# OBJECT SEGMENTATION BASED ON MOTION COMPENSATED BACKGROUND SUBTRACTION

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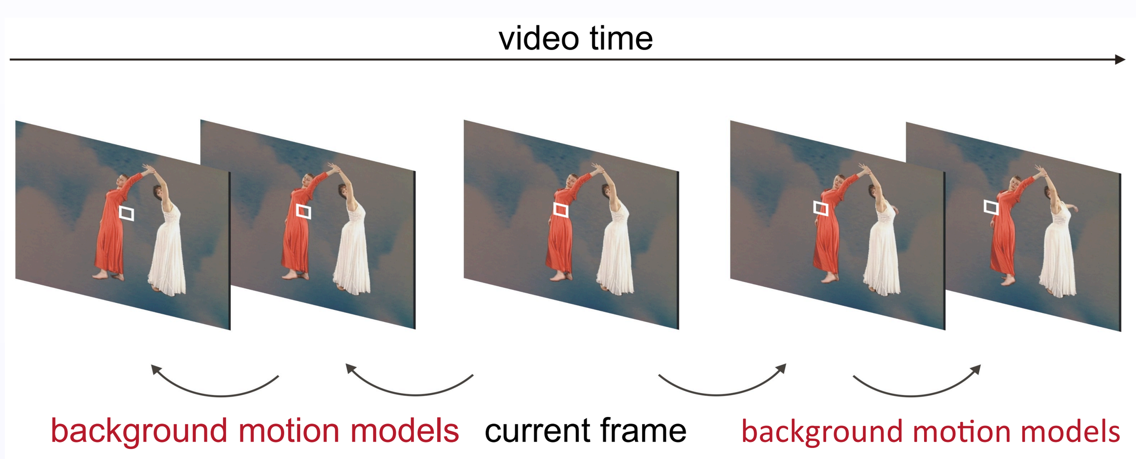
## Abstract

Background subtraction is a widely used technique for video object segmentation. Several proposals have been made to extend background model generation to camera movement, while few approaches can cope with many degrees of freedom in camera motion. We present a method to generate background images for unconstrained camera motion, zoom, rotation and even (weak) lens distortion. Our method is based on global motion estimation and a weighted summation of motion compensated images.

## Mosaicing

**Assumption:**
Objects move different from global motion




- "Warping" coordinates of the current frame into the future/past according to background motion models
- Estimate the probability that a pixel belongs to foreground / background
- Generating a background image for the current frame

## References

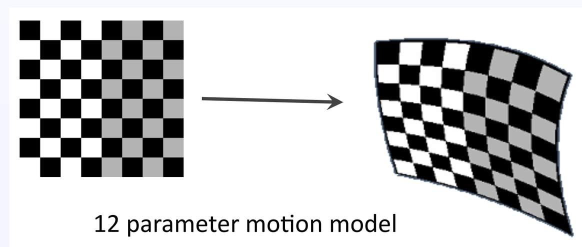
[1] M. Unger, M. Asbach, P. Hosten, Enhanced Background Subtraction using Global Motion Compensation and Mosaicing, In *ICIP'08*, 2008.

[2] M. Höynck, M. Unger, J.-R. Ohm, Robust Object Region Detection in natural Video using Motion Estimation and region-based Diffusion, In *PCS 2004*, 2004.

[3] J.-R. Ohm, and H. Lüke, Signalübertragung, vol. 9, Springer Verlag Berlin Heidelberg New York, 2005

## Background Motion Model


Quartic model $H_t$ can handle complex motion and small lens distortion:




$$x = X^T C_x X \qquad y = X^T C_y X$$

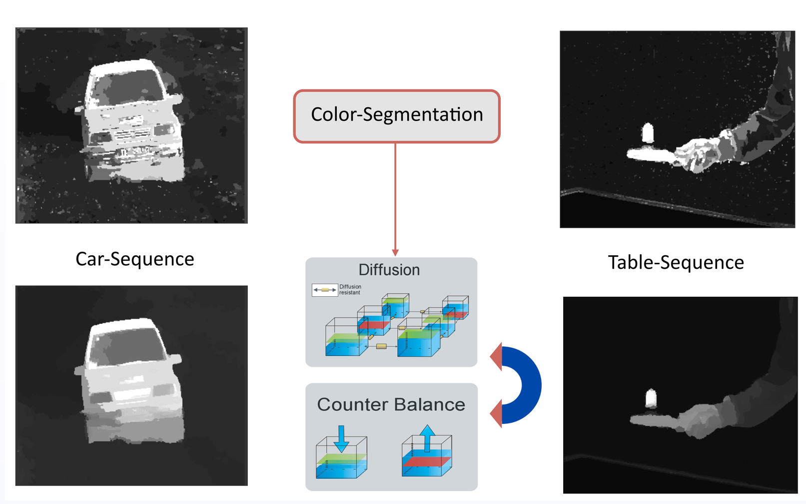
$$C_x = \begin{pmatrix} a & b & c \\ b & d & e \\ c & e & f \end{pmatrix} \; C_y = \begin{pmatrix} g & h & i \\ h & j & k \\ i & k & l \end{pmatrix}$$

## Background Subtraction


The background image at frame $t$ is estimated by the calculated weighted sum of pixels along its trajectory over time:

$$\begin{pmatrix} \hat{r}_t \\ \hat{g}_t \\ \hat{b}_t \end{pmatrix} = \frac{\sum_{i=-N}^{N} w_{t+i} \begin{pmatrix} r_{t+i} \\ g_{t+i} \\ b_{t+i} \end{pmatrix}}{\sum_{i=-N}^{N} w_{t+i}}$$

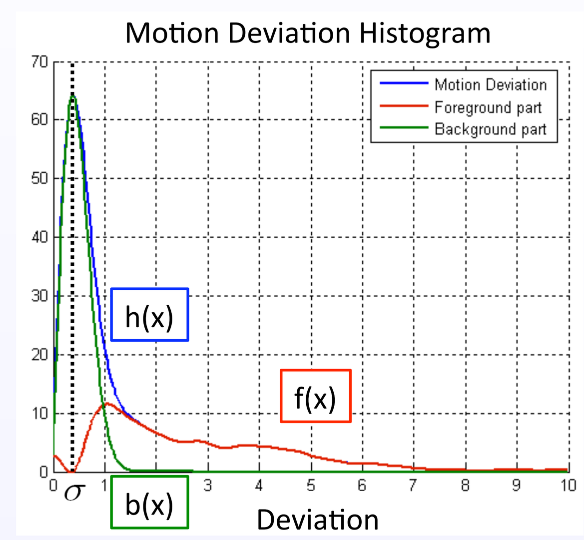
## Diffusion




Even if the background is estimated nearly perfect, object regions may have a similar color, leaving holes within the difference image. A segment based post-processing step removes these artifacts. [2]

## Probabilistic Weighting

The deviation $d$ from the background motion model $H_T$ and the $OpticalFlow$ is an indicator for the "backgroundness".

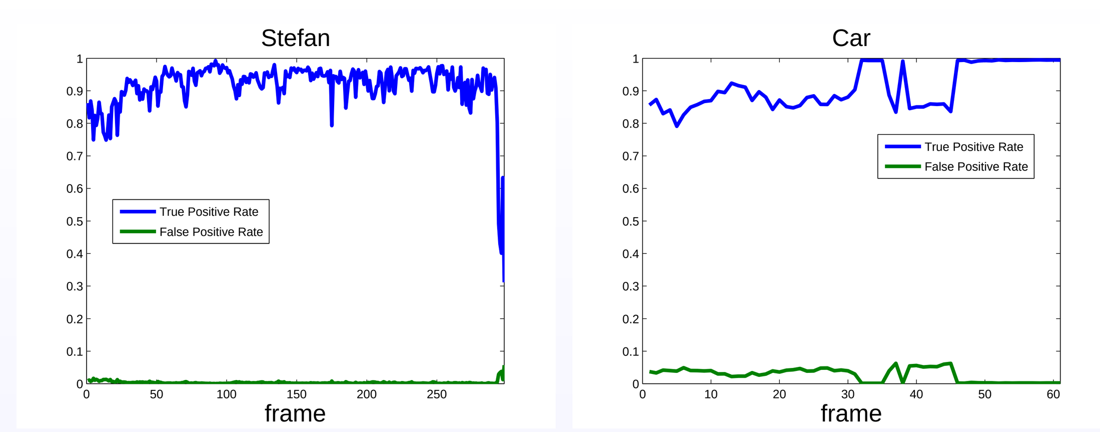



**Assumption:**
Background motion vectors are disturbed by Gaussian noise → $d$ is Rayleigh distributed [3]

Separation of a motion deviation histogram into Rayleigh and foreground part

"Backgroundness": $p(B|d) = \frac{b(d)}{h(d)} = w$

## Results




After thresholding the post-processed difference image, the True-\False-Positive-Rate is used for the evaluation of the object segmentation.

## Conclusion / Future Work

The illustrated method is able to estimate the appearance of the background for each frame in dynamic video sequences.
That way any object can be detected and segmented that moves different to the global motion.
Additional information about the object's appearance will be used in future work in order to deal with a violation of the motion model and the presence of multiple objects.

## Acknowledgements

Part of this work has been financed by the European Union in the framework of the INTERMEDIA NoE, IST-038419 within the 6th framework program.