Football Displays Real-time Fractal Dynamics

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New York / Heidelberg — Football, aka soccer, fascinates millions of fans, almost all of them unaware that the game is subject to the laws of physics. Despite their seemingly arbitrary decisions, players obey certain rules, as they constantly adjust their positions in relation to their teammates, opponents, the ball and the goal. A team of Japanese scientists has now analyzed the time-dependent fluctuation of both the ball and all players' positions throughout an entire match. They discovered that a simple rule governs the complex dynamics of the ball and the team's front-line. These findings [1], published in EPJ B [2], could have implications for other ball games, providing a new perspective on sports science.

The authors considered two scenarios of previous football matches. Namely, they focused on a quarter-final game in the 2008 FIFA Club World Cup and a regular game in the 2011 Japanese soccer league. Using a digital video camera, they then recorded the time fluctuation in the positions of all players and the ball.

Thanks to their analysis of the time-series variation in the ball versus the front-line movements of the players, they were the first to discover that these dynamics have a fractal nature. This finding implies that the movement of the ball/front-line at any given time has a strong influence on subsequent actions. This is due to the so-called memory effect, linked to the game's fractal nature.

The authors therefore found that, for professional football games, the ball possession time for one team lasts only 30 seconds at most. As a result, the superiority of one team tends to persist for 30 seconds or less before the other team gets an opportunity to regain the advantage. The authors show that their conclusion is in broad agreement with previous studies on the 2002 FIFA World Cup.

Reference: A. Kijima, K. Yokoyama, H.Shima, and Y. Yamamoto (2014), Emergence of self-similarity in football dynamics, *European Physical Journal B*, DOI 10.1140/epjb/e2014-40987-5

Links:
[1] http://link.springer.com/article/10.1140/epjb/e2014-40987-5
[2] http://www.springer.com/materials/journal/10051