AN ADAPTIVE REALTIME BACKGROUND MODEL

Renò V., Marani R., D'Orazio T., Stella E., Nitti M. - National Research Council
Institute of Intelligent Systems for Automation - {reno, marani, dorazio, stella, nitti}@ba.issia.cnr.it

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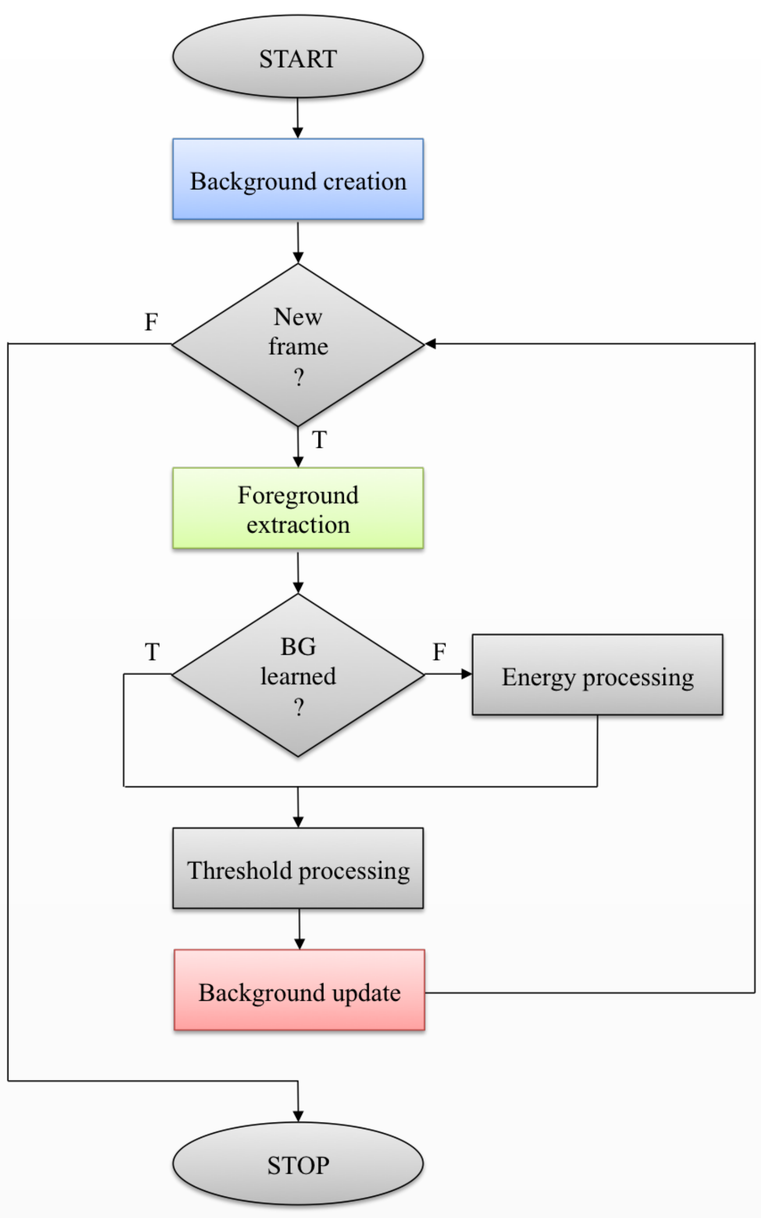
Abstract

The aim of this work is to provide an adaptive background (BG) model able to deal with:

- high frame rate videos
- dynamic scenes

finding a good compromise between the **model complexity** and its **responsiveness**.

Flowchart



Methodology

Three main steps, as it is shown in the flowchart:

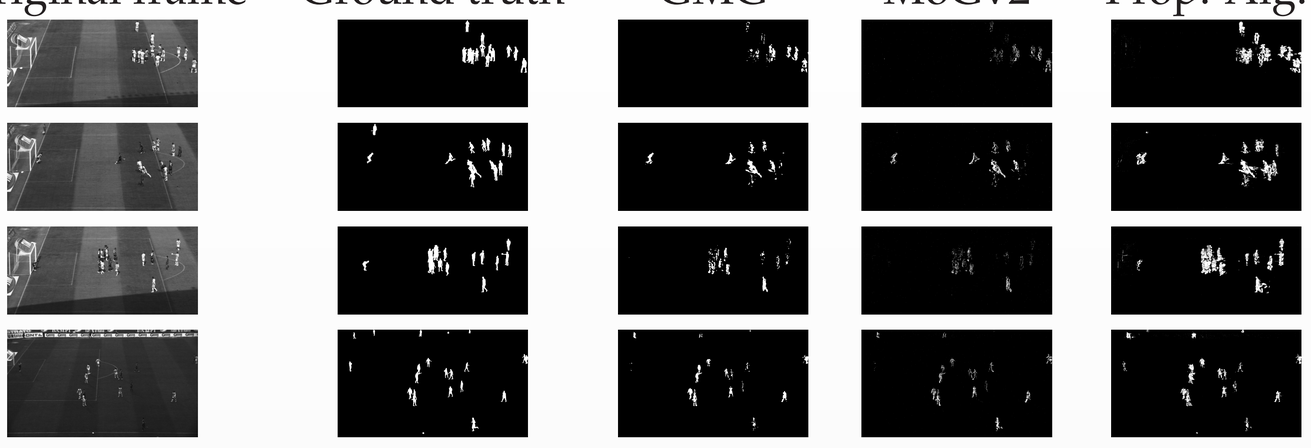
1. **Creation**: executed only once to set each pixel of the model to 128
2. **Foreground extraction**: takes place for every incoming frame and calculates the binary foreground mask at the time t. It takes the advantages of the **SSE2 instructions set**
3. **Update**: assuming that BG_{t-1} and BG_t are the background frames at the times t and $t-1$ and I_t is the incoming frame at the time t, the BG pixel of coordinates (x, y) is updated as follows:

$$BG_t(x,y) = \begin{cases} BG_{t-1}(x,y) - 1 & if BG_{t-1}(x,y) > I_t(x,y) \\ BG_{t-1}(x,y) & if BG_{t-1}(x,y) = I_t(x,y) \\ BG_{t-1}(x,y) + 1 & if BG_{t-1}(x,y) < I_t(x,y) \end{cases}$$

- **Energy processing**: $\varepsilon = ||BG_{t-1} - I_t||$ is evaluated in order to **stop the learning phase** when it reaches its minimum value
- **Threshold processing**: dynamically calculated starting from the **normalized** and **smoothed** histogram of an incoming frame

Experimental results

Tests carried out on athletic videos representing a **football match**:



GMG [1] and MoGv2 [2] are implemented in the BGS Library [3]. The proposed algorithm is linear, fast and shows a good Recall. Its Precision is penalized, but can be improved with add-on modules.

References

[1] A.B. Godbehere, A. Matsukawa, K. Goldberg, Visual tracking of human visitors under variable-lighting conditions for a responsive audio art installation, in *American Control Conference (ACC)*, 2012

[2] Z. Zivkovic, Improved adaptive Gaussian mixture model for background subtraction, in *Pattern Recognition (ICPR)*, 2004

[3] A. Sobral, BGSLibrary: An OpenCV C++ Background Subtraction Library, in *IX Workshop de Visão Computacional*, 2013

Conclusions

The proposed algorithm:

- is suitable for **smart cameras** embedding
- is designed to work on grayscale images for speed reasons, but the logic can be extended also to RGB images
- shows good overall performances even if it outputs false positive pixels rather than false negative ones

Future add-ons: **selective background update** or **shadow removal** module.