JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Outdoor Motion Surveillance: Modified GMM and Kalman

Dr. Navneet S. Ghedia[1], Dr. C. H. Vithalani[2], Dr. Ashish Kothari[3], Dr. Chiragkumar N. Jasani [4]

Principal, Sanjaybhai Rajguru College of Engineering, Rajkot, Gujarat, India[1]

Professor and Head of EC Dept., Government Engineering College, Rajkot, India[2]

Asso. Professor and Head of EC Dept., Atmiya Institute Of Technology and Science, Rajkot, India [3]

Principal, Sanjaybhai Rajguru College of Diploma Engineering, Rajkot, India [4]

Abstract: *To ensure the high-level safety measures at a communal place one must have to approximation the background model and foreground detection in video scene under different constraints. To detect and track the moving objects (human, vehicle, animal, etc)in a video or real time investigation must responsive about the interface amongst the motion objects, their abnormal motion in existence of the stationary or dynamic background. This paper exhibits the definitive solution to the problem of the visual monitoring in outdoor environment. To accomplish the objective of the paper we represent foreground and the background by means of the statistical approach. Approximate the background model in such a way that it can unable to handle the picture sensitivity and also deals with the other variation like abrupt motion, illumination variation and occlusions. Foreground can be easily estimated with the help of foreground mask and then the target object is being tracked with the recursive filtering approach. The proposed Gaussian based detection and tracking approach is implemented with MATLAB. The experimental result and performance evaluation shows the robustness of the proposed Gaussian base approach. The proposed approach is experimentally tested with standard datasets.*

Keywords: **Background Estimation, Video Surveillance,Foreground Detection, Object Tracking.**

1. Introduction

Ensuring high level security at a public place one must have to depend on the smart video surveillance system. Smart video surveillance system, simply detects tracks and identifies the motion as well as made correction and also react intelligently. The smart video surveillance system required at various places like people gathering in a space, airports, public places, and malls and inside the residential localities. Sometimes automated surveillance also plays a crucial role for detection and tracking of a motion as large amount of videos and their post analysis will create a monotonous task. To detect and track the moving objects (human, vehicle, animal, etc) in a video or real time analysis must aware about the interaction among the motion objects, their abnormal motion in presence of the static or dynamic background.

Basic operation for every surveillance system like automated, traffic or any autonomous control system is to estimate the background model or extract the scene sequence from available video streams. So, to recognize and take out the motion or to detect the foreground from the stationary background is crucial part of every surveillance system. Literature shows so many background modeling approaches like Median filtering, temporal difference, Approximate Median, background subtraction, Running Gaussian Average and optical flow. Among all approaches background subtraction is usually used for the background modeling because of its low memory requirement, implementation easy and requires fewer computational time. Background subtraction flexibility towards the environments constrains create it extra accepted in the researchers. After successful modeling the stationary pixel one must have to detect the foreground or the moving pixels or the static pixels. Sometimes background is accessible in the video scene but in a few videos the background isn't accessible so, needs to create or approximate the background. Now to detect the motion, segment the moving object from the approximate background the thresholding is the very fundamental approach accessible in the field of the image processing. For the segmentation either to use the constant or single threshold is termed the global threshold or to use the local threshold for the foreground detection. Successful detection of the foreground needs to track the interested object in the consecutive frames using the recursive or

non recursive approach. To track the object in different outdoor environment is a very tough task such as poor illumination, occlusion or crowded scenes creates challenges for the researchers to track the segmented objects.

Figure 1. Outdoor Tracking in Clutter Background

Our proposed new algorithm is capable to detect and track the moving objects for the outdoor surveillance from static camera videos. A large number of videos used in this paper from the standard datasets represent different constraints. Figure 1 represents the best examples of an outdoor object tracking form the standard datasets.

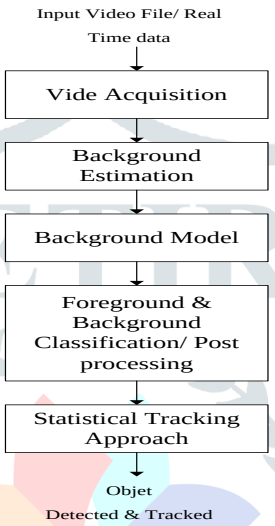

Figure 2. Block Diagram for Object Detection and Tracking

Figure 2 shows the general approach for the object detection and tracking. Initially, Image acquired with the help of acquisition block after that estimate and generates the background model. For the object detection in outdoor environment position of the object and shape of the object sequence is required. After successful detection of the background pixel, categorize the foreground and background with the help of segmentation or masking practice. Once the foreground detected object is extracted and with the help of post processing eliminate the outliers and the connected noise. Finally, the segmented objects are being tracked in the consecutive frame.

2. Related work

Usually, in a smart video surveillance system static high-resolution camera are located for the complete behavior for the outdoor surveillance. Once the cameras are static, foreground detection with orientation to the stationary background would make possible by easy subtracting the estimated background. Our proposed approach statistical Gaussian approaches approximate the background model with the help of mixture parameters, update the parameters frequently and finally the foreground is tracked with the help of filtering approach. [1] Proposed conventional Adaptive Gaussian Mixture Model a parametric statistical approach for the motion detection. They have used color as a feature and pixel as a silhouette and the model handles the dynamic scenes. The proposed approach requires little memory and also requires less computational intricacy. The proposed approach uses the multimodality rather than single gaussian. [2] Proposed a GMM based approach but they have used hue, saturation and motion parameters as a features rather than color. The proposed model uses the multimodality and able to detect the shadows in the outdoor sequences. [3] Proposed very well recognized approach based on single Gaussian. They have model each pixel in the video frame using the single Gaussian. Approach is useful in detecting the motion for the real time videos. Many researchers have tried to model the pixel with the help of intricate non static backgrounds. [4] Proposed an GMM base approach for the detection of motion for the outdoor surveillance. The proposed algorithm detects the object and classified the objects the bases of the estimated backgrounds and tracking is doe with the help of spatio-temporal filtering. [5] Proposed GMM based approach Mixture weights are on the bases of the learning parameters. After every iteration the parameters are updated. They have used correlation of the pixels for the foreground and background so, it works well on the outdoor surveillance. [6] Introduced novel illumination invariant feature such as, fusing color and edge information for the foreground detection and background estimation. It is very much helpful as some of the distribution of the background shows uniform distribution. [7] explained the unique

shadow removing technique. For outdoor scenes generally, shadow remains with the certain property of their areas and their connected region with the foreground. Proposed approach removes the shadow from the connected components. [8] Parametric modeling approach having tradeoffs between complexity and the flexibility. They proposed non parametric approach which overcomes the limitations of the parametric model. Model estimates the background density by means of the pixel intensity. [9] Exhibits the pixel level experiment for the background modeling. The proposed method is capable to handle various constrains and environments. [10] Recursive filtering approach suggested by the authors for the tracking of the segmented object in successive frames. Proposed approach able to track the moving objects efficiently in different circumstances. [11] Introduced exclusive hybrid HOG-LBP approach for the detection of the pedestrians. Suggested algorithm able to handle illumination variations and the abrupt motion of the moving objects. Adaboost along with the HOG-LBP makes it hybrid and HOG features focuses on the object appearance while LBP represents the texture information.

3. Proposed method

Estimate the background model in such a way that it can capable to handle the scene sensitivity and also deals with the other constrains like unexpected motion, light variation, and occlusions. Foreground can be easily estimated with the help of foreground mask and then the target object is being tracked with the recursive filtering approach. For the robust background modelling our proposed algorithm uses pixel by pixel approach which is a parametric type model. In the proposed approach every pixel is to be considered from a stationary background and the intensity remains fixed with respect to time so is to be consider as a single Gaussian [6] would detect the foregrounds from the video scenes.

$$F(X/\mu,\sigma) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad (1)$$

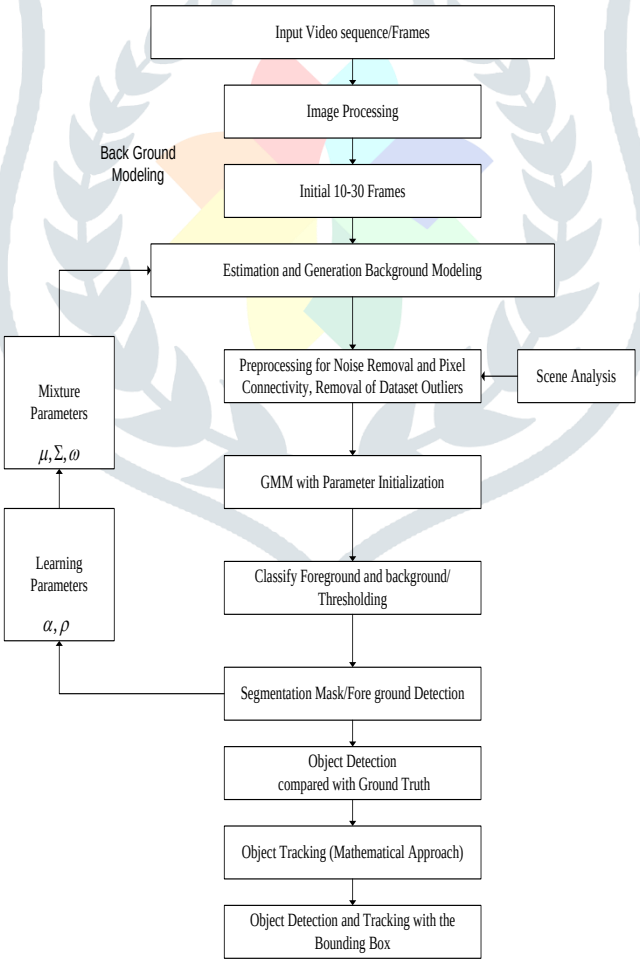

Figure 3. Proposed Modified GMM Algorithm

Figure 3 shows our proposed approach for the outdoor object detection and tracking. Fundamental operation for every surveillance system like automated, traffic or any autonomous control system is to estimate the background model or extract the scene information from available video streams. Our proposed approach statistical Gaussian approach estimates the background model with the help of mixture parameters and after every iteration's mixture parameters needs to be updated for the better classification of the foreground and background.

Gaussian Mixture Model:

To estimate the background model, proposed algorithm uses adaptive Gaussian Mixture Model a parametric RGB colour model. Pixel is used as a picture element it is purely a statistical approach where, common model is used to detect the static and moving components or single model simple classify the foreground and background. Instead of the single gaussian GMM deals with the multimodality so it can handle the various outdoor environments of the better estimation of the moving objects. In a RGB color space, frame pixel can be characterized $\{X_{1,}X_{2,}.....X_{t,}\}$ by intensities and its probability in the current fame is a weighted sum of M Gaussian distributions as given by the equation,[13]

$$p(X/\lambda)=\sum_{i=1}^{M}\omega_i g(X/\mu_i,\Sigma_i) \qquad (2)$$

Where,

ω_i = weighted associate to current frame Gaussian

M =no. of distributions.

μ_i,Σ_i = mean and covariance matrix of the pixel intensities

g = the Gaussian probability density function,

$$g(X/\mu_i,\Sigma_i)=\frac{1}{(2\pi)^{D/2}\left|\Sigma_i\right|^{1/2}}E\{-\frac{1}{2}(X-\mu_i)'\Sigma_i^{-1}(X-\mu_i)\} \qquad (3)$$

For every, $i=1,2,.....M$

The statistical approach defines with the mixture weight, mean and the covariance matrix. For every successive frame compute all three mixture parameters and classify the foreground and background. For the every pixel value the mixture weight satisfies the equation,

$$\sum_{i=1}^{M}\omega_i=1 \qquad (4)$$

In a certain outdoor sequence, the background isn't static say, water rippling, tree leaf's floating etc., will creates the dynamicity of the scenes and leads to the false detection. Using the GMM multimodality approaches it handles such dynamic outdoor environment.

Foreground detection:

Organization of the foreground and background is on the basis of the segmentation mask. To detect or segment the moving object from the estimated background the thresholding is the very primitive move towards in the field of the image processing. The categorization of the foreground and background of estimates from the following equation,

$$G=\begin{cases}G(i,j)\rangle T_h\\ G(i,j)\leq T_h\end{cases} \qquad (5)$$

If the pixel values are greater than the T_h threshold values are to be considered as a foreground otherwise background.

T_h Represent the thresholding value. Considering the minimum value as a static threshold to estimate or classify the foreground and background pixel. High threshold values will miss the foreground pixels and leads to false negatives while the lower threshold values will definitely identify the foreground objects but at the same time it will also allows some background pixel to be considered as a foreground so it will lead to false positives.

Object Tracking:

The objective of the tracking in a consecutive frame is to track the moving objects' connected region. In intelligent video surveillance, tracking is to be done along with the moving object detection. Figure 4 shows the general filtering approach for the segmented target.

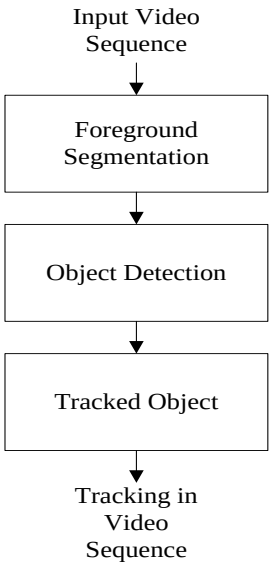

Figure 4 general Filtering/Tracking approach

Foreground and background classify using statistical background model and the segmented object is being tracked with the recursive kalman filter approach. Kalman estimates the state of a system with the linear equation. The prediction state used to for the next state prediction. Kalman filtering tracks the objects in the consecutive frames by means of the estimation, prediction and correction steps. It is purely a mathematical process to indentify the exact position of the object. Object tracking by means of kalman is purely depends on the statistical equation where, successive frames input and feedback made it possible. Time update and the measurement update are the other names of the prediction and correction steps of the mathematical approach.[12]

Object correct position can be simply and promptly considered by means of mathematical analysis. Kalman is the mathematical approach which uses statistical equations and successively inputs. [14]
Predictionstate equations,

$$\hat{x}_k^- = A\hat{x}_{k-1} + Bu_{k-1} \quad (6)$$

$$\bar{P}_k = AP_{k-1}A^T + Q \quad (7)$$

Correctionstate equations,

$$K_k = \bar{P}_k H^T (H\bar{P}_k H^T + R)^{-1} \quad (8)$$

$$\hat{x}_k = \hat{x}_k^- + K_k\left(z_k - H\hat{x}_k^-\right) \quad (9)$$

$$P_k = (I - K_k H)\bar{P}_k \quad (10)$$

4. Experiment result

Our proposed algorithm is being tested through standard datasets like PETS 2009 [15], ViSOR [16] and CDnet 2014 [17]. Proposed algorithm is implemented with the MATLAB® 2013 and successfully experienced on window7 with system specifications are Intel i3, 3GHz and 4GB RAM. We have verified our approach with the ground truth and performance evaluation matrices.

Figure 5.Outdoor Video Sequence - PETS 2009

Figure5 is a famous outdoor sequence from the standard dataset PETS 2009. Sequence is available with the challenges like near-far objects, occlusions and clutter background with varying intensity. Proposedoutdoor tracking algorithm handles all these constrain efficiently.Figure 6 is also from a well-known outdoor sequence ViSOR. The sequence having a challenging task such as static partial and fully occlusions, clutter background and similar appearance.Proposedoutdoor tracking algorithm the moving object efficiently in presence of all the constraints.

Figure6.Outdoor Video Sequence - ViSOR

Figure 7 is also from a well-known outdoor sequence CDnet 2014. The sequence having a challenging task such as high illumination, floating tree leaf's, similar appearance and non stationary background. Proposed algorithm able detects the moving objects and tracks it in consecutive frames. The detected objects (third row) is compared with the available ground truth (second row) which shows the robustness of the classification among the foreground and background. Using Kalman – Mathematical filtering approach, algorithm able to track the objects in consecutive frames. Proposed algorithm fails to track object with very far and similar appearance.

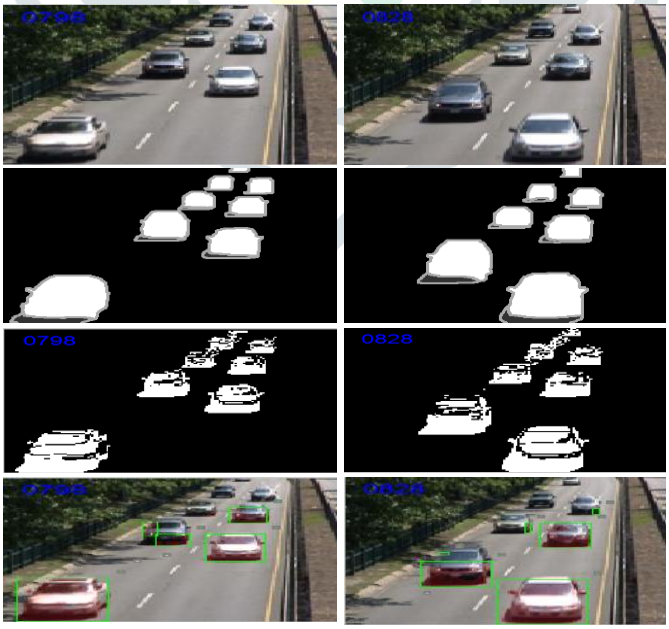

Figure7.Outdoor Video Sequences- CDnet 2014

Experimental results shows the robustness and the adptibiity to handle the backgorund challenges.

5. Conclusion

In this paper, we have implemented object detection and tracking algorithm for the outdoor environment. For the result validation, compare with some standard and challenging datasets. We have compared our result with the available ground truth and using performance evaluation matrices. Compare to other approaches the overall efficiency and the robustness of the algorithm is well suitable. Proposed algorithm is easy to implement, requires few memory and computational complexity. Kalman filtering approach makes it more flexible as it tracks the moving objects efficiently in consecutive frames. Our proposed algorithm does not respond well to challenges like fully occlusions, similar appearance and very high illuminations variations. Proposed algorithm capable to handles clutter and moving background.

6. References

[1] Chris Stauffer and W. Eric L. Grimson, "*Learning Patterns of ActivityUsing Real-Time Tracking*'' IEEE Transactions OncePattern Analysis and Machine Intellege, Vol. 22, No. 8,**(2000)**, pp 747-757.

[2] Cucchiara, R.; Grana, C.; Piccardi, M.; Prati, A., "*Detecting moving objects, ghosts, and shadows in video streams*" Pattern Analysis and Machine Intelligence, IEEE Transactions on, **(2003)**.

[3] B. Klare and S. Sarkar, "*Background subtraction in varying illuminations using an ensemble based on an enlarged feature set*" IEEE Conf. CVPR Workshops, **(2009)**, pp. 66 – 73.

[4] Manoranjan Paul, "*Human detection in surveillance videos and its applications - a review*", Springer open Journal,**(2013)**.

[5] Deepak Kumar Panda, SukadevMeher, "*A Gaussian Mixture Model with Gaussian Weight Learning Rate and Foreground Detection using Neighbourhood Correlation*", IEEE Asia Pacific Conference on Postgraduate Research in Microelectronics and Electronics,**(2013)**.

[6] C.R. Wren, A. Azarbayejani, T. Darrell, and A.P. Pentland,"*Pfinder: Real-Time Tracking of the Human Body*" IEEETrans. PAMI, vol. 19, no. 7, **(1997)**, pp. 780-785.

[7] Mohamed Taha, Hala H. Zayed, M. E. Khalifa and TaymoorNazmy, "*Moving Shadow Removal for Multi-Objects Tracking in Outdoor Environments*", International Journal of Computer Applications, Volume 97 No.10, **(2014)**.

[8] A. Elgammal, D. Harwood, and L. Davis. "*Non-parametric model for background subtraction.*" In *ECCV*, pages II:751–767, Dublin, Ireland,**(2000)**.

[9] W.E.L. Grimson, C. Stauffer, R. Romano, and L. Lee. "*Using adaptive tracking to classify and monitor activities in a site*". In *CVPR*, Santa Barbara, CA, **(1998)**.

[10] C. Ridder, O. Munkelt, and H. Kirchner. "*Adaptive background estimation and foreground detection using kalman filtering*". In *Proc. International Conference on recent Advances in Mechatronics*,**(1995)**, pp. *193–199*.

[11] Nikos Paragios and George Tziritas. "*Adaptive detection and localization of moving objects in image sequences*". *Signal Processing: Image Communication*, 4, **(1999)**, pp. 277–296.

[12] A. Yilmaz, O. Javed and M. Shah, "*Object Tracking: A Survey*", ACM Journal of Computing Surveys, Vol. 38(4), **(2006)**, pp. 1-45.

[13] Douglas Reynolds, "*Gaussian Mixture Models*", MITLincoln Laboratory, 244 Wood St., Lexington, MA 02140, USA.

[14] Greg Welch and Gary Bishop. "*An introduction to the kalman filter*", **(1995)**&**(2006)**.

[15] PETS 2009 Dataset16. S. M. Khan and M. Shah. "*Tracking multiple occluding people by localizing on multiple scene planes*". PAMI, 31(3), **(2009)**, 505–519.

[16] R.Vezzani,R.Cucchiara, "*Video Surveillance Online Repository (ViSOR): an integrated framework*"in Multimedia Tools and Applications, vol. 50, n. 2, Kluwer Academic Press,**(2010)**, pp. 359-380.

[17] http://www.changedetection.net.