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Basketball Tracking using Mean Shift Algorithm

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Abstract*: Video analysis plays a vital role in commercial application, sports and military systems. Various methods are presented in literature. Mean shift algorithm is presented in this paper for basket ball tracking because it is more efficient than other that is defined by histograms. The tracking is the important block in the detection and recognition of the basket ball. Different object tracking algorithms are investigated. The performance of tracking in two video sequences is performed and the method gives 91.3% precision for video sequence 1 and 93.6% for sequence 2.

***Keywords*: Ball detection, basketball detection, frame difference, histogram, Tracking, mean shift, video**

I. INTRODUCTION

Computer vision had made necessary in day-to-day life due to the tremendous growth of artificial intelligence. Computer vision also handles the problem of target tracking which can utilize in intelligent video surveillance, human-computer interaction and in other intelligent fields too. Digital equipments had keep o increasing for the purpose of recording and storing contents of the multimedia and along with that the upgrade of power in computers had paved way for analysis on video processing. The researchers would enjoy to research on sports video as it hold many contents or multimedia as well as it goes on commercially. The researchers would find a challenging task to figure out the enthusiastic events from the large volume of the sports video. The researchers are also improving the present algorithms for the convenience of the users. Object tracking is the most needed estimation in sports video. This would utilized for detecting either balls or players or both balls and players from the video sequence. For tracking the object, different algorithms had been used. Mean shift algorithm is efficient for target tracking in a traditional algorithm as many advantages such as minimal amount of iteration time, acceptable real time performance and implementation is ease etc.

In all ball type games, ball is the centre of attraction. The ball has stuck to many characteristics.

- Color: The ball color is designed for the clear vision of the players and viewers. The color of the basketball would be orange with black stripes still the ball could be in other colors too.
- Size: The size of the ball would be same in all the time. Basketball would carry diameter either 2.3 or 2.4 cm.
- Shape: Shape of the bal would be spherical and that would help to differentiate the ball from other similar objects.

In spite of having many features for ball, focusing a ball on video is not that much ease. In the toughest game, barriers may arouse due to the players who would be close to each other as well as to the ball. And also, the trajectory of the ball would not be straight because the ball was being thrown from one side to the other with the highest bouncing. Due to these problems the trajectory of the ball goes quite tuff.

II. LITERATURE SURVEY

The helinger distance has the scale elimination mechanism which was fully depend on the mean shift procedure, in order the overcome the obstacle in scale adaptation [1]. In case of background clutter in the scale elimination, the two improvements done in the mean shift tracker during scale elimination. Background Ratio Weighing (BRW) is used to improve in histogram color weighing which use the object neighborhood to differentiate the target. By improving the forward-backward consistency check in this scale estimation, the second improvement had been done to improve the tracker's performance. This would address and rectify two major problems: scale expansion and scale implosion. This had attained 30% of performance than the literature surveyed. Yun et al [2] presence conferred semantic -based slot event for identifying the gap between low-lever features and high-lever semantic by using Dynamic Bayesian Network (DBN). Thus result is obtained from this method is better than the previous methods.

Mean Shift (MS) technique had won the top place in the object tracking video. As the Ms assumed that the initialization would fall into the desired mode which had attracted, the global and local modes were not corresponded to each other. This had meant to fail the tracker. So, the novel multi bandwidth MS procedure had been presented which would concentrate on destiny function's global mode disregarding of initialization point [3]. This procedure was named as annealed MS procedure as it looked as same as the annealed sampling.

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This had seen as uni-modal because there was a combo of well smoothened density function and the ample large bandwidth. The global modes in the density function had rouse gradually by the continuous work of this procedure and the global modes had been located accurately. Many data had proved that this procedure had reduced the computational complexity. A new algorithm had presented which would reduce the repetitions of the work and been a better tracker than the previous.

In order to track location as well as to track the direction of the target, Wang Changjun and Zhang Li [4] presented a mean shift based tracking method for orientation tracking and Meer's location tracking algorithm by employing alternate iteration by the entire tracking method could be processed.

Some issues are to be created by changing the scale and orientation with classical mean shift tracking algorithm that is failed to track the target. Ming Zhao, et al [5]presented the algorithm by incorporating target components to overcome the variance matrix with Mean-Shift tracking algorithm. The result of this experiment showed that this methodology had enhanced in adaptability. Yuan-ming et al [6] enhance the tracking efficiency and establishment mean shift tracking algorithm to evaluative asymmetric kernel. Hence the combination expression and evolution of symmetric kernel function into mean shift algorithm methodology that had presented by employing regional similarity. At last, submission of asymmetric kernel function update strategy had been done. This result had given good accuracy and stability.

To rectify the problem of frequently varying tracking window size in Mean-shift progress, Jian Zhang et al [7] had presented a peculiar algorithm. By employing SURF, the feature points of present and earlier frame's target area had been detected. To raise the feature points' weights in the central area, Epanechnikov kernel function had been presented. After finding the identical feature points in both the frames, the target scale parameter had been calculated. Zhi-qiang et al [8] presented the basis of weighed accuracy which is unable to locate the moving object effectively from the clutter background. Histogram bins occurred between the saliency of target and background that are computed with those mentioned issues. The result showed that the methodology had overcome the pointed issues.

Qiang Wu [9] explained the combination of bipartite graph of adaptive object model in order to track the basketball and reduce the computational complexity. The experimental results showed that the degree of detection had raised and error rate had decreased.

Divya Chauhan, et al [10] had presented a potent method for highlighting the generation from basketball sports video. Video had been classified into three sections by employing Video shot classification: close-up view, far view and replay. Along with it, for every frame ball detection had been mentioned. J. Kwon et al [11] had presented the KCF method which was for tracking purpose. The KCF-based tracker had enhanced by adopting the components. The experiment had resulted better than its literature. Tong Zhou and Yunyi Yan [12] had pointed the strength and conveyed the weakness. And also, by incorporating the mean shift with Kalmann filter, an algorithm had been presented. This algorithm had overcome the weakness autonomous ball tracking algorithm often sticks of accuracy and speed of the ball detection. To overcome this issue, Tayeba Qazi et al, 2018 [13] had presented an autonomous ball tracking algorithm on the basis of machine learning. This experiment results had shown that this methodology had detected well with 91% of accuracy.

Bodhisattwa Chakraborty and Sukadev Meher, 2012 [14] had presented tracking algorithm based on ball detection for volleyball video by the various types of shots. The different shot of trajectory information the ball had been reviewed and location of the ball had been estimated. A set of candidates had been generated by employing a kalman filter. The experiment had performed clearly. Even though there were more methods for object tracking, a few efficient methods were there for ball tracking. So, Masaki Takahashi et al, 2015 [15] had targeted on the motion and appearance features of the ball. The presented method was on the basis of machine learning. This method had employed in real football game.

As the category of sports: shot, foul and rebound results from the players had denoted manually. To make it autonomous, JungSoo Lee et al, 2018 [16] had presented the technique in basketball game. Bodhisattwa Chakraborty and Sukadev Meher, 2013 [17] presented the video sequence used a trajectory-based ball tracking method to review the long shot. The trajectory of the ball had been determined along with it, the velocity and angle of ball thrown had been determined. The result had shown that the experiment performed well with moving background. While detecting the trajectory of the ball, there were so many issues arouse due to intermediate of the players and moving objects apart from ball. To overcome these barriers, Bodhisattwa Chakraborty and Sukadev Meher, 2012 [18] had presented a approximate median value of the background pixels had been employed to detect the background objects. This experiment had performed better to its convenience. To detect the moving of ball like structured objects, Congyi Lyu et al, 2015 [19] had presented an algorithm on the basis of frame difference and multi frame fusion. Along with it, the authors had implemented the algorithm in wireless pan-tilt camera system to evaluate its result. The experiment had performed better.

The player's performance had been monitored manually so sometimes the coaches would imbalance in concentrating on players. To overcome these occlusions, Abdul Monem et al, 2015 [20] had presented a computerized kinetic analysis for basketball free throw followed by examining the performance of the player with the help of HU image moments.

III. BACKGROUND METHODOLOGY

A. Feature Selection for Tracking

This method is one of the main tracking techniques. The feature selection is categorized easily in the feature space of unique techniques which is similar to the object representation. Several algorithms have employed both the features. The following would proclaim the contents of common visual features.

- Color: [21] presented RGB (red, green, blue) used for pointing the color under image processing by an object based on two physical aspects: 1) the spectral power distribution of the illuminant and 2) the surface reflectance properties of the object. [22]. From these mentioned ideas, there is no conclusion about the potent color space so, various color space had been used.
- Edges: The image intensities were changed by influencing object boundaries. These modifications have been identified by edge detection. The edges were not that much influenced by illumination when compared to the color features. Edges are pointed as representative frames in the algorithms for tracking the boundary. Canny Edge detector [23] was ease and efficient, so this was employed in most of the experiments. [23]had reported the gradual increase of edge detection algorithm.
- Optical Flow: They are the displacement vectors used in optical flow representation which would translate each pixel in a region. [24] explains pixel region based on brightness level. [24]- [27] calculate the mathematical representation were used to optical flow. [28] evaluated the performance of optical flow methods.
- Texture: [29], Law's texture measures and steerable pyramids [30] presented the texture which is used to compute the intensity variation of a surface like smoothness and regularity as edge features in the illumination conditions.

Features were selected manually with respect to the application domain.

B. Object Detection

To detect the object in the video sequence, the tracking method needs a mechanism. By employing data in one frame, object detection had been held. In order to minimize the false detection, some methods had made use of computed information in the sequence of frames. This information had viewed in the form of frame differencing and highlighted in successive frames. From one frame to the other, objects had tracked. Following are the object detection methods are,

- Point Detection
- Background Subtraction
- Segmentation
- Supervised Learning

C. Object Tracking

The object tracking is used to capture the object placed in every frame and it can be detected and processed by generating simultaneously or individually. Firstly, object detection algorithm had been used to detect the probability of occurring object regions and tracker had been used to detect the object in every frames. From the previous frames, object region and correspondence had been simultaneously evaluated by uploading repeatedly the object location and region information. This tracking involves four main methods based on Region, Contour, Feature point and Template by employing shape of the object that could be pointed out.

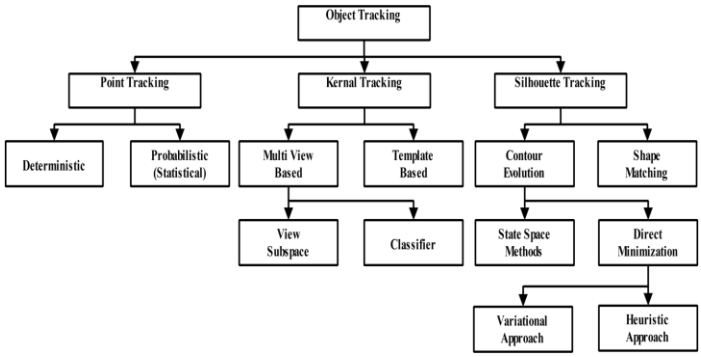


Fig. 1.Classification of Object Tracking

IV. OBJECT TRACKING ALGORITHMS

This journal uses double-blind review process, which means that both the reviewer (s) and author (s) identities concealed from the reviewers, and vice versa, throughout the review process. All submitted manuscripts are reviewed by three reviewer one from India and rest two from overseas. There should be proper comments of the reviewers for the purpose of acceptance/ rejection. There should be minimum 01 to 02 week time window for it. Object tracking algorithm first evaluates the consecutive video frames and gives the output as object trajectory. Several algorithms were provided which has both advantages and disadvantages. Visual object tracking system used to recognize the object in motion which holds two parameters such as; target representation and localization had been used. Algorithm would help for locating and tracking. Blob tracking had been used to track the motion of humans with the efficient contour. This algorithm would be work in high efficiency. Hence the two main parameter algorithms will explains as follows;

1) *Mean-Shift tracking*: This technique is carried repeatedly during frame by construction as parallel measurement which is also called as Kernel-Based tracking.
2) *Contour tracking*: This method is used to track the present location of the object from foregoing frame using tabulating the object boundary. Condensation Algorithm is another way to use this method.
3) *Kalman filter*: It is another type of technique used for object tracking which leads to linear function. Hence the algorithm has an optimal recursive Bayesian filter to measure the parameters and produce tabulation of unknown variables.
4) *Particle filter*: The filter that can distribute useful form of dividing the primary state-space distribution that could have nonlinear and non-Gaussian processes.

V. MEAN SHIFT TRACKING

One of the bigger utilization of object tracking is the mean-shift algorithm. The appearance of the tracking-objects is described as histograms.

The mean shift algorithm is also employed not only for tracking but also the visuals involved. Through this algorithm, a confidence map is generated for the new image. Hence the tracking process is mainly used for the place and color point that holds the probability density function of the new image that are formulated from the color histogram of the object. Thus the algorithm has to identify the high point of a confidence map which is present near the object's old position. The corresponding steps is used to explore the object that could apply during the process is search window size and the beginning position, calculate the mean position and at the mean position computed in previous process.

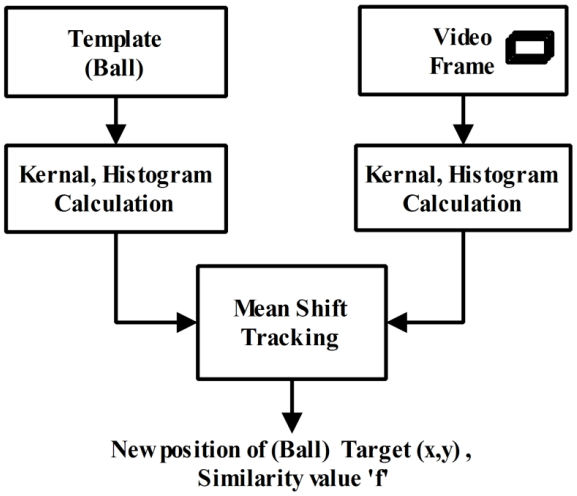


Fig. 2.Block diagram of Mean Shift Tracking

The weighting function is the process used in kernel function. Based on the position of x and y of the pixel, the weighting function permits the selection window to be measured. The kernel functions like uniform kernel function; Gaussian kernel function is the mean shift tracking used to apply. In general the center pixel has the peak weight with decreasing weights for pixels that radiate outwards from the center of the usual kernel. Therefore, through the comparison of the template image and the selection window, the center pixel which has the highest weight is identified to predict either the images are considered as similar in colors or not.

Thus the steps of kernel-based object tracking are given as follows:

The target model { $q_u\hat{}$ }(u =1 2…m, m bins of histograms) is to eliminate the target function which is gained from an elliptic region at y_0 and the target scale it is normalized in its pixel coordinates{ x_i* }.

$$\hat{q}_u = \frac{\sum_{i=1}^{n}(1-\| x_i^* \|^2)\delta(b(x_i^*)-u)}{\sum_{i=1}^{n}(1-\| x_i^* \|^2)} \quad (1)$$

Where n is represents the number of pixels and δ is represents the Kronecker delta function as;

$$\delta(x) = \begin{cases} 1 & x = 0 \\ 0 & otherwise \end{cases} \quad (2)$$

Apply y_0 from preceding an initial position has $\{\hat{p}_u(\hat{y}_0)\}$ estimation in the new frame.

$$\delta(x) = \begin{cases} 1 & x = 0 \\ 0 & otherwise \end{cases} \quad (3)$$

From the above equation calculate,

$$hx_i = \| \frac{y - x_i}{h} \|^2, \sum_{u=1}^{m}\{\hat{q}_u\} = 1 and \sum_{u=1}^{m}\{\hat{p}_u\} = 1 \quad (4)$$

$$\rho[\hat{p}(\hat{y}_0)\hat{q}] = \sum_{u=1}^{m}\sqrt{\hat{p}_u(\hat{y}_0)\hat{q}_u} \quad (5)$$

Denotes the weights for i=1,2,…,n respectively

$$w_i = \sqrt{\frac{\hat{q}_u}{\hat{p}_u(\hat{y}_0)}\delta(b(x_i)-u)} \quad (6)$$

Define the new position for targeting the candidate:

$$g(x) = -k'(x) \text{ for } x \in [0,\infty) \quad (7)$$

$$\hat{y}_1 = \frac{\sum_{i=1}^{n} x_i w_i g(hx_i)}{\sum_{i=1}^{n} w_i g(hx_i)} \quad (8)$$

Calculate the new probability value $\{\hat{p}_u(\hat{y}_1)\}$ for u=1,2,…,m, and define

$$\rho[\hat{p}(\hat{y}_1)\hat{q}] = \sum_{u=1}^{m}\sqrt{\hat{p}_u(\hat{y}_1)\hat{q}_u} \quad (9)$$

Hence the relationship between the new target region and the target region is less than that between the old target region which carries out the remaining operations of this step and estimates the similarity function in this new location

$$\rho[\hat{p}(\hat{y}_1)\hat{q}] < \rho[\hat{p}(\hat{y}_0\hat{q}] \quad (10)$$

$$\hat{y}_1 = \frac{1}{2}(\hat{y}_0 + \hat{y}_1) \quad (11)$$

$$\rho[\hat{p}(\hat{y}_1)\hat{q}] \quad (12)$$

Return to the beginning of this step 6.

1. If $\|\hat{y}_1 - \hat{y}_0\| < \varepsilon$ Otherwise, utilize the new location is started
2. $\hat{y}_0 = \hat{y}_1$, and continue with step 3

ALGORITHM

Step1: Read input video file

Step 2: Detect Ball in first frame using frame differencing

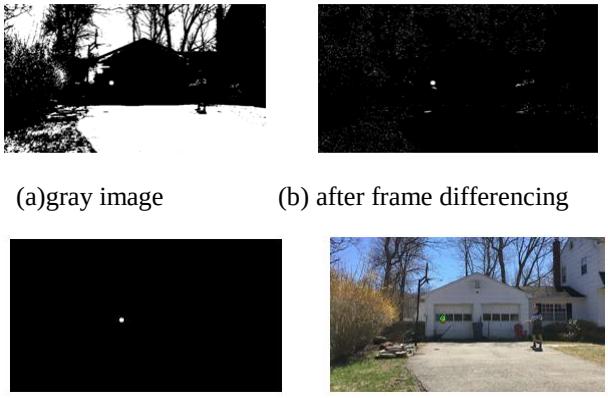
Step 3: create Kernel Density Estimation of the ball

Step 4: converts the RGB ball image to an indexed image using minimum variance quantization and dithering.
Step 5: Create Histogram of ball (template)
Step 6: for i=1: no. of frame
Track ball position using Mean Shift Tracking
Similarity Function
get new position of ball
display it in frame
repeat it for next frame
Step 7: end

The first step in basketball tracking is detecting ball. Hence after read the video file, position of ball in the first frame is extracted using frame differencing method. Here first two frames are subtracted and morphological operations detect the operation and move the ball object. Once ball is detected, kernel density function and histogram of ball is obtained to track the ball using Mean shift tracking.

VI. RESULT AND DISCUSSION

Thus the methodology shows the differential sources of internet usage that are obtained by the each video sequence by frame differencing method and the ball location. This process is recorded by the frame rate and simulated by the MATLAB in various form of sequences. The frame differencing method uses morphological operation like erosion and dilation in order to get the moving basketball and remove unwanted portions.

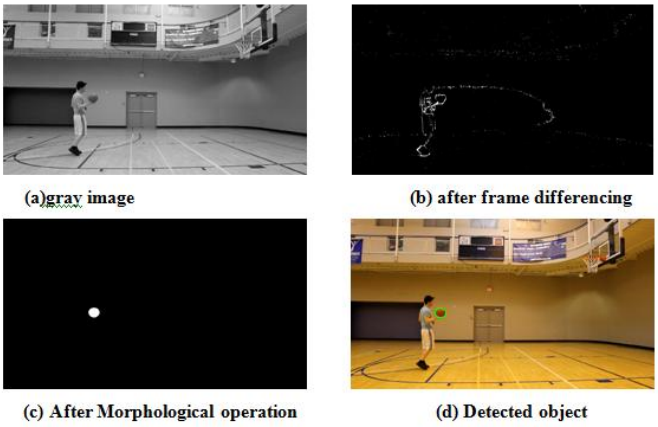


(a)gray image (b) after frame differencing

(c) After Morphological operation (d) Detected object

Fig. 3.ball detection in video1 using frame differencing method

The first step in frame differencing is conversion of color image into gray image which is shown in fig 3(a).after that successive frames to detect the moving object. The resultant image is shown in fig 3(b) and fig 4(b) for different video set. After frame differencing morphological operation is performed to detect object which is shown in fig 3(c) and fig 4(c). Thus the experiment shows the detected ball which is highlighted in original frame as in fig 3(d) and fig 4(d).



(a)gray image (b) after frame differencing

(c) After Morphological operation (d) Detected object

Fig. 4.ball detection in video2 using frame differencing method

The kernel density function and histogram of detected ball is obtained to apply mean shift algorithm. Figure 5 and 6 shows the tracked ball in different frames using Mean shift tracking.

Fig. 5.basketball tracking using MSA in Video1

Fig. 6.basketball tracking using MSA in Video2

Table- II: Name of the Table that justify the values

Video Sequence	Total Frame	Ball frame	Tracked	miss	Precision(%)
Seq1	58	58	53	05	91.3
Seq2	100	95	89	06	93.6

VII. CONCLUSION

In this paper a video analysis method for basket ball tracking using mean shift algorithm is presented. The tracking done in past using different methods are investigated. an efficient approach using mean-shift algorithm to tracking basketball is defined by histograms. The performance of tracking in two video sequences is performed. Experiments in the video sequence show 91.3% precision for video sequence 1 and 93.6% for sequence 2 .

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