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A Novel Filtering Approach for Tracking Visual Objects

Manne Dinesh Kumar, Krishna Samalla

Abstract*: Visual object tracking of moving objects is a dynamic area of research in computer vision. In developing video surveillance systems, it requires fast, consistent and robust algorithms for poignant object detection, classification, tracking, and activity analysis. Explicitly, tracking of multiple objects is more complicated than single object tracking. This paper suggests an algorithm by using a constant acceleration Kalman filter to track visual objects of variant sizes such as cars, ball and humans by varying few factors. Gaussian Mixture Model (GMM) is used for object detection using background subtraction. A blob analysis is carried for calculating area and centroid of detected objects. Theses, parameters are used for predicting and updating the location of tracked object using a Kalman filter. The proposed Kalman filter uses a constant acceleration model, as it is capable of tracking objects in all possible conditions of occlusions. The occlusion problem is minimized by defining a suitable cost function. Experiments using MATLAB show that the simulated results of proposed algorithm are accurate and can be used for real time multiple visual object tracking.

***Index Terms*: Blob Analysis, Cost Function, Gaussian Mixture Model (GMM), Kalman Filter, Visual Object Tracking**

I. INTRODUCTION

visual object tracking includes tracking of targets under occlusions and maneuvers. Moving object detection is the rudimentary step for further analysis of video. It is necessary to differentiate objects from each other to track and analyze their actions consistently [8]. In multiple objects tracking, occlusion is one of the important problems. Two or more objects interfere and appear as a new single object defines a merge condition and later separate from each other known as split. [9]. A tremendous of research has been done to find more efficient algorithms for the visual target tracking.

A Kalman filter is at its best in tracking of objects with maximum accuracy. There are many ways of defining its optimality. It processes all existing measurements of input data and process them to predict next location of target. Irrespective, of their precision, to calculate nearest value of the variables of interest, it uses data of the system and measuring device dynamics, system noises, dimension errors, and ambiguity in the system dynamics.

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* Correspondence Author

Manne Dinesh Kumar*, Department Electronics and Communication Engineering. MTech in Digital Systems and Computer Electronics from Sreenidhi Institute of Science and Technology. Ghtatkesar, India.

Dr. Krishna Samalla, Professor, Department of Electronics and Communication Engineering in Sreenidhi Institute of Science and Technology. Ghtatkesar, India.

II. RELATED WORK

For object tracking, Qingyong Hu proposed correlation filter-based technique [7]. Yayu Zhai used correlation particle filter based on RGBD data [2]. To deal with occlusions Jiyan Pan proposed a content-adaptive progressive occlusion analysis (CAPOA) algorithm [3]. Yulong Xu for occlusion detection used one step back tracking [1]. Xingping Dong advised Integrated Circulant Structure Kernels (ICSK) for online tracking in occlusion conditions [4]. Shehzad used k-means for long occlusions [5] Chao Zhu specified Boosted Multi-Task Model to detect and track pedestrian [6].in comparison to above algorithms, the proposed method is comparably effective and accurate in occlusion handling. This paper is organized as follows, overview of methodology used in section II, detailed description of proposed algorithm in section III, simulated results and analysis in section IV and concluded in section V.

III. METHODOLOGY

An algorithm for object tracking is stated which is robust to occlusions by processing a continuous video as input from a static camera (surveillance system). The video is segmented into n number of frames to detect object using GMM for object detection. The obtained features of object should be enhanced to remove noise using image processing techniques. A kernel based rectangular template matching is used. The object parameters such as centroid and area are obtained from blob analyzer and fed as inputs to Kalman filter for tracking the object [9].

Methodologies for proposed algorithm:

a) Object detection: Back Ground Subtraction based on Gaussian Mixture Model (GMM)

b) Object tracking: Kernel Tracking and Kalman filter (constant acceleration model)

IV. PROPOSED ALGORITHM

In visual object tracking, one of the challenging tasks is to overcome occlusions. These can be of short term, medium term and long-term durations. The proposed algorithm is capable of tracking more than one object of various sizes in a single frame accurately. Initially, a continuous video from a static camera such as CCTV is taken as input. The video is then divided into successive frames, back ground subtraction is carried by subtracting two consecutive frames based on.

Gaussian mixture model. GMM is used for object detection by choosing the connected components by assigning binary ‘1’ and ‘0’ for unconnected regions. In the next step a foreground rectangular mask is obtained by using foreground detector.

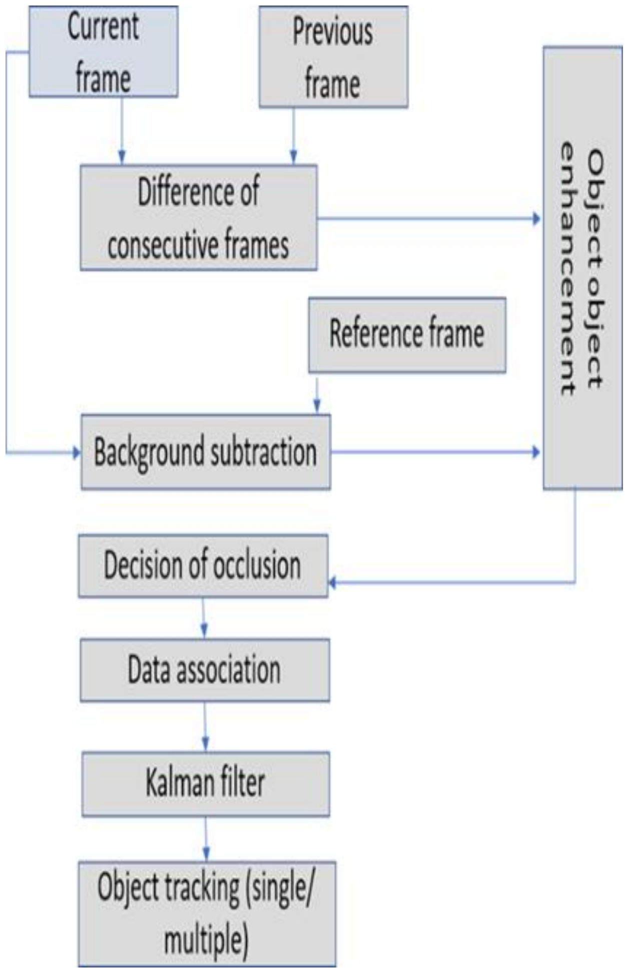

Fig 1. Flow Chart of the Proposed Algorithm

Blob analyzer is used for calculating area, centroid and bounding box of the detected object. A Kalman filter is used for tracking by predicting and updating object location based on above mentioned parameters. The Kalman filter uses an initial location to predict the next state by adjusting the measurement noise and process noise [3]. In the proposed method, both noises are assumed to be gaussian with initial parameters as defined, Motion model is a constant acceleration which has initial location as centroid,

initial estimate error = [1 1 1] $*1e^6$.

process noise = [10, 10, 10].

measurement noise = 5.

By choosing a suitable initial noise values, the accuracy of the algorithm can be increased. The algorithm can track visual objects of different sizes by adjusting the blob area. The less is the blob size the more are the chances of detecting small sized objects. Most of the human’s travel in linear fashion but a ball generally moves faster than humans and it is more advisable to consider a constant acceleration model of Kalman filter.

A. *Feature matching*

This technique used for multiple object tracking. Each moving object is defined by its centroid (a_{ik},b_{ik}) and tracking window area (A_{ik}). The distance between centroids of two objects is given as,

$$D(i,j) = \frac{\left|\sqrt{\left(a_k^i - a_{k+1}^j\right)^2 + \left(b_k^i - b_{k+1}^j\right)^2}\right|}{Max_n\left|\sqrt{\left(a_k^i - a_{k+1}^n\right)^2 + \left(b_k^i - b_{k+1}^n\right)^2}\right|} \quad (1)$$

Area between tracked object is calculated as:

$$S(i,j) = \frac{\left|A_k^i - A_{k+1}^i\right|}{Max_n\left|{}_1A_k^n - A_{k+1}^n\right|} \quad (2)$$

j^{th} object corresponding to l^{th} frame and k^{th} object w.r.t $l+1^{th}$ frame. where n, frames analyzed, l and h are length and height of window, where, $A^i_k=4l^i_kh^i_k$, which signifies the area of tracking window. [10]. After the tracking of object, the next step is dealing with occlusions and data association. we use a distance-based discrimination method to detect occlusions and also capable of successful and accurate tracking. For the data association we used a cost function [9].

B. *Occlusion Handling*

In general, occlusion is a two-step process, two objects merge and appear as a new object and then objects split from a merged object [1][3]. In above two cases, it is difficult to track object exactly. Hence, a major research is focused to solve this problem. Our proposed novel technique is able to cope up in detecting and solving occlusions efficiently. The distance between two centroids of the objects are calculated, if the value is larger than a threshold then there assumed to be no occlusion. If, the measured value is near or equal to zero, then they are in merge condition. This method is best suited for tracking few objects. In order to track multiple objects. We use a cost function, that relies both on distance between centroids and area of the detected objects.

Cost function is defined as, $\mathbf{C= \alpha D+\beta S}$ (3)

For i^{th} object in jth frame, the smaller the value of cost the function, the measurement probability true is also high. Based, on cost function, we can define number of assigned and unassigned tracks for multiple objects tracking.

V. EXPERIMENTAL RESULTS AND ANALYSIS

The proposed algorithm is verified by using MATLAB 2017.b on Microsoft Windows 10 and Intel Core i3 7th Generation Processor with 4GB RAM. The results are estimated based on three videos and are shown to be efficient and accurate. In fig 2., it can be observed that a car and a person riding bicycle are tracked simultaneously. The template is of rectangular shape which fits exactly according to the object size. All the tracked objects are travelling in linear direction. In fig 3. The ball is moving in an inclined direction, we can conclude that our algorithm is capable of tracking linear inclined moving visual objects. do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity in an equation.

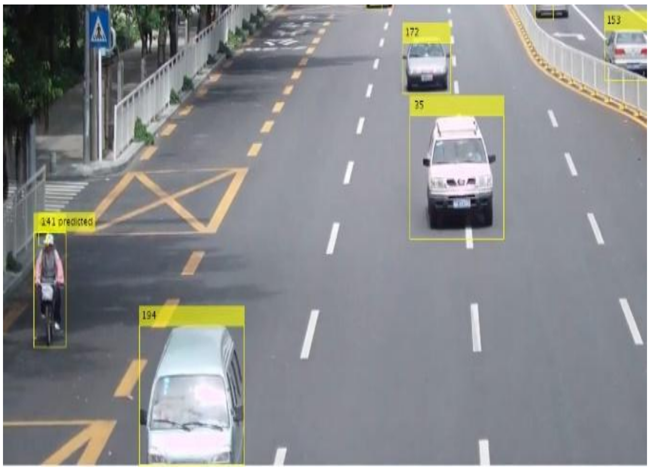

Fig 2. tracking of cars

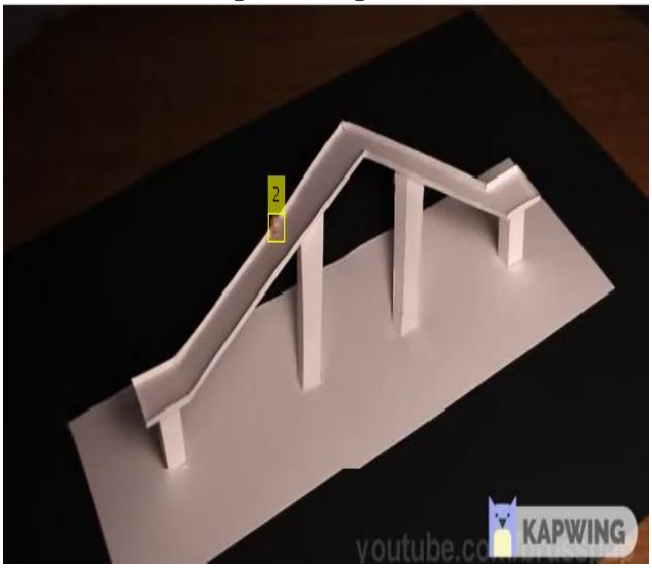

Fig 3. tracking of a small ball

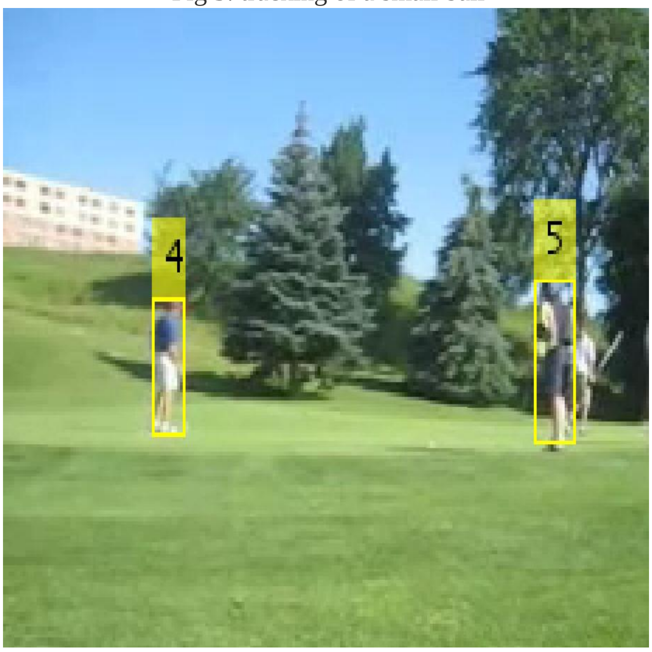

Fig 4.1 tracking in partial occlusion

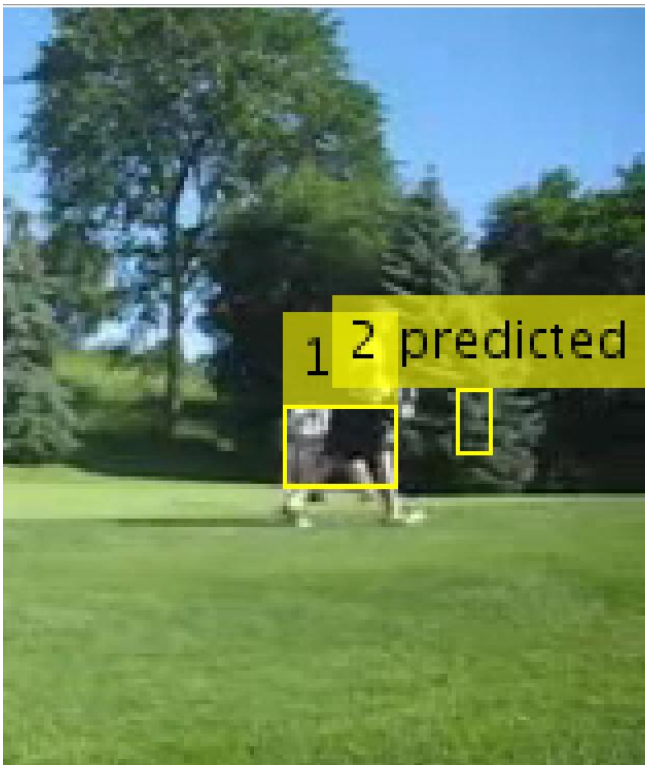

Fig 4.2 tracking during occlusion

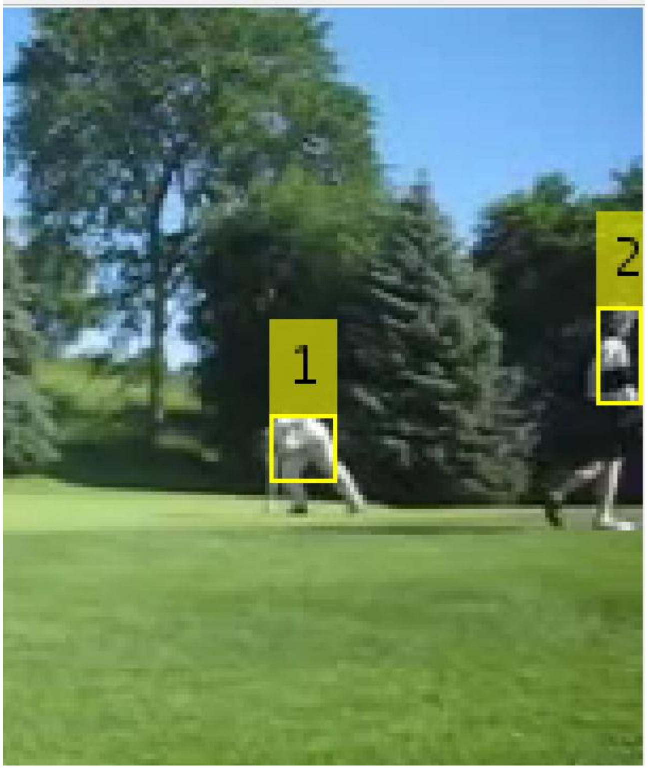

Fig 4.3 tracking after occlusion

From fig 4.1, fig 4.2, fig 4.3 we can observe our proposed method is efficiently handling occlusion scenario in the results obtained. fig 4.1 defines tracking under partial occlusion, as person 5 partially occludes person behind him.in fig 4.2 person 2 and person 3 are completely merged hence a single template is defined for them. In fig 4.3, after split condition the algorithm successfully, detects and tracks them precisely.

The proposed method is suitable for real time tracking of visual objects.

The following table depicts number of frames processed and processing time.

S. No	Type of video	Frame Size (in pixels)	No. of Frames analyzed	Detection time (in seconds)
1	Tracking of cars	720X1280	700	0.41
2	Tracking of Ball	358X640	540	0.42
3	Tracking in Occlusion	240X320	1137	0.77

Table1. Comparison of Proposed Method in Different Situations

VI. CONCLUSION

In this paper, we proposed an algorithm based on Gaussian Mixture Model (GMM) for object detection and Kalman filter for visual object tracking. Foreground detection, image enhancing for noise removal and data association in case of multiple objects are discussed in detail. Our suggested cost function effectively solves the occlusion problem and also helps in analysis of data associated with multiple objects by calculation of their areas and centroid positions. The objects are tracked in very less time even under complex situations. In the above work, various scenarios of occlusions are considered and proposed algorithm has tracked variant visual objects with good accuracy.

FUTURE SCOPE

The proposed method is effective for static cameras only hence in the future work, an algorithm for dynamic video based visual object tracking can be obtained. Object tracking is a challenging aspect of in presence of occlusions. Hence, more efficient algorithms can be derived to improve visual object tracking.

REFERENCES

1. Yulong Xu, Jiabao Wang, Yang Li, Zhuang Miao and Yafei Zhang," One-step backtracking for occlusion detection in real-time visual tracking", Electronics Letters ,Vol. 53 issue : 5, pp no:318–320, 2nd March 2017
2. Yayu Zhai , Ping Song, (Member, Ieee), Zonglei Mou, Xiaoxiao Chen, And Xiongjun Liu," Occlusion-Aware Correlation Particle Filter Target Tracking Based on RGBD Data", IEEE Access, Vol: 6, pp no: 50752 – 50764, 2018.
3. Jiyan Pan, BoHu and Jian Qiu Zhang, "Robust and Accurate Object Tracking Under Various Types of Occlusions", IEEE Transactions On Circuits And Systems For Video Technology, Vol. 18, NO. 2, pp no: 223 - 236 February, 2008 .
4. Xingping Dong, Jianbing Shen, Senior Member, IEEE, Wenguan Wang, and Hua Huang, "Occlusion-aware Real-time Object Tracking by Integrated Circulant Structure Kernels Classifier", IEEE Transactions on Multimedia, Vol: 19 , Issue: 4 pp no: 763 – 771, 2017.
5. Muhammad Imran Shehzad , Yasir A. Shah, Zahid Mehmood, Abdul Waheed Malik, Shoaib Azmat," K-means based multiple objects tracking with long-term occlusion handling", IET Computer Vision, Volume: 11 , Issue: 1, pp: 68 – 77, 2017.
6. Chao Zhu and Yuxin Peng, "A Boosted Multi-Task Model for Pedestrian Detection with Occlusion Handling", IEEE Transactions On Image Processing, Vol:24, Issue: 12, pp no: 5619 – 5629, 2015.
7. Qingyong Hu, Yulan Guo, Zaiping Lin, Wei An, and Hongwei Cheng, "Object Tracking Using Multiple Features and Adaptive Model Updating", IEEE Transactions on Instrumentation and Measurement, Vol: 66, Issue: 11, pp no: 2882 – 2897, 2017.
8. G Mallikarjuna Rao, Dr. Ch. Satyanarayana, "Object Tracking System Using Approximate Median Filter, Kalman Filter and Dynamic Template Matching", I.J. Intelligent Systems and Applications, pp no: 83-89, 2014.
9. Jong-Min Jeong, Tae-Sung Yoon, and Jin Bae park, "Kalman Filter Based Multiple Objects Detection-Tracking Algorithm Robust to Occlusion", SICE Annual Conference, pp no: 41-946, 2014.
10. XIAO Feng, SONG Mingyu, GUOXi, "Adaptive Kalman Filtering for Target Tracking", IEEE/OES China Ocean Acoustics (COA), pp no: 1-5, 2016

AUTHORS PROFILE

Manne Dinesh Kumar. He completed BTech in Electronics and Communication Engineering from ACE engineering college. Pursuing MTech in Digital systems and computer electronics from Sreenidhi Institute of Science and Technology. Ghtatkesar, India.

Dr. Krishna Samalla. He is a Professor in Department of Electronics and Communication Engineering in Sreenidhi Institute of Science and Technology. Ghtatkesar, India. He published several research in various International Journals and International Conferences. His research interests are signal processing, Image processing and Embedded systems.