19th Portuguese Conference on Pattern Recognition

Instituto Superior Técnico, Lisboa
November 1st , 2013

TÉCNICO LISBOA

Programme Overview

Time	Event	Location
09h30 – 10h15	Registration	Salão Nobre, Pavilhão Central
10h00 – 10h15	Welcome session	Salão Nobre, Pavilhão Central
10h15 – 11h00	Poster session 1	Salão Nobre, Pavilhão Central
10h45 – 11h15	Coffee break	Salão Nobre, Pavilhão Central
11h15 – 12:00	Poster session 2	Salão Nobre, Pavilhão Central
12h00 – 14h00	Lunch break	Restaurante Café Império
14h00 – 15h30	Invited Talk by Prof. Ana Fred	Salão Nobre, Pavilhão Central
15h30 – 15h45	Coffee break	Salão Nobre, Pavilhão Central
15h45 – 16h45	Poster session 3	Salão Nobre, Pavilhão Central
16h45 – 17h00	Best poster award and closing session	Salão Nobre, Pavilhão Central

Invited Talk

Physiological Computing: a PR Perspective

Prof. Ana L. N. Fred
Department of Electrical and Computer Engineering, Instituto Superior Técnico, Lisbon and Instituto de Telecomunicações (IT), Lisbon.

Abstract:

In a sentence, physiological computing (PC) deals with the study and development of interactive systems that sense and react to the human body. The most basic sort of PC simply records a signal, such as a heartbeat, and displays it on a screen. More complex systems work on a basis of a bio-cybernetic loop, the main purpose of this loop being to translate patterns of physiological activity into meaningful interaction. From emotional status to identity assessment, this talk addresses the exploration of electrophysiological data in the context of intelligent human-computer interaction. Electrocardiographic signals and electro-dermal responses, acquired in a pervasive manner at the hands level, are shown to be two complementary modalities in the emotion / identity dual assessment goal. The role of pattern recognition in the development of such systems is discussed. Finally, BITalino, a versatile and low cost biosignal acquisition system is presented as a promising tool for pervasive biosignal monitoring and physiological computation.

Speaker Biography:

Ana Fred received the M.S. and Ph.D. degrees in Electrical and Computer Engineering, in 1989 and1994, respectively, both from Instituto Superior Técnico (IST), Technical University of Lisbon, Portugal. She is a Faculty Member of IST since 1986, where she is currently a professor with the Department of Electrical and Computer Engineering. She is a researcher at the Pattern and Image Analysis Group of the Instituto de Telecomunicações. Her main research areas are on pattern recognition, both structural and statistical approaches, with application to data mining, learning systems, behavioral biometrics, and biomedical applications. She has done pioneering work on clustering, namely on cluster ensemble approaches. Recent work on biosensors hardware (including BITalino – www.bitalino.com) and ECG-based biometrics (Vitalidi project) have been object of several national and international awards, as well as wide dissemination on international media, constituting a success story of knowledge transfer from research to market. She has published over 160 papers in international refereed conferences, peer reviewed journals, and book chapters. She received the "Best paper award in Pattern Recognition and Basic Technologies", awarded by the IAPR, for the paper “Learning pairwise similarity for data clustering”. She is the editor of over 40 books with the proceedings of international workshops that she organized or co-chaired, including S+SSPR 2004 (Lisbon), S+SSPR 2006 (Hong Kong), ICAART, KDIR and BIOSTEC and editor of 12 Springer books of selected papers.

Poster Session 1 (10h15 to 11h00)

1 **Staffline Detection in Grayscale Domain**
Ana Rebelo and Jaime Cardoso

2 **Cancer cell tracking using a Kalman filter**
Tiago Esteves, Maria Oliveira and Pedro Quelhas

3 **Automatic images spectral unmixing of Leishmania infection macrophage cell culture for improved infection indexes acessing**
Pedro Leal and Pedro Quelhas

5 **Mass detection on mammogram images: A first assessment of deep learning techniques**
Inês Domingues and Jaime Cardoso

6 **An Automatic Method for Assessing Retinal Vessel Width Changes**
Behdad Dashtbozorg, A. M. Mendonça and A. Campilho

14 **Learning from uneven video streams in a multi-camera scenario**
Samaneh Khoshrou, Jaime S. Cardoso and Luís F. Teixeira

17 **Land and water segmentation of SAR images using textons**
Francisco Seixas, Margarida Silveira and Sandra Heleno

20 **Quality measures for iris images in mobile applications**
Ana Sequeira, Juliano Murari and Jaime S. Cardoso

33 **Interactive Air Traffic Control automation in oceanic airspace**
Francisco Freitas, Rodrigo Ventura and Miguel Barão

38 **Large Scale Automatic Detection of Sub-km Craters Using Texture Information**
Marlene Machado, Lourenço Bandeira, Jorge Salvador Marques and Pedro Pina

39 **An interactive application for the detection of impact craters in planetary images**
Nuno Benavente, Lourenço Bandeira, Marlene Machado, José Saraiva, Jorge S. Marques and Pedro Pina

41 **3D Texture Analysis using Local Binary Patterns**
Pedro M. Morgado, Margarida Silveira and Jorge S. Marques

44 **3D Breast Parametric Model for Surgery Planning - a Technical Review**
Hooshiar Zolfagharnasab, Jaime S. Cardoso and Hélder P. Oliveira

45 **Total Variation Denoising using a Recursive and Spatially Adaptive Filter**
Manya Afonso and João Sanches

46 **Selection of epilepsy-related EEG ICA components for simultaneous fMRI analysis**
Rodolfo Abreu, Alberto Leal and Patrícia Figueiredo

53 **Clustering 802.11 Wireless Access Points Using Mixture of Hidden Markov Models**
Anisa Allahdadi, Ricardo Morla and Jaime S. Cardoso

55 **Towards efficient path planning of a mobile robot in rough terrain**
Diogo Amorim and Rodrigo Ventura

65 **Assessment of reliability of cerebrovascular reactivity measurements using breath-holding fMRI**
Joana Pinto, Inês Sousa, Pedro Vilela and Patrícia Figueiredo

66 **A Critical Analysis about a Motion-based Approach to Extract Global Trajectories**
Eduardo Marques, Jaime Cardoso and Ricardo Morla

67 **Ground-plane based indoor mobile robot localization using RGB-D sensor**
Miguel Vaz and Rodrigo Ventura

68 **Parameter Estimation for a Quad Rotor Dynamics**
Rui Oliveira and Rodrigo Ventura

70 **Exploring monogenic decomposition in carotid atherosclerotic plaque characterization**
David Afonso and João Sanches

72 **Sialolith metrics computed from microtomography data**
Pedro Nolasco, Antonio P. Alves de Matos, Paulo V. Coelho, Carla Coelho, António Maúricio, Manuel F.C. Pereira, Raúl C. Martins, João M.R. Sanches and Patricia A. Carvalho

73 **Automatic gesture segmentation based on a predictive event segmentation approach**
Sofija Spasojevic and Rodrigo Ventura

Poster Session 2 (11h15 to 12h00)

4 **An assessment of the potential of distinct facial regions for biometric recognition**
João C. Monteiro and Eduardo Mota

7 **Colour Invariant Features for Narrow-Band Imaging in Gastroenterological Examinations**
Bruno Mendes, Ricardo Sousa, Carla Rosa and Miguel Coimbra

8 **Insights into primates genomic evolution using a compression distance**
Diogo Pratas and Armando Pinho

11 **Impact of SVM Multiclass Decomposition Rules for Recognition of Cancer in Gastroenterology Images**
Ricardo Sousa, Mario-Dinis Ribeiro, Pedro Pimentel-Nunes and Miguel Tavares Coimbra

13 **Forecasting the Usage of Home Appliances with Denoised Signal Patterns**
Marisa Figueiredo, Bernardete Ribeiro and Ana Maria De Almeida

15 **Temporal subsampling impact on echocardiography based analysis of the left ventricle dynamics**
Susana Brás, José Ribeiro, Augusto Silva and José L. Oliveira

19 **Nociception/Anti-Nociception Balance During Anesthesia**
Ana Castro, Pedro Amorim and Miguel T. Coimbra

22 **Automatic Classification of Meals with Calorie Count**
Pedro Rodrigues, Pedro Brandão and Miguel Coimbra

23 **Face Recognition with Neural Networks Classifier using SIFT and SURF Descriptors**
João Sargo, João Caldas Pinto and João Costa Sousa

24 **Automatic Visual Inspection of Ceramic Plates based on SIFT and SURF Descriptors**
João Caldas Pinto, Rafael Baeta, Mariana Pereira, Ricardo Laranjeira, João Sargo and Carlos Cardeira

25 **Classificação da posição de estores de uma fachada de um edifício por análise de fotografias**
José Mota and João Caldas Pinto

26 **Building and Evaluation of a Mosaic of Images using Aerial Photographs**
João Costa, Tiago Coito, João Caldas Pinto and José Azinheira

34 **Development of a System for Automatic Detection of Air Embolism Using a Precordial Doppler**
Ana Rita Costa Tedim, Pedro Amorim and Ana Castro

35 **Neural Network Model for Wind Power Forecasting**
Paulo Salgado and Paulo Afonso

36 **Prediction of solar radiation using artificial neural networks**
João Faceira and Paulo Salgado

47 **Detection, classification and localisation of football players and ball from Handycam videos**
Tiago Vilas, J.M.F Rodrigues and Pedro Cardoso

50 **Region clustering using colour tuned keypoints**
Miguel Farrajota, J.M.F. Rodrigues and J.M.H. Du Buf

51 **AAM Based Vocal Tract Segmentation from Real-Time MRI Image Sequences**
Samuel Silva and António Teixeira

54 **Antifungal defensin Psd1 increases membrane roughness and promotes apoptosis in Candida albicans**
Patricia Silva, Sónia Gonçalves, Luciano Medeiros, Eleonora Kurtenbach and Nuno C. Santos

57 **Processing sports acquired information from a tracking system**
António Belguinha, Pedro Cardoso and J. M. F. Rodrigues

59 **Caracterização de Patologias da Pele por Ultrassons**
Sara Barbosa, Jose Silvestre Silva, Jaime B. Santos, Mario Santos and Alexandra Andre

62 **Object tracking with UAVs**
João Palma, Pedro Mendes Jorge and Arnaldo Abrantes

63 **Análise da Textura de Padrões Pulmonares em Imagens TCAR Baseada na Lacunaridade**
Verónica Vasconcelos, José Silvestre Silva, Luís Marques and João Barroso

69 **Using bioinformatics and biological approaches to uncover novel non-coding disease-related variants**
Patricia Oliveira, Hugo Pinheiro, Sonia Sousa, Joana Carvalho, Karey Shumansky, David Huntsman and Carla Oliveira

71 **Voice Type Discovery**
Mário Amado Alves, Ricardo Sousa, Sérgio Lopes, Vítor Almeida and Aníbal Ferreira

Poster Session 3 (15h45 to 16h45)

9 **Comparative study of two movement identification strategies on BCI motor task**
Mariana Branco, João Sanches and Rodrigo Ventura

10 **EEG time-frequency analysis for ERD/ERS temporal pattern characterization on brain computer interface motor task**
Mariana Branco, Fernando Lopes Da Silva and João Sanches

12 **Heart Sound Analysis for Cardiac Pathology Identification: Detection of Systolic Murmurs**
João Pedrosa, Ana Castro and Tiago T. V. Vinhoza

16 **Knowledge on Heart Condition of Children based on Demographic and Physiological Features**
Pedro Ferreira, Tiago Vinhoza, Ana Castro, Felipe Mourato, Thiago Tavares, Sandra Mattos, Inês Dutra and Miguel Coimbra

18 **Mobile framework for recognition of musical characters**
Rui Silva, Jaime Cardoso and Ana Rebelo

27 **SignalBIT Framework: Principles and Applications**
Ana Priscila Alves, Hugo Silva, Andre Lourenco and Ana Fred

28 **Correction of Geometrical Distortions in Bands of Chromatography Images**
Bruno Moreira, António Sousa, Ana Maria Mendonça and Aurélio Campilho

29 **A novel sparsity and clustering regularization**
Xiangrong Zeng and Mário A. T. Figueiredo

30 **Exploiting Two-Dimensional Group Sparsity in 1-Bit Compressive Sensing**
Xiangrong Zeng and Mário A. T. Figueiredo

31 **Exploring Heartbeat Sub-patterns for Person Identification**
Carlos Carreiras, Hugo Silva, André Lourenço and Ana Fred

32 **Fluorescence Microscopy Based Classification of E-cadherin Missense Mutation Pathogenicity**
Martina Fonseca, Joana Figueiredo, Raquel Seruca and João Sanches

40 **A mathematical model of the baroreflex physiology: model parameters measurement**
Anastasiya Strembitska, Alexandre Domingues and João Sanches

42 **Automatic sleep parameter computation from Activity and Cardiovascular data**
Alexandre Domingues, João Sanches and Teresa Paiva

43 **Supervised Feature Discretization with a Dynamic Bit-Allocation Strategy**
Artur Ferreira and Mario Figueiredo

48 **Mosaicing the Interior of Tubular Structures**
David Pereira, João Tomaz, Ricardo Ferreira and José Gaspar

Processing sports acquired information from a tracking system

António Belguinha
Pedro Cardoso
http://w3.ualg.pt/~pcardoso
J.M.F Rodrigues
*http://w3.ualg.pt/~*jrodrig

Instituto Superior de Engenharia, University of the Algarve, 8005-139 Faro, Portugal
LARSyS, University of the Algarve, 8005-139 Faro, Portugal
Vision Laboratory, LARSyS, University of the Algarve, 8005-139 Faro, Portugal

Abstract

In order to improve the players' and teams' performances in sports, the technical staffs are now using an ever increasing number of technologies. In this paper we present a study based on a video tracking of players and ball, that can return heat, passes and ball losses maps, which can be a good resource to measure a player/team performance and a base to their improvement.

1 Introduction

Paper support maintains until our days as one of the basic ways to log the player's and team's actions (e,g., passes, rebounds, turnovers, recurrent movements). At the end of the matches, those documents are statistically analysed by the technical staff and the players are notified about their actions. The log work is made by someone that is observing the game (live or recorded) and marking those moments by hand. This is a slow process and, in live games, can require more than one person to process all actions with an optimum precision.

This paper shows our alternative to that kind of work. Our system rests on a one camera tracking system: (a) a portable camera that can be placed in the stands to acquire the images; (b) software to process the (live or recorded) matches. The returned data is then used to show individual or team actions. This work deals with the constructions of the heat, passes and loss ball maps for a football match. With this process, the information can be given in real time, allowing an instantaneous analysis of the players and teams actions, which gives the possibility to the technical staff to make in game adjustments, based on that information. As expected, knowing the opposite team performance is also possible with this system, which can give an extra advantage to those using these features. This work is a part of the Footdata project [1].

On the market there are some systems which incorporate partially some of the components of this project, for example, Kizanaro ® [2] Tracab ® [3] Prozone ® [4] Amisco ® [5], and SportVU ® [6]. We can also find some research that explores aspects of the project, such as Spatial and Spatiotemporal Analysis of Soccer [7], and tactical analysis in football, [8], [9] and [10]. Our system, which integrates the tools presented in this paper, will integrate some of the functionalities that these systems already have.

Since one of the main objectives of the Footdata project was to build an operating system (OS) independent software it was decided to make it as a web application, so it can run in all equipment that have a browser (such as, Chrome, Firefox, or Safari) and an internet connection. The web application is being developed with the django [11] framework were all the coding is made in python [12]. The user interface is not in the scope of this article, which will focus on the creations of a set of action maps which were built using a SVG [13] library developed by us in python, so it can be integrated with the django framework. You can find more detailed information about the referred system in [1].

The remaining paper is divided as follows: heat maps, passes maps and ball loss maps, are approached in Sections 2, 3, and 4, respectively. Section 5 presents some conclusions and future work.

2 Heat Maps

The heat maps are graphical representation of data where the elements of a matrix are represented as colours. In sports, the heat map can have different uses. Depending on the sport, heat maps help to visually analyse which areas a team, a player, or a set of players preferably occupy. In the particular case of football, they can be used to infer if a player has a preferred side, area, or if the defence is occupying the respective positions.

In our case, the data structure behind the heat map is a matrix, HM, that has the same size as the image resolution used to draw it. HM is build using the data from the tracking system, that returns for each frame the players' and ball's positions in meters, $\{"frame\_id": t, "teamA": \{player_1: (x_1, y_1), player_2: (x_2, y_2), \dots\}, "teamB" : \{\dots\}, "ball" : (x, y)\}$. Those positions are relative to the pitch top left corner and are obtained using an homography [14]. To compute HM we start by setting it to the null matrix, $HM = [\mathbf{0}]$, then for each frame a cross-multiplication is used to get the corresponding positions of the players in the pitch, (x, y), to their corresponding entry in HM matrix, (x', y'), and $HM_{x'y'}$ is incremented by one unit. Once all the frames and players are processed, the matrix is normalized, .i.e., each entry of the matrix is divided by the matrix maximum element. Finally, the HM values (ranging from 0 to 1) are used to build the SVG image, by setting the colour opacity of the pixels that form the heat map.

Figure 1 sketches a team heat map from one minute of a football match. The heat map can be filtered within different time intervals, and individual or multiple players (Figure 2).

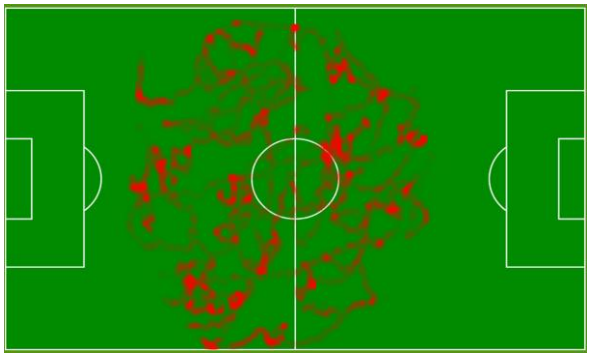

Figure 1: Team heat map, from one minute of a football match.

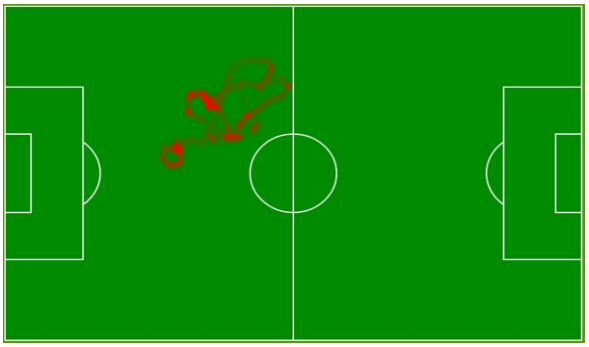

Figure 2: Single player heat map, from one minute of a football match.

3 Passes Maps

The passes maps are a graphical representation of the passes made by the players in the game. It shows the passing player's number and the receiver's number. The passes map is a tool which allows several analyses, like how a team organises the attack or maintains the ball possession. Other statistics can also be inferred like who are the most important players in the teams' strategies, in the sense that they have more ball actions.

The following process is operated to find the passes between the players. In each frame, (1) the distance between the players and the ball is calculated; (2) if the ball enters in a player's radius (empirical tests, revealed good results considering a radius distance equivalent to 1,3 meters), that frame and player are tagged, and the ball velocity and direction are calculated using the current position and its position five frames before; (3) if the ball leaves that player's radius, the velocity and direction are also calculated, considering the ball's current position and its position five frames after; (4) the velocity and

direction values are then subjected to a set of conditions (changes in the ball direction or velocity), in order to see if it's a pass or not: if the ball changes direction or velocity then it is almost sure a pass. The pass detection process is summarized in Algorithm 1. Figures 3 - 4 show a passes map where it's possible to see all the passes made by both teams, a team or by a single player.

Simultaneously, a log is built as the game is processed, containing a list with the intervening players numbers, teams and time of the pass execution and reception.

Algorithm 1: Passes Extraction

```
For each frame
    If ball enters player radius
        vi = velocity( frame_id, frame_id - 5 )   // ball initial velocity
        di = direction(frame_id, frame_id - 5 )  // ball initial direction
    If ball leaves player radius
        vf = velocity(frame_id, frame_id + 5)    // ball final velocity
        df = direction(frame_id, frame_id + 5)  // ball final direction
        If di <> df  or vi <> vf
            Almost sure it's a pass
        Else
            Not considered as a pass
```

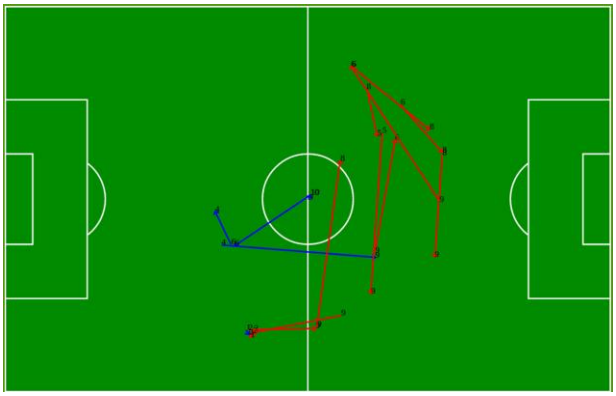

Figure 3: Teams passes map, from one minute of a football match.

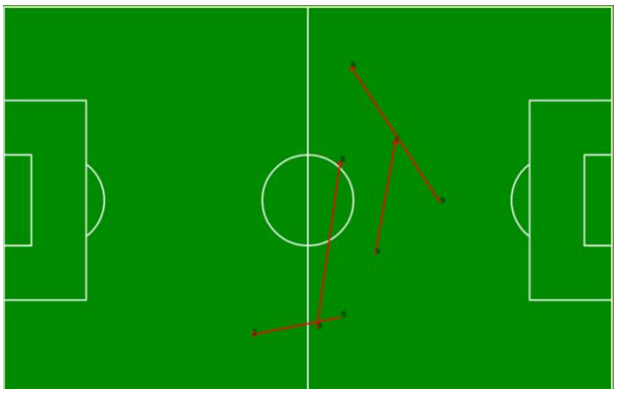

Figure 4: Single player passes map, from one minute of a football match.

4 Ball Loss Maps

Similar to the passes maps, we have the ball loss maps that can be also filtered by time interval and by player/team (see Figure 5).

Using this map, it's possible to see which player loses more balls, or in which areas more ball are loss. Analyzing both the passes and loss ball map, we can have a general view about the player and team performance, by seeing how many correct passes were made and how many balls were loss.

The loss ball map is generated using the passes log (Section 3) as base. The passes algorithm counts the passes made by players from different teams, so when the pass is made to the other team we have a ball loss. Although, we have to distinguish two cases: ball loss made when passing or when dribbling. In order to distinguish both its considered the distance between the position where the pass was made and where it was received. If the distance is less than two times the player's radius it is considered that the ball was lost while dribbling, otherwise the ball was lost while passing.

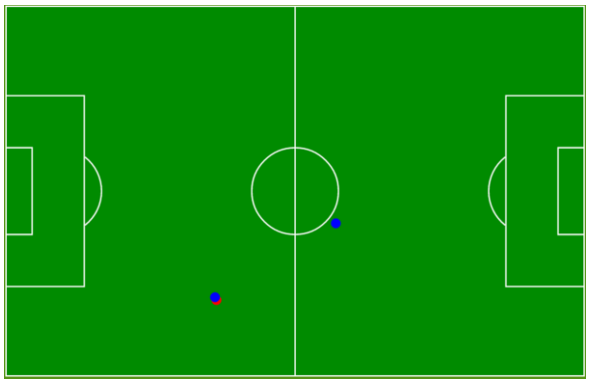

Figure 5: Teams ball loss map, from one minute of a football match.

5 Conclusion and future work

In this paper we have shown a small part of the overall system that is being built to help coaches and technical staff in the improvement of their players and team's performance, by using: heat maps, passes maps and loss ball maps. The maps can be filtered by time intervals, by team or by players, in order to in an easier way understand and evaluate the player's / team performance. It was also explained our approach in extracting the passes from the information given by the tracking system and how we get the ball losses.

The system is being optimized for football, but the difference between other ball sports is not big, so maybe in a near future our system will be adapted to other sports.

Acknowledgements: This work was supported by FCT project PEst-OE/EEI/LA0009/2013 and project FootData QREN I&DT, n.º 23119. We also thanks to project leader Inesting, S.A. [www.inesting.com], and the consultant football coach Domingos Paciência and our colleague Carlos Gomes.

6 References

[1] P. Rodrigues, A. Belguinha, C. Gomes, P. Cardoso, T. Vilas and J.M.F Rodrigues, "Open source technologies involved in constructing a web-based football information system," in *In Proc World Conf. on Information Systems and Technologies (WorldCIST'13). Advances in Information Systems and Technologies, AISC 206, Á. Rocha et al. (Eds.),*, Vilamoura, Portugal., 2013.

[2] Kizanaro. Available: http://www.kizanaro.com.

[3] Tracab. Available: http://www.tracab.com.

[4] Prozone. Available: http://www.prozonesports.com.

[5] Amisco. Available: http://www.sport-universal.com.

[6] Sportvu. Available: http://www.sportvu.com.

[7] H. Kim, O. Kwon and K. Li, "Spatial and Spatiotemporal Analysis of Soccer, In Proc,," in *19th ACM SIGSPATIAL GIS '11*, Chicago, USA., 2011.

[8] J. Peña and H. Touchette, "A Network Theory Analysis of Football Strategies," in *arXiv:1206.6904v1 [math.CO]*, 2012.

[9] G. Zhu, C. Xu, Q. Huang, Y. Rui, S. Jiang, W. Gao and H. Yao, "Event Tactic Analysis Based on Broadcast Sports Video," vol. 11, 2009.

[10] F. Moura, L. Martins, R. Anido, R. Barros and S. Cunha, "Quantitative analysis of Brazilian football players' organisation on the pitch," in *Sports Biomech*, 2012.

[11] Django. Available: http://www.djangoproject.com.

[12] Python. Available: http://www.python.org/.

[13] SVG. Available: https://svgwg.org/svg2-draft/.

[14] N. Sebe e M. Lew, Robust computer vision: Theory and applications., The Netherlands: Kluwer Academic Publishers, 2003.