Computer Vision Systems in Road Vehicles: A Review

Kristian Kovačić, Edouard Ivanjko and Hrvoje Gold
kristian.kovacic@fpz.hr, edouard.ivanjko@fpz.hr, hrvoje.gold@fpz.hr
University of Zagreb, Faculty of Transport and Traffic Sciences
www.unizg.hr, www.fpz.unizg.hr, its.fpz.hr

INTRODUCTION

- Recent decades can be characterized by a significant increase of the number of road vehicles accompanied by a buildup of road infrastructure
- Traffic accidents take a large number of human fatalities and injuries
- Statistics show that there is about 1.2 million fatalities and 50 million injuries related to road traffic accidents per year worldwide
- Review written from aspect of transport and traffic engineering

EXISTING SYSTEMS AND REQUIREMENTS

- Since the first intelligent vehicle was introduced in the mid 1970s, computer vision systems also started to develop as one of its main sensor systems
- Computer vision systems in vehicles are part of autonomous vehicle parking systems, adaptive cruise control, lane departure warning, driver fatigue detection, obstacle and traffic sign detection, and others
- Computer vision system has to work in real time
- Capability to adapt to rapid changes of environment monitored using cameras

IMAGE PROCESSING

VEHICLE DETECTION

- Several sensors (active and passive) can be used for vehicle detection
- Vehicle detection is made from two main steps:
  1. Finding all candidates in an image that could be vehicles using:
     - Knowledge-based method
     - Stereo-vision method
     - Motion-based method
  2. Performing tests that can verify the presence of a vehicle

LANE DETECTION AND DEPARTURE WARNING

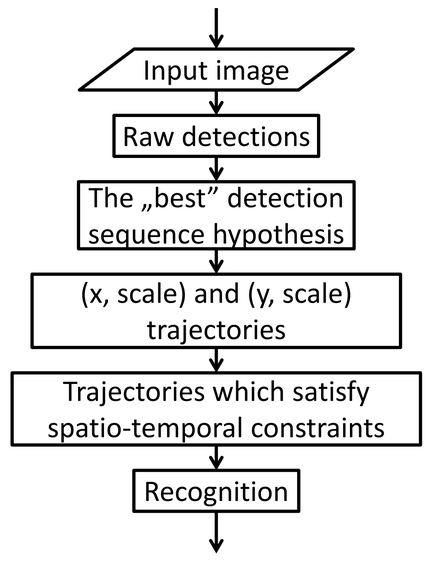
- To resolve lane detection and departure warning problems, key element is to detect road lane boundaries (horizontal road signalization and width of whole road)
- Lane detection includes:
  - Image enhancement, edge detection (histogram, canny edge detector, thinning algorithm – erosion)
  - Extraction of lane features (lane radius, edges, lane centre)

DRIVER FATIGUE DETECTION

- The process of falling asleep at the steering wheel can be characterized by a gradual decline in alertness from a normal state due to monotonous driving conditions or other environmental factors.
- Driver fatigue detection system can be made using following methods:
  - Method that analyse driver's current state related to eyelid and head movement, gaze and other facial expression
  - Method based on driver performance, with a focus on the vehicle's behaviour including position and headway
  - Method based on combination of the driver's current state and driver performance

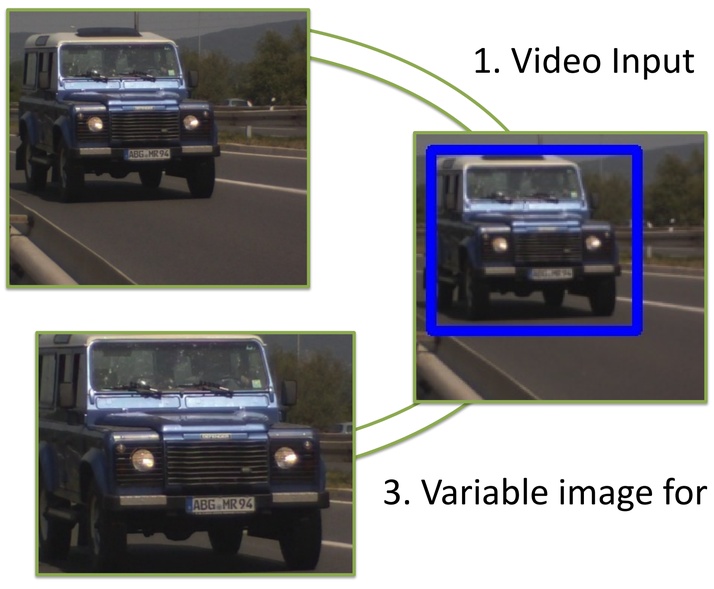
TRAFFIC SIGN DETECTION AND RECOGNITION

- Traffic sign detection is performed with two main steps:
  1. Color segmentation based extraction of traffic signs (color-quantization, region of interest analysis)
  2. Traffic sign recognition based on template matching, linear discriminant analysis, support vector machine and artificial neural network

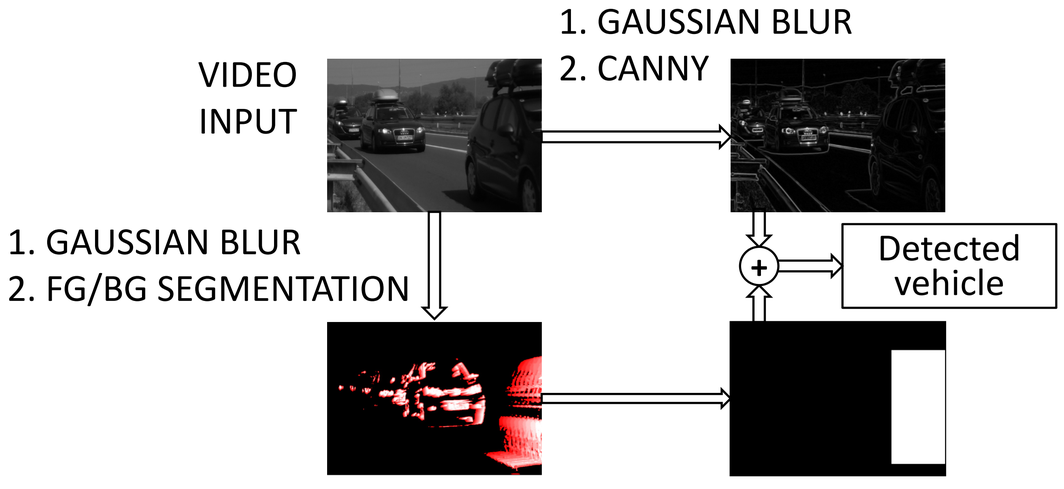


RECENT RESEARCH RESULTS

VEHICLE ORIGIN DETECTION USING LICENSE PLATE RECOGNITION



IMPLEMENTED VEHICLE DETECTION



Vehicle origin analysis (532 cars total):

Country	Number of cars	Percentage [%]
Germany	166	31.2
Poland	88	16.5
Austria	83	15.6
Czech Republic	72	13.5
Croatia	47	8.8
Others	76	14.4

CONCLUSION & FUTURE WORK

- Tracking multiple vehicles on a road
- Real time capability using GPU and support for multicore CPU
- Traffic network origin-destination matrix estimation

ACKNOWLEDGMENT

This research has been supported by the project VISTA financed from the Innovation Investment Fund Grant Scheme, EU COST action TU1102 and Faculty of Transport and Traffic Sciences - University of Zagreb.