COVERED DISTANCES OF HANDBALL PLAYERS OBTAINED BY AN AUTOMATIC TRACKING METHOD

Tiago G. Russomanno[1], Milton S. Misuta[1], Rafael P. Menezes[1], Bruno C. Brandão[2], Pascual J. Figueroa[2], Neucimar J. Leite[2], Siome K. Goldstein[2], Ricardo M. L. Barros[1]

[1]Laboratory of Instrumentation for Biomechanics – College of Physical Education –Campinas State University – Campinas – Brazil
[2]Institute of Computing – Campinas State University – Campinas - Brazil

The aim of this work is to obtain the distances covered by handball players and their velocities during a match using a new approach based on automatic tracking method described in Figueroa et. al. (2006a, 2006b) and the Adaboost detector (Okuma, 2004). A whole game of a Brazilian regional handball championship for players under age of 21 was recorded. Applying the mentioned automatic tracking, the accumulated covered distances and the velocities were calculated for all the players. The results of average covered distances (±SD) in the 1st and 2 nd halves were 2199(±230) and 2453(±214). The results of covered distances and the velocities allow individual and collective analyses of the players by the team staff. The proposed method revealed to be a powerful tool to improve physical analysis of the handball players.

KEY WORDS: automatic tracking, handball, biomechanics, covered distance

INTRODUCTION

Tracking players in team sports has been conducted with many different purposes. Special interest has been devoted to tracking sport players automatically focusing the motion analysis of the game and the players. The distance covered by players during a match can be used for better planning of subsequent training periods and also to evaluate the player performance during competitions.

A tracking method based on an automatic video was presented in Figueroa *et al.* (2006). The method provides automatically the soccer players position in function of time in 94% of the processed frames. The relative error was 1.4% in the determination of the covered distance. An interface was used to complete the trajectories manually when automatic tracking fails. This system was developed in the Laboratory of Instrumentation in Biomechanics of the State University of Campinas (Brazil) and it was denominated DVideo.

Another solution based on computer vision techniques was used with the purpose of developing efficient methods for tracking players in sports (Pers and Kovacic, 2000; Pers *et al.*, 2002; Kristan *et al.,* 2006). Using CCD cameras with wide-angle lenses mounted to the ceiling of a sports hall, these authors developed, tested and optimized different algorithms for players tracking. In Okuma *et al.* (2004), the authors proposed a vision system based on a Boosted Particle Filter for multitarget detection and tracking hockey players. The algorithm combines the strengths of two successful algorithms: mixture particle filters and cascaded Adaboost algorithm of Viola and Jones (2001). According to the authors, the learned Adaboost proposal distribution allows to detect quickly players who are entering the scene, while the filtering process enables to keep tracking the individual players.

Considering advantages and drawbacks of previously mentioned approaches, this paper aims to obtain the distances covered by handball players and the velocities during all the match using a new approach based on an automatic tracking method described in Figueroa et al. (2006a, 2006b) and the Adaboost detector (Okuma, 2004).

METHODS

A whole game of a Brazilian regional handball championship for players under age of 21 was recorded by two digital video cameras (JVC GR-DVL 9500), which were installed at bleachers in elevated positions. Each one them covering approximately one half of the court,

but with an overlap for certain areas (Figure 1). After recording, the video sequences were transferred to a PC and stored in AVI file format (30 frames/s, with image resolution of 720x480 pixels). The cameras were calibrated using the court's known dimensions and the 2D coordinates of player's positions, which was reconstructed according to procedures described in Figueroa et. al.(2006)
The novel approach presented in this work to obtain the kinematical variables is based on the automatic tracking method presented by Figueroa et al. (2006a, 2006b) and also on Adaboost classifier. The first one consists in the tracking using a representation based on graph theory and the other one consists in the detection of the players. After measuring the player's positions in the video sequences, the 2D coordinates of the players related to the court game are reconstructed using an image-object transformation method (Direct Linear Transformation).

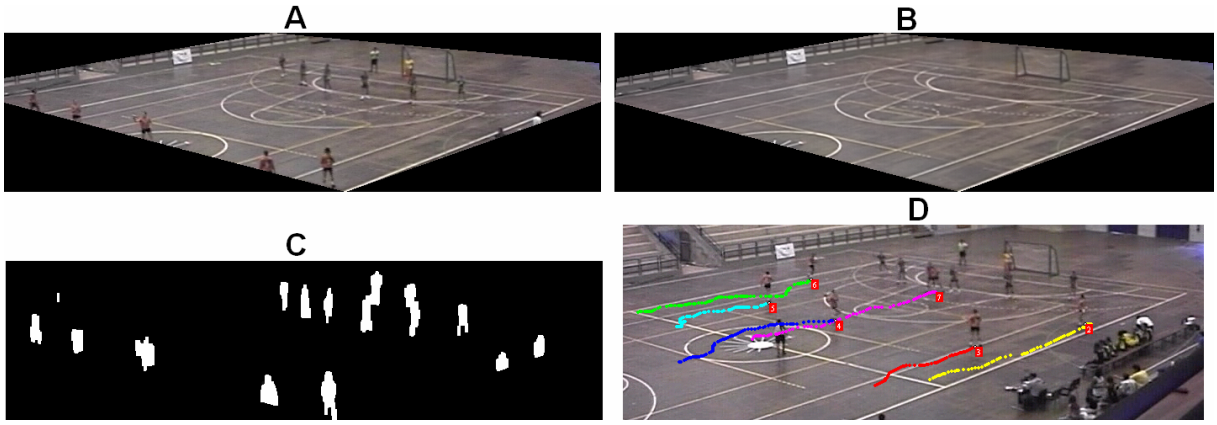

Figure 1: A) image of the players; B) image of the court without the players; C) Image segmentation results. D) Automatic tracking results.

Applying the mentioned automatic tracking method, all players were tracked in the whole match. The covered distance was calculated as the accumulated sum of the player's displacement between two successive time sample (0.016s).
Using the time-position curve obtained for each player, the time-velocity curve was numerically derived. According to this new curve the spent time of each player was classified in five types of movements based on the work proposed by Misuta (2004): standing - displacements with velocities from 0 to 0.2 m/s; walking - displacements with velocities from 0.2 to 2 m/s; jogging - displacements with velocities from 2 to 4 m/s; running - displacements with velocities from 4 to 6 m/s and sprinting - displacements with velocities higher than 6 m/s. The players were then classified in six positional groups: right backcourt player (RB), left backcourt player (LB), center backcourt player (CB), left wing player (WP), right wing player (RW) and pivot (P).

RESULTS

The average results of covered distances and the time spent in each one of the types of movements were presented considering only the players that participated in the whole match (n=9 players). The results of covered distances by the players in function of time are shown in the figure 2. This representation distinguishes between individual player's performances. As noticed in this match, the right wing player (RW) of the team A and B had a better performance than other players during the whole match.
It is also possible to recognize specific situations of the game. For example, the curves of all players presented a little plateau around the minute 22 for team A and B (Figure 2). This means that the reduction of the average velocities and this is caused by specifics situations as many sequences of free throws and finalizations with a 7-meters throw.

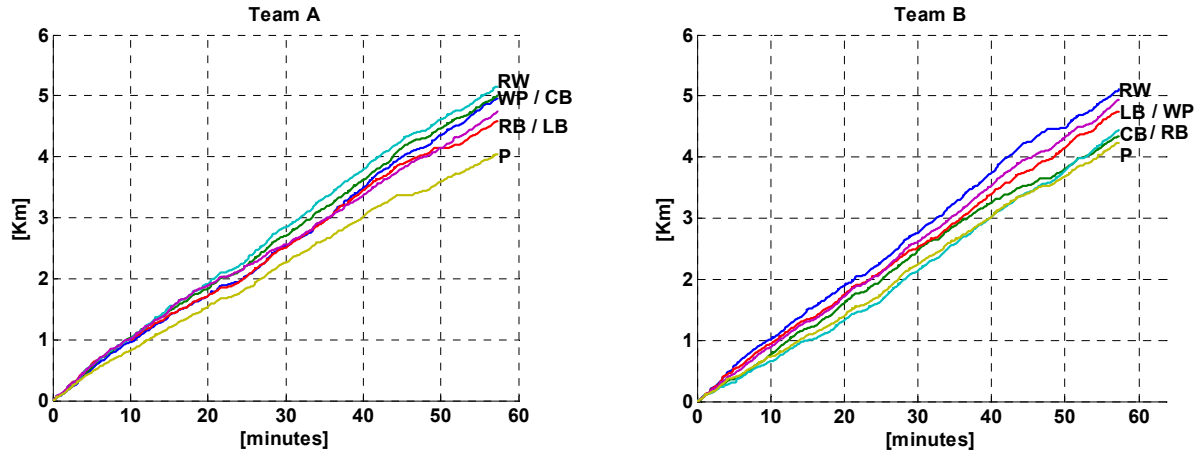

Figure 2: The accumulated covered distances by the players of the teams A and B. The players are identified as right backcourt player (RB), Left backcourt player (LB), Centre backcourt player (CB**),** Left wing player (WP), right wing player (RW) and Pivot (P). The respective players CB, RB (team A) and CB (team B) were substituted during the game.

The results of average covered distances (±SD) in the 1st and 2nd halves were, respectively, 2199m (±230m) and 2453m (±214m) considering only the players that took part of the whole match (n=9 players). The shortest and the longest covered distance in the 1st half was respectively 1845m and 2506m and in the 2nd half was 2018m and 2693m.

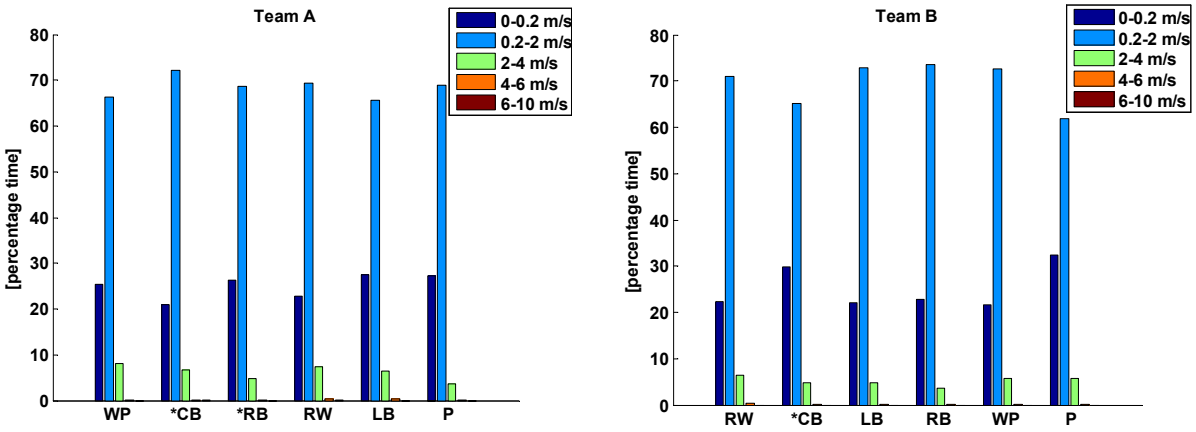

Figure 3: Percentage of time spent in each type of movement during the game. The following players CB, RB (team A) and CB (team B) were substituted during the game.

The results of the percentage of time spent in each one of the types of movements are shown in figure 3. The time averages spent by team A were: standing (14 minutes / 25%), walking (38 minutes / 67%), jogging (3 minutes / 6%), running (0.12 minutes / 0.2%) and sprinting (zero / 0%). The results for team B were: standing (13 minutes / 24%), walking (40 minutes / 70%), jogging (3 minutes / 5%), running (0.08 minutes / 0.1%) and sprinting (zero / 0%).

DISCUSSION

In this paper, we presented the results referent to the covered distances in function of time and the percent of time spent in each type of movement for all of the outline players. These were obtained by an automatic tracking method. The automatic tracking method applied to the soccer by Figueroa (2006) was 94% automatic against 75% as presented in this work.
This difference can be related to some of the following aspects: reduction of the match space in function of the size of the court and number of players; a great number of occlusions caused by great number of players during attack and defence. For a better player tracking

aiming to increase the automatic tracking, more cameras should be used in the other side of the court.
The results of average covered distance presented in this paper (4653m) are close to the one obtained by Pers et al. (2002) in a controlled game (4800m). The similarities and differences can be explained by the methodological differences among the studies, such as, the method used to obtain the covered distances.
The percentage time spent in each type of movement was presented by Pers et. al. (2002) as follows: 37% walking(velocities lower than 1.4 m/s); 31% light running(velocities between 1.4 and 3 m/s); 25% running (velocities between 3 and 5,2 m/s); 7% high speed running (velocities higher than 5,2 m/s). Comparing these results to the ones obtained by the method exposed in this paper, the differences noticed may have a relationship with the technical level and age of the players.

CONCLUSION

In this paper, the covered distances by handball players and the velocities in percentage time spent in five different types of movements were obtained using a novel and accurate video-based automatic tracking method. The representation allows individual and collective analyses of the players by the team staff. Furthermore, the distances covered give useful information about the physical performance of the players.
The proposed method revealed a powerful tool to improve physical analysis of the game.

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