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Object Tracking using Association Rule in Clutter Environment

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ABSTRACT: In multiple objects tracking it become difficult to track the objects when they get cluttered due to proximity of the object. Such a cluttered environment leads to misleading target tracking in video analysis. This becomes important when video system is employed for security purpose or behavior analysis of the object. The object get merged and split due to occlusion or obstacles in viewing angle of the camera. In this paper we present the novel algorithm to handle issue of split and merge of the objects. To increase the robustness, association rules for object tracking are proposed. The algorithm tracks number of objects by keeping record of the split and merge of these objects with each other. Association rules are developed to track the multiple objects from frame to frame. Due to association rule application processing time increases when objects are merged or split, otherwise time required is same as normal object detection condition. In order to save the memory requirement for association of objects from frame to frame, linked list structure is implemented, which will expand and collapse as number of objects changes in given video frame. Object descriptors are stored as one node of the linked list along with object ID and flags indicating split and merge of objects. This list is updated as the video frames progresses for tracking of the objects. Such a system shows good result while tracking the multiple objects in cluttered environment due to shadow or occlusion or overlapping with in a frame.

KEYWORDS: multiple object tracking, split and merge, object separation, cluttered environment.

I. INTRODUCTION

In all video analysis application it is necessary to detect and track the object robustly. The applications like security system, radar, traffic analysis and video content analysis need, not only object detection but object tracking at individual level. In video analysis object tacking algorithms should be able to deal with various dynamic in the scene. Various situations in the scene disturb object detection and tracking. Situation like dynamic background, changing lights, changing environmental conditions or multiple objects creating clutter of the objects disturb the detection. When multiple objects get involved in the scene, objects get merged due to self-shadow or occlusion. [8] The objects get split due to occlusion or object region split in pixel detection. The objects get cluttered either with background or with other objects. Due to this number of objects present get wrongly counted by system. In this paper we have proposed the algorithm which will track the objects reliably in clutter environment. For this propose object properties like position, area and flags are stored along with object ID number. Flags are used to indicate merging and splitting of objects in frame. To store information we propose linked list type data structure for all the objects detected in video frame. This information is filled as node of list when object enters the frame and updated per frame of the video. As number of objects increase the linked list will expand to accommodate the objects present in video frame. As object get disappear from the frame, object ID and other information stored associated with that object will get deleted from the list which will free the memory occupied by the node of the object. This will increase the memory utilization of the system. The comparison of linked list of respective frame is done according to the association rules formed. Distance between the object position in current frame and previous frame is considered for continuation of the object ID. Distance within given threshold keep track of the object ID. The other rules are applied for comparison if distance is reduced or increased. The processing time remain almost constant for normal situation and increases only if merge or split detected in the frame. The detection of multiple objects separately is very important in the application of security, traffic monitoring, mob monitoring and analysis of human behaviour in group.

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Overall organization of the paper is as follows. In this paper section II consider survey of related techniques. Section III deals with proposed algorithm. Section IV with result and last section with conclusion.

II. RELATED WORK

Object tracking methods are generally classified as model-based, appearance based, contour based and feature based. Hybrid methods are also employed which are combinations of some of the groups named above. Model based tracking method uses a priori knowledge of the shape of the object to track the object. But number of shapes stored in database is the limitation in this method. Appearance based methods track connected component to the 2D shapes of the object. The information provided by entire region is utilized to track the object. In contour based instead of tracking entire region only contour of the object is used. This is to save the computational requirement over the appearance based method. This method is unable to track the objects that are partially occluded. In feature based method feature of the object to be tracked are collected and these are compared in consecutive video frames. This is able to track even in partial occlusion of the object. However, selection of the required feature and grouping them for comparison is major hurdle of this scheme. Computational complexity also increases as number of feature used to track the object. To increase the reliability of the detection and tracking combination of above techniques are employed. These techniques are called as separate group as hybrid method. For detecting multiple objects in case of clutter, contextual information generated from scene can be used as feedback to detector.[6] Birth and exit of objects in case of occlusion of objects is compared with spatial information gather by adaptive Gaussian mixture model of background detection.This model is used by probability hypothesis density filter that spatially modulates its strength based on learned contextual information from previous frames. Multiple hypothesis tracker populates the association between the set of hypothetical states of objects. in another technique to identify the objects form frame to frame, blobsdetected by background model are labelled.[13] Blob direction and velocity are stored to predict next position of blobs. Euclidian distance detected in consecutive frames identifies the object in occlusion. Kalman filter is used by many application to track the objects.[7] To increase the reliability of object tracking shortest path in graph is used to identify the correct object [12]. Dynamic programming technique is used by authors to compare the object identity in case of occlusion.

III. PROPOSED ALGORITHM

This section deals with procedure of detecting multiple objects from the input video. This algorithm deals with situation in which objects get merged, overlapped or split. The steps involved in object tracking are object segmentation, validation and feature association.

A. Extraction of moving objects

The tracking of objects is done by association of object and their properties. The background subtraction module separates the background steady pixel and dynamic foreground pixels. There is no information about the object detected in the region. Therefore it is necessary to devise the algorithm which can distinguish number of objects present separately. Major hurdle in separating the multiple objects are shadow, occlusion and overlapping of moving objects. Gaussian mixture model with shadow removal [ ] shows good result but unable to handle the situation of occlusion and overlapping. Occlusion and overlapping generates the object merging. Sometime object pixel blob get separated by stationary object or moving objects which creates split situation. To handle situations of split and merge condition following algorithm is proposed.

B. Registration of objects.

After extracting foreground pixels which are detected by frame differencing of consecutive frames. Each object is detected as homogeneous region of connected pixels. The properties of each object is collected and compared with properties of the objectsstored in previous frames to track the objects.The properties or descriptor used for registering the objects are centroid, area, size, shape, vertices of the edges etc. either all or some of the descriptor are used to trace the object under different situations. The application of the object detecting system decides the
number of descriptor used for verification of the object. For faster detection of objects it is essential to use optimum number of descriptor for object registration. The objects are labelled and data association is carried out from frame to

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frame to identify exact object. In proposed system each object detected in scene is marked by object ID. Every object ID is associated with feature vector consisting of object descriptor. To save the descriptor of objects in memory linked list data structure is used. It helps in flexible data storage and faster comparison of the feature. As number of objects appearing and disappearing from the frame it is necessary to vary the storage space. Therefore linked list is preferable over fixed size data storage. Object tracking is two stage processes. In first step object descriptor are projected from current frame. The projected features are compared and object are identified in second stage and updated for next step. For each frame n, objects are defined by object partition Π_o^n , and object properties are defined by Π_ϕ^n .
The information of current frame 'n' of objects present Oi(n) is given by descriptor Φi(n). This operation can be defined as object descriptor projection. The object descriptor is defined as

$$\Phi_i = (\Phi_i^1(n), \Phi_i^2(n), \Phi_i^3(n), \dots\dots, \Phi_i^k(n)) \qquad \dots\dots\dots (1)$$

Where k are number of features describing the object i at given frame n. The number of feature selected will decide the complexity of object detection.
Let object ID is Φ_i^1(n) ,the centroid of the object, $(\Phi_i^2(n), \Phi_i^3(n))$,the area of the object $\Phi_i^4(n)$, and the mean displacement of the object $\Phi_i^5(n)$.... .... (2)
The number of feature selected and type of features selected depends upon the application to be developed. More features will increase the complexity of execution and requires more memory space for storage. The accuracy of object tracking will enhance with more feature registered for comparison. An updated object descriptor in next frame is defined as

$$\Phi_i(n+1) = (\Phi_i^1(n+1), \Phi_i^2(n+1), \Phi_i^3(n+1), \quad \dots.., \Phi_i^K(n+1)) \dots\dots (3)$$

The updated values of features become initial values of next frame during processing, which reduces the memory space requirement for the feature vector.

C. Feature association.

The correspondence of the video objects in successive frames is achieved through association of object features. Tracking the object with feature association leads to the flexible technique that overcomes the problem of occlusion and merging of the objects due to proximity. Given the object feature of new frame and object feature of previous frame the proposed method performs two tasks
i) It defines the association between the object feature in current frame (n+1) and previous frame (n).

ii) It provides an effective initialization of the features comparison in successive frames.

The object segmentation and validation between consecutive frames is achieved by object ID defined. Feature association operates at low level and validate feature with specific descriptor. The two steps generate final correspondence between the objects present in consecutive frames.
i) Object segmentation validation: Object segmentation validation initialize the object attribute collection. Every separate object is given the object ID which helps in increases the accuracy of object detection in case of merge and split of the objects. For association of the objects features of current frame are compared with feature of previous frame. As generally frame to frame variations are not large unless drastic condition takes place. The feature vector of current frame becomes values for comparison for next frame.It is stored as linked list structure defined by object ID.Only two linked list are sufficient for tracking of objects from frame to frame to detect the changes.If numbers of linked list are increased then array of the entire previous linked list can be compared with correct frame number for more accurate detection of objects. In this context a new object identify as new nodein linked list. This node is not associated with any tracked object as new ID is allotted for it.Here linked list structure gives many advantages over other storage techniques as space requirement are defined dynamically and comparison can be done on any attribute as per rule of association.
ii) Object Tracking: The projection feature of all the objects in next frame are not taken for association but only $(X_i, Y_i)^n$, A_i^n and d_i^n are considered for comparison. Then tentative correspondence of the objects in frame n and next n+1 is established withcollected objects of next frame that isΠ_o^{n+1}.For convenience in our proposed work we have taken centroid, area and mean distance of objects in consecutive frames for association. i.e. $\Phi_i(n) = [(X_i, Y_i)^n, A_i^n, d_i^n]$.

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As stated above number of features will change according to the application of system. The feature use for tracking may get modified due to viewing angle, illumination changes or motion change of the objects.Updated feature descriptor is defined asΦ_i (n+1)=[$X_i^{'}, Y_i^{'}, A_{i,}^{'} d_i^{'}$].
The correspondence is established as

$$[(X_i^{'}, Y_i^{'})A_i^{'}, d_i^{'}, n+1)]: [(X_{i\,,} Y_{i\,,})A_{i,}\ d_i, n]$$

This procedure works well if objects are correctly segmented and remain same in each frame. But in reality the objects may appear merging due to occlusion. Some objects split due to occlusion by stationary objects.Sometimes due to noise in image object gets split into different blob which is temporary phenomena and may get original object in short time. An occlusion takes place when two or more objects overlap each other or by getting close to each other. All the possible situations can be detected by conditional validation of the object features.
iii) Association rules for object detection:For applying the rules for detection of different situationscreating clutter, blobs are considered as smallest unit. Blob is set of connected pixels in given frame. This can be treated as separate objects.Blob can be formed by following situations in video

1) Single separate object
2) Multiple object merge together due to proximally or occlusion.
3) Part of object split due to occlusion by stationary object.

Following rules are formed to detect object in above situations. Every object is identified by unique object ID.

Rule I
For identification of object minimum distance between objects in consecutive frames is considered as first condition. Values of centroid stored are used for calculation of distance in all the objects present in next frame.

$$d_i = \sqrt{(X_i - X_i^{'})^2 + (Y_i - Y_i^{'})^2)}\ldots\ldots(4)$$

Out of the distances calculated with each object the smallest is considered for object similarity.
If d_i<Th_1 Then $O_i(n+1) = O_i(n)$ else new object initiated $O_{k+1}(n+1)$.
If distance is within threshold then object is matched and tracked with same object ID. No other feature is tested as object ID remain same. Only updating of initialization values take place. Threshold depends upon the application and motion factor of the object.

Rule II
If (d(O_i^{n+1},O_j^{n+1}) < Th_1) AND (O_i^{n+1},$O_j^n + 1 \epsilon O^n$)
Then condition of object split or merged may have occurred. We have to compare (A_i ,n) : (A_i,n+1).
If (A_i(n) < A_i(n+1)) AND (A_j(n) <A_j(n+1)) then split flag is set for object ID i, j in frame n+1.
If (A_i(n) > A_i(n+1)) AND (A_j(n) >A_j(n+1)) then merge flag is set for object ID i, j in frame n+1.
In both merge and spilt condition new object ID generated in frame n+1. This rule verifies the condition of partial or full occlusion. To test whether object disappeared from frame separate timer is attached. When time expires object is deleted from list and new object created is taken as true object from frame n+1. In this case rule I is applied fromnext frame. If merge or split flag is set comparisons are carried out according to rule III.

Rule III
If merge flag is set then $O_i^n \notin O^{n+1}$, but it is not immediately removed from list of objects. Timer object is attached to this object to test if it is disappeared or occlude by some other objects. If object reappears flags get reset. New object due to rule II will follow rule I and rule II as if independent object in list. When timer attached to object expires it is removed from list. If flags are set all rules are applied to that object. In case of clear flag condition only rule I is sufficient to track the object.
Applying above association rule objects are tracked using matching of objects from current frame with existing objects in previous frame.

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IV. Storage Structure

To improve the matching linked list type of object storage is used. Advantage of linked list is that it is linear data storage hence depending upon the number of objects present the length of linked list can be varied which save the memory space. It also keeps the algorithm expandable to match with number of objects present in frame. List accommodates dynamic existence of object due to merge and split. Objects inserted in list are consecutively connected if they are spatially together.

I) Node Structure:

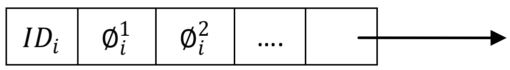

Fig. 1.Typical node of linked list used for storage per object. It contains object ID, features required for comparison, flags and pointer to next node.

II) Spilt

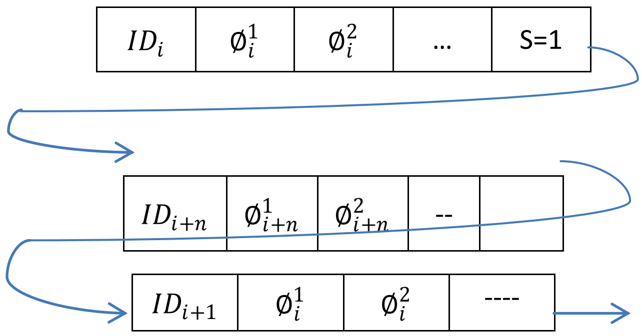

Fig. 2 Typical linked list status when object split take place. New node is created with split flag set and new object ID with highest ID but linked near split object.

III) Merge

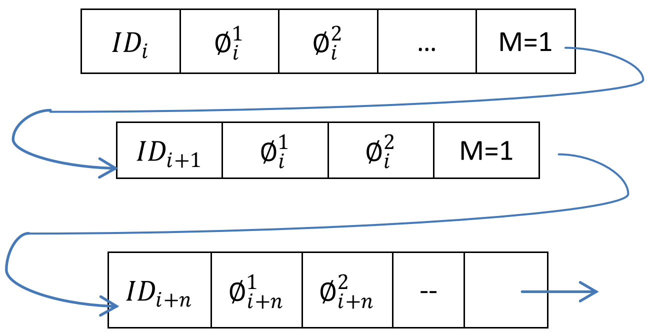

Fig. 3Typical linked list status when object merging take place. New node is created with merge flag set and new object ID with highest ID but linked after merged objects.

Fig. 1 displays typical node structure used for experiment. Every node of the linked list has header and feature vector stored. Node have separate field for every attribute, flag and the pointer point to next node in the list. If new object is

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detected it is added to the end of the list. If object present in the list is spilt or merge additional node are generated with new object ID as shown in fig. 2 and fig. 3 . Merge flag is set and it is inserted next to the node having distance closed to the existing object. Note that new object introduced has object ID next to last object present.

V. EXPERIMENTAL RESULT

Experiments are carried out in simulated and real videos. Results are verified with keeping the track of no of objects present in the frame. The association rule proposed above is applied with in area of interest instead of entire frame.

(A) (B)

Fig.4 (A) Sample frame 20 showing normal moving objects. (B) Sample frame 22 showing partial occlusion.

(A) (B) (C)

Fig.5 A) object blog detected using background subtraction algorithm. B) Merged Flag set as object blog is one C) split condition due to discontinuity in blog set split flag.

Fig.4. Shows the video frames of simulated video. In which objects are moving with constant speed as shown in Fig.4 (A). Fig. 4(B) shows merge condition in during the video run. The split and merge conditions are simulated and algorithm response is tested for number of object detected. Fig. 5 (A), (B), (C) shows the pixel conditions during merge and split. The objects detected due to pixel blobs are displayed in red boxes. The table 1 shows contains of linked list with object ID for some sample conditions. Table 1 shows result of applying proposed association rule for detection of split and merge on simulated video of two objects moving in same direction with constant speed. Though new object created by split are counted they are not finalized as split flag is set. Similarly during merging of objects count get reduced but not finalized as merge flag is set. The setting of flags can be used for detection of anomalies in surveillance.

VI. CONCLUSION

In this paper we proposed algorithm to handle clutter situation in tracking of multiple objects. The clutter of objects take place due to proximity appeared in camera view. In computer vision 3D information is converted into 2D information hence this type of clutter of objects appear in image. The association rule application with consecutive frames finds the object merging and splitting due to proximity. This method overcomes the computation complexity of other methods as rules are applied when the pixel blog near existing objects in previous frame shows drastic change in their properties. Number of properties considered for testing increases the accuracy of the detection. Fast response to the merge situation detection can help in earlier alarm generation for action. For saving of attributes of comparison linked list structure is proposed for saving of memory space. This also helps in adding and deletion of node as number of objects in frame increases or decreases. Memory storage overhead of is less as compared to other techniques in related works.

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REFERENCES

[1] Xiaowei Zhou, Can Yang, Weichuan Yu, "Moving Object Detection by Detecting Contiguous Outliers in the Low-Rank Representation", IEEETransactions on Pattern Analysis & Machine Intelligence, vol.35, no. 3, pp. 597-610, March 2013,
[2] M. Piccardi, "Background Subtraction Techniques: A Review," Proc. IEEE Int'l Conf. Systems, Man, and Cybernetics, 2004.
[3] P. Ochs and T. Brox, "Object Segmentation in Video: A Hierarchical Variational Approach for Turning Point Trajectories Into Dense Regions", Proc. IEEE Int'l Conf. Computer Vision, 2011.
[4] Z. Zhou, A. Wagner, H. Mobahi, J. Wright, and Y. Ma, "Face Recognition with Contiguous Occlusion Using Markov Random Fields", Proc. IEEE Int'l Conf. Computer Vision, 2010.
[5] D. Parks and S. Fels, "Evaluation of Background Subtraction Algorithms with Post-Processing", Proc. IEEE Int'l Conf. Advanced Video andSignal Based Surveillance, pp. 192-199, 2008.
[6] Maggio, E.; Cavallaro, A., "Learning Scene Context for Multiple Object Tracking", Image Processing, IEEE Transactions on , vol.18, no.8, pp.1873,1884, Aug. 2009.
[7] Azari, M.; Seyfi, A.; Rezaie, A.H., "Real Time Multiple Object Tracking and Occlusion Reasoning Using Adaptive Kalman Filters", Machine Vision and Image Processing (MVIP), 2011 7th Iranian , vol., no., pp.1,5, 16-17 Nov. 2011.
[8] Halkarnikar, P.P.; Talbar, S.N.; Vasambekar, P.N., "Object separation in shadow clutter in video sequences," Radar, Communication and Computing (ICRCC), 2012 International Conference , vol., no., pp.299,302, 21-22 Dec. 2012
[9] Cai, Ling, He, Lei, Xu, Yiren, Zhao, Yuming and Yang, Xin. "Multi-object detection and tracking by stereo vision", Pattern Recognition 43, no. 12 (2010): 4028-4041.
[10] Jiyan Pan; Bo Hu; JianQiu Zhang, "Robust and Accurate Object Tracking Under Various Types of Occlusions", Circuits and Systems for Video Technology, IEEE Transactions, vol.18, no.2, pp.223,236, Feb. 2008
[11] Cavallaro, A.; Steiger, O.; Ebrahimi, T., "Tracking video objects in cluttered background," Circuits and Systems for Video Technology, IEEE Transactions, vol.15, no.4, pp.575,584, April 2005
[12] Kumar, P.; SurendraRanganath; Sengupta, K.; Huang Weimin, "Cooperative Multitarget Tracking With Efficient Split and Merge Handling", Circuits and Systems for Video Technology, IEEE Transactions on , vol.16, no.12, pp.1477,1490, Dec. 2006.
[13]J.S.Kim, D.H. Yeom, "Fast and Robust Algorithm of tracking multiple moving objects for intelligent video surveillances system", IEEE Transactions on Consumer Electronics,vol.57, no.3, pp.1165- 1170, August 2011.

Table 1

Fr. No.	Object ID	X	Y	Area	M	E-Distance	S	No. of objects
4	1	230	310	507	0	10.91	0	2
4	2	261	310	507	0	10.91	0	2
7	1	230	270	219	0	3.04	1	4
7	3	230	280	219	0	3.02	1	4
7	2	261	270	219	0	3.04	1	4
7	4	261	285	219	0	3.02	1	4
8	1	230	267	446	1	3.04	0	2
8	2	261	267	446	1	3.04	0	2
9	1	230	256	443	0	10.68	0	2
9	2	261	256	443	0	10.68	0	2
19	1	230	147	442	0	10.99	0	2
19	2	261	147	442	0	10.99	0	2
20	1	230	129	221	0	2.99	1	4
20	3	230	144	220	0	2.99	1	4
20	2	261	129	221	0	2.99	1	4
20	4	261	144	220	0	2.99	1	4
22	1	230	118	220	0	10.90	0	4

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22	3	230	133	221	0	10.85	0	4
22	2	261	118	220	0	10.90	0	4
22	4	261	133	221	0	10.85	0	4
24	1	130	115	442	1	2.80	0	2
24	2	261	115.	442	1	2.80	0	2
26	1	230	104	507	0	10.96	0	2
26	2	261	104	507	0	10.96	0	2

Fr. No. =Frame Number, Obj. =Object, M= Merge Flag, S= Split Flag. E-dist. = Euclidian Distance.

BIOGRAPHY

P. P. Halkarnikar received B.E. from Government College of Engineering, Pune in 1986and M.E. from Walchand College of Engineering, Sangli in 1993. Presently he is working as Associate Professor in Department of Computer Science And Engineering at D.Y. PatilInstitute of Engineering, Pune. He is visiting Professor atP.G. center, Department of Technology, Shivaji University, Kolhapur. He is consultant to many industries for development of microcontroller based products. His interest lies in microcontroller based instrumentation, computer vision, data mining and web technology. He is member of ISTE and IEI.

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