Advances in Intelligent Systems and Computing 392

Paul Chung
Andrea Soltoggio
Christian W. Dawson
Qinggang Meng
Matthew Pain *Editors*

Proceedings of the 10th International Symposium on Computer Science in Sports (ISCSS)

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Janusz Kacprzyk, Polish Academy of Sciences, Warsaw, Poland
e-mail: kacprzyk@ibspan.waw.pl

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Paul Chung
Loughborough University
Loughborough
UK

Andrea Soltoggio
Loughborough University
Loughborough
UK

Christian W. Dawson
Loughborough University
Loughborough
UK

Qinggang Meng
Loughborough University
Loughborough
UK

Matthew Pain
Loughborough University
Loughborough
UK

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Preface

The 10th International Symposium of Computer Science in Sport (IACSS/ISCSS 2015), sponsored by the International Association of Computer Science in Sport and in collaboration with the International Society of Sport Psychology (ISSP), took place between September 9–11, 2015 at Loughborough, UK. Similar to previous symposia, this symposium aimed to build the links between computer science and sport, and report on results from applying computer science techniques to address a wide number of problems in sport and exercise sciences. It provided a good platform and opportunity for researchers in both computer science and sport to understand and discuss ideas and promote cross-disciplinary research.

This year the symposium covered the following topics:

- Modelling and Analysis
- Artificial Intelligence in Sport
- Virtual Reality in Sport
- Neural Cognitive Training
- IT Systems for Sport
- Sensing Technologies
- Image Processing

We received 39 submitted papers and all of them underwent strict reviews by the Program Committee. Authors of the thirty-three accepted papers were asked to revise their papers carefully according to the detailed comments so that they all meet the expected high quality of an international conference. After the conference selected papers will also be invited to be extended for inclusion in the IACSS journal.

Three keynote speakers and authors of the accepted papers presented their contributions in the above topics during the 3-day event. The arranged tour gave the participants an opportunity to see the Loughborough University campus, and facilities in the National Centre for Sport and Exercise Medicine and the Sports Technology Institute.

We thank all the participants for coming to Loughborough and hope you had enjoyed the event. We also thank the Program Committee members, the reviewers and the invited speakers for their contributions to make the event a success.

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- Dr. Michael Hiley, Loughborough University, UK
- Prof. Thomas Schack, Bielefeld University, Germany

Evaluation of changes in space control due to passing behavior in elite soccer using Voronoi-cells

Robert Rein[1], Dominik Raabe[1], Jürgen Perl[2], Daniel Memmert[1]

[1]Institute of Cognition and Team/Racket Sport Research, German Sport University Cologne
[2]Institute of Computer Science, FB 08, University of Mainz, Germany

1 Introduction

A soccer player's ability to make an "effective" pass in a play situation is considered one of the key skills characterizing successful performance in elite soccer (Bush, Barnes, Archer, Hogg, & Bradley, 2015; Hughes & Franks, 2005; Mackenzie & Cushion, 2013). However, although there is ample evidence in the literature that passing behavior is important it is much less clear what actually characterizes a "good" pass. One common topic investigated with respect to passing behavior in elite soccer is the frequency of passing events and their correlation with game performance (Lago-Peñas, Lago-Ballesteros, Dellal, & Gómez, 2010; Liu, Gomez, Lago-Penas, & Sampaio, 2015). Results from this line of research show for example that the number of passes made during the FIFA World cup finals between 1966 and 2010 continuously increased (Wallace & Norton, 2014) and that the number of crosses and assists are positively related to game performance (Lago-Peñas et al., 2010; Luhtanen, Belinskij, Häyrinen, & Vänttinen, 2001). Similar, Hughes and Franks (2005) found that longer passing sequences increase the goal scoring likelihood (see also Yiannakos & Armatas, 2006). Although all these studies provide valuable information regarding the importance of passing behavior in elite soccer it remains unclear what characterizes successful passing. Accordingly, it is not known which effects individual passes exert on concrete game play situations which impedes the application of research findings by practitioners. Here, we introduce a novel approach to evaluate individual passing behavior during game play using Voronoi cells to investigate changes in space control.

The assumption behind this novel approach is that an effective pass gives the attacking side an advantage with respect to the control of space in front of the goal (Ensum, Pollard, & Taylor, 2004; Pollard, Ensum, & Taylor, 2004). Accordingly, a pass which increases space dominance of the attacking team is considered advantageous. To be able to evaluate changes in space control due to passing behavior however, an appropriate model of space dominance by the attacking team must be found. Previously, several methods to quantify the control over pitch space have been proposed (Fonseca, Milho, Travassos, & Araujo, 2012; Kim, 2004; Nakanishi, Murakami, &

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Naruse, 2008; Taki & Hasegawa, 2000). Conceptually, all these approaches are variations of the so-called Voronoi diagram.

A Voronoi diagram is a partitioning of a plane into different cells according to the distances between points in the plane. Each point, also called seeds, is associated with a single unique cell and the geometry of the cell is chosen such that all points within a given cell are closer in terms of the Euclidean distance to the seed associated with that cell than to any other seed. The individual cells are called Voronoi cells. Applied to soccer, the pitch constitutes the plane and each player represents a seed respectively. Each player can therefore be associated with a unique cell containing all pitch locations which are close to this player compared to all other players (compare Figure 1).

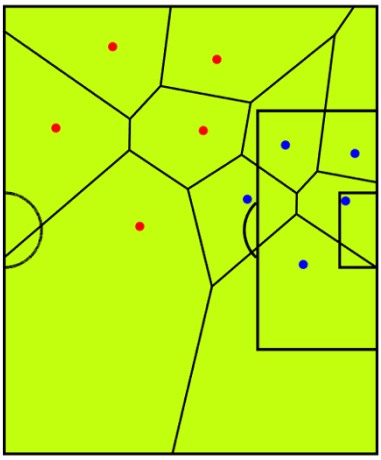

Fig. 1. Voronoi diagram of a player configuration: ● Team A, ● Team B

The player therefore controls the region contained in that cell. Naturally, this model simplifies the true situation as it assumes that all players are equally fast and neglects the current movement directions of the players. Early applications of this approach have been made by Taki and Hasegawa (2000) who used the Voronoi diagram. The authors did not use the standard Voronoi tessellation based on the Euclidean distance but defined a constant velocity function based on the concept of reachability and the finite running velocity. Result showed that the attacking team occupies a greater area compared to the defending team (compare also Gudmundsson & Wolle, 2014; Taki & Hasegawa, 2000). Fonseca et al. (2012) used Voronoi diagrams to investigate space control in experimental Futsal games. The results showed that the attacker team dominated more space compared to the defending team.

To obtain an assessment of passing efficiency, in the present work we combined therefore passing behavior with changes in space control using a Voronoi diagram. We expected that according to the region on the pitch from where the pass was made and to which region the pass was directed different effects on the space dominance of the attacking team would be visible.

2 Methods

In total 12 first halve-time games from the German first Bundesliga during the season 2012/2013 were analyzed. The dataset consisted of the x-y position data for each player and the ball recorded at 1Hz. The soccer pitch was divided into three areas: defensive third, mid-field, offensive-third (Tenga, Ronglan, & Bahr, 2010) to allow categorization of pass origin and pass target. Passing efficiency was calculated according to the change in space dominance of the attacking team in the 30m attacking zone. To this end the Voronoi diagram at pass initiation and at pass completion were calculated. Subsequently, the space dominance (in %) of the attacking and defending teams at these two time-point were determined. Finally, the attacking team space dominance at pass completion was subtracted from space dominance at pass initiation. All statistical tests were performed using the R statistical software. To take into account varying number of games analyzed for the teams a mixed-effects model was used with game and team as random-effects. In addition, non-parametric statistics were used where appropriate. The alpha level was set at $\alpha = 0.05$.

3 Results

On average relatively small changes were observed for changes in the percentage of the attacking areas dominated by the attacking team, $space_{30} = 1\% \pm 7\%$. However, as visible In Figure 2 this is mainly a result of the large fluctuations of the measure. Nevertheless, some general trends are immediately visible.

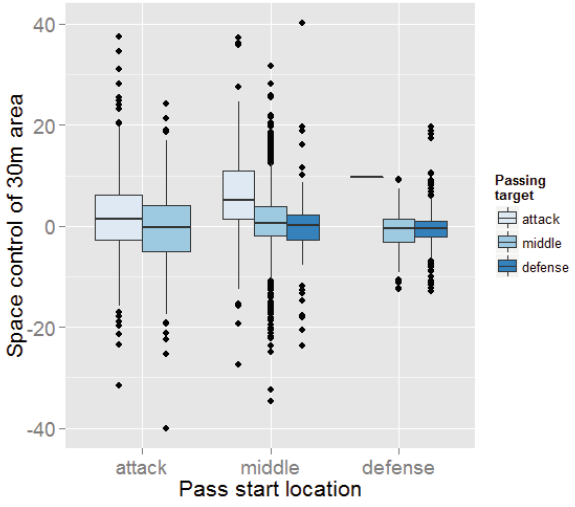

Fig. 2. Changes in space control of the 30m area as a function of pass start location and pass target location.

The plot indicates a trend that passes initiated from the mid-field lead to an increase in space dominance when targeting the attacking third whereas backwards passes into the defensive third decrease space dominance. Passes starting from the attacking area show a weak decrease in space dominance when targeting the mid-field and appear to increase space dominance when staying with the attacking area. In contrast, passes from the defensive third do not seem to influence attacking dominance. Statistical analysis indicated a significant main effect for passes made for from the mid-field, $\chi^2(2) = 156.7$, $p < 0.001$,with significant post-hoc tests for mid-field to attacking area passes, $z = 12.06$, $p < 0.001$ and within the middle area, $z = 3.7$, $p < 0.001$. Passes from the attacking area showed a significant main effect, $\chi^2 (1) = 8.8$, $p < 0.01$, with significant effects for passes within the attacking area, $z = 3.5$, $p < 0.01$. No significant effects were found for passes from the made from the defensive third.

4 Discussion

Here we introduced a novel assessment method to evaluate the effectiveness of individual passes using changes in space dominance of the attacking area by the attacking team. The results show that passes made from the mid-field as well as from the attacking field on average provide the largest gain in space dominance for the attacking team although individual pass space gains vary widely. Thus, this indicates that the application of the present approach for team average measurements might be of limited value to assess passing effectiveness with respect to space dominance. However the approach provides however some interesting venues for future research. For example, rather than investigating the passing behavior of the whole team the present approach can be used to evaluate individual contributions to team passing behavior. A potential application could be to evaluate opponent's passing efficiency in preparation of team tactics for upcoming games. The approach allows to easily identify opponent’s key players and their typical passing behavior in particular as the evaluation can be made automatically once passing events are identified in the data. The present method could also be combined with previous approaches (Gudmundsson & Wolle, 2014) to evaluate simulated passing opportunities versus actual made opportunities to improve decision making in players.

In summary, in the present work we introduced a novel approach to evaluate passing efficiency by analyzing the effect of passing behavior on changes in space domination of the attacking area. The approach taken might also be valuable to study other team sports like field and ice hockey or American football.

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