Moving Basket Ball Detection and Tracking System by different Approaches

G. Simi Margarat, S. Sivasubramanian

Abstract: This paper presents the detail investigation on different methods used for the basket ball detection and tracking. The object detection and tracking with high performance ratio for video object detection and tracking is achieved in the methods investigated. But most of the methods suffer from computational complexity. The reduction of complexity can happen at any stages of the ball tracking like preprocessing, segmentation, feature extraction, background subtraction and hole filling. The methods investigated in this paper are trajectory based ball-detection and tracking method, region growing algorithm, PSO algorithm and Mean Shift algorithm with HSV color space and texture features. Detail investigation on the approaches, implementation issues and future trends are presented.

Keywords: Basket ball detection, Tracking, Trajectory, Particle swarm optimization, Mean shift algorithm, segmentation

I. INTRODUCTION

The application of the object detection method has spread from a ball detecting system to a pick and place robots. The object is of various types and it has to be identified from a video frame. Normally after detection the objects in the video frame are categorized into various classes such as humans, vehicles and other moving objects []. For example To estimate the number of goals in soccer, image of soccer is mandatory. Barriers, obscurity, objects same as the ball and real time processing were the problems had to be faced. There was a challenge to track and detect the object and some techniques had been developed such as optical flow, frame difference, background subtraction and skin color extraction. This is done by first segmenting a region of interest from video frames and tracking its motion and position []. The other areas of its application are perceptual user interface, remote surveillance, content-based image storage and retrieval, athletic analysis. In literature several authors have presented their contribution towards the detection of the objects.

II. LITERATURE SURVEY

In previous years, more methods had been developed for circle detection which made many impacts on image processing applications. Soccer game had been considered. T. D'Orazio et al(2002) had worked to obtain many results by using modified directional circle Hough transform. To give a change for every image lightning had been varied for each image. This had shown effectiveness in the image sequence. This method had undertaken many experiments to prove that it had high detection score. To identify the location of the ball in Broadcast Soccer Video (BSV), X. Yu et al 2006 had presented the trajectory-based detection and tracking algorithm. Identifying the ball in the frame is very challenge in the case of BSV. While capturing the image some distortion occurred owing to speed of the ball, barrier or fusing with other objects, so direct detection algorithm did not work. To overcome these disadvantages, two-phase trajectory based algorithm had been used. This would first contribute a group of ball-candidates for each frame and calculate them to find total of all ball-trajectories. Here, they had found two ideas, 1) the identification of the ball is highly challenged but locating the ball in the ball-like candidates is quite easy. 2) The study of the direction information of ball was important as it plays major role in soccer. If the ball trajectories were calculated the location of the ball can be easily evaluated. This had revised on advantage; it also can detect the barrier and fusing with other objects. This paper had achieved 81% of efficiency to detect the location of the ball.

Baseball game highly concentrated on pitching contents. Motion of a ball had been used by HUA-TSUNG CHEN et al to track the ball automatically and evaluating the pitch in broadcast baseball video. The detection and tracking was very difficult in broadcast baseball video as it had many occlusions, small-sized ball and high speed of the ball. To overcome those obstacles, balls had been retained but other objects had been filtered. A parabolic curve had been drawn in 2D type in the video frame by analyzing the position of the ball and its trajectory information. To enhance the efficiency on calculation, the unqualified trajectories were eliminated. By predicting the position, missed balls had been known. This presented work had been helpful for the trainers for their training.

Computer assisted games were in trend nowadays. This paper provided the content beyond the practical video evaluation system. There was a design had made to track the ball and projecting 3d trajectory for basketball video and it also figured out the locations. This design was physics-based algorithm. There would a loss in 3D information while projecting in 2D frames. Hua-Tsung Chen et al presented the work to overcome the interference of 2D to 3D by acquiring the knowledge on domain intelligence and physical characteristics of movement of the ball in the tracking system of the object. The 3D trajectories had been constructed by accessing the calibration of parameters while capturing and motion of the ball and concluded by figuring the locations. This work had given the best results for the basketball game.

Tracking and detection of the object is one of the important tasks in security system, monitoring activity and surveillance applications. While detecting the objects, noise had been occurred.

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G. Simi Margarat, Reseach Scholar, Department of Computer Science and Engineering, Bharath University, Chennai (Tamilnadu), India.

S. Sivasubramanian, Principal & Professor, Mohamed Sathak College of Engineering, Chennai (Tamilnadu), India.

In this paper B. Sugandi et al had had presented a new idea by the help of low resolution image. This would ensure the best performance in tracking of the object. h. Shum and T. Komura had presented an idea for calculating the 3D trajectory of a basketball game. In this method, it was necessary to have a single-view television clip. This may used in both live matches and previous matches. It can project the pitch of the ball in 3D trajectory. This method had provided robust in performance and used in trainings for the trainee.

D. Liang et al presented a work for detection and tracking of a ball in broadcast soccer video. Different colors, shapes and size were determined for ball candidates in each frame which would help to track the ball. A weighed graph had been drawn to note the pitch of each ball in alternative frames. Herewith, viterbi algorithm had been used to have knowledge of location of the ball. To track the ball from the consecutive frames, Kalman filter with template had been used. The detection results had been updated in the template for the use of re-detection. They had verified that their results were better than previous work.

W. Chen and Y.J. Zhang developed an algorithm for highlighting the lever to broadcast the table tennis. To track the ball, the color, size and position of the ball candidates was attained using bayesian decision framework. And from this framework, the position of the ball can be identified by Kalman filter.

Kyuhyoung Choi et al had had worked to initiate a new idea for tracking the players and ball in soccer game. Homography transformation had been used to notify the position of the players. And from each frame of a video, the position had been identified. Before that the color of the ball had sequenced in each frame s every frame contained different RGB value. Firstly the players had been tracked by their position and color sensor characteristics. After that, players had been eliminated and the balls had been tracked.
Thomas Pollard and Matthew Antone had worked to invent a system which could track and detect even in the low resolution objects in different shape and size in the wide-area aerial video. This would provide better robust performance than the previous methods as it is efficient in work and trained in 1-megapixel with a single CPU-core.

S. Mohamed Mansoor Roomi and S.Anu karpaga had developed quite simple and good performance fuzzy texture in the video sequence. This would detect the moving object. And this object had been tracked by mean shift tracking algorithm. This had been identified the motion of the object, Kinjal A Joshi, Darshak G. Thakore had presented a tracking and detecting the object in surveillance video. Detection of object is challenging. Tracking of the object is more challenging than detection. For the purpose of detecting the moving objects background subtraction with alpha, statistical method, Eigen background Subtraction and Temporal frame differencing had been used. To track the objects, point tracking, kernel tracking and silhouette tracking had been used. This paper was presented by G Sharmila Sujatha1 and V Valli Kumari1 to track and detect the moving objects as their existing system had failed give the noiseless results in the narrow variations. To extract the feature color, size and motion had been extracted. Efficient motion estimation algorithm had been used to extract the motion of feature. The same had been used for oter feature extraction.

Particle swam methodology had been used by James Kennedy' and Russell Eberhar-1995. One of the models had been suggested and described. Besides this, nonlinear function and neural network training had been put on in this paper. Zoran Zivkovic and Ferdinand van der Heijden had used repeated equations which would used to renew the sections of Gaussian mixture model and for every pixel components had been determined. Beside this, simple non-parametric adaptive density estimation method had been switched on. Bogdan Kwolek-2009 had presented a work for tracking the object in the surveillance video by using particle swam optimization. For the purpose of covering the exact position, Gaussian distribution had been found. An algorithm for tracking had been combined to ccovariance in order to know the perfect location by avoiding some barriers.

To recognize the complex multi-player behavior, q Matej Perše et al worked on trajectory-based approach. In a player trajectory, play model had been enforced which would split up the play into game phase. At last, by comparing this project with manual work it had been effected in a better way. To reduce the background intervention in the target location, J. Ning1 et al had presented corrected BWH. Here, transformation occurred only in the transformation model and not in the transformation candidate model. It is effective on high convergence and correct location. To obtain a better result while tracking and to get same results, Yi Wu et al had presented the state-of-line-art online object tracking algorithm. This had been evaluated with before algorithm results and it had been concluded with good coming results.

Tomas Vojir et al had worked to solve the problem on scale adaptation. This had been solved by applying trusted scale estimation algorithm which was trusted on mean-shift procedure for the purpose of helinger distance. This had given two improvements on mean-shift tracker which had made scale estimation a better performance in the background cutter. This work had been given better results than the state-of-the-art algorithm. It had got a good outcome of 30% of the sequences than the previous reference algorithms.

Fei Feng et al developed a combo of mean shift method and adaptive local object tracking algorithm, in order to enhance the robustness of kernel correlation filters (KCF). A confidential map had been evolved in order to track the object. If the KCF is not providing better results, the mean shift algorithm had been used. This had been effective than the previous one.

III. INVESTIGATION ON FRAME DIFFERENCING METHOD

Figure.1 represents the block diagram of this method. Initially, frame differencing method of background subtraction had used in segmenting the moving object in every frame. This had been worked out by taking three successive frames for simultaneous processing.

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After segmenting, morphological operations had been executed in order to bridge the gaps and eliminate the noise. In order to differentiate the objects in motion in the background, an edge detection technique had been exploited. A group of ball candidates and the objects which had looked like balls were obtained in the segmentation results and from that the ball candidates had been strained according to their color, shape and compaction trait of the ball range. While pointing the ball candidates' centroid location over time, the generation of 2D candidate generation plot had been done. By proceeding trajectory growing process, a group of ball trajectories were formed. By figuring out the physical motion and the trait of the ball trajectory, the true trajectory of the ball can be determined. To detect the missing ball trajectories, trajectory interpolation had been done and on the original frame the calculated trajectory had been overlying. This would help to determine the ball position along with the trajectory.

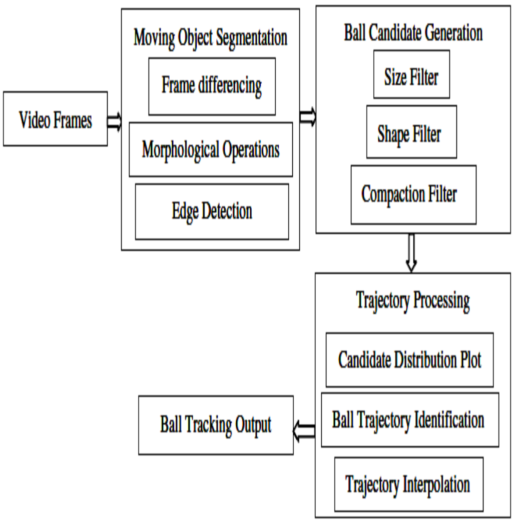

Figure 1: Block diagram for position estimation and tracking of a basketball from a real time video

The investigated framework are mentioned below

The integrated framework had been proceeded for detecting and tracking of the ball automatically for a long-shot arrangement of basketball video. At least two distinct methods had been used in this frame work: Feature-based algorithm had been used to achieve the group of ball candidates in each frame and to test the location of the ball in consecutive frames, data association algorithm based tracking operation is used.

The objects which were moving in the foreground in a complex and in the case of background, changeable scene in presence of different moving objects were segmented by a robust and fast background subtraction algorithm. In order to reduce the time for computation, it is unnecessary to detect and eliminate the stationary objects such as border lines, basketball board boarders.

Reduction of non ball objects in the frame had been done by using the characteristics of size, shape and compaction. This had been used to generate less number of ball candidates in the trajectory process and deduce the computational time.

As the color of the ball was not needed for tracking and detecting, it had eliminated. This would reduce the wrong detection while the color of the ball changes from each frame with high speed in motion.

In the trajectory processing phase, the location of the ball in the consecutive frames had been determined by a simple prediction function and it had been predecessor to the best finding technique that was applied to the quadratic functions employing statistical regression analysis. From a group of path, the trajectory of the ball had found out by the physical features of the ball trajectory. Interpolation technique had been used to recover the location of the ball which had missed.

Elimination of complication calculation to assess camera parameters and reduction of calculation complexity of the algorithm which was possible by obtaining the input from a single camera.

Highlights -Moving object segmentation & Background subtraction

Background subtraction method had been used to segment the objects in moving position present in the moving frame. The simple frame differencing method had been used to employ the background subtraction. Equation (1) represents calculation of the intensity difference between every two successive frame and for obtaining foreground pixels using threshold.

Eq. (1).

$$\text{Intensity}_n(i,j) \quad \begin{cases} 255, \text{if } |\text{Intensity}_n(i,j) - \text{Intensity}_{n-1}(i,j)| > Ts \\ 0, \text{Otherwise} \end{cases} \qquad (1)$$

Where, n represents the number of frames and T_s represents the threshold value. Three successive frames were used to perform the difference in these frames as between f_n, and f_{n-1} and f_n, and f_{n+1}. Equation (2) and (3) represents the d_{n-1}, and d_{n+1} which denotes the frame differencing in the output image. Separation of the object in motion in background had done by employing judicially selected threshold T_d on these images.

$$d_{n-1} = |f_n - f_{n-1}| \qquad (2)$$

$$d_{n+1} = |f_n - f_{n+1}| \qquad (3)$$

$$d_N(i,j) = \begin{cases} 1, \text{if } d_N(i,j) > Td \\ 0, \text{Otherwise} \end{cases} \qquad (4)$$

$$\text{Where} N = n-1 \text{and} n+1,$$

For finding the similarity between the two different images, AND operation had been done between them.

$$d = d_{n-1} \cap d_{n+1} \qquad (5)$$

The unwanted moving objects in the foreground were eliminated which would quash the background using equation (5).

Morphological operations

For filling the holes arose by the motion of the objects which are in the moving position, morphological operations were performed. This operation would decrease the noise arose because of the discontinuation in the motion of the camera.

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Morphological operation could be categorized into three types: morphological opening, closing and dilation. Input image A had been processed to the morphological operation by the structuring element B and it is expressed below.

$$A \circ B = \bigcup (B + x : B + x \subseteq A) \qquad (6)$$

Smoothening of object contour and due to discontinuation in motion thin projections were broken, done by the morphological opening operation. To perform the join narrow breaks and filling the holes in the segmented image, morphological closing operation had been done. This is expressed mathematically in equation (7).

$$A \bullet B = (A \oplus B) \otimes B \qquad (7)$$

Performing the changes in the boundary region of foreground pixels and filling the holes in the boundary were done by morphological dilation. This operation can be done in both binary operations as well as in grey images with a little change. Input image A had been undertaken to the morphological dilation by a structuring element B and is expressed by the equation (8).

$$A \oplus B = \bigcup \{B + a : a \in A\} \qquad (8)$$

Edge detection

Discontinuation occurred in the intensity value of the segmented images were detected using edge detection technique. Due to the motion of the camera and the object in the foreground discontinuities occurred. Canny edge detector [30, 31] had used to detect the edges because of its highest detecting capability of the strong and weak edge simultaneously. Noise had been removed using a Gaussian filter. The derivative of the Gaussian filter image gives the gradiant magnitude and direction of the edges.

$$|G| = \sqrt{g^2{}_x + g^2{}_y} \text{and} \theta = \tan{-1}\left(\frac{g_y}{g_x}\right) \qquad (9)$$

Edges were defined as the local maxima of the gradient magnitude image. Edges were detected by thresholding twice. Strong edges were included to the final edges and but weak edges were included only if they were associated with strong edges.

$$C_D = P^2 / 4\pi A \qquad (10)$$

Trajectory processing

From a group of ball candidates, a group of trajectories were generated at that time a detection and tracking algorithm on the basis of trajectory had been used. This would help to identify the ball on the basis of its trajectory information and the missed out ball due to some barriers. In a parabolic path the ball moves in the time of long shot sequence of a basket ball game. For indicating the trajectory of the ball, a 2D distribution evaluation of the ball candidates was used. By pointing the ball candidates' centroid location, generation of candidate distribution plot had been done. This plot would help to point out the ball candidates' location in each frame. Ball is meant as the moving object in all the frames of the basket ball game. A path which is smooth and long parabolic trajectory path is the trajectory path of the ball. Other objects would have small or no projections. Plotting of the 2D ball candidates were presented in Figure.2.

Ball trajectory identification

The ball trajectory had been identified from the set of candidate trajectories which was generated from the candidate distribution plot. Figure 2. represents the trajectory generation algorithm. Ball candidates were linked with its successive frames. The equation (11) represents the prediction function used to give the ball location.

$$y = a \bullet n^2 + b \bullet n + c, a > 0 \qquad (11)$$

To predict the ball location a threshold of prediction error had been used. For every ball the best-fitting quadratic equation had been calculated by the statistical analysis. Until the predicted location match the original location, predicted function continued to predict the location of the ball candidates. The trajectory is being stood up to the vertical frame and ball locations were pointed out by the predicted locations in the intermediate frames. Intermediate frames were not said to be missing frames. The procedure for trajectory growing would come to an end, when the number of consecutive missing frames is greater than the threshold value. The algorithm then recognized the new pair of ball candidates in the upcoming frames and iterated the procedure.

From the group of candidate trajectories, the ball trajectory had been identified and the consideration of the physical features of the motion of the ball had been done. Consideration of prediction error would lead to take off the ball trajectory from the group of candidate trajectories. The average distance of each predicted ball location and the original ball location determined the predicted error. Sufficient error tolerance determined the prediction error's threshold. The candidate trajectory with high value of prediction of error was dropped off. On the basis of trajectory length, shape and prediction error, the trajectory of the ball had been determined.

Trajectory interpolation

By using trajectory interpolation, the missed ball positions were determined. Equation 11 gives the ball location by the trajectory. This had been evaluated by the ball candidate location in the frame.

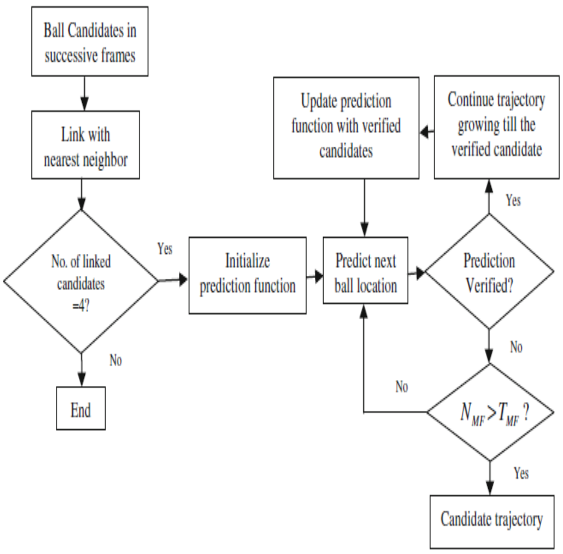

Figure 2: Flowchart of the candidate trajectory generation algorithm

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IV. EXISTING METHOD MODIFIED REGION GROWING ALGORITHM

Modified region growing algorithm had been used to detect the object in motion. Multi features threshold value had been used to track the detected objects. Input is give as the video from the database. This video had been segmented into any frames. Here, (V_d) represents the video database and $\{v1_{i,j}, v2_{i,j} \ldots v\, n_{i,j}\}$ represents the sum of frames in the video.

To avoid noise, adaptive median filter had been used in the pre-processing stage. In this stage, segmentation had done using median region growing algorithm. Frame differencing method had been used to reject the background in the video frame. Many features such as color, texture, motion, wavelet, edge had been obtained from both segmented frames and its related background frame. Block matching algorithm had been used to calculate the distance from background frames to segmented frames. Then comparison occurred between the results and the threshold value. If the result is as same as the threshold value, it is registered as foreground object where it used for morphological closing and opening operations for the purpose ignoring the holes and useless breaks presented in it.

3.1. Investigated framework blocks,

i) Pre-processing was implemented using the adaptive median filter

ii) Object detection was done using the Modified region growing algorithm

iii) Feature extraction -Color, Texture, Motion, Wavelet, Edge, Mean, Standard deviation and Skewness

iv) Hole filling was performed with Morphological operation.

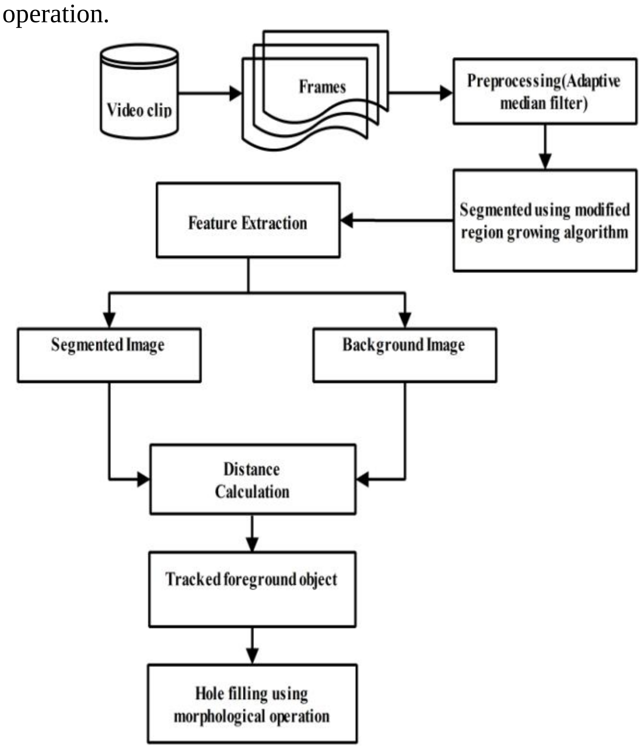

Figure 3: Architecture of the Region Growing Algorithm Preprocessing by utilizing Adaptive Median Filter (AMF)

Since at a high noise level, AMF filter had been used to eliminate the noise. This filter would reject the 90% of salt-and-pepper noise. It is necessary to eliminate the noise in the image to obtain better accuracy. On the basis of local statistics characters, performance of Adaptive Median Filter had been done. By checking the difference in the standard deviation of the pixel present inside the filter window and associate current pixel, the impulse could be detected.

(V_d) represented the video which consists of n numbers of video frames. Let $v_{i,j}$ represents one of the grey level frame. Let v_{min}, v_{max} represents the lower and upper bounds of the image v .

$$V_{min} \le V_{i,j} \le V_{max} \forall (i, j) \in a, a \equiv \{1,2,...m\}x\{1,2,...n\} \quad (12)$$

Probability of the pixel location (i, j)for the grey level image v had given below,

$$P_{i,j} = \begin{cases} V_{min}, \text{with probabality } p_x \\ V_{max,} \text{with probabality } q_x \ n \\ V_{i,j}, 1-p-q \end{cases} \quad (13)$$

$$\text{The noise level, } n(l) = p_x + q_x$$

There were an engage of V_{min} , v_{max} , Local mean value $l(\mu)$ of the moving window and Local standard deviation $l(\sigma)$. Coupling had been done between the standard deviation and a user defined multiplier upper and lower bounds by the means of local mean.

Object detection

Segmentation using modified region growing algorithm:

On basis of seed point selection, segmentation had been done in the image segmentation region growing technique which was meant as a best method. On the bass of intensity threshold, the seed points had been selected by the normal Region Growing Technique, which had caused to over-segmentation or holes owing to noise or fluctuation in intensity. Shadings of real image would not be differed in the usage of normal region growing technique. In the pre-processing stage, while selecting the seed points, the intensity and orientation threshold had to be included for eliminating these limitations. The MRG technique had been given in the step wise.

Step 1: Compute the gradient of the frames for x-axis and y-axis and consider it as ($\hat{g}x_{rd}$) and ($\hat{g}y_{rd}$) .

Step 2: To get the gradient vector GV, the gradient values should integrated according to the equation given below

$$GV = \frac{1}{1+\left(gx^2{}_{rd} + gy^2{}_{rd}\right)} \quad (14)$$

Step 3: Modify the gradient vector value from radians to degrees for obtaining orientation values.

Step 4: Split up the image into grids grd_i.

Step 5: Attain the intensity threshold as ($I_{(thld)}$) and orientation threshold as($O_{(thld)}$).

Step 6: until the number of grids equals the sum of grids for an image, continue the previous given procedures in step 7 regarded to every grid grd.

Step 7(a): Pick out the histogram (hsgm) of each pixel in grd_i.

step 7(b): Pick the most frequent histogram of the grd_i^{th} grid and it denoted as $Freq_{(hsgm)}$.

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Step 7(c): Choose any pixel, as per $Freq_{(hsgm)}$ and point out that pixel as the seed point which has the intensity (Iy_p) and Orientation (On_p).

Step 7(d): The intensity and orientation of the neighboring pixel is represented as (Iy_n) and (On_n) .

Step 7(e): Analyze the parameters of intensity and orientation on the behalf of pixels p and n by the equations shown below,

$$dif_{int} = \left\| Iy_p - Iy_n \right\|$$
$$dif_{orient} = \left\| On_p - On_n \right\| \qquad (15)$$

Step 7(f): Region should be grown by adding the related pixels when $dif_{int} \leq I_{(thld)}$ && $dif_{orient} \leq O_{thld}$, else step to 7(h).

Step 7(g): Check out whether all the pixels were added to the region. If yes, step out to step 6 else step to step 7(h).

Step 7(h): Re-examine the region and locate the new seed points and perform the procedure from step 7(a).

Step 8: Stop the whole process. Herewith, the object in motion had been split from the video frame by using modified region growing algorithm.

Feature extraction

Regarding the segmented and the background image, multi-features such as color, texture, motion, wavelet, edge, mean standard deviation, and skewness were extracted in the time of feature extraction stage of our technique.

Color feature

The color feature had been extracted by employing histogram on the video frame. This histogram gives the summary in a compactable size of the data distribution in the image or the video. Firstly, re-sampling process had been executed for the image and secondly, anisotropic diffusion process had been accomplished. Finally for the anisotropic diffused image, histogram had been employed.

While constructing the color histogram, process of transformation and quantization had been done. First, transformation of image colors to the apt color space and at last, by using specific code block of size K, quantization had been done.

$$I(h)i = \frac{n_{ocr}}{N}, 0 \leq i < gl \qquad (16)$$

Where, g_l represents the sum of number of gray levels in the image, n_{ocr} represents the number of occurrences of gray level i . N represents the sum of number of pixels in the image, and $I_{(h)}i$ represents the image histogram for pixel value i .

Texture feature (LGXP)

In this technique, Texture feature extraction had been done by using local gabor xor patten. For quantized phases of the central pixels and its neighbor, LGXP had applied. The below equation illustrate the mentioned parameters.

$$LGXP^{g}_{\mu,h} = q(\varphi_{\mu,h}(Z_c) XOR_q(\varphi_{\mu,h}(Z_i)) \quad (17)$$

Where $LGXP^{g}_{\mu,h}$ (K=1,2 ,..., K) , = = signifies the pattern calculated between $\phi_{\mu,h}$ (i) and its neighbor z_c , $\phi_{\mu,h}$ (z_c) represents the phase, q ($\phi_{\mu,h}(z_i)$) represents the quantized value of the phase and $\phi_{\mu,h}(l)$, represents the position of the central pixel in the Gabor phase map of scale w and orientation µ, k represents the neighborhood size.

At last the related binary labels were made to form a local pattern of the central pixel.

$$LGXP_{\mu,h}(z_c) = [LGXP^{k}_{\mu,h}, LGXP^{k-1}_{\mu,h,\ldots,LGXP^{1}_{\mu,h}}]_{binary} = \sum_{i-1}^{\wedge} 2^{i-1}, LGXP^{i}_{\mu,h}$$

(18)

Object tracking using dissimilarity calculation

Comparison taken place between the segmented image features and the background image features in the time of object tracking phase, calculation done for dissimilarities between them. The result had been compared with the threshold value (η)). Dissimilarity calculation had given below,

$$trackedobject = \begin{cases} correct, (\eta) \leq disimilaritry \\ notcorrect, (\eta) > disimilaritry \end{cases} \qquad (19)$$

When the distance of the object equals the threshold condition in the equation mentioned above, then the object had meant to track. The tracked object would initiate for post processing. Elimination of holes and discontinuities of the tracked object had done by morphological operation in the pre-processing stage.

Post processing using morphological operation

Holes and discontinuities had found in the site of object tracking by dissimilarity calculation and these were eliminated using morphological operations such as erosion and diffusion. After the performance of erosion and diffusion operation which would eliminate the intensity of the image or it would brighter than the original image

V. INVESTIGATION AND ANALYSIS OF BASKETBALL FREE THROW TRAJECTORY USING PSO ALGORITHM

Basketball Detection

This method would pave the way for trajectory of the basketball free throw by ball detection. For the purpose of initialize the tracking automatically and in the time of trajectory failure to re-detect, ball-detection method had been used. Background subtraction algorithm had been used to extract the moving objects (Zivkovic and van der Heijden, 2006). Two conditions were checked for every object after the process of extraction: If both cases were true, the object had termed as ball. First the size of the object had been compared with the ball radius by computing the radius of the object in the outer side. The firs condition was in the form as given below,

$$| r_o - r_b | < m \qquad (20)$$

where r_o represents radius of outer circle of the object, r_b represents radius of the ball and m represented as margin factor, whose value was confirmed at 22% of r_b. The second condition applied the circularity factor $f_c = 4\pi A/P^2$ where A represents the area of the object and P represents the perimeter of the object. If the object is excellently round in shape, value of f_c equals 1. The second condition is in the form:

$$T_c < f_c, \qquad (21)$$

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where T_c represents the circle threshold which is equal to 0.78. Values of m and T_c had been termed experimentally. Tracking process had been allowed, when both the conditions satisfied the object. Besides to remove the risk in tracking, elimination taken place for the objects before the free-throw line and below the height of 1.5 metre.

Ball Tracking

Particle swarm optimization algorithm (PSO) (Kennedy and Eberhart, 1995) had been used for tracking the ball. This method had been well-versed for solving problems regarding ball tracking. (Kwolek, 2009; Kwolek et al., 2012). Regarding to get a best solution, particle swarm had been used from PSO algorithm. In the time of estimation, particles analyze the search space and then information had been exchanged. Every i-th particle consists of the present position as x_i , velocity as v_i, and its best position as $pbest_i$. The best global position gbest, had accessed by the particle, which could be done by any particle in the swarm. The velocity of d-th component and every particle's position were updated by te given solutions.

$$v^{k+1}{}_{i,d} = w[v^{k}{}_{i,d} + c_1 r_1, d(pbset_{i,d} - xk_{i,d}) + c_1 r_1, d(pbset_{i,d} - xk_{i,d})],$$

$$v^{k+1}{}_{i,d} = x^{k}{}_{i,d} + v^{k+1}{}_{i,d} \tag{22}$$

where ω represents the constriction factor, c1, c2 represents the positive constants and $r_{1,d}$, $r_{2,d}$ represents the uniformly distributed random numbers. On the basis of fitness function value, the best position for i-th particle ($pbest_i$) and best global position (gbest) were selected which would analyze the image which had been considered is the tracked object or not. Hypothetical position of the ball had employed in the position of the i-th particle.

VI. INVESTIGATION AND ANALYSIS OF AN OBJECT TRACKING METHOD BASED ON MEAN SHIFT ALGORITHM WITH HSV COLOR SPACE AND TEXTURE FEATURES

Mean Shift algorithm based object tracking

On the basis of Bhattacharyya coefficients, feature matching process had been done using mean shift based target tracking. Similarity had been occurred between target model and candidate object model and is defined below,

$$p(y) = p[p^\wedge(y), q^\wedge] = \sum_{u=1}^{m} \sqrt{p^\wedge{}_u(y) q^\wedge{}_u} \tag{23}$$

where p^ (y) represents the candidate target model at y place, q^u represents the target model, m represents feature numbers in feature space, expand the equation by Taylor formula at y0:

$$p(y) = \frac{1}{2}\sum_{u=1}^{m}\sqrt{p^\wedge{}_u(y_0)q^\wedge{}_u} + \frac{Ch}{2}\sum_{u=1}^{m} w_i k\left(\| \frac{y-x_i}{h} \|^2\right)(6)$$

where

$$C_h = \frac{1}{\sum_{i=1}^{n_h} k\left(\| \frac{y-x_i}{h} \|^2\right)} \tag{24}$$

And

$$w_i = \sum_{i=1}^{m}\sqrt{\frac{q^\wedge{}_u}{p^\wedge{}_u(y_0)}}\delta(b(x*_i)-u)$$

$$\frac{1}{2}\sum_{u=1}^{m}\sqrt{p^\wedge{}_u(y_0)q^\wedge{}_u} \tag{25}$$

Eq.25 is a fixed value, so when $\frac{Ch}{2}\sum_{u=1}^{m} w_i k\left(\| \frac{y-x_i}{h} \|^2\right)$ get maximum value, the ρ (y) will also go maximum, then:

$$y_1 = \frac{\sum_{i=1}^{n} x_i w_i g\left(\| \frac{y_o - x_i}{h} \|^2\right)}{\sum_{i=1}^{n} w_i g\left(\| \frac{y_o - x_i}{h} \|^2\right)} \tag{26}$$

$$where\, g(x) = -k'(x)$$

HSV color model

HSV color model is one of the models which would suit for human visual perception. This model can be pictorially represented by an inverted cone as given below. HSV are considered as cylindrical geometries with hue and their angular dimension initiating at the red primary at 0◦ and travelling through the green primary at 120◦ and then to the blue primary at 240◦ then wrapping again to the red at 360◦. For representing the HSV color space, simple color had been chosen. Each weight of HSV had been quantized and they were tabled as in Table 1. Simply classify the colors in the VS coordinate system, When the color is nearby the centre axis and without the respect of the line, then it is said to grey in color. The color is said to be black when $v \le 0.2$, the color is said to be white when $s \le 0.2$ and $v \ge 0.7$, light grey, grey and dark grey would section their color space when $s \le 0.2$ and $0.2 < v < 0.7$. In other area, when h=0, it is said to be red. The color is said to be light red when $0.2 < v < 0.7$ and $v \ge s$, the color is said to be red when $0.2 < v < s$ and the color is said to be dark red when $0.2 < v < s$. Entire color frames would represent by using 7 * 3 + 5 = 26 bins. Figure 4(a) and (b) shows the HSV color model and color wheel used in the analysis.

$$h\begin{cases} 0h \in [0^o, 22^o] \cup (330^o, 360^o) \\ 1h \in [22^o, 45^o] \\ 2h \in [45^o, 70^o] \\ 3h \in [70^o, 155^o] \\ 4h \in [155^o, 186^o] \\ 5h \in [186^o, 278^o] \\ 6h \in [278^o, 330^o] \end{cases} \tag{27}$$

Eq.27 is the Quantization of hue weight

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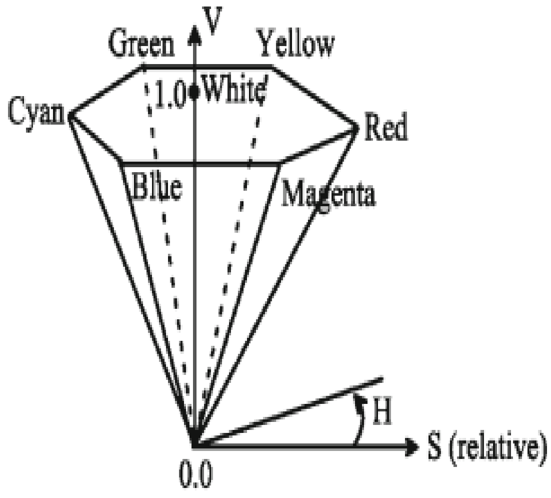

Figure 4(a): HSV color model

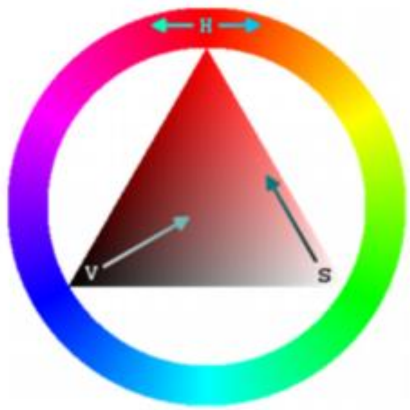

Figure 4 (b): HSV color wheel

Local binary patterns for texture feature representation

In order to classify the computer vision, Local Binary Pattern (LBP) had been used which is a type of visual descriptor. LBP had been presented in the year 1990, which is the Texture Spectrum model. It was first characterized in the year 1994. So far it been influenced for texture classification. Detection performance can be improved in some data sets when LBP had been combined with Histogram of oriented gradients (HOG) descriptor. In this way, the window of 3 by 3 can be encoded to an 8-bit binary array. The main defect of this LBP operator is to cover a few areas within a fixed radius. Ojala et al. [6] had done some improvisations for the LBP operator. This had done by increasing 3x3 windows to any further neighborhood and would replace the square neighborhood by circular neighborhood. This would enhance the different scales' texture feature and obtain the grey scale requirements and rotation invariance.

The LBP operator is defined as follows:

$$LBP_{P,R}(x_c, y_c) = \sum_{p}^{p-1} x(g_p - g_c)2^p \quad (28)$$

where P represents the number of pixels in the neighborhood. R represents the radius. g_p represents the gray value of P pixels which regards the pixel point (x_c, y_c) as the center point, and R as the radius of the neighborhood. g_c represents the gray value of the center pixel (x_c, y_c).

As the characteristics of LBP were not described in a better way and rotation invariance had not given, [7] had made some improvements in LBP operator and that was described as shown: Where U $LBP_{P,R}$ said to be the sum of jumps of the number of LBP binary like 0 to 1 and 1 to 0 said to be interference factor and the absolute value of R would be greater when the tolerance of the change of grey value is greater.

Mean Shift algorithm fusing color feature and texture feature

Target tracking had been done by involving both mean shift algorithm and color histogram of statistical information. But this would present for the proportion of different colors in the entire image alone not describing the space position of each color. In this paper, block method would consider the color space information. But the target area had divided into nine parts in the time of real-time process. While the weight had considered to each block, difference in contribution of centre position and edge position of model had highlighted. For every block, a joint histogram of the color and texture of current block had been employed.

VII. RESULT AND DISCUSSION

The investigation is carried out on the implementation of the existing methods.

In method 1 based on tragectory, to replicate the function the algorithm is tested with a video file containing the moving basket ball as shown in Figure 5.(a). The results after moving object segmentation using three-frame difference method is shown in Figure 5(b). , The morphological operation is performed (5(c) followed by the edge detection method(5(d)).

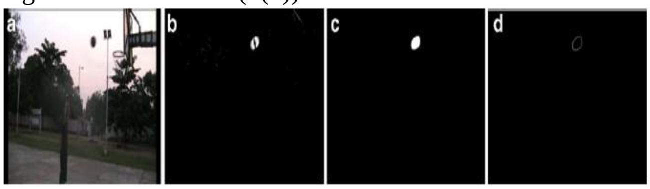

Figure 5: Moving object detection method. a Original frame, b Moving object segmentation using three-frame difference method, c ball image after morphological operation, d ball image after applying edge detection method

The frame length used was between 90 to 140 with a total of 344 frames. Out of 344 frames, in 331 the ball is detected with the detection rate of 96.33% accuracy. 13 frames were falsely detected. Similartly out of 93 frames the ball tracted was 93 with a 100% precision.

In this method 2 the authors have reported the specificity in addition to accuracy and detection rate. The altered region growing method shown a 98%, 84% and 99% for accuracy, specificity and detection rate respectively. The reported results were compared with the Fuzzy C-means algorithm which shown a 97%, 77% and 98% for accuracy, specificity and detection rate respectively.

The comparison of the accuracy of the four methods investigated is shown in table 1. From the table it can be observed that the most of the methods have accuracy nearer. The variation in the implementation and complexity varies.

Table 1: Comparison table for the accuracy of investigated methods

Method	Accuracy%
Method1(Trajectory Based)	96
Method2(Modified Region Growing)	98
Method3(PSO Based)	98
Method4(MS With HSV)	98

The PSO method is analyzed with respect to average tracking time which was not done in other methods. The average time occupied for the tracking was 0.2s. But this time varies with the processor speed of the system on which the software or program been executed.

VIII. CONCLUSION

Various methods and algorithms for the detection of objects and ball tracking are presented in this paper. For investigation four different methods were chosen. The methods have their own advantages and disadvantages. The accuracy of the methods are investigated. Methods like trajectory detection, region growing, particle swarm optimization and HSV were analyzed. In future a new method will be proposed to detect the trajectory of the ball movement.

REFERENCES

1. D'Orazio T, Ancona N, Cicirelli G and Nitti M, "A ball detection algorithm for real soccer image sequences", in Proc. of 16th International Conference on Pattern Recognition, vol. 1, pp. 210–213, 2002.
2. Yu X, Leong H W, Xu C and Tian Q, "Trajectory-based ball detection and tracking in broadcast soccer video", IEEE Trans. Multimed., vol. 8, no. 6, pp. 1164–1178 ,2006.
3. Chen H T, Chen H S, Hsiao M H, Tsai W J and Lee S Y, "A trajectory-based ball tracking framework with visual enrichment for broadcast baseball videos", J. Inf. Sci. Eng. 24, pp. 143–157, 2008.
4. Chen H T, Tien M C, Chen Y W, Tsai W J and Lee S Y, "Physics-based ball tracking and 3D trajectory reconstruction with applications to shooting location estimation in basketball video", Elsevier Sci. J. Vis. Commun. Image Represent. 20, pp. 204–216, 2009.
5. Sugandi B, Kim H S, Tan J K and Ishikawa S, "Tracking of moving object by using low resolution images", in Proc. Of International Conference on Innovative Computing, Information and Control, pp. 408–411, 2007.
6. Nepal S, Srinivasan U and Reynolds G, "Automatic detection of 'goal' segments in basketball videos", in Proc. of the 9th ACM International Conference on Multimedia, pp. 261, 2001.
7. Shum H and Komura T, "A spatiotemporal approach to extract the 3D trajectory of the baseball from a single view video sequence", in IEEE International Conference on Multimedia and Expo, pp. 1583–1586, 2004.
8. Liang D, Liu Y, Huang Q and Gao W, "A scheme for ball detection and tracking in broadcast soccer video", Springer Berlin, vol. 3767, pp. 864–875, 2005.
9. Chen W and Zhang Y J, "Tracking ball and players with applications to highlight ranking of broadcasting table tennis video", in Proc. of IMACS Multi conference on Computational Engineering in Systems Applications, pp. 1896–1903, 2006.
10. Choi K, Park B, Lee S and Seo O, "Tracking the ball and players from multiple football videos", Int. J. Inf. Acquis. World Scientific Publishing Company, vol. 1, no. 8, pp. 1-8, 2006.
11. Pollard and Anton, "Detecting and tracking all moving objects in wide-area aerial video", In Computer Vision and Pattern Recognition Workshops (CVPRW), IEEE Computer Society Conference, pp. 15-22, 2012.
12. Roomi and Karpaga, "Detection and tracking of moving objects by fuzzy textures",Computing, Communications and Networking Technologies (ICCCNT), 2013 Fourth International Conference on Tiruchengode, pp. 1-5, 2013.
13. Kinjal and Darshak, "A Survey on Moving Object Detection and Tracking in Video Surveillance System", International journal of soft computing and Engineering, vol. 2, no. 3, pp. 44-48, 2012.
14. Sharmila Sujatha G and Prof. Valli Kumari V, "An Efficient Motion Based Video Object Detection and Tracking System", International Conference on Innovative Trends in Electronics Communications and Applications" (ICIECA15), vol. 1, no. 13, pp. 85-97, 2015.
15. Kennedy J and Eberhart R, "Particle swarm optimization", In Proc. of IEEE Int. Conf. on Neural Networks, vol. 4, pp. 1942–1948, 1995.
16. Zivkovic Z and van der Heijden F, "Efficient adaptive density estimation per image pixel for the task of background subtraction", Pattern Recogn. Lett., vol. 27, no. 7, pp. 773–780, 2006.
17. Kwolek B, "Object tracking via multi-region covariance and particle swarm optimization", 11th IEEE Int. Conf. on Advanced Video and Signal Based Surveillance (AVSS), pp. 418–423, 2009.
18. Perˇse M, Kristan M, Kovaˇciˇc S, Vuˇckoviˇc G and Perˇs J, "A trajectory-based analysis of coordinated team activity in a basketball game Computer Vision and Image Understanding", Computer Vision Based Analysis in Sport Environments, vol. 113, no. 5, pp. 612 – 621, 2009.
19. Ning J, Zhang L and Zhang D et al, "Robust mean shift tracking with corrected background-weighted histogram", IET Comput. Vis., vol. 6**,** n**o.** 1, pp. 62–69, 2012.
20. Yi Wu, Jongwoo Lim and Ming-Hsuan Yang, "Object Tracking Benchmark", IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 37, no. 9, pp. 1834–1848, 2015.
21. Vojir T, Noskova J and Matas J, " Robust scale-adaptive mean-shift for tracking", Pattern Recognition Letters, vol. 49, pp. 250–258, 2014.
22. Feng F, Wu X J and Xu T, "Object tracking with kernel correlation filters based on mean shift", 2017 International Smart Cities Conference, 2017.
23. Pawel Lenik, Tomasz Krzeszowski, Krzysztof Przednowek and Justyna Lenik, "The analysis of basketball free throw trajectory using PSO algorithm", 3rd Int. Congress on Sport Sciences Research and Technology Support, pp. 1-7, 2015.
24. Sharmila Sujatha G and Prof. Valli Kumari V, "An Innovative Moving Object Detection And Tracking System By Using Modified Region Growing Algorithm", Signal & Image Processing : An International Journal (SIPIJ), vol. 7, no. 2, pp. 39-55, 2016.
25. Jinhang Liu and Xian Zhong, "An object tracking method based on Mean Shift algorithm with HSV color space and texture features", Springer, pp. 1-12, 2018.
26. Bodhisattwa Chakraborty and Sukadev Meher, "A real-time trajectory-based ball detection-and-tracking framework for basketball video", Springer, vol. 42, no. 2, pp. 156-170, 2013.

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