Video Annotation and Player classification Using Hough-Grid Transformation (HGT) Method

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Abstract:

Video processing is a most challenging research area among image processing. It has made its mark over the world by the rapid development of technology in various fields. Extending the study in the area of sports video digitization, proposed methodology initiated the novel approach on Asian game that is 'Kabaddi'. It is a team game, in which we emphasize on half of the court. This paper proposes a content analysis of kabaddi game includes both foreground and back ground annotation. Player classification, detection and tracking by dominant Color-based Feature Extraction (CFE). Blob generation for each player with consequences of team has performed using accumulation array with grid based transaction and Centroid Region Of Interest (CROI). Then by applying the grids over the play court, line detection and labeling is done by Hough Grid Transformation (HGT) method. Algorithms are implemented on MATALAB tool and tested on self developed videos having 535 frame set videos clips for privileged accuracy in the obliged aspects. By examining the results, proposed methodology can be referred in the Kabaddi tournaments for game annotation and player performance analysis.

Key Words: HGT; HLT; player tracking; Line detection; Labeling

1. Introduction:

Research in the video processing has spread over all corner of the world because of rapid development of technology and user demands in the internet broadcasting system. The immense profitable appeal to sports program has major focus in the field of entertainment. It made focus on content analysis includes video summarization, player performance analysis, game point validation, strength and weakness measures etc. These major observations insist researchers to develop large scale real time systems. Having glimpse over the existing research has majority of trained systems for tennis, badminton[3], cricket, soccer[2] and table tennis. Plenty of techniques and digital equipments are introduced by the researchers by giving more accuracy in the required aspects[4]. Where as in team games, scene extraction, condensed gain points, each player examination by occlusion handling, precise tracking with prediction are challenging issues to the area of video processing.

By diversifying the study in the field of sports and the existing literature over match analysis system, very less surveillance has found in Kabaddi game. This made us to take an initiation towards the novel approach of Asian Game. It is on the whole of an Indian game, which requires both skill and power. It combines the distinctiveness of wrestling and rugby. Kabaddi is an Asian game that includes more than sixty five Countries. It is a team game includes 7 players in each team(two). The complete court has 13 x 10 meters for men, 11 x 8 meters for boys and women. We have followed a line of investigation only on the half of the kabaddi court as per women's court measures. With this appendix we have developed kabaddi annotation system in MATALB tool.

The major Contributions of this paper are

1. Frame by frame analysis of object and its behavior modeling
2. Background extraction for court line detection and ground truth measures for line labeling.
3. Foreground extraction, Player detection and tracking with accurate occlusion handling process.
4. Team classification based on the dominant color based feature extraction process.
5. Player identification and labeling for individual player performance measures.

2. Literature Review:

Wei-Lwun Lu[1], introduced an intelligent system that tracks and identifies players and labeling in broadcast sports videos filmed by a single pan-tilt-zoom camera. Introduce a new source of weak labels – the play-by-play text, which is widely available in sports videos. To assign a game time-stamp to every video frame, applied optical character recognition (OCR) system. Deformable Part Model (DPM) helps to automatically locate sport players in video frames. Hidden Markov Model (HMM) [30] for shot segmentation. The emission probability is modeled by a Gaussian Mixture Model (GMM) where features are RGB color histograms, and the transition probability is formulated to encourage a smooth change of shots. The DPM consists of 6 parts and 3 aspect ratios and is able to achieve a precision of 73% and a recall of 78% in the test videos.

Jia Liu et al [2] proposed automatic player detection, labeling and tracking in broadcast soccer video for multiple player detection, unsupervised labeling and efficient tracking. Players' position and scale are determined by a boosting based detector. Player tracking is achieved by Markov Chain Monte Carlo (MCMC) data association. Some data driven dynamics are proposed to improve the Markov chain's efficiency. This method can reach high detection and labeling precision, and reliably tracking in cases of scenes such as multiple player occlusions, moderate camera motion and pose variation.

Anurag Ghosh et al[3], proposed an end-to-end framework for automatic attributes tagging and analysis of sport videos to analyze a large amount of badminton broadcast videos by segmenting the points played, tracking and recognizing the players in each point and annotating their respective badminton strokes. evaluate the performance on 10 Olympic matches with 20 players and achieved 95.44% point segmentation accuracy, 97.38% player detection score (mAP@0.5), 97.98% player identification accuracy, and stroke segmentation edit scores of 80.48%. Like many video processing techniques have developed for the different sports video[4].

3. Proposed Methodology:

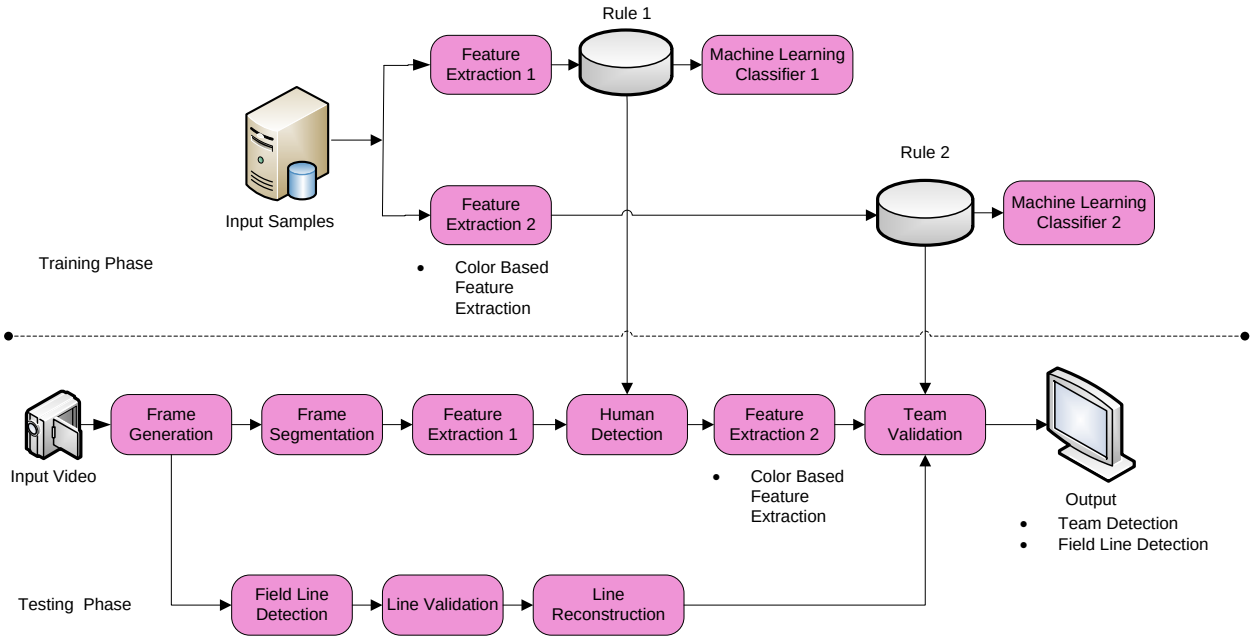

Fig 1: Proposed System Architecture

Once we state a research problem, the first most things required is the valid data base to carry out the research. This was the major issue we faced in the proposed case study. There is no appropriate data available for the research purpose that to process as per computer vision criteria's. Since, we decided to develop our own data which meet-out the ground truth measures and game conventions. We took help of Physical Education Department (PED) director and kabaddi coach to guide accordingly. The accurate ground truths are produced on the indoor 1/ 2 of the court. The game was played by 8(one- teaser, 7-chasers) international woman kabaddi players to shoot

required game points with respect to research objectives. Every scene has captured as per the instruction of the coach.

3.1 Line Segmentation and Labeling:

a) **Flowchart for Line segmentation and labeling:** In Fig.2 We stated flow chart which elaborates the work flow of line segmentation in which each frame is tested for the presence of court lines with respective constant measures. Because every sports annotation is completely depends on the boundary lines over the court[28][20].

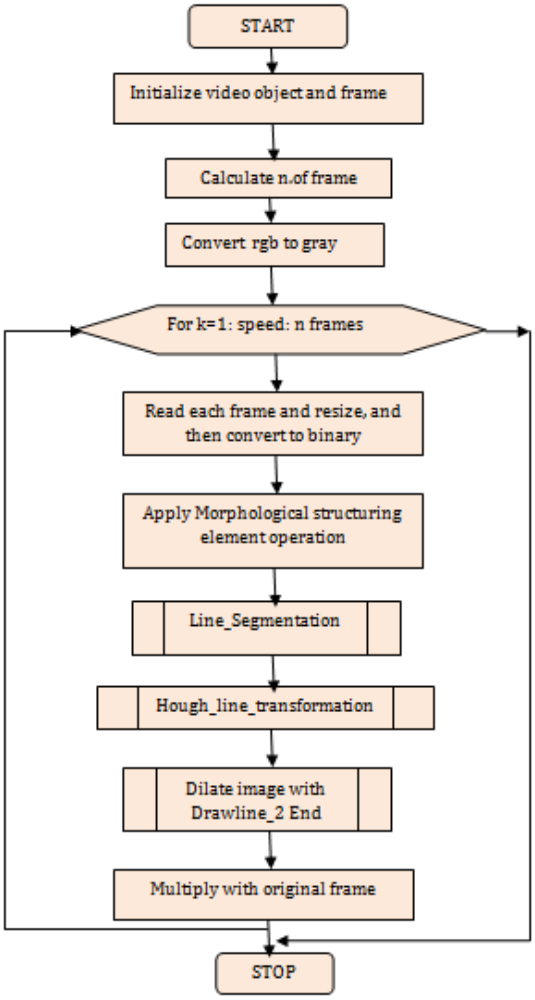

Fig 2. Flow chart of line segmentation, detection and each line labeling

Proposed work primarily obtains the data on half of the court. In that we get one end line, one middle line, two lobby lines. Based on these circumstances we have taken the matrix measurements on the ground truth in a predetermined angle. Then we extracted the background object with foreground subtraction process. Line segmentation is done with Hough line transformation technique. We applied color based feature extraction and morphological structuring elements to detect the line and symbolize with black color throughout the court. Each line labeling is done based on accurate ground measures on matrix grid analysis method. This gridding is applied on each frame then extracts the static line measure on base of pixel distribution in matrix measure. Then we apply the 2D digital film on each frame after processing with morphological operations, and then we apply HGT method for grid analysis to detect the line covariance's. This process will get sphere on all the frames in the current scene. Then we named the each line with their respective significance.

b) Algorithm for Team classification and tracking using HGT method:

Step1. Hough Grid Transform (GHT) for detecting the straight lines in sports video.
Step 2.This algorithm uses two new techniques: a gridding method to select points to work on; a linelet processing to acquire the linelets and compute the measure function based on linelets. (we find the linelets from each block (grid). A long straight line should be cut into some linelets. In contrast these linelets will indicate the existence of the long line over the frame grids. There it finds the court line existence
Step 3. Gridding method is to draw horizontal and vertical straight lines on the each frame
Step 4. Each square is called a block and four sides of block consist of the boundary of the block.
Step 5. We ignore the block that has more than τ 1 (a threshold) points on its boundary because such block has a low signal-to-noise ratio.
Step 6 obtain a set of linelets
$\Omega = \{K_1, K_2, ..., K_p\}$. Let $K \in \Omega$ be a linelet
Step 7. Voting grid function with straight line parameter

$$V(K, \rho, \theta) = \begin{cases} 1, & \text{if the parameters of K is } (\rho, \theta). \\ 0, & \text{otherwise.} \end{cases}$$

Step 8. The measure function is defined on the Hough space based on the voting function

$$M(\rho, \theta) = \sum_{i=1}^{p} V(K_i, \rho, \theta).$$

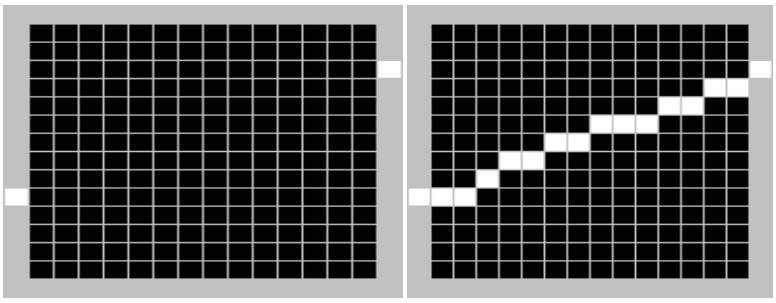

Fig 3. An enlarged gridded block. It is a block in Fig 1 at the 7th row and 8 is the 8th column. (a) shows two points on its boundary; (b) shows all the points between two boundary points.

4. Algorithm for Team tagging and Tracking:

Line detection is done with background extraction. Moving on to foreground data, we consider each player inside the court boundaries. These edges have already framed by the HGT method. We apply the Color-based Feature Extraction (CFE) technique for the team tagging. Player(team) classification is done with RGB color based classification based on their track suit as represented in video. The following work flow states the player classification, tracking process.

Algorithm:
step 1: Analyzing the frame by frame pixels, set default parameter value
step 2: Calculate No.of Frames
step 3: Measuring and building the accumulation Array
step 4: Apply the Local Maximum Filter
step 5: Segment the area of interest
step 6: Calculate the maximum No.of pixels in the group
step 7: Compute the Centroid point
step 8: **Gridding and Linelet:** Grid the map into the small blocks with s being the side length several times.
Find linelets in each block and form the set of linelets
Ω = {K1 , K2 , ..., Kp} .
step 9: **Computing the Measure Function:** Compute the measure function M(ρ ,θ)
through doing statistics on the parameters of all the detected linelets.
step 10: Find Straight Line Candidate p Consider (ρ ,θ) are the straight line parameters in which
if M(ρ ,θ) > τ 2 (τ 2 is predefined threshold).

step 11: **Evaluation of Straight Line Candidates and then Label the each line:** line detection and labeling is done with Hough line transformation(HLT) and CROI in which each line with respect to the x and y axis will measured and detected with black line indent. Each line is labeled with their respective meaning.

step 12: Apply fill image region and holes with Morphological operation

step 13: **Player classification:** Calculate mean color for team 1 and team 2 max min value R , G, B region using CFE.

step 14: Measure the properties of image region.

step 15: Create Bounding Box with different color.

5. Experimental Results:

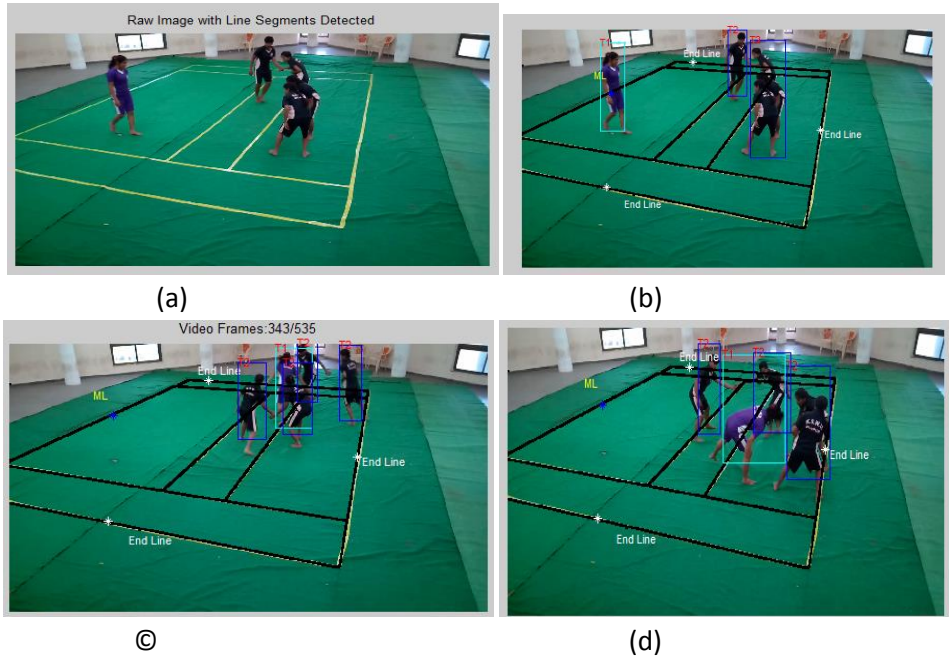

Fig. 4. Figure a) shows the current processing frame, b) shows line segmentation and each line labeling, c & d- player classification by labeling and tracking

Frame by frame analysis is done as shown in the above result snapshots. The fig 4(a), shows the current processing frame in the input video. The Fig 4(b) shows the line detection by black color with respect to the each line labeling that indicates the identity of each line framing on half of the game court. The fig 4c and d, shows the processing frame 343 with player detection with unique team identification by T1 and T2. Each player is detected and tracked along with bounding box by differentiating with blue and green color with respect to the team members. Detection and tracking accuracy is as follows.

Table 1. Overview of Result analysis with different sports videos with respect to the techniques implemented, detection & tracking accuracy is shown based on number of players & detection modes.

Sl.No	Sports Video	Algorithm Used	No.of Players	Detected/Tracked Players	False detection	Accuracy
1	Soccer[2]	MCMC	11	10(o labeling)	01	94.8%
2	Tennis(2009) [38]	GMM	2	2(No labeling)	00	98.78%
3	Basket Ball (2016)	MIM	9	8(with labeling)	01	94.67%
4	Basket Ball[28]	Linear Programming Relaxation	8	8(with labeling)	00	89%
5	Badminton(2017) [03]	HOG, Kalman Filter	2	2 (without court line, no labeling)	01	97.78%

6	Foot Ball(2017) [34]	GM-PHD (Gaussia Model-Probability Hypothesis Density)	14	12(No labeling)	02	99.20%
7	Tennis(2014)[30]	Logical AND operation	2	2(with ball tracking)	9.36%	88.33%
8	Baskel Ball(2014)	Morphological operation and Homograph matrix	7	7(no label no bounding box) pixel point detection	00	95.6%
9	Kabaddi (current case study)	Proposed Method CROI,HGT,CFE	5	5 (with player & line labeling)	00	100%

6. Acknowledgment:

There is no legal data set available for the research on the kabaddi game, since have created our own data set. This was done with the guidance of Dr.Rajakumar Malipatil, (Registrar Evaluator) Director of Physical Education Department (PED), Akkamahadevi Woman's University Viajayapur (AWU), for the right ground truth examination and played by AWU-PED International Kabaddi players. Another data set was created in Mangalore University by taking official permission from the parent university and Alva's PED Director. We are grateful to both PED team for their supervision, which made possible to develop required data set on as per the required research criterions.

7. Conclusion:

The proposed method proves the vigorous technique for play court detection and player classification process on innovative case study. Algorithms are tested on self developed data set. Both the approaches have given the best result as compared with the existing work, such as tennis, soccer video. Experimental results are clearly shown the detection accuracy inside the field in accordance with frame by frame evaluation. Since this paper concludes that HGT and HLT are preeminent techniques for the kabaddi video analysis process.

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