International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 4, Issue 9
September 2017

Comparative Estimation of Trajectory based Tracking System and Impact of Subsequent on Projectile Course in 3-D Utilizing Motion Technique

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ABSTRACT:
There are various approaches to estimate the trajectory based tracking system and subsequent brunt point of a projectile course. The mainly methods are more accurate and require a lot of input data, but some others methods are fairly trivial and less accurate. It will investigate a video demonstrating a projectile flying through the air, and before the shot will achieve its goal, the framework will show on screen the staying of its course including its arrival area. In first stage, will fabricate a framework that recognizes question and following article in mid-air, compute the 3-D position vector of protest. It will predicts its residual course in 3-D utilizing a Projectile Motion Theory and outline its anticipated course on 2-d unique picture and anticipated way super forcing on the video. The system is automatically analyzing long-shot using trajectory-based object tracking method from a given sequence of video. The accuracy of a long-shot in a game is mostly dependent on the object throwing angle and the velocity at which the object is to be thrown. The given system detects and tracks the object in a long-shot sequence by exploiting the trajectory information of the object. The object motion characteristics are used to determine the object trajectory. The trajectories are generated a set of object candidates in each and every frame. The specifically in object sports, very accurate technological solutions identify in presence. The particular deficiency of these systems is the need of mosaic and extravagant hardware which is not economical for less familiar provincial/traditional sports events. The object locations verified by the tracking results are then used to estimate the object throwing angle and the throwing velocity. The rate of error of object tracking in the video is minimized by using trajectory-based object tracking which occurs due to occlusion and merging of the object image with other objects in the frame, distortion of the object image due to object and camera motion and the presence of many moving objects in the foreground and background in the video. The system continues capturing the object throughout its entire flight and makes adjustments to its predicted course if necessary.

***KEYWORDS: - Detection and Tracking, Trajectory Based Tracking, Angle and Velocity Estimation**.*

I. INTRODUCTION:

The utilization of PC helped dubious plays determination in wear occasions essentially benefits coordinators, arbitrators and gathering of people. These days, particularly in question sports, extremely precise innovative arrangements can be found. The primary downside of these frameworks is the need of intricate and costly equipment which makes them not moderate for less known provincial/customary games occasions. The absence of aggressive frameworks with decreased equipment/programming multifaceted nature and prerequisites persuades this exploration. The use of PC helped disputable plays determination in wear occasions altogether benefits coordinators, refs and group of onlookers. These days, particularly in question sports, extremely exact mechanical arrangements can be found. The fundamental disadvantage of these frameworks is the need of mind boggling and costly equipment which makes them not reasonable for less known local/customary games occasions. The absence of focused frameworks with lessened equipment/programming unpredictability and necessities persuades this research. 2. Calculate the course according to projectile motion theory. For that it assumes that the object is subjected to constant external force only (gravity force) throughout its whole motion.The generation of large execution computers, the availability of high quality video cameras at affordable prices and the increasing need for automated video evolution has developed an extreme deal of interest in object capturing algorithms. The detection of the target of position changing objects frame by frame, for capturing and analysis to perceive their performance are the usual pipeline in video analysis [1].

The role of Object tracking has a prominent within the computer vision field. The expansion of superior computer, the accessibility of superb camcorders at moderate costs, and the expanding requirement for mechanized video investigation has created a lot of enthusiasm for object tracking calculations. The utilization of PC helped questionable plays determination in brandish occasions essentially benefits coordinators, refs and gathering of people here our endeavor to foresee the Path for basic protest, as still as area of achieve question. These days, particularly in sports, exceptionally exact mechanical arrangements can be discovered, the intend to identify shot and anticipate the reaming Path of the shot. From application territory point of perspective, tracking systems are vitality received in sport game broadcasts, arrange viewer with additional information. Due to the high execution equipment requirements, the renting of this gracious of systems is entirely lavish, making them unaffordable for small producers or broadcaster. In current scenario there are many country lunches their rockets, missiles and planes [2, 3, 4]. Before launching it they should have to calculate for predicting the identical section at where the missiles or rockets reach and for that they make very complex in calculation. Here it is proposed to predict the location of reach as well as path for simple object. In future it will extended and useful for varies defense services. In this paper, it is proposed to built a system that detects object in mid-air, predicts its remaining course and illustrates its predicted course on 2-D original image and 3-d graph, in real-time. For that it is assume that the object is subjected to constant external force only (gravity force) throughout its whole motion

II. RELATED WORK

Numerous robots depend on standard HD cameras and are found in inadequate situations, it concentrate on the Nao humanoid bots utilized as a part of the Robo Cup Standard Platform League (SPL) given that all groups are obliged to a similar arrangement of robot equipment and rivalry. Bouncing spreads a wide range quickly to evade the robot's direct walk yet goes with the peril of hurting the robot and moreover furthermore debilitates the robot until the point that it can stand up yet again. Hopping is viably performed by getting thing heading gages with the two additions from persistent edges [5]. Contrasted with plunging, a robot needs more exact and prior protest direction gauges since its feet cover substantially less zone than its body and a walk is ease back contrasted with an about prompt jump. The expanded exactness prerequisites of question directions will require considerably more precise sensor information that is hard to catch by the robot all alone. In the Robo Cup Standard Platform League (SPL), colleague sensor information is normally just depended upon for errands where worldwide positions are imperative, similar to which part of the field to search for the protest. For assignments requiring precise relative positions, such as moving toward a protest, a robot winds up depending individually sensor readings since partner sensor information is temperamental in the robot's own particular egocentric directions [6]. They show a mechanical protest catcher with inserted visual servo processor. The installed visual servo processor with forlorn parallel registering capacity is utilized as the calculation stage to track and triangulate a flying item's position in 3D in view of stereo vision. A recursive minimum squares calculation for display based way expectation of the flying item is utilized to decide the catch time and position. Exploratory outcomes for ongoing getting of a flying article are introduced by a 6-DOF robot arm. The level of achievement rate of the mechanical protest catcher was observed to be roughly 60% for the question tossed to it from five meters away. Once the protest has been hurled, information stockpiling, fitting and expectation start. An acceptable catch time/point is refreshed with each change (around 58Hz) and controlled by utilizing the anticipated allegorical constants. Once an acceptable catch point is resolved, the robot arm endeavors to block and match position with the flying item.

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III. VECTOR POSITION OF 3D FOR DETECTION OF OBJECT

Specifically, protest recognition and limitation in each casing is an issue that still requires more examination. The question is constantly the concentration of consideration amid the diversion; hiver, its programmed recognition and limitation in pictures is trying as an extraordinary number of issues must be settled [7]. Hopeful question extraction can be performed utilizing worldwide data, for example, size, shading and shape or a blend of them. Specifically, the roundabout Hough change (CHT) and a few altered renditions have for quite some time been perceived as vigorous strategies for bend identification and have been to a great extent connected by established researchers for applicant protest discovery purposes.[8]. The Circle Hough Transform (CHT) has turned into a typical technique for hover discovery in various picture handling applications. Different adjustments to the essential CHT operation have been recommended which include: the incorporation of edge introduction, synchronous thought of a scope of circle radii, utilization of an intricate aggregator exhibit with the stage relative to the log of span, and the usage of the CHT as channel operations [9].

a) Find 3-D Position Vector of detected Object: To predict the object location and recover the 3-D trajectory it has to find the object position in 3-D. so, it required the 3rd dimension of detected object. For that it are using stereo vision system for locate the detected object in 3 D.

b) Binocular Stereo Vision System: Stereo means having 3 dimensions. It comes from the Greek word 'Stereos' which means firm or solid. Stereo vision is a technique for building a three dimensional description of a scene observed from several viewpoints this concept of stereo vision is based on the human 'Eyes and Visual System'. This concept is implemented in the electronic world with two cameras, which mimic the way the human eye by capturing two images. As it observe that in image from the single camera that all the point into the same projection line are same image point. In fig 10(a) both real points (P and Q) projected as same image point (p=q) on the image plane. This occurs for all the points having same line of sight and creates optical illusion. In contrast stereo camera have two or more observation points so at one viewpoint P and Q are projected as the different point shown in fig 10(b). By using this relation it can recalculate the 3rd co-ordinate of that point so it achieves the depth information of that point using the triangulation.

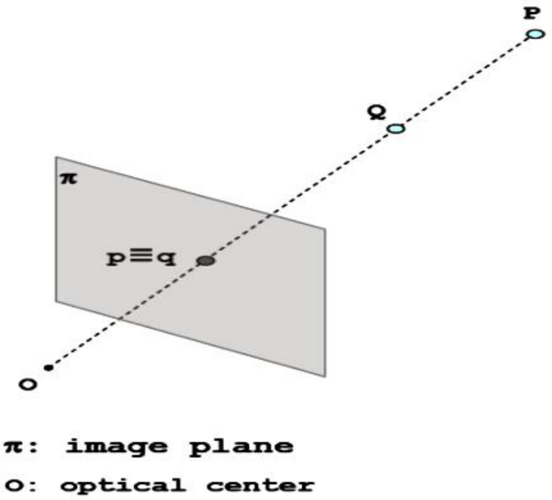

Fig1: (A) Single Camera

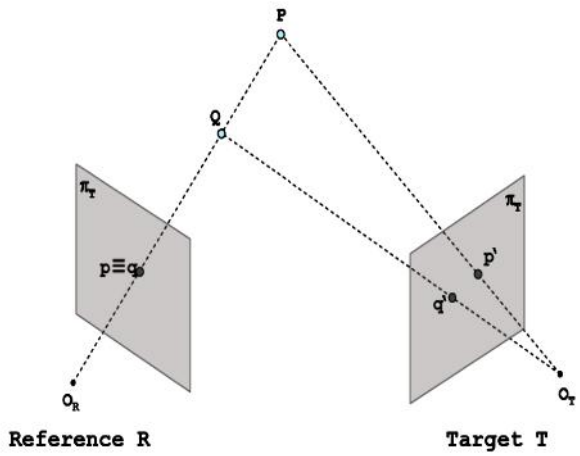

Fig 1: (B) Stereo Camera

Epipolar Geometry: The epipolar geometry describes the geometric relationship batten two perspective views of the same 3D scene. The key finding, discussed below, is that corresponding image points must lie on particular image lines, which can be computed without information on the calibration of the cameras. This implies that, given a point in one image, one can search the corresponding point in the other along a line and not in a 2D region, a significant reduction in complexity.

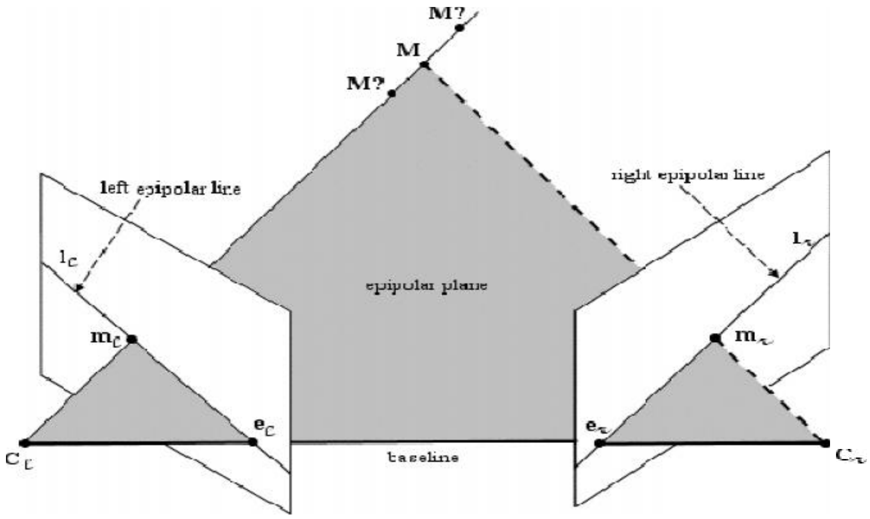

Fig 2: Epipolar geometry

Any 3d point m and the camera projection focus c and cr characterize a plane that is called epipolar plane. The projections of the point m, picture focuses m and mr, likewise lie in the epipolar plane since they lie on the beams associating the relating camera projection focus and point m. the conjugate epipolar lines, l and lr, are the crossing points of the epipolar plane with the picture planes. The line associating the camera projection focuses (c, cr) is known as the benchmark. The pattern converges each picture plane in a point called epipole. By development, the left epipole e is the picture of the correct camera projection focus cr in the left picture plane. Additionally, the privilege epipole er is the picture of the left camera projection focus c in the correct picture plane. all epipolar lines in the left picture experience e and all epipolar lines in the correct picture experience er the epipolar imperative. An epipolar plane is totally characterized by the camera projection focuses and one picture point. In this manner, given a point m , one can decide the epipolar line in the correct picture.c) [10]

Object Detection and Tracking Flow: The proposed algorithm discussed in this paper will be helpful in developing better and efficient algorithms in the field of tracking. A basic flow chart diagram for the proposed algorithm is shown below: the blocks present in the flowchart are being explained below in the following steps: step1: capture the video frames using the video input function. Step2: set the properties of video object. Step3: start the video acquisition. Step4: set a loop that starts after 50 frames of acquisition. Display the image. Again a loop is used to bind the red objects in a rectangular box. Step5: stop the video acquisition. Step6: flush all the image data stored in the memory buffer. Step7: clear all the variables.

IV. TRAJECTORY PROCESSING:

To tolerate the shape and compactness variations in near and far view frames, a wide range of thresholds are used for the filters. As a result some non-object objects pass through the filters and miss-classified as object candidates. Thus, the object motion characteristics along x-direction and y-direction over a number of frames are used to determine the actual object locations. The object locations along x- and y-direction are plotted against the number of frames to generate the x-candidate plot (XCP) and y-candidate plot (YCP). It has been observed that the object moves in a straight line along the x-direction and follows a near parabolic path along y-direction. This information is used to generate the candidate trajectories in XCP and YCP [11].

4.1 Candidate Trajectory Generation: The candidate trajectory generation algorithm starts with a pair of object candidates in consecutive frames which are close to each other. A Kalman filter-based [12] prediction method is used to predict the object locations along the trajectory and it is independent of velocity and acceleration of the object. The Kalman filter-based system can be describes as, where the state is vector representing the estimated object location in frame h and is the measurement vector which is the position of detected object candidate. is the system evolution matrix and is the process noise vector. is the measurement matrix and represents the measurement noise vector [13].

4.2 Object Trajectory Identification: The actual object trajectory has been identified from the set of candidate trajectories using two criterions: i) the trajectory length ( ) and ii) the prediction error ( ). The prediction error is defined as the average distance (in pixel) between each predicted location to the object candidate location in a frame. The candidate trajectories having prediction error greater than a threshold ( ) are eliminated. The value of is selected to be 05 (in pixel) for this work. The process for object trajectory identification is shown in Algorithm 2 [14].

4.3 Object Selection: The presence of players generates a number of moving objects in the foreground of the video frames. The dynamic background comprising of flags, banners, spectators, twigs and leaves of branches often leads to wrong segmentation of the scene despite of a robust moving object segmentation algorithm used. The high speed motion of the object and the camera motion deform the object image. The merging of the object image with other objects in the frame and the occlusion of the object with players also leads to the deformation of the object image by a great extent. To filter out the original object image from other moving objects present in the frame, some feature-based filters has to be used. In this work, the shape and circularity features of the object are used to distinguish the object image. The objects that do not satisfy the shape and circularity constraints are pruned and the remaining objects are considered as "object candidates" in the frams [15].

***Algorithm 1 :** Candidate Trajectory Generation*

Input: Set of object candidates Output: Set of candidate trajectories for each frame in video do for each object candidate in frame do

for each object candidate $_{+1}$ in frame (+ 1) do

if distance(, $_{+1}$)< then Initialise the Kalman filter;

Predict the location for frame (+ 2); if the prediction is verified then

Add , $_{+1}$ and $_{+2}$ to trajectory ; Update prediction function;

Else $^{\text{if}}$ > $^{\text{then}}$ Record new trajectory;

end if

Estimate new object location;

end if

end if

end for

end for

end for

***Algorithm 2** Object Trajectory Identification*

Input: Set of candidate trajectories ( )

Output: Object trajectory

for a candidate trajectory , ∈ ( ) **do**

if forms a line in XCP and a parabolic curve in YCP **then**

if (≥ && <) **then**

else

Remove from ( )

end if

end if
end for

4.4 Process to Find Velocity for Moving Object:

Velocity of moving object is determined using the distance travelled by the Centred to the frame rate of the video [16, 17]. Algorithm for calculating velocity is explained as follow:

1. Make a Video of movable object with take a reference distance (0.5m).
2. Find meter/pixels ratio. (with a logic how much pixels in width and how much pixels in height with reference height & width).
3. Read the distance travelled by the object and time taken of 1 frame from frame rate.(29 f/s)
4. Velocity = distance travelled/frame rateV = d/t (m/s)
5. Save the value in an array
6. The velocity of moving object in the sequence frames is defined in meter / second.

The feature-based pruning of the object candidates ensures a less number of candidates to be processed during the trajectory processing which reduces the computational complexity of the overall system [18, 19, 20]. It also reduces the FAR which leads to an excellent TDR for the proposed method. The extracted object locations are used to determine the throwing angle of the object which in turn is used to determine the shooting velocity. The system is very much cost effective as it does not require sophisticated hardware like high speed cameras. It believe this is the first algorithm where a complete analysis. 3-D trajectory, reconstruction will be used to get more information about the object trajectory and for better representation.

V. RESULTS

The proposed algorithm for object detection-and-tracking with applications to shooting angle and velocity estimation is tested with a set of six videos. The test videos are having different resolution (360p, 480p, 720p) and the illumination conditions are also varying. Some videos are of indoor court, while some are of outdoor court environment, thus provid-ing a wide range of variety in the background scenes. The ground truth object locations are detected using ViPER (Video Performance Evaluation Resource) video annotation tool [21]. The results of object detection and tracking are summarized in Table I. “Correct” refers to those frames where the algorithm detects and tracks a object in a object frame and does not detect and track a object in a non-object frame where “False” refers to those frames where a object is wrongly detected in a non-object frame and/or the algorithm fails to detect and track the object in a object frame.

TABLE I: Performance of the system for object detection and tracking

Video clip	Ground Truth		Object Detection Results			Object Tracking Results		
	Total Frames	Object Frames	Correct	False	Accuracy	Correct	False	Accuracy
BBD-0005	70	25	59	11	84.29	62	08	88.57
TPB-0002	90	29	84	06	93.33	87	03	96.67
BBSD	50	32	41	09	82.00	44	06	88.00
BBN-0022	60	31	55	05	91.67	57	03	95.00
BBP-0003	65	36	55	10	84.62	61	04	93.85
BBn-0020	90	27	76	14	84.44	85	05	94.44
Total	425	180	370	55	87.06	396	29	93.18

The accuracy of object detection and tracking is calculated as the ratio betiten the correct detection to the number of total frames in the video. It can be seen that, the proposed algorithm successfully detects a object in the long shot test video sequences with an average accuracy of 87.06%. The use of trajectory-based method improves the result by a great extent and the final result of object detection-and-tracking yields and average accuracy of 93.18%.

TABLE II: Results of object throwing angle and velocity estimation

Video Sequence	K (In FPS)	K (In Second)	K (In Degree)	K (In Meter/Seconds)
BBD-0005	29	0.8021	84	4.24
TPB-0002	25	1.10	55.5	7.00
BBSD	25	1.1034	68.73	0.59
BBN-0022	29	1.07	68.00	5.00
BBP-0003	30	1.20	58.07	0.80
BBn-0020	29	0.931	73.16	4.11

In Table II the results of shooting angle estimation and object throwing velocity estimation using the proposed method has been shown. In this work, air resistance to the movement of the object is considered negligible. Also, the object release height is not considered here, the experimental results of object detection-and-tracking in a set of videos. The first row shows the results of object detection solution while the second row shows the results of trajectory-based solution where the missing object locations are predicted and verified. The detected and tracked object locations are shown by green dots, segmentation method based on background subtraction and frame differencing is used to determine the moving objects in the foreground which gives reliable results for dynamic background scenes with heavy background clutter and can withstand the effects of camera motion.

The same approach can be used in surveillance application where the trajectory of the moving object has to be tracked. Object locations during trajectory processing are represented by yellow dots. To compare the performance of the proposed algorithm, a mean-shift based tracking method [22] is implemented. The mean shift algorithm is a till-known statistical method for finding local maxima in probability distributions which is extensively used in the field of object tracking. For performance evaluation, the track detection rate (TDR) and the false alarm rate (FAR) are used. TDR and FAR can be derived as, where, '*TP*' is the number of true positives for the tracked object, '*FP*' is the number of false positive and '*FN*' is the number of false negative. The comparison results are shown in Table III. It can be observed that the average TDR for the proposed method is as high as 95.29% where that of the mean-shift based method is 67.22%. [23] The FAR of the proposed method is very less (18.59%) as compared to the mean-shift based method (29.65%). Fig. 4 illustrates the comparison on object tracking in terms of TDR and FAR.

TABLE III: Comparison of proposed method and Mean-Shift based method

Video Clips	Proposed Method		Mean-Shift Based Method	
	Track Detection Rate (%)	False Alarm Rate (%)	Track Detection Rate (%)	False Alarm Rate (%)
BBD-0005	88.00	26.67	44.00	47.62
TPB-0002	96.55	15.15	75.86	29.03
BBSD	87.50	15.15	71.87	23.44
BBN-0022	93.55	9.38	70.97	18.52
BBP-0003	88.89	15.79	63.88	32.35
BBN-0020	85.29	3.30	74.07	31.03
Total	95.29	18.59	67.22	29.65

VI. CONCLUSIONS

In this paper, a trajectory-based object detection-and-tracking framework and find velocity for moving object in frames which can be used to extract the object locations in long shot video sequences. The motion characteristic of the object is used to identify the object trajectory using 2-D distribution analysis of the object candidates along x- and y-direction separately. In this paper poison changing object is traced by the proposed algorithm and also determine the velocity of the phenomenon. In future it is proposed to predict the trajectory of projectile in 3-D using stereo vision technique as well as to find the predicted maximum height which the object covers in parabolic path and the entire distance overspread by the object will be calculated. These algorithms can also be extended for the use of real-time applications like sports. Most important is that the idea of detection-continuous tracking prediction can be employed to many other (commercial) uses.

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