# MOVING TARGET DETECTION IN TRAFFIC VIDEO SURVEILLANCE

**Tudor-Ioan CERLINCĂ** [1]
**Ştefan-Gheorghe PENTIUC** [2]
*"Stefan cel Mare" University of Suceava*
*str.Universitatii nr.1, RO-5800 Suceava*
[1] *tudor_c@eed.usv.ro*
[2] *pentiuc@eed.usv..ro*

***Abstract.*** *The aim of the paper is to present a Moving Target Detection Module (MTDM) used in a traffic surveillance system. In a first approach the MTDM is used to minimize the disk space storing the images taken by a video camera in a video-surveillance system. This component analyze the images files, detects the moving targets in the frames, and store the significant frames with time stamping. The MTDM is able to detect and to track a target selected by the user. Various images source are accepted by the MTDM, and the produced results are available on Intranet.*
***Keywords:*** *image processing, moving target detection, surveillance system, background model*

## Introduction

In a traffic surveillance system based on image processing, the moving targets detected on fixed tracks are cars. The supervising of a crossroads implies a permanent evaluation of the number of cars incoming from different direction.
The proposed image processing system detects the moving target on the base of a background model, updated continuously in accordance with light and meteorological conditions. Even the initial background model is an issue of a learning process.
The video surveillance system used is a monitoring computer based system.
In order to detect the moving targets, the estimated background is eliminated from the grabbed image and a new image containing the moving targets is obtained. This new image will be processed further.
The background model identification method uses a sequence of static images that does not contain moving objects as starting point. Various mathematical models for background identification, subtraction and maintenance may be found in [1], [2] and [3].
During the surveillance, by subtracting the background from the processed image results a new one containing only the moving objects and eventually their shadows. Usually, in the next stage, the system can find moving vehicles and people that should be identified or tracked.
The procedure based on background subtraction is simple in principle, but not trivial to apply in specific conditions, because the background may change sometimes due to illumination changes or scene modifications (new construction or landscape changes according to the four seasons of the year). All these changes make difficult the estimation of the current background. One good approach is to maintain a background model to the change of real background as in [4] or [5].

## Background model at pixel level

Let a pixel $i(x,y)$ from the background of the reference image. Its color may be expressed as

$$E_i = [E_R(i), E_G(i), E_B(i)] \qquad (1)$$

where $E_R(i)$, $E_G(i)$, and $E_B(i)$ are the levels of red, green and yellow.
Let a sequence of images grabbed at the time moments $t_1$, $t_2$, ... , $t_n$. For the pixel $i(x,y)$ the background value at the t moment $B_{it}$ will be evaluated as an average of the values $B_{itk}$ in the previous images

$$B_{it} = \frac{t-1}{t} B_{it-1} + \frac{1}{t} E_{it} \qquad (2)$$

In a background subs traction model the moving objects may be determined by measuring the distance between $B_{it}$ and $E_i$ for each pixel $i(x,y)$ and comparing it with a threshold value.
The background model depends on lighting conditions, and an update procedure is always needed in such conditions (adaptive models are described in [4] and [5]). To update the background model, only the pixels not belonging to the moving objects are used.
The initial background model is build upon a sequence of $N$ static images that contain no moving objects as in [6]. For every pixel in the image field the average values for every color will be computed

$$\mu_{ci} = \frac{\sum_{k=0}^{N} E`_{cik}}{N} \tag{3}$$

where *c=Red, Green, Blue*. With these values the corresponding standard deviation for every color can be calculated as follows:

$$\sigma_{ci} = \frac{1}{N} \sum_{k=0}^{N} E_{cik} * E_{cik} - \mu_{ci}^{2} \tag{4}$$

with *c=Red,Green,Blue*.
The chromatic distorsion at pixel level can be computed by the bellow expression:

$$CD_i = \left[ \sum_{c=R,G,B} \left( \frac{E_{ci} - \alpha_i \mu_{ci}}{\varpi_{ci}} \right)^2 \right]^{1/2} \tag{5}$$

where $\alpha_i$ is a coefficient called the illumination distortion calculated as the minimum $CD_i$ for all the pixels in the image field [7].
The chromatic distortion value is compared with a threshold in order to determine if the pixel $i$ belongs to the background or to a moving object. The choice of the threshold value is very important. It can be result from experiments or as an issue of a sophisticated algorithm ([8],[9] and [10]).

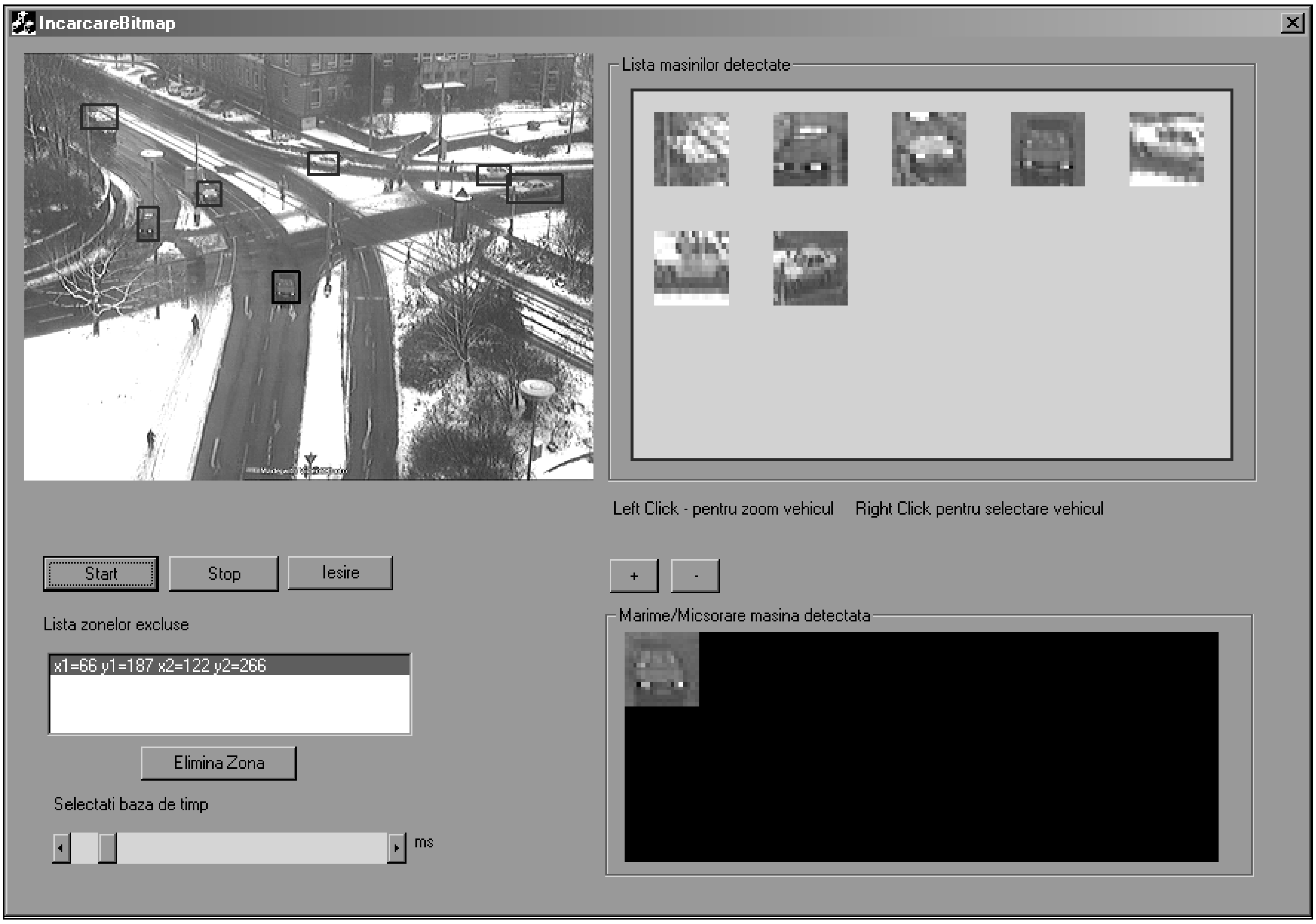


Figure 1. The main window of the MTDM experimental software

## The Moving Target Detection

The surveillance system produces images saved on a hard disk. The Moving Target Detection Module (MTDM) processes these images in the aim of the detection of multiple targets in a cluttered environment. This process is divided into several phases as in [8]:

- *learning phase* - the module build the initial background model based on an image sequence selected by the trainer;
- *moving objects detection* - by thresholding the chromatic distortion the background is eliminated from the image, and remains the moving objects; the moving objects are determined by a fill algorithm;
- *target identification* – processing the image in the moving object areas by filtering, edge detection etc.

In the last phase the noise elimination is an important operation having the goal to eliminate:

- isolated pixels that does not belong to objects or
- the false moving objects.

In general the false moving objects are small areas belonging in fact to the background, but that have been detected by thresholding the chromatic distortion as moving objects.

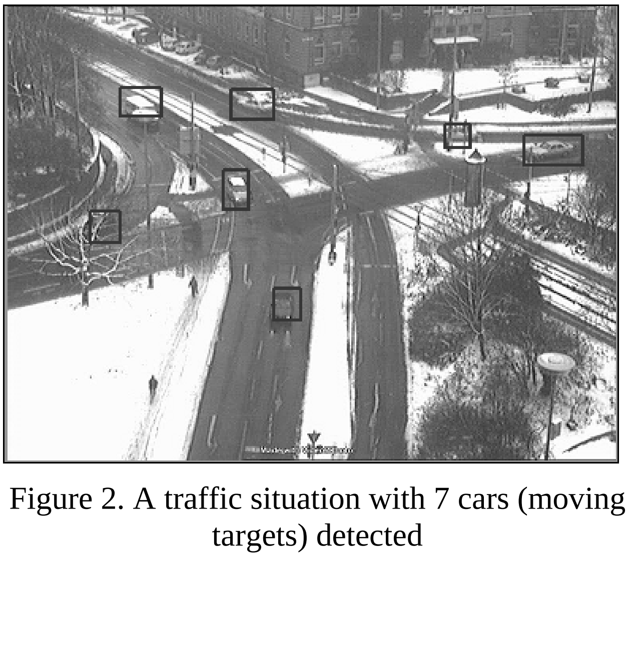

Figure 2. A traffic situation with 7 cars (moving targets) detected

In order to eliminate such objects their surfaces are compared with a threshold value.

The further aim of this image processing system consists in the development of a video-space-time database that will manage complex information about the identified targets. In this stage was created a database containing the images of the targets with their space localization information and a time stamp. The database was hosted on a web server and accessed by an ODBC for the PostgreSQL Database Management System.

## Experiments

The MTDM was tested on a traffic movie available on Internet at the address *http://i21www.ira.uka.de/image_sequences/*. A special platform was designed to experiment various algorithms. The main window is presented in figure 1.

Figure 3. Temporarily undetected moving target (with pixels too close to the background's color)

This window is divided into 4 areas. In the upper-left area, the moving sequence is presented with targets delimited by rectangles. The time base of the sequence player may be modified through a sliding button located in the bottom of the window. In the upper-right area all the detected moving objects are depicted at a 2x zoom. A greater zoom factor is possible for each object in the right-bottom area. The zoom factor may be increased or decreased by the user with 2 push buttons.

In the figure 2 is presented a traffic situation with 7 cars (targets) moving in various directions. In the figure 3 is presented another traffic situation with 6 cars detected and one car which are not detected for instant. This is because all the car's points are too close to the background's color and there weren't enough detected points in order to consider that there was a moving target. That can be fixed by adjusting the threshold value, but in some cases we'll have to deal with false detection. The detection rate depends on image resolution. A fully color image will give better results.

The system has the capability of target tracking. The user may select a target with a mouse click. In figure 3 is depicted such a case, the target tracked being marked with a darker rectangle.

**Conclusions**

In the paper is presented the background and the overall structure of a MTDM experimented with a movie made by a traffic surveillance system. A similar system designed for the laboratories surveillance was presented in [7]. In this case the problem is a bit different due to the target identification. The system can evaluate the number and the direction of significant moving targets (cars) in the frames produced by a traffic surveillance system.

The main contribution that may be revealed is the target identification based on an adaptive background model and on the target images processing. Each of these stages comprises a learning phase in order to increase the speed of target detection.

The system will permit the target tracking under some restrictions due to the limitation of the surveillance field. For target trajectory prediction a temporal filtering algorithm will be introduced.

The final aim consists in the development of a video-space-time database containing the signature of the targets together with other complex information.

**References**


[1] Ashraf Elnagar and Anup Basu, (1995), *Motion detection using background constraints*, Pattern Recognition Volume 28, Issue 10, pp 1537-1554, available online (2000)

[2] J. Rittscher, J. Kato, S. Joga, and A. Blake., ( 2000), *A probabilistic background model for tracking. ECCV00*, pp 336–350

[3] K. Toyama, J. Krumm, B. Brumitt, and B. Meyers, (1999), *Wallflower: Principles and practice of background maintenance*. *ICCV99*, pp. 255–261

[4] C. Stauffer andW.E.L. Grimson, (1999), *Adaptive background mixture models for real-time tracking. CVPR'99*, pp. II:246–252.

[5] C. Ridder, O. Munkelt, and H. Kirchner, (1995), *Adaptive background estimation and foreground detection using Kalman-filtering. ICRAM'95*, pp. 193–199.

[6] D. Gutchess, M. Trajkovic, E. Cohen-Solal, D. Lyons, and A.K. Jain, (2001), *A background model initialization algorithm for video surveillance. ICCV01*, pp. 733–740.

[7] Tudor-Ioan Cerlinca, Stefan-Gheorghe Pentiuc, (2003), – *Detectarea persoanelor in inregistrarile unui sistem de supraveghere video*, (*Detection of Persons in the Laboratories Rooms based on the Images Stored by a Video Surveillance System*). Vol. Tehnologii informationale, Editura Universitatii Suceava, ISBN 973-666-059-1, pag. 82-93

[8] N. Friedman and S. Russell, (1997), *Image segmentation in video sequence: A probabilistic approach*. Annual Conf. on Uncertainty in Artificial Intelligence.

[9] B. Stenger, V. Ramesh, N. Paragios, F. Coetzee, and J.M. Buhmann, (2001), *Topology free hidden Markov models: Application to background modeling*. In *ICCV01*, pp. I: 294–301.

[10] J. Yedidia,W.T. Freeman, and Y.Weiss, (2001), *Bethe free energy, Kikuchi approximations, and belief propagation algorithms*. In *SCTV01*.