Turning Real Time Biometric and On-Court Data into Actionable Performance Gains: The Major Big Data Challenge

> Robert A. Connor, MHA, Ph.D. CEO, Medibotics LLC robert.connor@medibotics.com







Wearable Tech, Sports, and Data: Big Picture and Trends

# 2013

Wearable Tech Expo 2013 December 9, 2013

Robert A. Connor, Ph.D. CEO, Medibotics



sports data collection and analysis with little or no wearable tech

Wearable Tech, Sports, and Data: Big Picture and Trends

## 2016

Wearable Tech Expo 2013 December 9, 2013

Robert A. Connor, Ph.D. CEO, Medibotics



Collection and Use of Sports Data:

Model and Examples of Data Collection, Elements, Specific Sports, Applications, and Users

Wearable Tech Expo 2013 December 9, 2013

Robert A. Connor, Ph.D. CEO, Medibotics

\*List of companies and publications at end.



#### **COLLECTION: HUMAN**

Time-honored data collection and analysis by human senses unaided by additional technology.

Humans miss some things due to their limited focus and sensory range limitations.

Does not automatically provide objective and/or quantitative data for analysis.

\*List of companies and publications at end.



#### **COLLECTION: FIXED CAM**

Traditional single fixed location (not worn) camera.

Can use pattern recognition for (limited perspective) posture and "play" recognition. Can use non-visual (e.g. infrared) light.

Hard to pinpoint XYZ location or path... or to track multiple places simultaneously.

Less good for obscured or large-area sports (e.g. swimming, wrestling, distance running).

\*List of companies and publications at end.



#### **COLLECTION: MANY CAMS**

Data collection and integration among multiple fixed-location (not worn) video cameras.

Can integrate data to track XYZ location (path, speed, acceleration) and (with pattern-recognition or human assist) posture and "play." Better for sports in unobscured, constrained area with limited player overlap (e.g. basketball). Less good for obscured, overlap, or large-area sports (e.g. swimming, wrestling, skiing, distance running).

\*List of companies and publications at end.



#### **COLLECTION: WEAR CAM**

Data collection by one or more wearable cameras (e.g. head, torso, wrist).

Rare now, but will increase as cameras become less obtrusive and more durable.

Good for fan engagement and first-person perspective.

Pattern recognition for (limited inverse) location tracking.

Better than fixed cameras for large-area or scenic sports (e.g. running, biking, skydiving).

\*List of companies and publications at end.



### **COLLECTION: INERTIAL**

Data collection by one or more wearable inertial sensors (e.g. accelerometers, gyros). Single sensor at one place on body (e.g. pedometer, smart watch) can track steps or overall "activity level."

Sensors at different body locations can track full-body posture/motion, but current tech can be obtrusive, complex, drift, and expensive. Improving.

Good for obscured, large-area, or complex-posture sports (e.g. swimming, running, golf).

\*List of companies and publications at end.



### **COLLECTION: ElecMag**

Data collection by worn EM (ElectroMagnetic), RF (Radio Freq) and/or GPS. Less good in some settings. Single RF/GPS sensor can track general XY location; good for large-area sports (e.g. running, biking), but limited for posture or "play." Full-body EM sensor systems can be obtrusive, complex, and range limited. ECG, EEG, and EMG sensors measure heart/brain/muscle activity and may increasingly also measure body posture.

\*List of companies and publications at end.



### **COLLECTION: PRESSURE**

Data collection by wearable pressure sensors in helmet, hand-held equip, clothing, socks, shoes, etc. More common as sensors less obtrusive and more durable.

Measure impact/force for performance and/or safety. Changes in pressures in tubes spanning joints to est. changes in joint angles -- to recognize body posture, motions, and "plays."

Potential for obscured, largearea, or high-overlap sports.

\*List of companies and publications at end.



## Sports Data/Video Analysis:

Active Analysis, Amisco (Sport Universal Process), **Baseball Info Solutions. Baseball Perspectives**, CourtVision, Dartfish, Elite Sports Analysis, EON Reality, IBM, Kizanaro, MasterCoach, OnCourt, Prozone (SUP), SAP. Scanball. Sport Universal Process, Sports Data Hub, SportsBoard, Sportstec

\*List of companies and publications at end.



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Tracking

ChyronHego,

Mikromak,

Motion Reality, Sportvision,

STATS



Fixed Camera(s)-Only Tracking (less sports focus): B & L Engineering, Microsoft, Motion Analysis Corp, Organic Motion, Pfinder,

> PhaseSpace, Qualisys,

> > Vicon

\*List of companies and publications at end.



Fixed Camera(s) Plus Wearable Inertial and/or EM Tracking:

Cairos Technologies, Dynamic Athletic Research Institute, GestureTek, GolfTEC, Motek, Northern Digital (inc. Ascension)

\*List of companies and publications at end.



Wearable Camera:

Autographer, Google Glass, Memoto (see Narrative Clip), Narrative Clip, Omate Watch, Parashoot, Pivothead, Samsung Gear, Vuzix

\*List of companies and publications at end.



## Wearable (Single) Inertial Sensor:

Adidas, Aliphcom (Jawbone), Amiigo, APDM, Applied Technology Holdings, Basis Science, BodyMedia (see Jawbone), Coach 2.0, Fitbit, Fitbug, Freescale, Goal Physics, Gruve, Hexoskin (Carre Tech.), i1 Biometrics, InterSense, Jawbone (Aliphcom, BodyMedia), K-Motion Interactive, Lumo BodyTech, MicroStrain, Misfit Wearables, Nike, Pebble, Plantronics, Qualcomm, Runner Groove, Ultimate Balance, Zepp Labs

\*List of companies and publications at end.



Inertial-Based Ball/Equipment/Object Tracking:

AiLive, Creative Kingdoms, Nintendo, SONY

\*List of companies and publications at end.



\*List of companies and publications at end.



#### Wearable Heart Monitor:

Bionym, Clothing Plus (Clothing+), Impact Sports Tech., Physical Enterprises Inc, Preventice, Under Armour, Zephyr Technology

\*List of companies and publications at end.



\*List of companies and publications at end.



\*List of companies and publications at end.



Wearable RF/GPS/ Non-Biological-EM Tracking:

Ascension Tech. (see Northern Digital), Catapult Sports, Garmin, GPS Sports, Inmotio Object Tracking, Polhemus/Alken, Real Track Football, Trakus, ZXY Sport Tracking

\*List of companies and publications at end.



Wearable Pressure/Bend/Mech Sensors:

Biomedtrics, Biopac, Heapsylon, Medibotics, Tactonic Technologies, Vista Medical

\*List of companies and publications at end.



Electrically-Functional Clothing and Tattoos:

AiQ Smart Clothing, MC10, TechnoSkin, Textronics (see Adidas)

\*List of companies and publications at end.



Other & Potential:

Apple, Honda, Immersion, MapMyFitness (see Under Armour), Measurand, Metamotion, Proteus Digital Health, Rock My World, Vivonoetics

\*List of companies and publications at end.

# SELECTED EXAMPLES AND APPLICATIONS BY SPORT

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- Lowe (2013c), "A New View: The NBA Will Install STATS LLC Cameras in Every Arena in the League", Grantland
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- Alamar et al. (2011b), "Sports Analytics, Part 2: The Role of Predictive Analytics, Organizational Structures and Information Systems in Professional Sports", Analytics Magazine
- Alamar et al. (2012), "Improving Resource Allocation with Portfolio Decision Analysis", Analytics Magazine
- Goldsberry (2012), "CourtVision: New Visual and Spatial Analytics for the NBA", MIT Sloan Sports Analytics Conference 2012
- Gregory (2013), "Big Data Takes Big Step Forward In The NBA", Time

- Lowe (2013a), "The SportVU Follow-up: Answering the Most Common Questions and More Ghost Raptors", Grantland
- Lowe (2013b), "Lights, Cameras, Revolution", Grantland
- Pileggi (2012), "Snapshot: Visualization to Propel Ice Hockey Analytics", IEEE Transactions on Visualization and Computer Graphics
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- Maymin (2013), "Towards an Algorithmic Taxonomy of Basketball Plays", MIT Sloan Sports Analytics Conference 2013
- (2011), "The Importance of Being Open", queencityhoops.com
- Boudway (2013), "The NBA Will Now Track Every Player's Movements", Business Week
- Dubin (2012), "Basketball Enters the Space Age", ESPN.go.com (TrueHoop)
- Feldman (2012), "Analytically Inclined Coach: Oxymoron?", ESPN.go.com (TrueHoop)
- Henschen (2013), "4 Analytics Lessons From Professional Sports", Information Week

- Mason (2011), "Optical Tracking Data and the Importance of Screening in the Boston Celtics' Offense", Hoopspeak.com
- Schwartz (2013), "Net Loss: How the NBA's Love for Advanced Stats Has Slowed Our Understanding of the Game", Slate Magazine
- Weil (2011), "The Importance of Being Open: What Player Tracking Data Says about NBA Field", MIT Sloan Sports Analytics Conference 2011
- Bourbousson et al. (2010b), "Space-Time Coordination Dynamics in Basketball: Part 2. The Interaction between the Two Teams", Journal of Sports Sciences
- Fisher (2013), "Missile-Tracking Tech Fuels Stats", Street & Smith's SportsBusiness Journal
- Garcia et al. (2013), "Identifying Basketball Performance Indicators in Regular Season and Playoff Games", Journal of Human Kinetics
- Schuhmann (2013), "The Evolution of NBA Stats", NBA.com
- Solieman (2006), "Data Mining in Sports: A Research Overview", MIS Masters
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- Bourbousson et al. (2010a), "Space-Time Coordination Dynamics in Basketball: Part 1. Intra- and Inter-Couplings Among Player Dyads", Journal of Sports Sciences

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- Lemmick et al. (2013), "Tactical Performance Analysis in Invasion Games: Perspectives from a Dynamic System Approach with Examples from Soccer", Routledge Handbook of Sports Performance Analysis
- Oliver et al. (2013), "Assessing Team Strategy Using Spatiotemporal Data", 19th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining
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- Di Salvo et al. (2006), "Validation of PROZONE: A New Video-Based Performance Analysis System", International Journal of Performance Analysis in Sport
- Nandan (2013), "Live Analytics on High Velocity Sensor Data Streams Using Event-Based Systems", Journal of Industrial and Intelligent Information
- Neville et al. (2010), "Accelerometers: An Underutilized Resource in Sports Monitoring", Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), 2010 Sixth International Conference
- Pileggi (2012), "Snapshot: Visualization to Propel Ice Hockey Analytics", IEEE

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- Siegle (2013), "Design of an Accuracy Study for Position Detection in Football", Journal of Sports Sciences
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- Reilly (2007/2009), "Science and Football: An Update", Science and Football VI, the Proceedings of the Sixth World Congress on Science and Football
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- Van Haaren et al. (2013b), Machine Learning and Data Mining for Sports Analytics
- Wixted et al. (2007), "Measurement of Energy Expenditure in Elite Athletes Using MEMS Based Triaxial Accelerometers", Sensors

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- Carling (2013), "Interpreting Physical Performance in Professional Soccer Match-Play: Should We be More Pragmatic in Our Approach?", Sports Medicine
- Folgado et al. (2012), "Length, Width and Centroid Distance as Measures of Youth Football Teams Tactical Performance During Small-Sided Games", European Journal of Sport Science
- Frencken et al. (2013), "Size Matters: Pitch Dimensions Constrain Interactive Team Behaviour in Soccer", Journal of Systems Science and Complexity
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- Frencken et al. (2011), "Oscillations of Centroid Position and Surface Area of Soccer Teams in Small Sided Games", European Journal of Sport Science
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## **BASEBALL:**

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- Van Haaren et al. (2013b), Machine Learning and Data Mining for Sports Analytics
- Baumer et al. (2013a), The Sabermetric Revolution: Assessing the Growth of Analytics in Baseball: Slideshow Preview to Book
- Baumer et al. (2013b), The Sabermetric Revolution: Assessing the Growth of Analytics in Baseball

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- Henschen (2013), "4 Analytics Lessons From Professional Sports", Information Week
- La Canfora (2012), "NFL Collecting Data that Could Revolutionize Websites, Video Games", CBS Sports

## **TENNIS:**

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- Duffield et al. (2010), "Accuracy and Reliability of GPS Devices for Measurement of Movement Patterns in Confined Spaces for Court-Based Sports", Journal of Science and Medicine in Sport
- Hines (2012), "How Sports are Embracing Big Data", CCCBlog.org

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- Weissbock et al. (2013), "Use of Performance Metrics to Forecast Success in the National Hockey League", Machine Learning and Data Mining for Sports Analytics

## GOLF:

• Keating (2013), "Mr. Hot Shot: One Golf Fan is Changing the Way the Sport Approaches Shots", ESPN: The Magazine
### **RUNNING:**

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## **RUGBY:**

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# **MULTIPLE SPORTS/GENERAL:**

- Fry et al. (2012a), "Introduction to the Special Issue on Analytics in Sports, Part I: General Sports Applications", Interfaces
- Cochran (2010), "The Emergence of Sport Analytics", Analytics Magazine
- Coleman (2012), "Identifying the "Players" in Sports Analytics Research", Interfaces
- Varley et al. (2012a), "Validity and Reliability of GPS for Measuring Instantaneous Velocity During Acceleration Deceleration and Constant Motion", Journal of Sports Sciences
- Sports Analytics Issue, ESPN: Magazine
- Zimmerman (2013), MLSA13: Proceedings of "Machine Learning and Data Mining for Sports Analytics" Workshop 2013

## **Complete List of Referenced Companies**

3DSuit Inc (from Innalabs?)	Wearable Inertial Full-Body Tracking
Active Analysis	Sports Data/Video Analysis
Adidas	Wearable Inertial, Heart, and Pressure Tracking (sports)
AiLive	Inertial-Based Object Tracking
AiQ Smart Clothing	Wearable Electrically-Functional Fabric
Aliphcom (see Jawbone)	Wearable Inertial Tracking (sports)
Amiigo	Wearable Inertial Tracking (and heart monitoring and other)
Amisco (see Sport Universal Process)	Sports Data/Video Analysis
Animazoo	Wearable Inertial Full-Body Tracking (and other)
APDM	Wearable Inertial Tracking
Apple	Wearable Applications for Sports (potential wearables)
Applied Technology Holdings	Wearable Inertial Tracking (sports)
Ascension (see Northern Digital/NDI)	Camera-Based and Wearable EM-Based Full-Body Tracking
Athos	Wearable EMG Monitoring
Autographer	Wearable Camera
B & L Engineering	Camera-Based Full-Body Tracking
Baseball Info Solutions	Sports Data/Video Analysis
Baseball Perspectives	Sports Data/Video Analysis
Basis Science	Wearable Inertial Tracking (and other)
Biomedtrics	Wearable Mechanicial/Goniometer Tracking

Bionym	Wearable Heart Monitoring (for identification)
Biopac	Wearable Mechanicial/Goniometer Tracking
Birmingham City University	Wearable Inertial Tracking (and other, vibrating suit)
BodyMedia (see Jawbone)	Wearable Inertial Tracking (and other)
Brown University	Wearable EEG Monitoring
Cairos Technologies	Camera-Based and Wearable EM-Based Location Tracking (sports)
Catapult Sports	Wearable GPS and Inertial Tracking (sports)
Charnwood Dynamics	Camera-Based Full-Body Tracking (sports)
ChyronHego	Camera-Based Tracking (sports)
Clothing Plus (Clothing+)	Wearable Heart Monitoring (sports)
Coach 2.0	Wearable Inertial Tracking (sports)
CourtVision	Sports Data/Video Analysis
Creative Kingdoms	Inertial and IR Based Object Tracking
Dartfish	Sports Data/Video Analysis
Dynamic Athletic Research Institute	Camera-Based and Wearable Inertial Tracking (sports)
Elite Sports Analysis	Sports Data/Video Analysis
EMGSrus (Motion Lab Systems)	Wearable EMG Monitoring
EON Reality	Sports Data/Video Analysis
Fitbit	Wearable Inertial Tracking (and altimeter)
Fitbug	Wearable Inertial Tracking (sports)
Freescale	Wearable Inertial Tracking and Pressure Sensors
Garmin	Wearable GPS and Inertial Tracking

GestureTek	Camera-Based and Touch-Based Gesture Tracking
Goal Physics	Wearable Inertial Tracking (sports)
GolfTEC	Camera-Based and Wearable Inertial Tracking (sports)
Google	Wearable Camera
GPS Sports	Wearable GPS and Inertial Tracking and Heart Monitoring (sports)
Gruve (was Muve)	Wearable Inertial Tracking
Heapsylon	Wearable Pressure-Tracking Fabric
Hexoskin (Carre Technologies)	Wearable Inertial Tracking (and heart monitoring and other)
Honda	Wearable Exoskeleton for Walking Assistance
i1 Biometrics	Wearable Inertial Tracking and Impact Monitoring (sports)
IBM	Sports Data/Video Analysis
IMEC	Wearable Neural Sensors
Immersion	Touch/Haptic Feedback
Impact Sports Technologies	Wearable Heart Monitoring (sports)
Inmotio Object Tracking	Wearable RF-Based Location and Heart Monitoring (sports)
Innalabs (see 3DSuit Inc)	Wearable Inertial Full-Body Tracking
InterSense	Wearable Inertial Tracking
Jawbone (Aliphcom, inc. BodyMedia)	Wearable Inertial Tracking (and other)
Kizanaro	Sports Data/Video Analysis
K-Motion Interactive (KMI)	Wearable Inertial Tracking (sports)
Lumo BodyTech	Wearable Inertial Tracking
MapMyFitness (see Under Armour)	Mobile Location Tracking/Planning

MasterCoach	Sports Data/Video Analysis
MC10	Wearable Electronic Tattoos/Stickers
Measurand	Wearable Fiber-Optics for Shape Recognition
Medibotics	Wearable Pressure-Based Full-Body Tracking (early stage)
Memoto (see Narrative Clip)	Wearable Camera
Metamotion	System Distributor
Microsoft	Camera-Based Full-Body Tracking (and potentially more)
MicroStrain	Wearable Inertial Tracking
Mikromak	Camera-Based Full-Body Tracking (sports)
Minisun	Wearable Inertial Tracking (and other, multiple sensors)
Misfit Wearables	Wearable Inertial Tracking
Motek	Camera-Based and Wearable Inertial Tracking
Motion Analysis Corporation	Camera-Based Full-Body Tracking
Motion Reality	Camera-Based Tracking (sports)
Motion Workshop	Wearable Inertial Full-Body Tracking
Narrative Clip (was Memoto)	Wearable Camera
NeuroSky	Wearable EEG Monitoring
Neurowear	Wearable EEG Monitoring (and camera activation)
Nike	Wearable Inertial Tracking (sports)
Nintendo	Inertial-Based Object Tracking
Noraxon	Camera-Based and Wearable Inertial and EMG-Based Tracking
Northern Digital (inc. Ascension)	Camera-Based and Wearable EM-Based Full-Body Tracking

Notch	Wearable Inertial Tracking (multi-sensor)
Omate	Wearable Camera
OnCourt	Sports Data/Video Analysis
Organic Motion	Camera-Based Full-Body Tracking
Parashoot	Wearable Camera
Pebble	Wearable Inertial Tracking
Pfinder	Camera-Based Body-Recognition
PhaseSpace	Camera-Based Full-Body Tracking
Physical Enterprises Inc	Wearable Heart Monitoring (sports)
Pivothead	Wearable Camera
Plantronics	Wearable Inertial Tracking
Polhemus/Alken	Wearable EM-Based Full-Body Tracking
Preventice	Wearable Heart Monitoring
Prozone (see Sport Universal Process)	Sports Data/Video Analysis
Qualcomm	Wearable Inertial Tracking
Qualisys	Camera-Based Full-Body Tracking
Real Track Football	Wearable GPS Tracking and Heart Monitoring (sports)
Rock My World	Wearable Sensor-Based Music Selection
Runner Groove	Wearable Inertial Tracking (sports)
Samsung	Wearable Camera
SAP	Sports Data/Video Analysis
Scanball	Sports Data/Video Analysis

SONY	Inertial-Based Object Tracking
Sport Universal Process	Sports Data/Video Analysis
Sports Data Hub	Sports Data/Video Analysis
SportsBoard	Sports Data/Video Analysis
Sportstec	Sports Data/Video Analysis
Sportvision	Camera-Based Tracking (sports)
STATS	Camera-Based Tracking (sports)
Tactonic Technologies	Wearable Pressure Sensors
TechnoSkin	Wearable Electrically-Functional Fabric
Textronics (see Adidas)	Wearable Electrically-Functional Fabric
Thalmic Labs	Wearable EMG Monitoring and Inertial-Based Tracking
Trakus	EM/RF-Based Tracking (sports)
Ultimate Balance	Wearable Inertial Tracking
Under Armour	Wearable Heart Monitoring (and other, sports)
Vicon	Camera-Based Full-Body Tracking
Vista Medical	Wearable Pressure-Tracking Fabric
Vivonoetics	Wearable System Partnerships
Vuzix	Wearable Camera
Xsens	Wearable Inertial Full-Body Tracking
Zephyr Technology	Wearable Heart Monitoring (and other)
Zepp Labs	Wearable Inertial Tracking (sports)
ZXY Sport Tracking	Wearable RF-Based Location Tracking (sports)

#### Complete List of Articles and Books (sorted by source)

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Frencken et al. (2009)	Taking Initiative in Small-Sided Soccer Games	14th Annual Congress of the European College of Sport Science (ECSS)	Oslo, Norway
Frencken et al. (2009)	Oscillations in Small-Sided Soccer Games	14th Annual Congress of the European College of Sport Science (ECSS)	Oslo, Norway, 73-74
Oliver et al. (2013)	Assessing Team Strategy Using Spatiotemporal Data	<u>19th ACM SIGKDD International</u> <u>Conference on Knowledge Discovery</u> and Data Mining	1366-1374
Kim (2011)	Spatial and Spatiotemporal Analysis of Soccer	<u>19th ACM SIGSPATIAL International</u> <u>Conference on Advances in</u> <u>Geographic Information Systems</u>	Chicago, USA, Nov. 1-4, 385-388
Sotiropoulos et al. (2005)	Comparison in Goal Scoring Patterns Between Greek Professional and Amateur Teams	<u>1st International Scientific Congress in</u> <u>Soccer</u>	Trikala, 2005
Zhu et al. (2002)	Statstream: Statistical Monitoring of Thousands of Data Streams in Real Time	28th VLDB Conference	August, 2002, 358-369
Frencken et al. (2008)	Small-Sided Games in Soccer and Goal-Scoring Opportunities	2nd International Congress on Complex Systems in Sport (ICCSS)	Technical University of Lisbon, Portugal
Lames et al. (2008)	Oscillations in Football: Order and Disorder in Spatial Interactions Between the Two Teams	2nd International Congress on Complex Systems in Sport (ICCSS)	114-115
Potter (2013)	Remediation in Data Visualization: Two Examples of Learning in Real-Time Data Processing Environments	<u>31st ACM International Conference on</u> <u>Design of Communication</u>	2013

Lemmink et al. (2010)	Tactical Match Analyses in Soccer: New Perspectives from a Dynamical System Approach	<u>3rd International Congress on Complex</u> <u>Systems in Medicine and Sport</u> (ICCSMS)	Kaunas, Lithuania
Fernandes et al. (2003)	A New Method in Time-Motion Analysis in Soccer Training and Competition	5th World Congress on Science & Football (WCSF), Reilly et al (eds.)	Lisbon: Editorial Gymnos, 270-271
Lemmink et al. (2011)	Tactical Match Analysis in Soccer: New Perspectives?	7th World Congress on Science & Football (WCSF)	Nagoya, Japan, 22
Frencken et al. (2011)	Analysis of Game Dynamics and Related Game Events in 11v11 Soccer	7th World Congress on Science & Football (WCSF)	Nagoya,Japan, 102
Silva et al. (2011)	Development of a Tracking System Using Invisible Markers for Association Football	7th World Congress on Science & Football (WCSF)	8(Sup. 1), 103
Elferink-Gemser et al. (2003)	Multidimensional Performance Characteristics in Talented Youth Field Hockey Players: A Longitudinal Study	8th Annual Congress of the European College of Sport Science	Institute of Sport Science, University of Salzburg, Austria
Pena (2012)		<u>A Network Theory and Analysis of</u> <u>Football Strategies</u>	University College London, Physics of Sports, Paris 2012
Rodrigues et al. (2013)	Open Source Technologies Involved in Constructing a Web-Based Football Information System	Advances in Information Systems and Technologies / Advances in Intelligent Systems and Computing	Vol. 206, 2013, 715-723
Solomon (2013)	SEC, Pac-12 and Big 12 will Electronically Track Football Players' Speeds and Movements	All Alabama	http://www.al.com, Feb. 26, 2013
Reich et al. (2006)	A Spatial Analysis of Basketball Shot Chart Data	American Statistician	60(1), 3-12
Olsen (1988)		An Analysis of Goal Scoring Strategies in the World Championships in Mexico	London, 1988
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(2011a)	of Sports Analytics, Part I		
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Lemmink et al. (2009)	Physiological and Tactical Match Analyses in Ball Team Sports: New Perspectives	Aportaciones Teóricas Y Practices Para El Baloncesto Del Futuro	<u>a</u> Sevilla, Spain
Sanchez et al. (2006)	GPS Applications in Sport Science	Archivos De Medicina Del Deporte	Vol. 23, No.112, pp 143- 152, Mar., 2006
Abdel-Aziz et al. (1971)	Direct Linear Transformation From Comparator Coordinates into Object Space Coordinates in Close-Range Photogrammetry	ASP Symposium on Close-Range Photogrammetry	American Society of Photogrammetry
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