

Research Article

Soccer Teams Behaviors: Analysis of the Team's Distribution in Function to Ball Possession

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Abstract: Innovative tools to soccer analysis are the main concern of the sport performance analysts. Considering team players occupation as one of the fundamental characteristics of soccer success, is too important generate new systems to interpret the post-match reality. These systems must be easy for the coach's applications. Thus, this study proposes an easy tool to understand the team's collective behaviour in function to their ball possession status. Through the histograms of all team players will be possible understand the most occupied areas by each team, trying understand possible tendencies in the moments with and without ball possession. Were analyzed two teams during an official soccer match, collecting their positions at each instant. Using this tracking was possible perform two heat maps by each team, representing the moments with and without ball possession. Through this method was possible analyze different collective behaviors and explain how could coaches interpret outcomes.

Keywords: Collective behaviour, heat maps, match analysis, soccer

INTRODUCTION

Despite of the complex characteristics, different organizational levels can be identified on team sports. During the match, the global opposition relationship breaks down into partial opposition relationships, i.e., sub-phases. These opposition settings momentarily involve by few players, generating specific shapes of play representing the organizational level partial forefront (Gréhaigne *et al.*, 2005). Thus, this rapport of strength is a permanent characteristic of the game, in function of the ball possession and the quality of the teams' organization to achieve their main goals and annul the opponent's strong points. Therefore, collective behaviour needs to be performed through some rules of play improving the whole' potentiality (Clemente, 2012), resulting in the notions of the strategic and tactical behaviour. Strategy relates to the principles of play or action's orientations allowing an organization and preparation of the team for the match (Bouthier, 1988). By the other side, tactics relates to the operation's orientation made during the game by the players in order to adapt the initial requirements to the dynamical constraints performed by the opposite team.

The principles behind strategy and tactics are majority related with players' action. All of these

principles are linked with the main goal of the game, i.e., overtake the opponents' action and achieve the victory (*cf.* Clemente *et al.*, 2012b). One of these principles is the team's competency. Cohesion is obtained through the competency network that involves different roles and functions among teammates. Thus, the whole acquires a certain homogeneity that makes it possible to lower the maintenance energy cost (Gréhaigne *et al.*, 2011). In other words, the competency principle relates to the efficiency of the collective action trying reducing the individual energy cost acting more closely and organized. Nevertheless, the strategic positions of the players, as well as their movements are closely related with two different states: with and without ball possession (Lago, 2009). The ball possession characterizes the offensive phase, where teams try to seek the score zone and achieve their main goal, i.e., score a goal (Clemente, 2012). By the other side, without ball possession, teams try avoid the opponent's offensive action seeking recover the ball (Vilar *et al.*, 2012). Thus, two different goals are related with different tactical behaviors.

Theoretically, teams on defensive phase needs reduce the distances between teammates, protecting the centralzone. This behavior is generally called by

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concentration principle (*cf.* Costa *et al.*, 2010). Their guidelines are related with the team's contraction, reducing the number of players by the different field areas. Inversely with ball possession, teams seek expand their area of play, i.e., increasing the dispersion by the field. Some authors call this behaviour as width and length tactical principle (*cf.* Costa *et al.*, 2010).

Considering the general principles of play, the players' distribution in function to the ball possession status should be analyzed (Lago-Peñas *et al.*, 2010) in order to understand how teams behave on defensive and offensive phases. For the coaches and their staffs should be designed easy ways to measure the field occupation (Moura *et al.*, 2012) in function to the ball possession, trying understanding possible patterns of the team, as well as the opponent team. One of these possibilities is provide histograms of all game, considering the players positioning at every instant. Although of the general application of the histograms for individual analysis, until now few studies apply this technique to understand the whole team (*cf.* Clemente *et al.*, 2012a). Thus, this study aims propose an easy tool to improve the perception of the field occupation in function to the ball possession. Through this study it is expected analyze the tactical behaviour of the team and expose the pertinence of the team's heat maps for the soccer match analysis.

METHODOLOGY

This study was conducted within the guidelines of the American Psychological Association and the protocol received approval from a local university ethics committee. All parents signed the Free and Clarified Consent Form respecting the Helsinki Declaration. The participants did not have any kind of physical or psychological diseases.

Data collection: Data were recorded from one official soccer match of the under-13 district final of Portugal. The match occurred in the specific situation of a 7-a-side game, according to the normative rule of *Federação Portuguesa de Futebol*. Teams' actions were captured using a digital camera (*GoPro Hero* with 1280 × 960 resolution), with capacity to process images at 30 Hz (i.e., 30 frames per second). The camera was placed above the ground in order to capture the whole game. After capturing the soccer match through the camera, the physical space was calibrated using direct linear transformation (i.e., *DLT*), which transforms elements' position (i.e., players and ball) to the metric space (*cf.* Clemente *et al.*, 2012a). After calibration, the tracking of players was accomplished, thus resulting in the Cartesian positioning of players and the ball over time. At the same time was recorded the ball possession status of both teams at every instant. The whole process inherent to this approach, such as

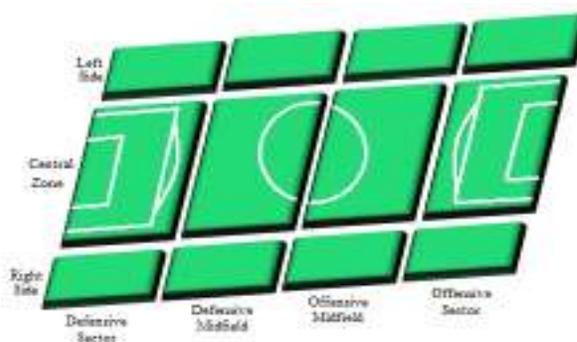


Fig. 1: Splitting the soccer field

the detection and identification of players' trajectories, the space transformation and the computation of metrics, was handled using the high-level calculation tool *MatLab*.

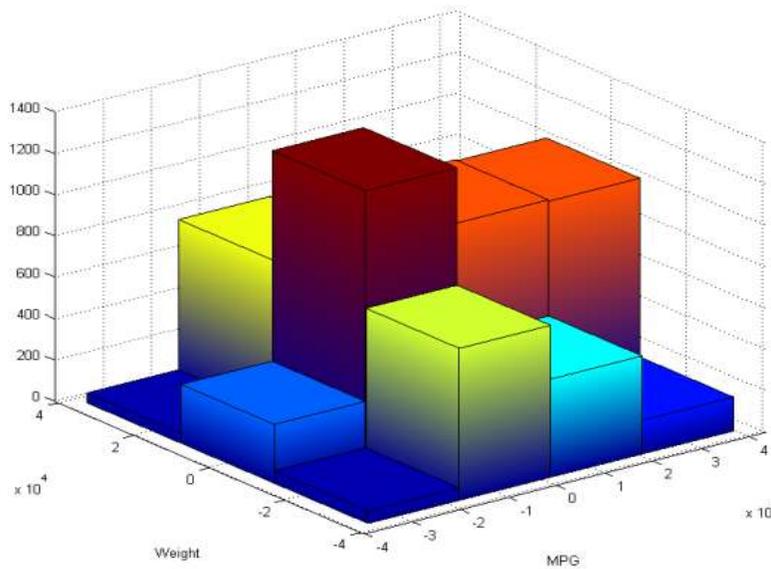
Data processing: The soccer field can be segmented into four longitudinal sectors as well as into three lateral sectors (Castelo, 2004), splitting the field on 12 sectors (*cf.* Fig. 1).

Thus, through this splitting is possible trying understanding the frequency of the players' occupation during the whole game at each sector. This kind of frequency analysis may allow understand some collective tendencies to play into preferential sectors comparing to others. Thus, an easy way to verify this rate' occupation is create histograms (*cf.* Clemente *et al.*, 2012a), resulting after on heat maps.

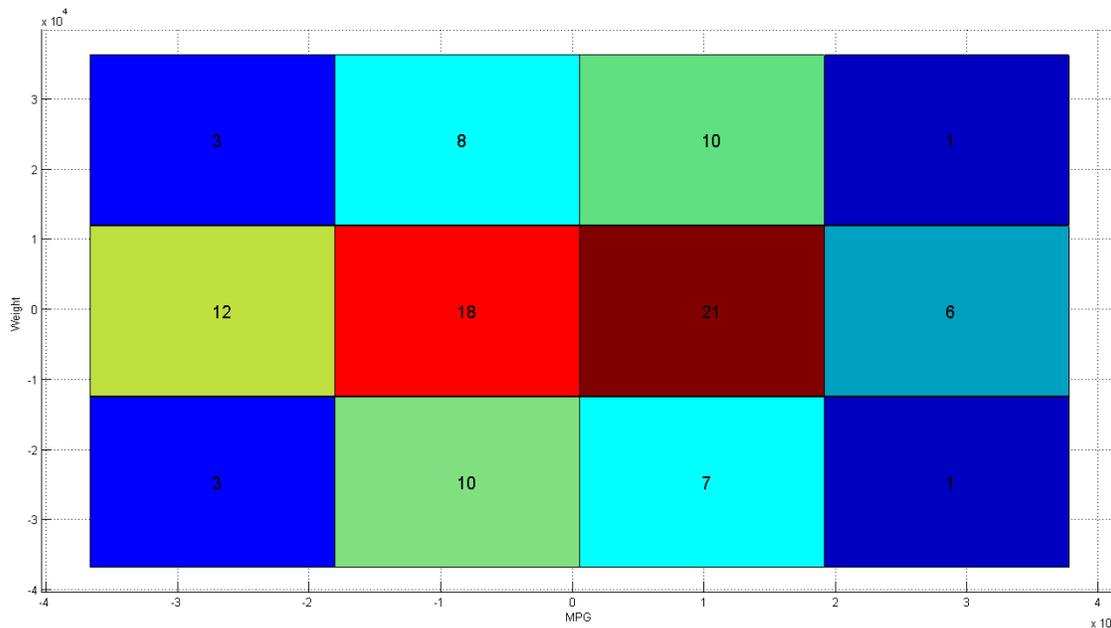
Through the players tracking, is possible generate frequency histograms based on the spatial distribution of all team players, thus resulting in the graphical representation of heat maps. For this purpose, the whole field was split on 12 windows (i.e., field sectors), thus obtaining a histogram representative of the more occupied zones of the field by all team players during the match. Figure 2 illustrates an example of a histogram.

To support the analysis of the occupied zones was proceeded to the design of heat maps. These heat maps consist of a graphical representation of the data in which the frequency values obtained by the spatial distribution histograms are represented in a two-dimensional table with different colors. The hot colors represent a higher occupation frequency in a certain zone of the field.

Considering the ball possession status of each team over each instant were processed two histograms and heat maps by each team, resulting on heat map of all moments with ball possession and heat maps of all moments without ball possession. Through this analysis will be possible observe some differences between team's occupation in function to their defensive or offensive status, helping the coaches and their staff to integrate and process information about team's collective behaviour.



(a)



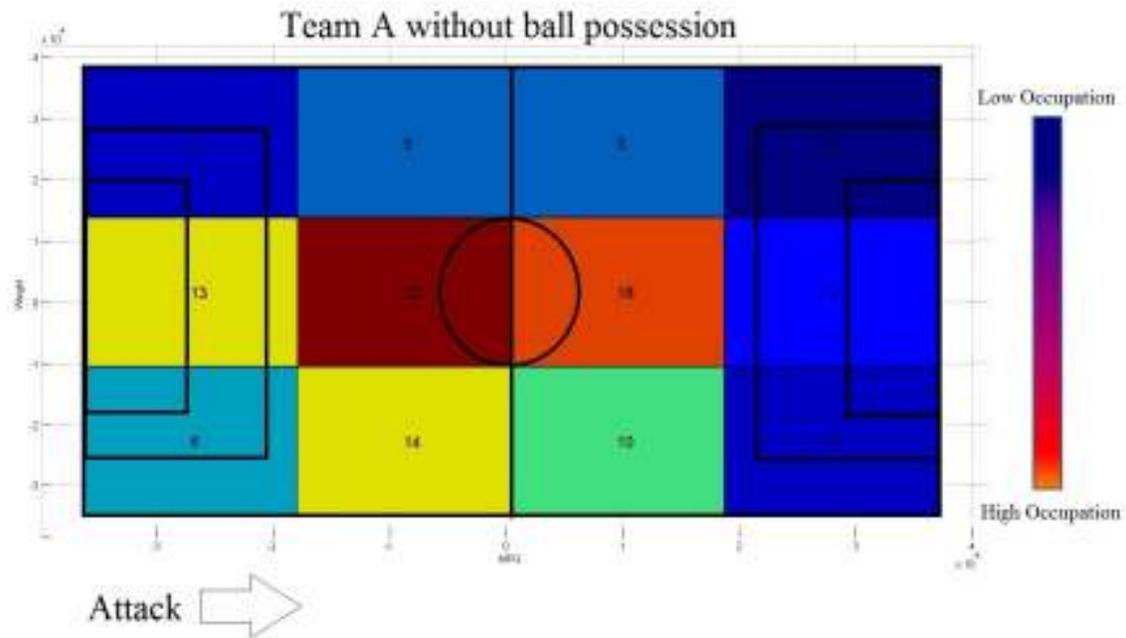
(b)

Fig. 2: Illustrative image of a histogram (left) and its heat map (right) representative of the busiest areas of the field by team players during the match

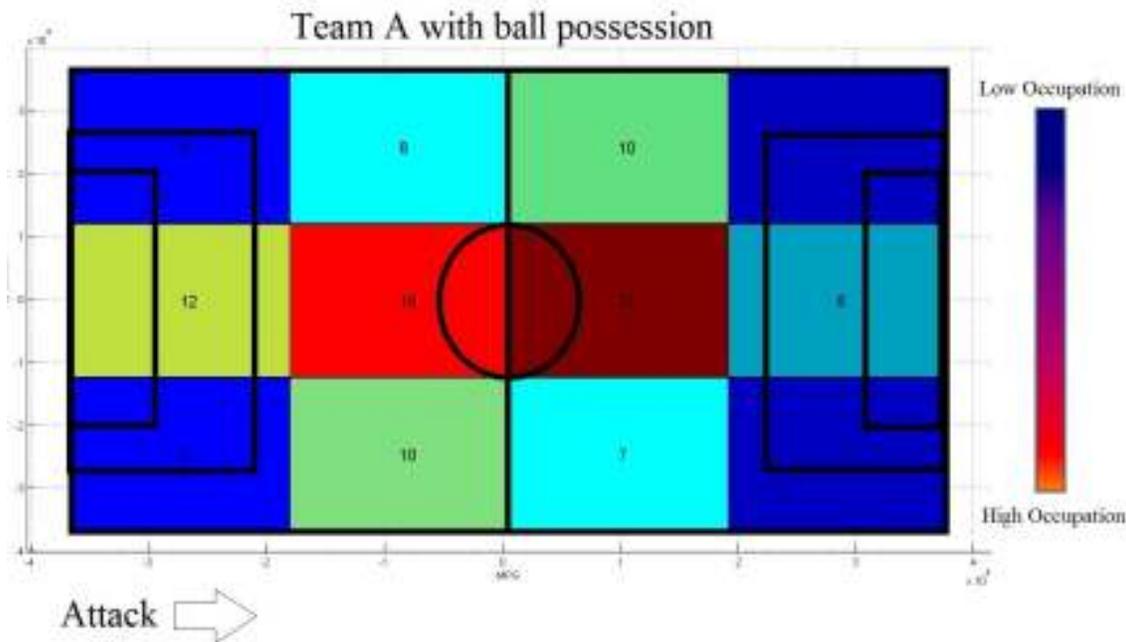
RESULTS AND DISCUSSION

Generally, offensive and defensive phases of soccer teams characterizes by their dynamic interactions oscillating between stability and instability (Vilar *et al.*, 2012). Nevertheless, the main goal of the defensive action is reduce the instability in order to keep protected the fundamental areas, i.e., the score zone (Bangsbo and Peitersen, 2002). Thus, theoretically

the central areas should maintain higher level of occupation on defensive phase. By the other side, on offensive phase the main focus should be increase the instability of the opponent team generating defensive breaks to penetrate with success on score zone. This kind of instability can be generated through a high level of field occupation, increasing their dispersion at length and width ways. Thus, in order to destabilize the opponent defensive organization, teams with ball



(a)



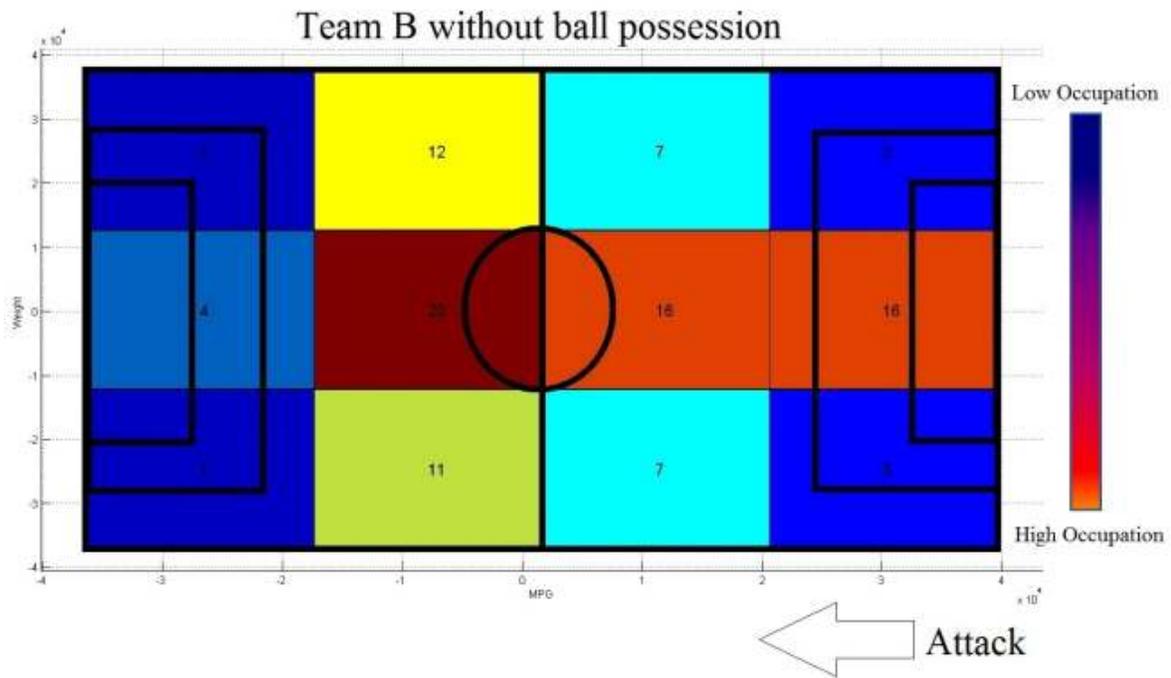
(b)

Fig. 3: Heat maps of the Team's A

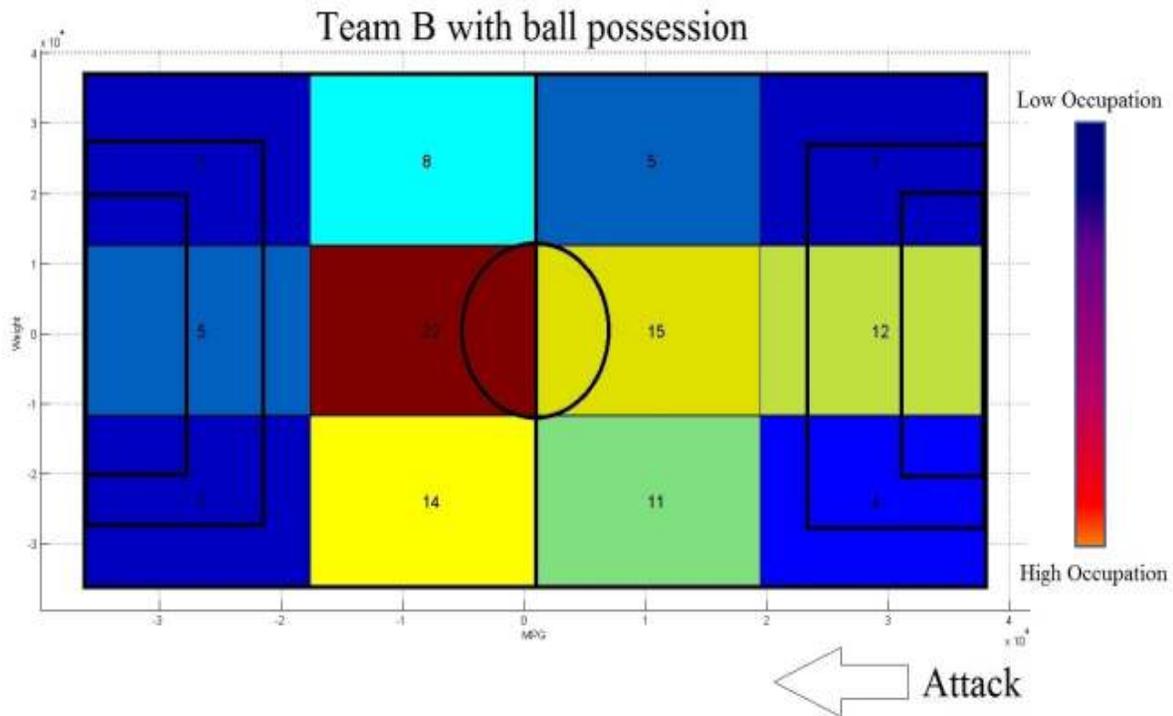
possession displace their players and the ball irregularly to generate a cascade of local instabilities in their opponent's defense (Vilar *et al.*, 2012).

Through the heat maps can be possible to coaches analyze the business field areas in soccer match. This kind of qualitative analysis allow a better understanding about some team patterns in two different moments,

i.e., with and without ball possession. Considering team's a (*cf.* Fig. 3) some post-match considerations can be discussed. With ball possession teams distributes their action by the midfield sectors (74%), mainly in the central zones (39%). On midfield zone is possible observe an inverse on the external areas, i.e., on the right side the area with higher occupation is the most



(a)



(b)

Fig. 4: Heat maps of the Team's A

defensive (10%) comparing with the most offensive midfield right zone (7%). By the left side, is possible observe a higher occupation on left offensive midfield side (10%) comparing with the defensive midfield area

(8%). This information may suggest a tendency to the right midfield players build their play closer to their defensive zone, possibly due to a higher opponent's opposition on this side. By the left side this results may

suggest a tendency to team's attacks for the left offensive midfield areas, possible due to a higher opportunities to explore this zone.

Comparing the heat maps with and without ball possession is possible verifies a tendency to reduce their position on the field, approaching their positions of their own goal. Similarly to the offensive phase, is possible observe that the central zone is the most business area (57%). This information reveals that on central zone was allocated a higher level of importance than the wings, confirming previous studies as such Vilar *et al.* (2012). Through this heat map without ball possession coaches can analyze that the central and right side defensive midfield area are the most business area of the team's considering their defensive phase. There are two main possible to explain this: *i*) own team strategies try protect this side in order to save possible weaknesses; or *ii*) team's A adjusted their position in function to team's B offensive behaviour (Fig. 4).

Considering the team's B occupation, is possible observe a higher distribution comparing with team's A. This kind of information may suggest an intrinsic team's property. Furthermore, the results suggest that without ball possession teams focus their action on central areas (56%), protecting the fundamental score zones. Inversely to the team's A, team's B with ball possession shows a tendency to attack through their left side (25%) comparing to right side (13%). These results confirm a previous discussion justifying why team's A defends more by their right side.

As commonly teams' tendencies as possible suggest that central area is the main focus of the players' occupation. This behaviour can be performed in order to protect the fundamental scores zones, considering that on FIFA World Cup 2002 the majority of the goals (37%) were scored from inside of the penalty area, specifically the area between the edge of the 5.5 m and the penalty spot (Carling *et al.*, 2005). The second area where scored more goals (29%) was between line of goal and 5.5 m. The third area where scored more goals (18%) was between 11 and 16.5 m, decreasing considerably with the increasing distance to the goal line. Therefore possession with a high degree of ball control inside penalty area has the potential for producing quality shots (Tenga *et al.*, 2010).

The heat maps show an easy way to post-match analysis, in order to coaches and their staff analyze team's collective behaviour considering their field occupation. Furthermore is possible detect some opponent's tendencies, adopting a singular strategy for the match in order to take advantage from the opponent's mistakes. Nevertheless, further developments may be undertaken in order to increase the potentialities of the heat maps. New developments

may consider the instant heat maps and through the ball position, generating new possibilities to interpret the dangerous zones, i.e., designing new estimative methods to evaluate the risk to further offensive plays. Furthermore may be possible organize the dangerous zone in function to players' triangulations (Lucchesi, 2001).

CONCLUSION

This study aimed proposes an analysis method for soccer application. Tracking all team players during a single match, was possible perform histograms about the most field areas occupied. These histograms resulted on heat maps, an easy way to analyze team's collective tendencies. Considering the moments with and without ball possession were performed two heat maps by each team. These heat maps allowed analyze the different team's behaviors in two different status (i.e., with and without ball possession), as well as analyze that central field areas are the most occupied by the teams. Through this method is possible to the coaches quickly analyze the collective tendencies and detect how fix some mistakes or take advantage from opponent's errors.

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