 17 stages and uses 299 features..



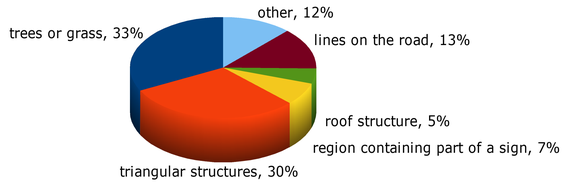
The pool of features used for training.

First four features of cascade stage 1 superimposed on sign images.

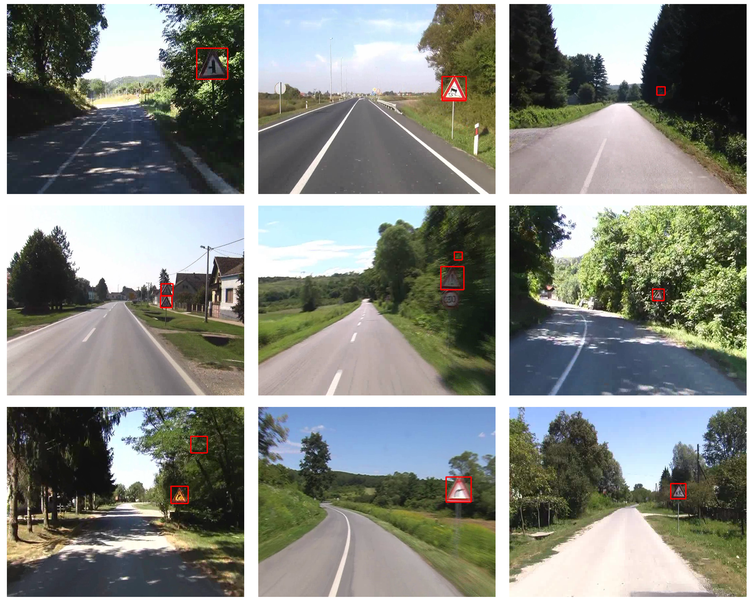
Test set	Scale factor	Signs	Hits [% test set]	Misses [% test set]	False positives [% test set]
1	1.05	101	96 %	4 %	84 %
1	1.20	101	93 %	7 %	42 %
2	1.05	72	93 %	7 %	163 %
2	1.20	72	90 %	10 %	53 %

Experimental results for the trained detector on two testing sets, one containing images of 101 signs and the other containing images of 72 signs. The detector runs at 3 fps with scale factor 1.05, and at about 9 fps with scale factor 1.20.

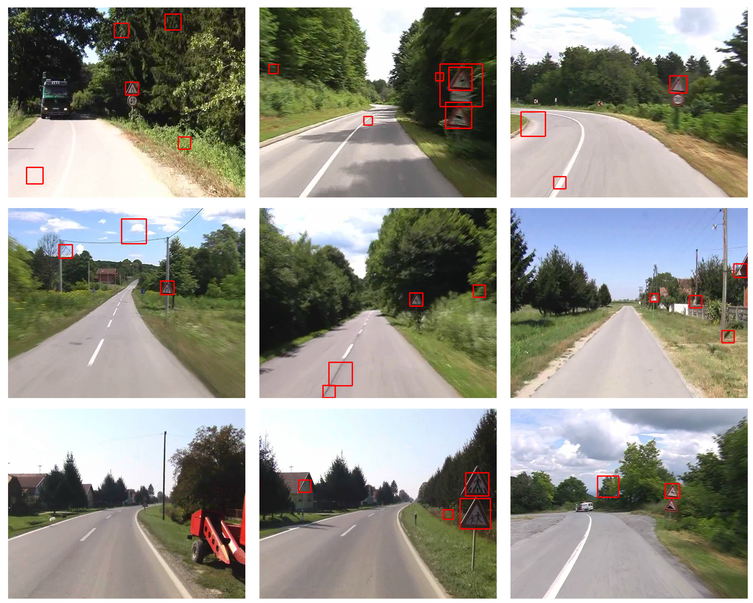
Causes of false positive detections



Detection examples



The detector is robust to the effects of motion blur, shadows and color inconsistency.



Examples of false detections and misses.

Conclusions

- the obtained detection rate is satisfactory for the given problem domain
- the false positive rate could be reduced by verifying the detections against a model of a traffic sign as well as exploiting contextual and temporal constraints
- the Viola-Jones detector augmented with a sign model might be the right solution for traffic sign detection in videos filmed in adverse illumination conditions with low-quality cameras

Poster presented at the 33rd Workshop OAGM/AAPR, Stainz, Austria, May 14-15 2009

This work was supported by