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Basketball training via behaviour analysis in basketball match video

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ABSTRACT

In recent years, basketball match video analysis and video mining has received much attention, and it also can help player to predict the behavior of ball carriers. This paper proposed a novel method for play training by analysis the much video which has cluttered background, the low resolution of the head images and fast motion of the sportsman. This paper proposes the adoption of a covariance descriptor to min the video features of the head images, and finishes the head pose classification by the trained model. According to the video analysis and trained model, we can predict the behavior of each player, such as pass route or shot. Based on this model and video analysis, we can help player training more accurate and efficient. Finally, the tests on the basketball match verify theeffectiveness of our model.

KEYWORDS

Behaviour prediction; Basketball match video; Artificial intelligence; Sports training.

INTRODUCTION

According to the research by sports experts at home and aboard, shows that the digital video technology introduced in sports training can great improve the efficiency of training[1,2]. How to use the computer video analysis techniques such as image processing to realize the scientific training, and it becomes a current research hotpot. At present, the computer technology mainly applies to analysis the gesture recognition and analysis of player[3,4].

Basketball is one of the world's most popular sports. It is a sport played by two teams of five players. The objective is to score by to shoot a ball. Basketball team generally have conceptions of positions and offensive and defensive position, because it has many techniques, such as shooting, passing, dribbling, smack down and rebounding[5].

This paper proposes a novel method to do behaviour predict of ball carriers in basketball match video. This paper proposes the adoption of a covariance descriptor to min the video features of the head images, and finishes the head pose classification by the trained model. According to the video analysis and trained model, we can predict the behaviour of each player, such as pass route or shot.

RECOGNITION THE RANGE OF VISION

Before the recognition of head state of ball carriers, we should to determine the position of each player in the image by artificial markers and particle filter. The eight head poses show in Figure 1.

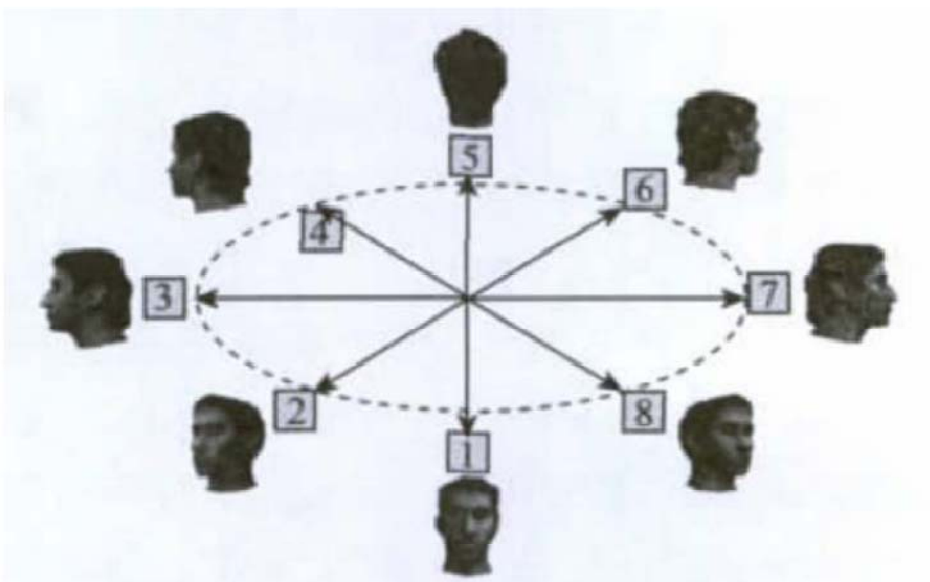

Figure 1: Eight head poses

Feature extraction

For each training sample, we should exact square area from image, and compute 12 dimensions feature vector.

$$\phi = [x, y, R, G, \mathrm{B}, \mathrm{Ix}, \mathrm{Iy}, \mathrm{O}, \mathrm{Gab}\{0, \pi/3, \pi/6, 4\pi/3\}] \quad \textbf{(1)}$$

Where, x, y represents the pix of image, R, G, B represents color channel, Ix and Iy representsfirst-order derivative, O is gradient direction.

Then compute the covariance descriptor,

$$X_k^r = \frac{1}{S_k^r}\sum_{i=1}^{S_k^r}(z_i - \xi_k^r)(z_i - \xi_k^r)^T \quad \textbf{(2)}$$

Where, ξ_k^r is mean vector of feature vector for Kth sample.

Exponential map $\exp_x(V)$ and log map $\log_x(Y)$ are definition as following.

$$Y = \exp_x(V) = X^{1/2}\exp(X^{-1/2} V X^{-1/2}) X^{1/2} \quad \textbf{(3)}$$

$$V = \log_x(Y) = X^{1/2}\exp(X^{-1/2}YX^{-1/2})X^{1/2} \quad (4)$$

$$u = \arg\min_{y\in m}\sum_{i=1}^{N} d^2(X_i, Y) \quad (5)$$

$$d^2(X,Y) = tr(\log^2(X^{-1/2}YX^{-1/2}) \quad (6)$$

Finally, we should orthogonalization the vector which reflects to cut space.

$$vec_u(\mathrm{V}) = vec_1(u^{-1/2}Vu^{-1/2}) \quad (7)$$

Training of detection classification model

Input: $(X_1^k, y_1),...,(X_n^k, y_n)$ represents the kth sample and covariance descriptor of each training image set.

Step 1: Compute u^k by gradient method $u^{t+1} = \exp_{ut}[1/N*\log_{ut}(X)]$, and then map to cut space and orthogonalization $x_i^k = vec_{uk}(\log(\mathrm{X}))$.

Step 2: Initial weight $w_{ij}^k = 1/N, F_j(x_i^k) = 0, \Pr_j[x_i^k] = 1/9$.

Step 3: Loop compute to get classification hypothesis.

$for, l = 1,2,3,...,L, do$

$for, j = 1,2,3,...,9, do$

Compute w_{ij}^k and z_{ij}^k.

$$w_{ij}^k = \Pr_j[x_i^k](1-\Pr_j[x_i^k]).$$

$$z_{ij}^k = (y_{ij}^k - \Pr_j[x_i^k])/(\Pr_j[x_i^k](1-\Pr_j[x_i^k])).$$

(2) Using least square method to match the classificationfunction.

(3) Update $F_j(x_i^k)$.

$$F_j(x_i^k) + f_{ij}(x_i^k) \rightarrow F_j(x_i^k).$$

where $f_{ij}(x_i^k) = 8/9(g_{\mathrm{lg}}(x_i^k) - 1/9\sum_{d=1}^{9} g_{\mathrm{ld}}(x_i^k))$.

(4) Update $\Pr_j[x_i^k]$.

(5) Save F_j.

BEHAVIOUR PREDICTION OF BALL CARRIERS

Through player detection classification and head state recognition of ball carriers, we can get vision information and player position in video. Based on this information, this paper proposes a behaviour prediction algorithm based on artificial potential field.

Information content based on artificial potential field

The artificial potential field of each player can compute by following formula[6,7].

$$U_{APF}(X) = U_{goal}(X) + U_{obs}(X)$$

where $U_{APF}(X), U_{goal}(X), U_{obs}(X)$ each represents artificial potential energy, attract potential energy, exclude potential energy. x represents the position of each player.

$$U_{goal}(X) = 1/2 * (kp) * \left(1/(x - x_{goal})\right)^2$$

where $x - x_{goal}$ represents the distance between offensive player and basketry.

$$U_{obs}(X) = \begin{cases} 1/2 * kd * (1/\rho - 1/\rho 0)^2, \rho \le \rho 0 \\ 0, \rho > \rho 0 \end{cases}$$

Due to can't directly extract the role of each player from the basketball match video, first we should build a table to indicate the detail information of each player.

TABLE 1: Shooting and tackling ability (initial state)

	Player Index									
	A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**
kp	a	a	a	a	a	a	a	a	a	a
kd	β	β	β	β	β	β	β	β	β	β

p_{ball} is the position of ball, and algorithm pseudocode shows as following.

Initialize ability of each player.

$$T = 1 : for(i = 1, i \le 5; i++)$$

$$kp_{Ai} = a; kd_{Ai} = \beta; kp_{Bi} = a; kd_{Bi} = \beta;$$

Update shooting and rebounding ability.

while(T ≠ end)

If($p_{ball} = Ai \rightarrow p_{ball} = Bi$)

$$kd_{Bi} = kd_{Bi} + \gamma$$

$elseif\,(p_{ball} = Bi \rightarrow p_{ball} = Ai)$

$$kd_{Ai} = kd_{Ai} + \gamma$$

Behaviour prediction of ball carriers

Figure 2 is example of ball carrier behaviour selection.

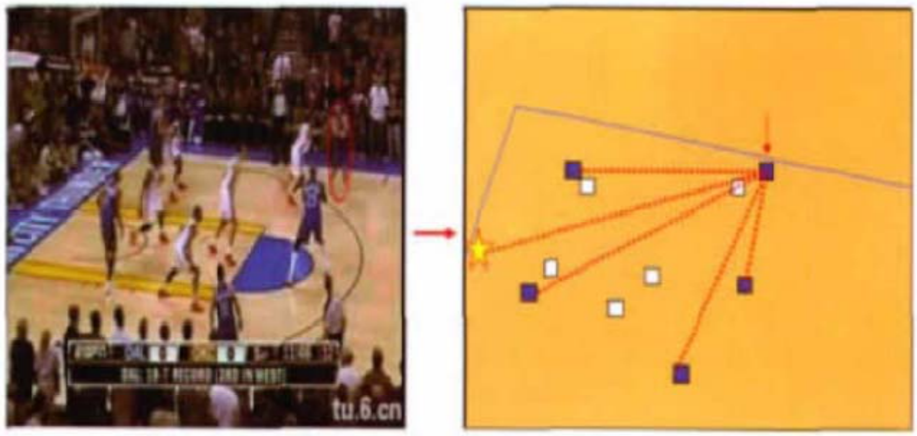

Figure 2: Example of ball carrier behaviour selection

The complexity of artificial potential field is $O(n)$.

SIMULATION AND RESULT

The input and the simulation result show in Figure 3 and Figure 4. And TABLE 2 is the result of head pose recognition experiment.

Figure 3: Typical training examples of the head pose classifier

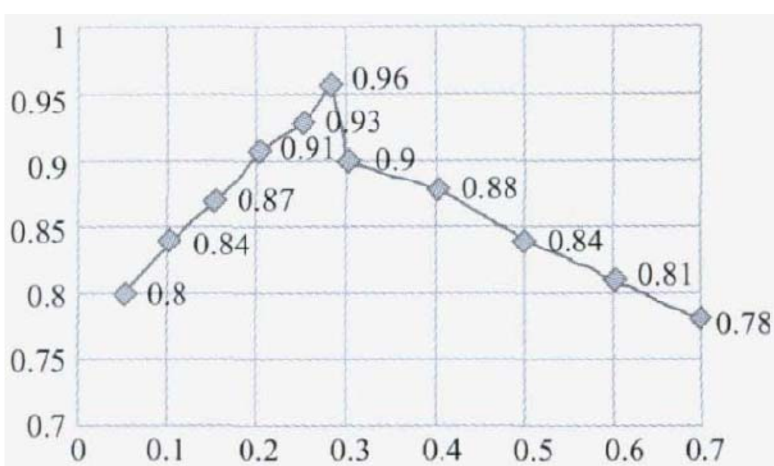

Figure 4: The relation curve between head pose recognition accuracy and relative patch dimension of extracted square region

TABLE 2: Result of head pose recognition experiment

Degree	0	45	90	135	180	225	270	315
0	0.98	0.01	0	0	0	0	0	0.01
45	0.01	0.96	0.02	0	0	0	0	0.01
90	0	0.02	0.95	0.01	0	0.01	0	0.01
135	0	0.01	0.02	0.95	0	0.01	0	0.01
180	0	0	0	0	0.99	0.01	0	0
225	0	0	0	0.01	0	0.97	0.02	0
270	0	0.01	0	0	0	0.01	0.96	0.02
315	0.02	0	0	0	0	0.01	0.01	0.96

The behaviour prediction of ball carriers shows in Figure 5.

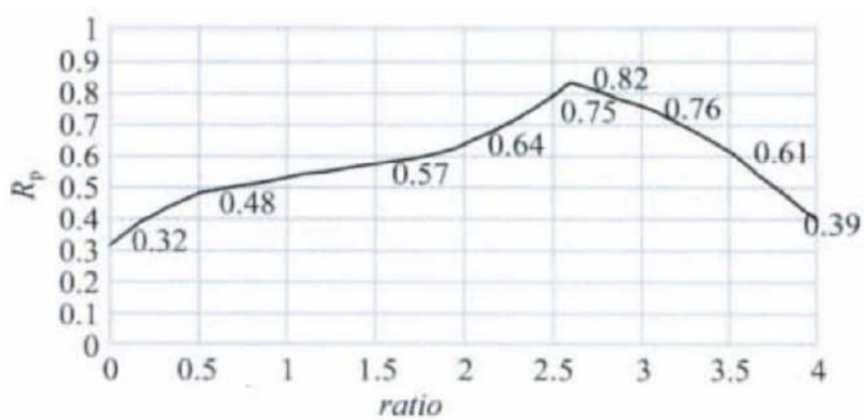

Figure 5: Relation curve between behaviour prediction accuracy and the defined ration

From the simulation result, we can conclude that the accuracy of prediction can reach 80%.

CONCLUSIONS

Sports match video analysis has become a hotpot in computer vision, and recently it is mainly in position detection and track area. This paper proposes a novel analysis model to analysis the basketball player behavior and predicts the intention of player. And through simulation and result analysis, it is verify that the proposed algorithm has high accuracy.

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