

# Efficient video processing method for traffic monitoring combining motion detection and background subtraction

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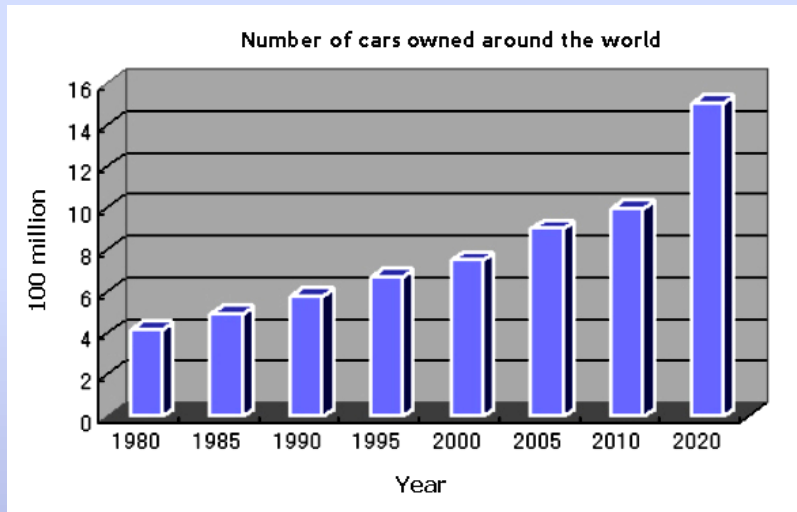


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# Motivation

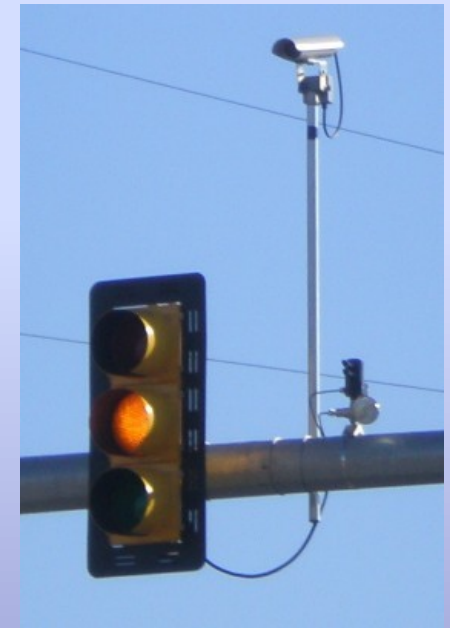
- Growing number of vehicles demands intelligent management of traffic
- We propose efficient video processing method for vehicle detection (vehicle counting)



[http://e2af.com/trend/090113\\_p1.shtml](http://e2af.com/trend/090113_p1.shtml)



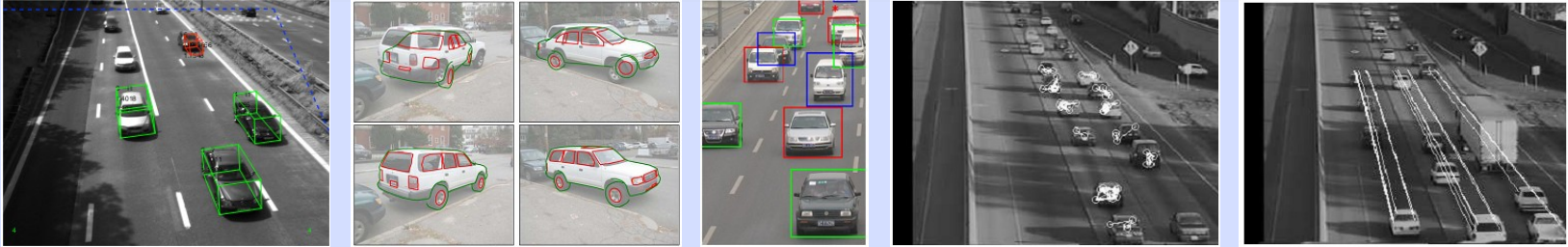
<http://www.telegraph.co.uk/travel/travelnews/6408123/Drivers-face-chaos-as-15-million-cars-on-road-for-half-term.html>



<http://sideth.com/cameras-set-up-to-navigate-capital%E2%80%99s-traffic-jams/>

# Prior work

- Topic of research for more than thirty years



- Widespread methods: movement detection, background subtraction



- Different parameters are acquired from the images:

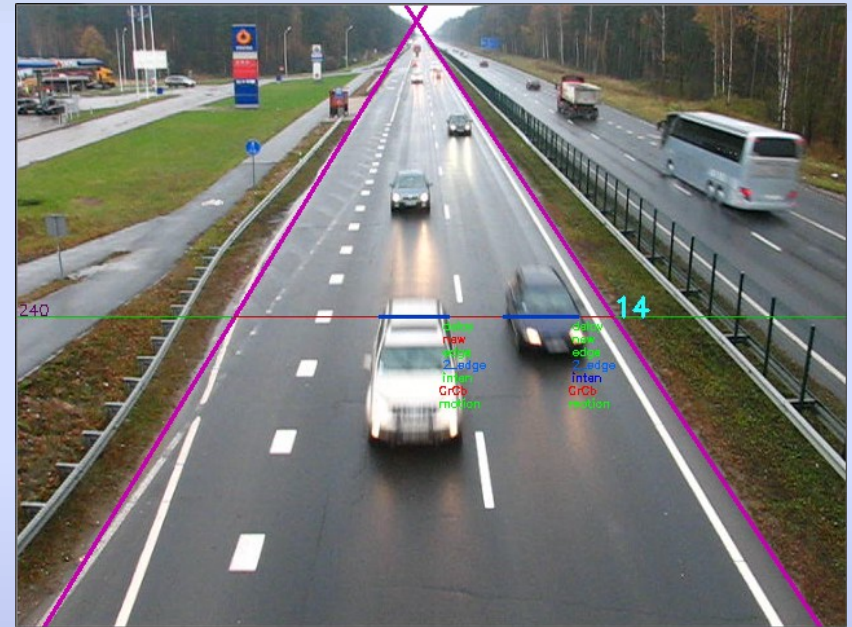


- Reduction of pixels processed - formation of virtual detectors:



# The Proposed Method

- Detection line is perpendicular to the road
- Motion detection and background subtraction is used for different parameters
- Intervals are created when vehicles cross detection line; when vehicles leaves detection line – intervals are closed
- Method is usable without specifying road lanes; number and direction of lanes may change over time



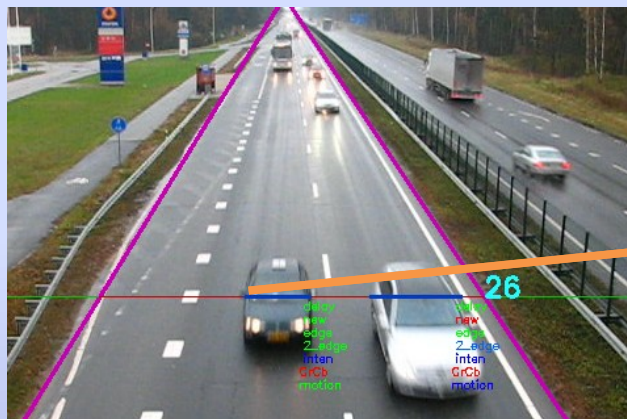
Detection line

Interval



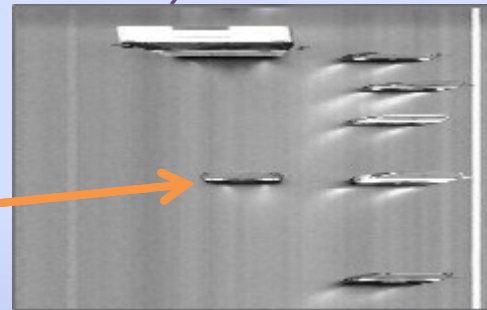
# Movement detection – creation of intervals

- Absolute value of inter-frame difference of detection line is obtained and thresholded
- Intervals are created on the detection line according to the moving objects



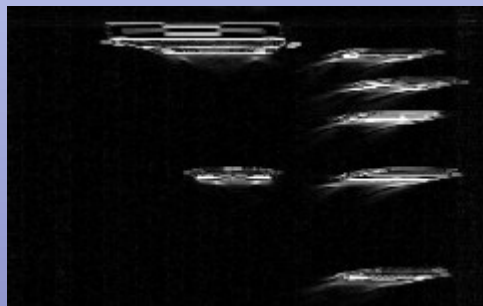
a)

*Intensity:*



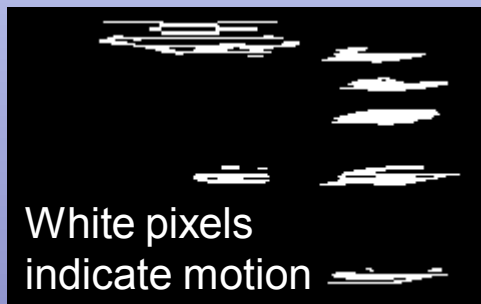
b)

*Inter-frame difference:*



c)

*Thresholding:*



d)

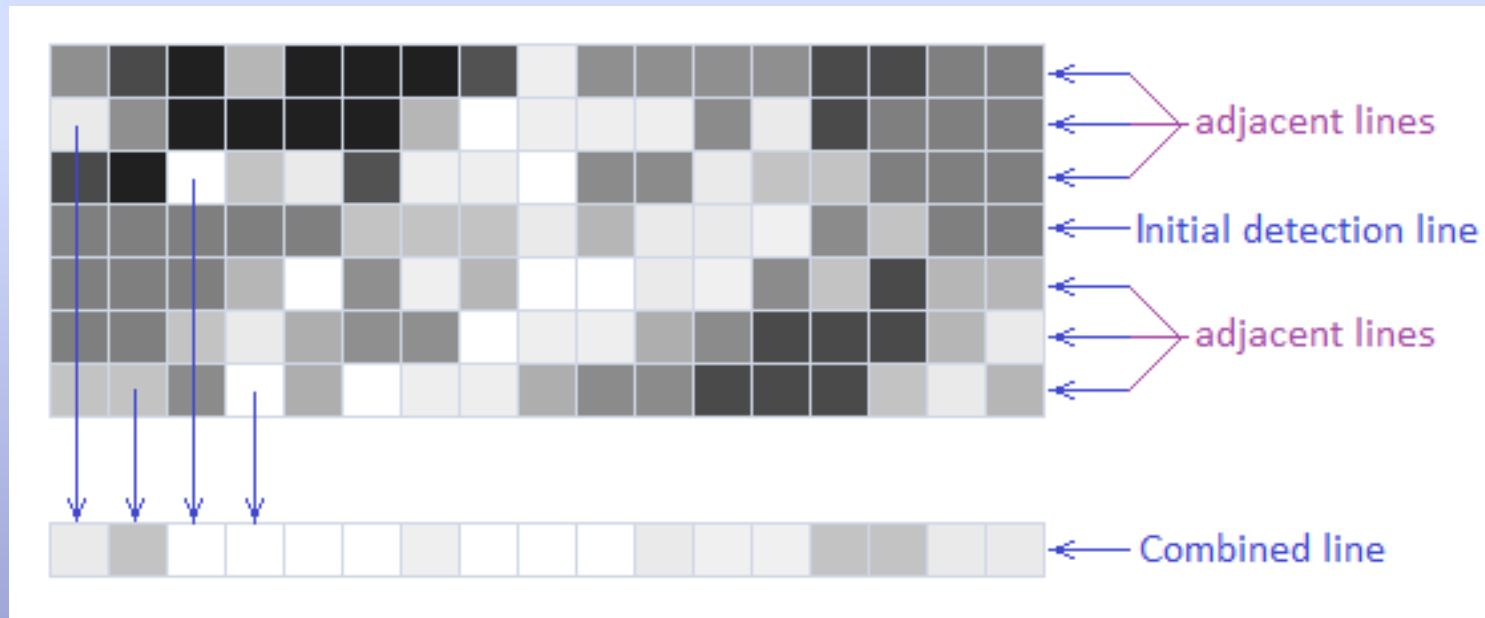
*Intervals:*



e)

# Use of several adjacent lines

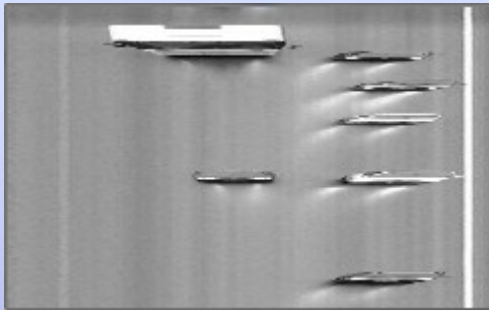
- Inter-frame difference may be obtained for several adjacent lines
- Differences of lines are combined in to single line
- Combined line is thresholded and processed same way as before



# Background subtraction - intensity

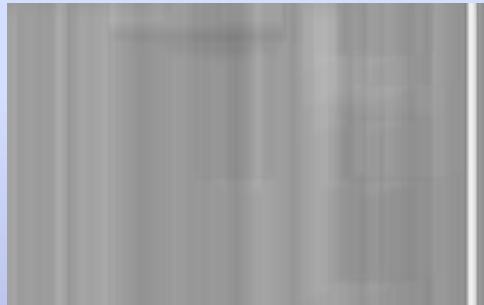
- Background subtraction is used to detect stopped and uniformly painted vehicles
- Several parameters are used to find foreground objects – intensity, edges and colors

*Intensity:*



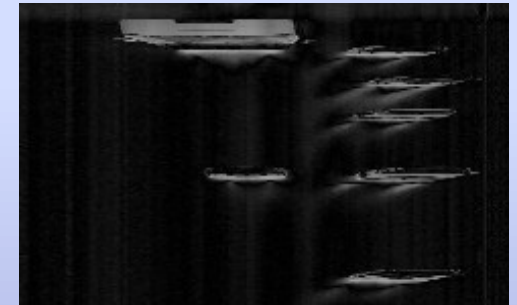
a)

*Intensity background:*



b)

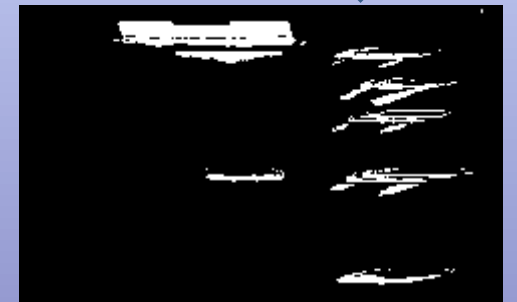
*Background subtraction:*



c)

$$F_k = \alpha \cdot F_{k-1} + (1 - \alpha) \cdot S$$

*Thresholding:*

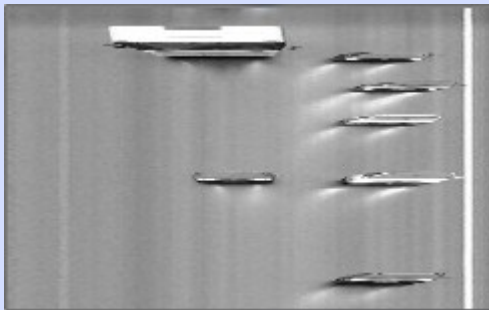


d)

$F$  – intensity of background pixels  
 $S$  – pixel intensity of current frame  
 $\alpha$  – background update rate  
 $k$  – frame number

# Background subtraction - edges

*Intensity:*



a)

*Edges:*



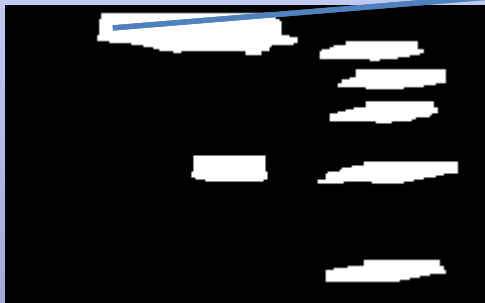
b)

*Edge background:*



c)

*Intervals:*



g)

*Background subtraction:*



d)

*Thresholding:*



e)

- Usually significant edges are at the ends of intervals



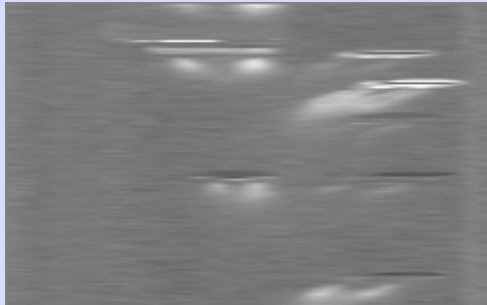
# Background subtraction - colors

*Color component:*

*Background:*

*Background subtraction:*

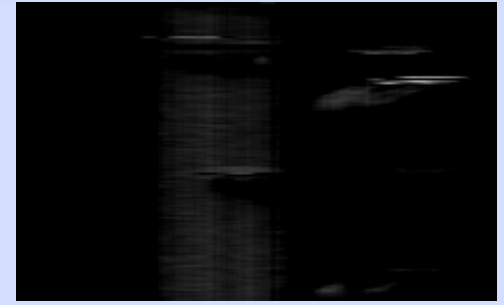
*Cr:*



a)



c)

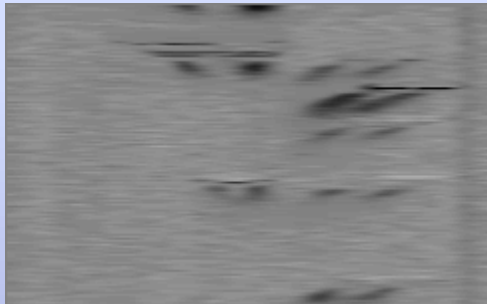


e)

+



*Cb:*



b)



d)



f)

*Sum of components:*

*Thresholding:*



g)



h)

# Acquisition of adaptive threshold

In Otsu method, pixels are divided so that sum of spread of foreground and background pixels is at its minimum:

$$\sigma_w^2 = W_f \cdot \sigma_f^2 + W_b \cdot \sigma_b^2$$

$W_f$  – number of foreground pixels

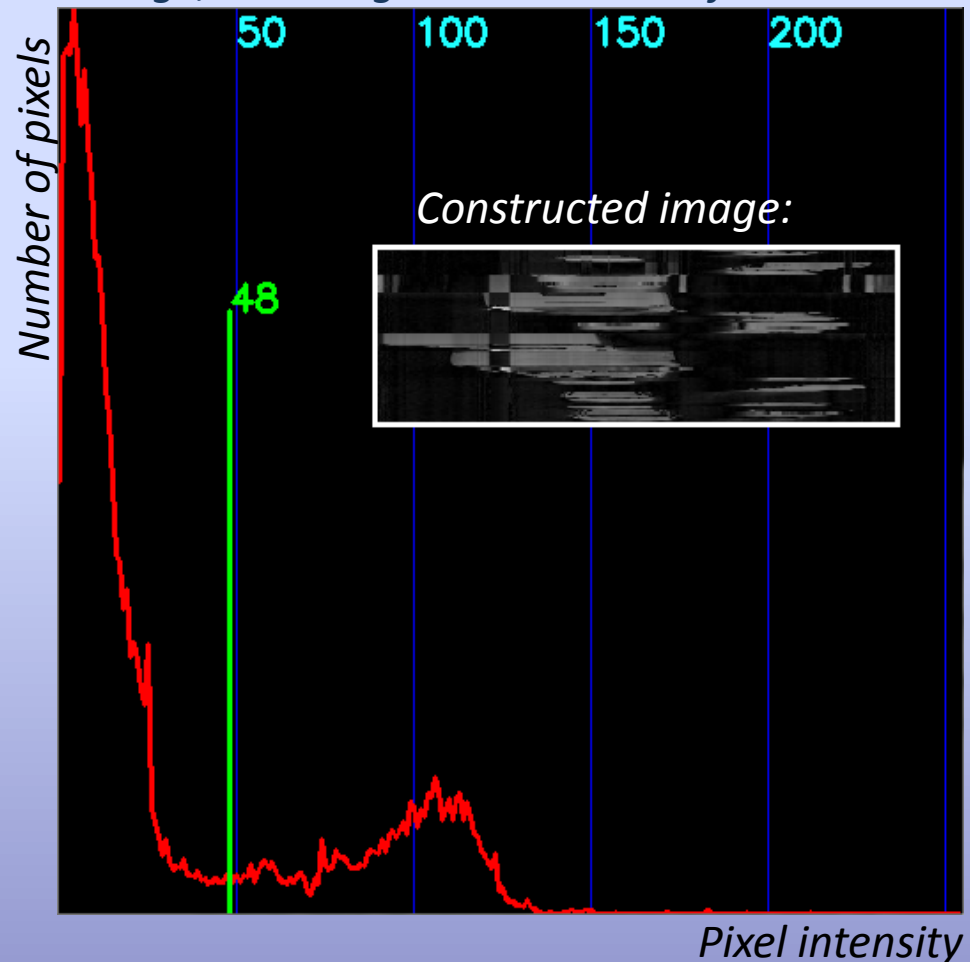
$W_b$  – number of background pixels

$\sigma_f^2$  – variance of foreground pixels

$\sigma_b^2$  – variance of background pixels

$\sigma_w^2$  – sum of weighted variances

*Image, its histogram and value of threshold:*



# The Proposed Method

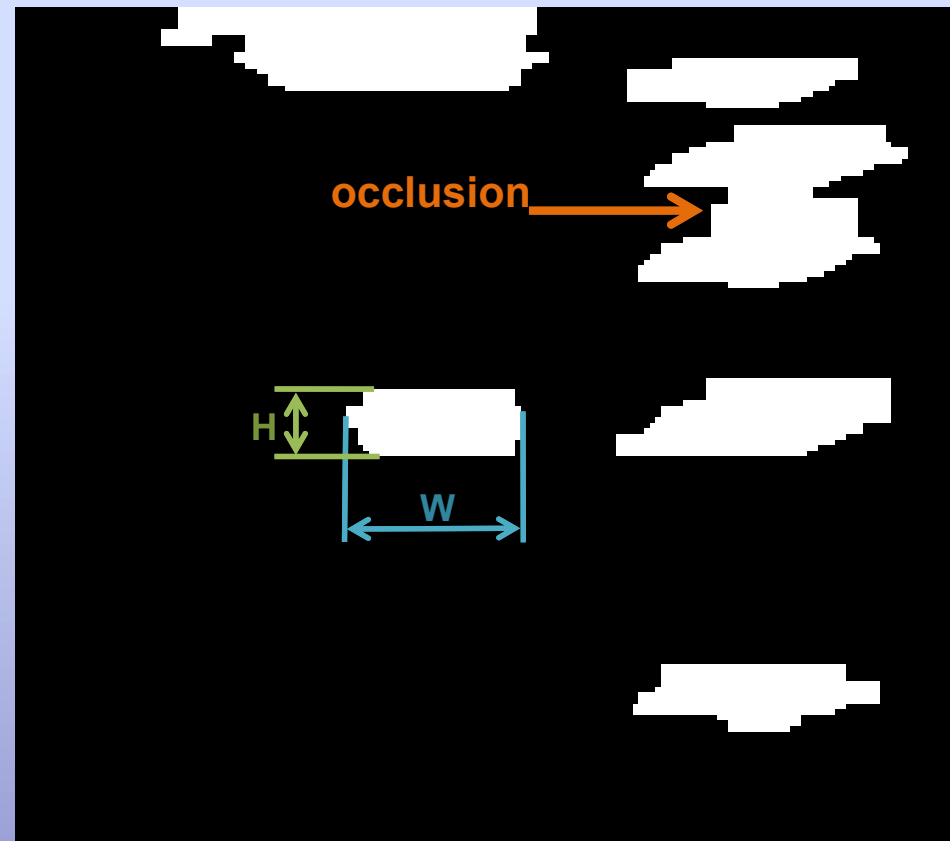
## Counting of vehicles

- If interval has been wide enough and it has existed longer than defined number of frames, number of vehicles is increased at interval closing
- Detection of specific vehicle occlusions is implemented

**W** – maximal width of interval in pixels

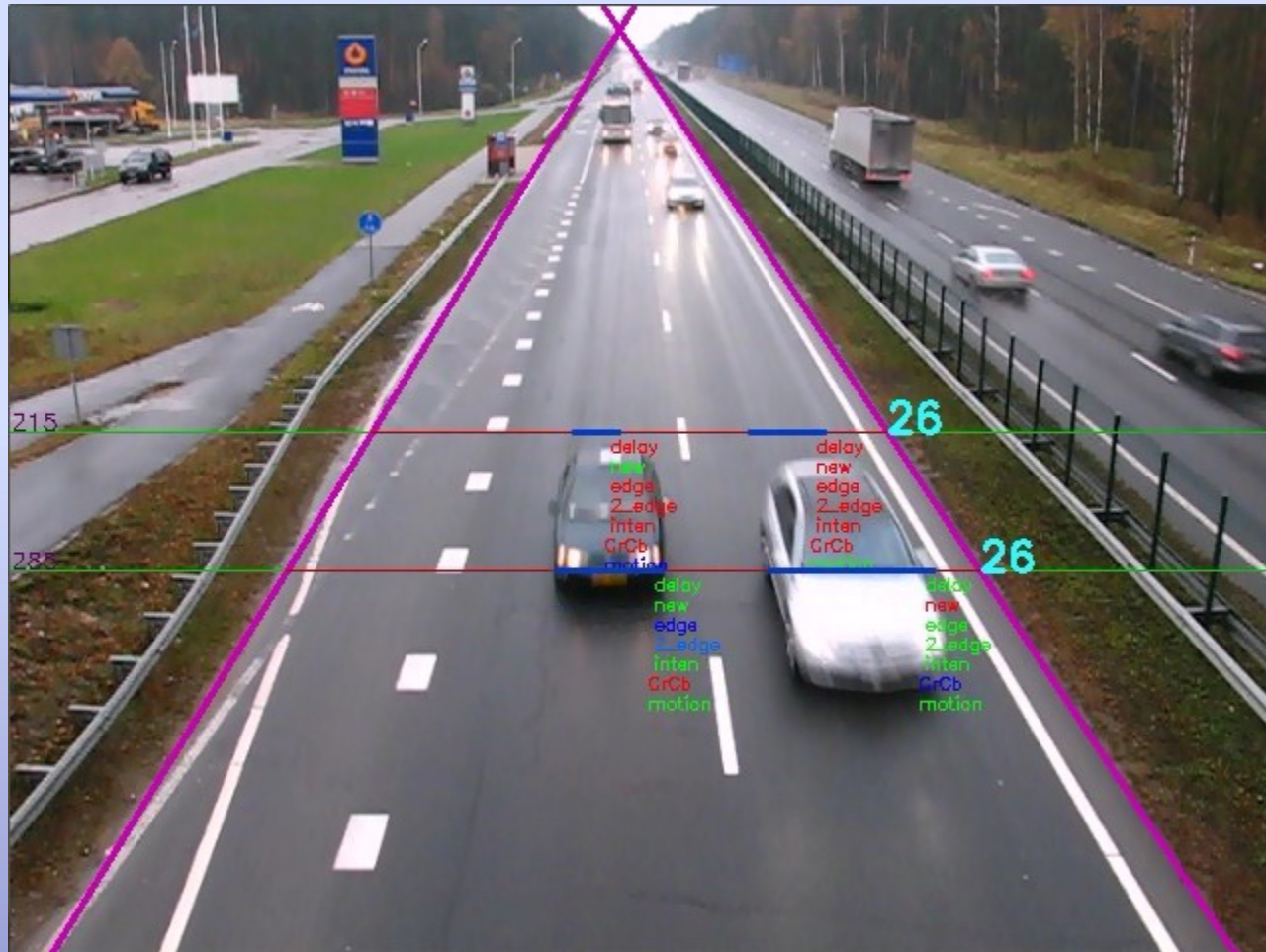
**H** – number of frames interval existed

*Intervals:*

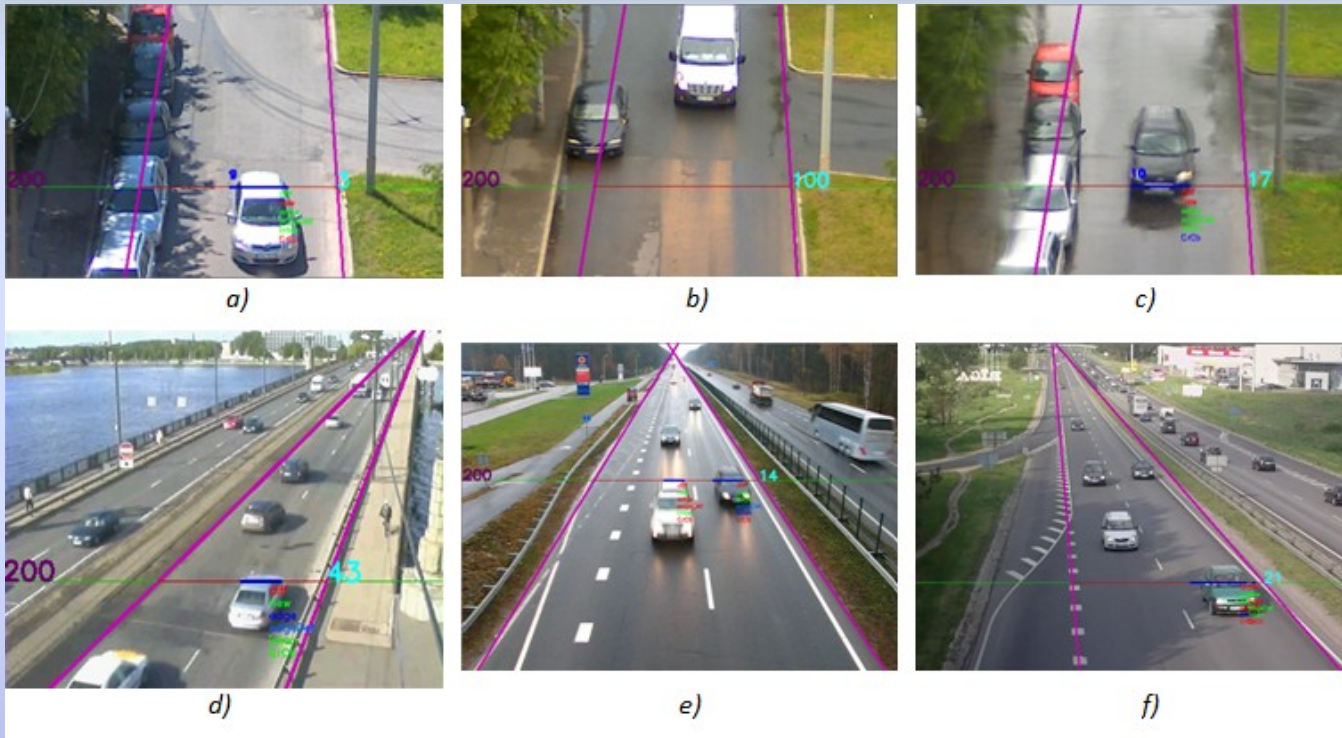


# The Proposed Method

## Demonstration of algorithm



# Test results

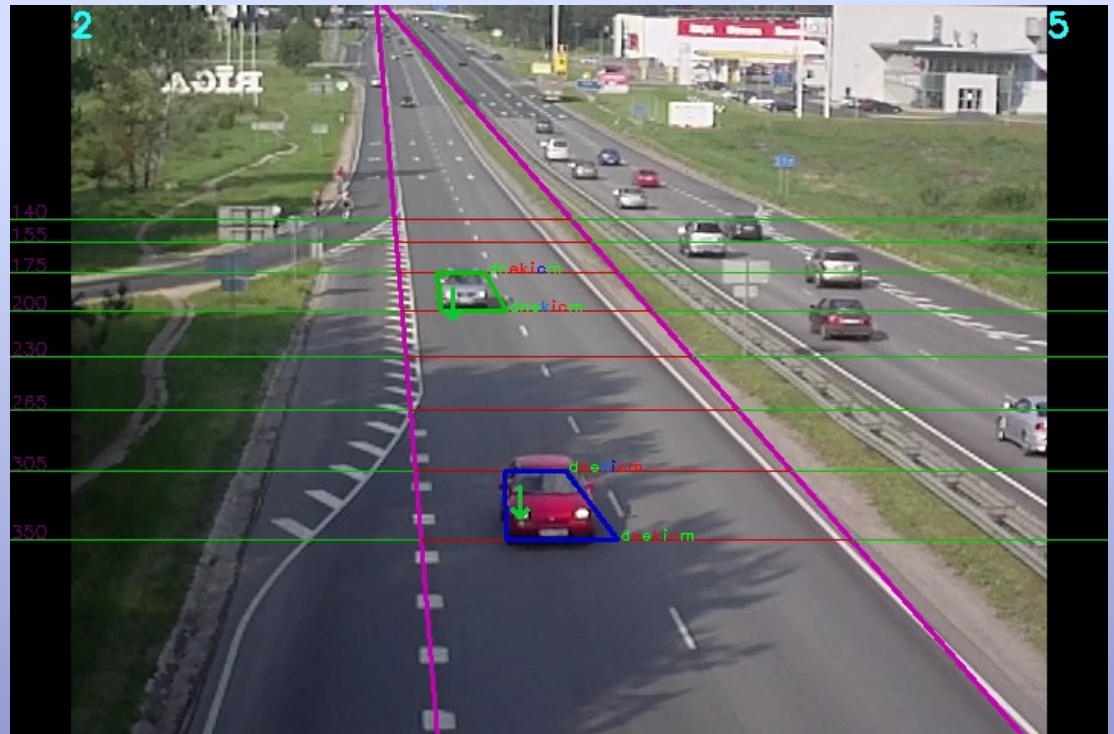


Video	Ground - truth	Detected vehicles	Errors			Accuracy
			Occlusion	Counted as two	Other	
a)	100	105		5		95.2%
b)	100	105		4	1	95.2%
c)	100	100	3	3		100%
d)	77	71	7	3	2	91.5%
e)	42	44			2	95.5%
f)	48	46	2			95.7%



# Conclusions

- Method for vehicle detection and counting
- Method is robust to different lighting and weather conditions
- Test results are comparable to other approaches that use virtual detectors
- Computational efficiency of algorithm allows use of multiple detection lines



Thank you for your attention!