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Moving object tracking based on position vectors

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Abstract— *In this paper, a novel algorithm for moving object tracking based on position vectors has proposed. The position vector of an object in first frame of a video has been extracted based on selection of ROI. Region of Interest (ROI) is a cropped image in a first frame. In this algorithm, object motion has shown in nine different directions based on the position vector in the first frame. We extract nine position vectors for nine different directions. With these position vectors second frame is cropped into nine blocks. We exploit block matching of the first frame with nine blocks of the next frame in a simple feature space. The matched block is considered as tracked block and its position vector is a reference location for the next successive frame. We describe algorithm in detail to perform simulation experiments of object tracking which verifies the tracking algorithm efficiency.*

1 INTRODUCTION

The moving object tracking in video pictures has attracted a great deal of interest in computer vision. For object recognition, navigation systems and surveillance systems, object tracking is an indispensable first-step.

The conventional approach to object tracking is based on the difference between the current image and the background image. However, algorithms based on the difference image cannot simultaneously detect still objects. Furthermore, they cannot be applied to the case of a moving camera. Algorithms including the camera motion information have been proposed previously, but, they still contain problems in separating the information from the background.

In this paper, we propose block matching based Method for object tracking in video pictures. Our algorithm is based on position vector calculation and block matching .The proposed method for tracking uses block matching between successive frames. As a consequence, the algorithm can simultaneously track multiple moving and still objects in video pictures.

This paper is organized as follows. The proposed method consisting of stages position vector calculation, feature extraction, block matching and minimum distance measure which are described in detail.

2 PROPOSED CONCEPT FOR MOVING OBJECT TRACKING

2.1 Position vector calculation

2.1.1 position vector calculation for first frame

In general, image segmentation and object extraction methods are used to calculate position vectors. In the proposed concept, first select the portion of an object which is to be tracked. The portion of an image is cropped in the first frame which is referred as block ie shown in the figure below

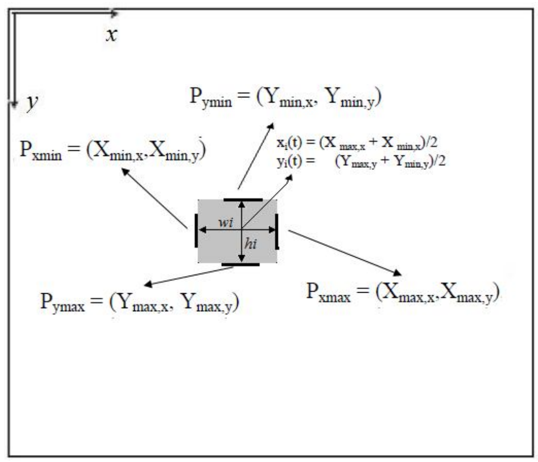

Fig.1: Explanation of the position vector calculation from the cropped image result

Based on co-ordinate parameters of an object, we extract the position of the pixel Pxmax (Pxmin) which has the maximum (minimum) x-component

$$P_{xmax} = (X_{max,x}, X_{max,y}),$$
$$P_{xmin} = (X_{min,x}, X_{min,y}),$$

Where Xmax,x, Xmax,y, Xmin,x, and Xmin,y are x and y coordinates of the

Rightmost and leftmost boundary of the object i, respectively. In addition, we also extract

$$P_{ymax} = (Y_{max,x}, Y_{max,y}),$$
$$P_{ymin} = (Y_{min,x}, Y_{min,y}).$$

Then we calculate the width w and the height h of the objects as follows

$$w_i(t) = X_{max,x} - X_{min,x},$$
$$h_i(t) = Y_{max,y} - Y_{min,y}.$$

We define the positions of each object in the frame as follows

$$P = (X_1, Y_1)$$

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$X_1(t) = (X\ max,x + X\ min,x)/2$
$Y_1(t) = (Ymax,y + Ymin,y)/2$

2.1.2. Position Vectors in nine different directions

Frame to Frame movement distance of an object is negligible. So, we consider movement shift by "m" units in nine different directions as shown in the below figure.

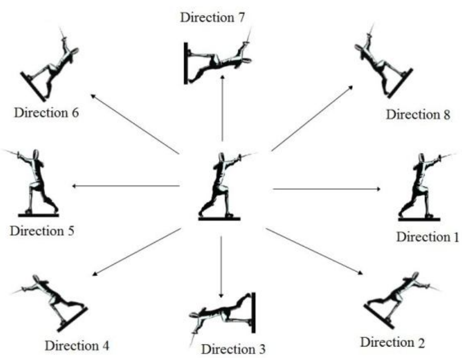

Fig.2: Position of object in nine different directions

For Direction 1, position vector shift $P_1= (X_1-m,Y_1)$
For Direction 2, position vector shift $P_2= (X_1+m,Y_1)$
For Direction 3, position vector shift $P_3= (X_1,Y_1+m)$
For Direction 4, position vector shift $P_4= (X_1,Y_1-m)$
For Direction 5, position vector shift $P_5= (X_1-m,Y_1-m)$
For Direction 6, position vector shift $P_6= (X_1+m,Y_1+m)$
For Direction 7, position vector shift $P_7= (X_1-m,Y_1+m)$
For Direction 8, position vector shift $P_8= (X_1+m,Y_1-m)$
For Direction 9, position vector shift $P_9= (X_1,Y_1)$

Based on the position vectors $P_1,P_2,P_3,P_4,P_5,P_6,P_7,P_8$ and P_9 crop the second frame into nine blocks as shown in figure.3.

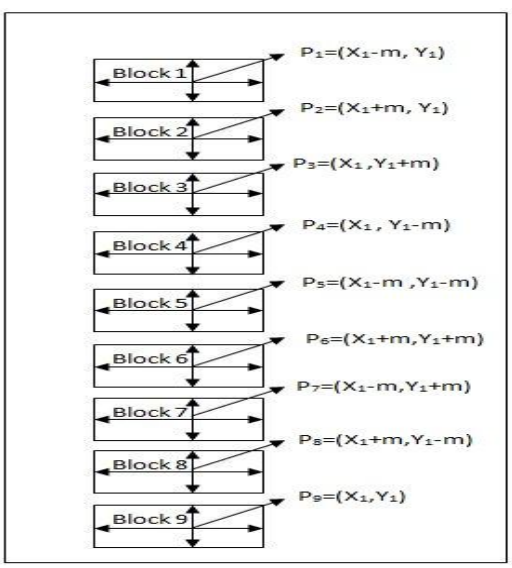

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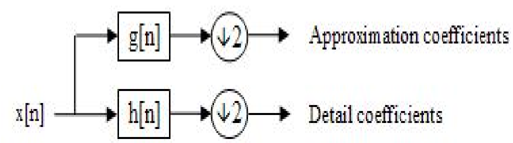
Fig.3: Block Extraction using Nine Position Vectors

2.2 FEATURE EXTRACTION FOR BLOCKS

2.2.1 DISCRETE WAVELET TRANSFORM

2D-Discrete Wavelet Transform

A weakness shared by most of the texture analysis schemes is that the image is analyzed at one single-scale. A limitation that can be lifted by employing multi-scale representation of the textures such as the one offered by the wavelet transform. Wavelets have been shown to be useful for texture analysis in literature, possibly due to their finite duration, which provides both frequency and spatial locality. The hierarchical wavelet transform uses a family of wavelet functions is associated scaling functions to decompose the original signal/image into different sub bands. The decomposition process is recursively applied to the sub bands to generate the next level of the hierarchy.



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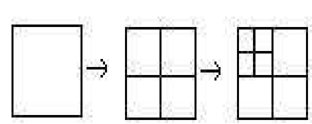
This shows one level DWT. At every iteration of the DWT, the lines of the input image (obtained at the end of the previous iteration) are low-pass filtered and high pass filtered. Then the lines of the two images obtained at the output of the two filters are decimated with a factor of 2.

Next, the columns of the two images obtained are low and high pass filtered. The columns of those four images are also decimated with a factor of 2. Four new sub-images representing the result of the current iteration are generated. The first one, obtained after two low-pass filtering, is named approximation sub-image (or LL image). The others three are named as detail sub-images: LH, HL and HH. The LL image represents the input for the next iteration.



In this paper we have used level 2 Haar transform. Only the second level LL image is used for the analysis as that contains most of the important information for feature vector calculation. For first frame the feature vector is f1 based on cropped image using position vector P1.For next frame feature vector set is V={V1,V2,V3,V4,V5,V6,V7,V8,V9} based on position vectors P1,P2,P3,P4,P5,P6,P7,P8 &P9.

2.3 Block Matching and Distance Measure

Proposed algorithm for object tracking exploit block matching with the DWT features above and make use of minimum distance search in the feature space. We now go into moré details of our algorithm.

Using the cropped images result of the object in the t^{th} frame, we first extract the DWT coefficients of the cropped image (N+1,i). Here the notation N+1,i stands for the cropped image in the t^{th} frame. Then we perform the minimum distance search between (N+1,i) and (N,j) for all cropped images j in the next frame using position vectors. Finally the cropped image N+1,i is identified with the cropped image in the next frame which has minimum distance from N+1,i. Repeating this matching procedure for all the frames with first frame, we can identify all blocks one by one and can keep track of the blocks between frames.

Further refinements of the proposed algorithm are as follows: We have not specified the distance measure used for matching yet. In the simulation experiments we could confirm that besides the Euclidean distance DE the simpler Manhattan distance DM is already sufficient for object tracking purposes. Figure 4 shows a Distance measure between feature vectors. Figure 5 shows a Block diagram of the proposed object tracking algorithm.

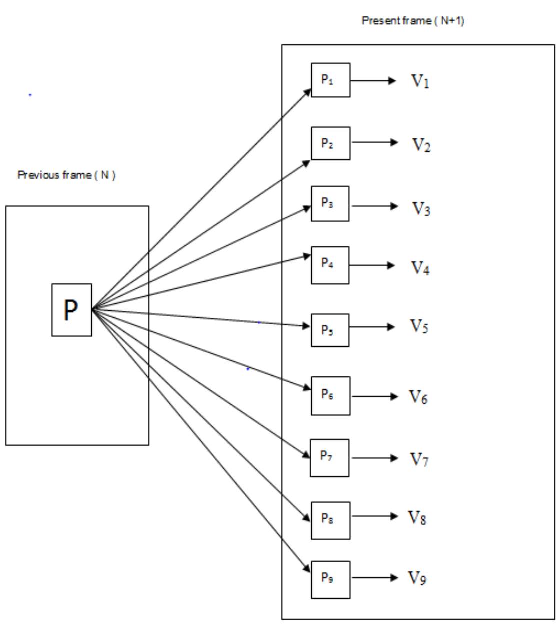


Fig.4: Distance measure between feature vectors.

2.3.1 OBJECT TRACKING ALGORITHM

1. Input video
2. Crop the first frame for ROI(Region Of Interest)
3. Calculate position vector for cropped portion. $P=(X_1,Y_1)$
4. Based on position vector calculate nine position vectors with X and Y co-ordinate shift by 'm' units.

$P_1= (X_1\text{-}m,Y_1)$, $P_2= (X_1+m,Y_1)$, $P_3=(X_1,Y_1+m)$,$P_4=(X_1,Y_1\text{-}m)$, $P_5= (X_1\text{-}m,Y_1\text{-}m)$,$P_6= (X_1+m,Y_1+m)$, $P_7= (X_1\text{-}m,Y_1+m)$, $P_8= (X_1+m,Y_1\text{-}m)$, $P_9= (X_1,Y_1)$

5. For previous frame i.e first frame perform DWT for cropped block to get feature vector f_1.
6. Similarly perform DWT for all cropped blocks in the next frame N+1 to get the feature vectors V_1 ,V_2, V_3, V_4, V_5, V_6, V_7 ,V_8, V_9 .

   $V= \{ V_1, V_2, V_3, V_4, V_5, V_6, V_7, V_8, V_9\}$
7. **Block matching distance measure**
   a.) Calculate the distance measured using Manhattan distance between f_1 and V.
   We get distance set of $D = \{D_1, D_2, D_3, D_4, D_5, D_6, D_7, D_8, D_9\}$
   where D_1= Distance between f_1 and V_1 similarly for D_2,D_3,D_4,D_5,D_6,D_7,D_8 and D_9 are calculated.
   b.) Apply block matching of N^{th} frame cropped image with minimum distance block of $N+1^{th}$ frame. If not matched, perform for next successive frame.
   c.) After matching remove the position vector data of N^{th} frame and store the data of position vector of $N+1^{th}$ frame.
   d.) Increase the value of N by N+1.
8. Repeat the steps from 1 to 7.

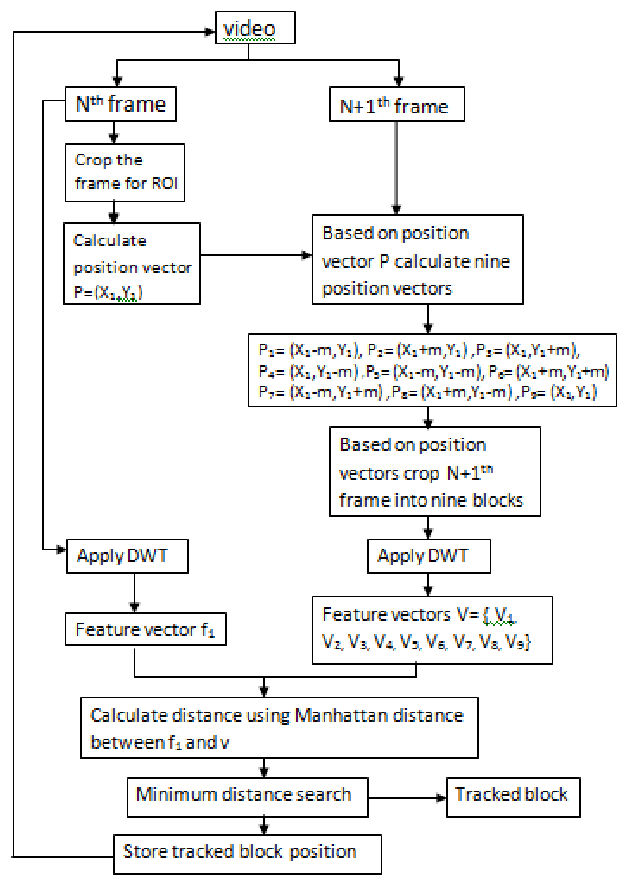


Fig.5: Block diagram of proposed object tracking method

3 Simulation Results

The proposed algorithm is tested by using Matlab 7.1. For experimental verifications two different video sequences were taken from moving camera, then frames were extracted from the video sequences. Since, all the processing has done on colour images, 24 bit color image first frame has been initially taken as reference frame to calculate position vector. By giving frames one after the other to the Matlab program of proposed algorithm, the tracked object location is extracted.

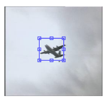
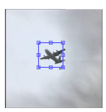
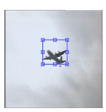
Video Pictures	Result	Tracked object area in the frame
	object tracked	
	Object tracked	
	object tracked	
	Object tracked	
	Object tracked	

Fig.6: The tracked object results from successive frames

4 Conclusion

We have proposed an object tracking algorithm for video pictures, based on position vectors and block matching of the extracted objects between frames in a simple feature space. Simulation results for frame sequences with moving objects verify the suitability of the algorithm for reliable moving object tracking. We also have confirmed that the algorithm works very well for more complicated video pictures including rotating objects and occlusion of objects. It is obvious that, the simulation result in the proposed algorithm is quite enough to apply for the real time applications. We would like to implement this algorithm with feature vectors in different vectors for future applications too.

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