



Università  
di Roma  
Tor Vergata



# The Pervasive Electromagnetic Lab

RFID for Internet of Things

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# Pervasive Electromagnetics Lab

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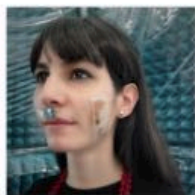
Director: [Prof. Gaetano Marrocco](#)

SPIN-OFF [RADIO6ENSE](#)

## In Evidence

### Best Student Paper Award

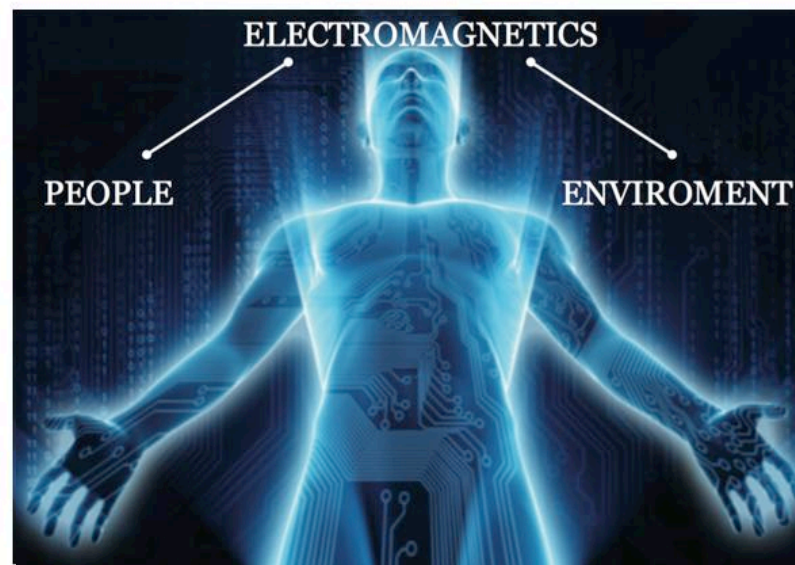
11th European  
Conference on  
Antennas and  
Propagation  
Paris (France)  
19-24 March 2017



[get paper](#)

### Movement Detection of Human Body Segments

IEEE Antennas &  
Propagation Magazine



The positive interaction of the classic Electromagnetics with the Materials Science, Computer Science, Sensors, Medicine, Mechanics and Electronics may originate the **Pervasive Electromagnetics**, a cross-discipline with the potentiality to provide the physical layer of the emerging **Internet of Things** that enables the Internet to get into the Real World of physical objects. Things equipped with electronic labels, having both identification and sensing capability, could be turned into digital entities readable from remote.

The Radiofrequency Identification (**RFID**) technology offers the natural substrate to achieve such features, provided that the basic physics governing the sensing and electromagnetic interaction phenomena is fully exploited.

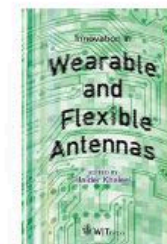
Thanks to multidisciplinary research, the **Pervasive Electromagnetics Lab** aims to develop new radio devices for short-range sensing, ready to be seamlessly embedded into objects, plants, buildings as well as over and even inside the human body with application to

## In Evidence

Introducing



The last meters of  
Internet of Things



### Wearable and Flexible Antennas

our chapter in the new book



Pervasive Em  
Magazine







# The Team

## TEAM

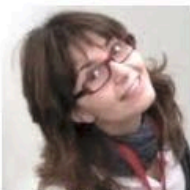
prof. Gaetano Marrocco

Director



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Cecilia Occhiuzzi



occhiuzzi@disp.uniroma2.it

Sara Amendola



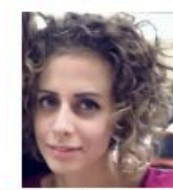
sara.amendola88@gmail.com

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Michela Longhi



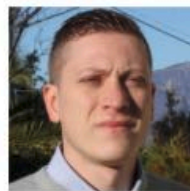
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Silvia Guido



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## Collaborations:

Prof. L. Bianchi (Neuroscience)

Prof. C. Di Natale (Sensors)

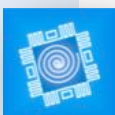
Prof. A. Meda (Materials Tests)

Prof. P. Valentini (Biomechanics)

Prof. A. Bianco (Biomaterials)

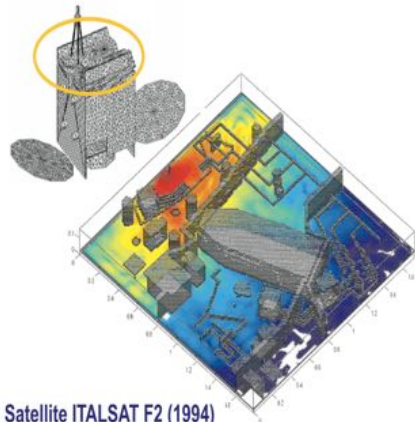
Prof. J.M Laheurte (Univ. Paris E.)

Prof. J. Batchelor (Univ. Kent)

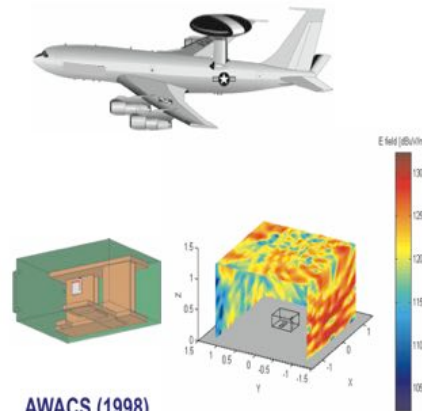


# Classic Background

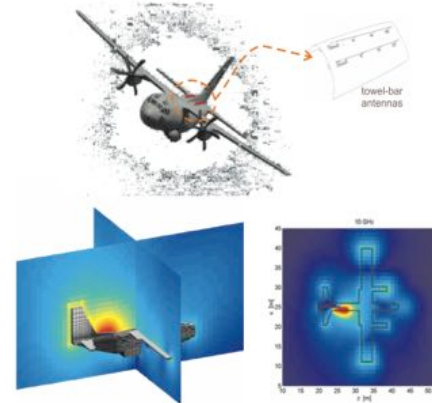
## Naval, Satellite and Avionic RF Systems



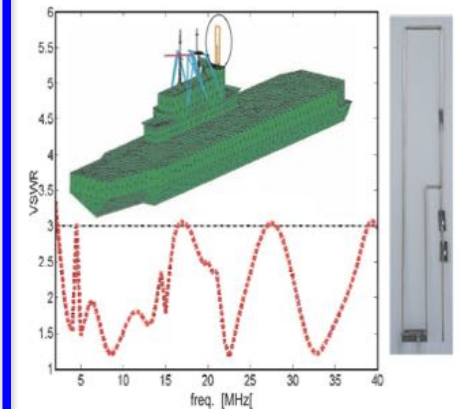
**Satellite ITALSAT F2 (1994)**  
Evaluation of PIM hardening kit  
Leakage electric field at 1 GHz from an antenna's connector



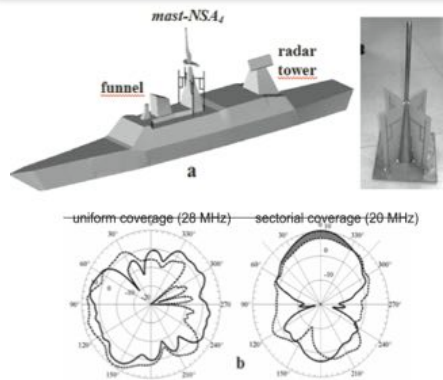
**AWACS (1998)**  
Electromagnetic compliance of IFF systems  
Leakage field at 5 GHz



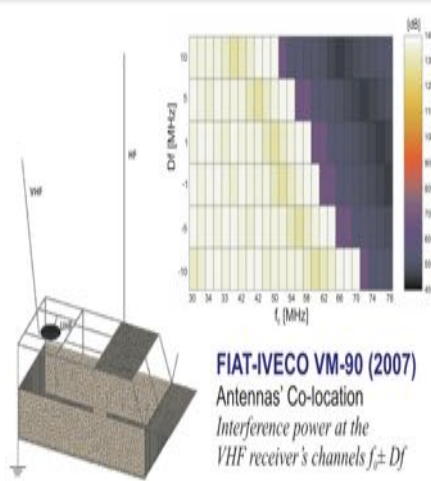
**SPARTAN C27-J (2002)**  
HF antenna performances  
Near-field at 10 MHz due to towel-bar antennas



**Aircraft-carrier G. GARIBALDI (2005)**  
Design and Evaluation of the Bifolder Antenna  
HF loaded antenna matched over a broad band



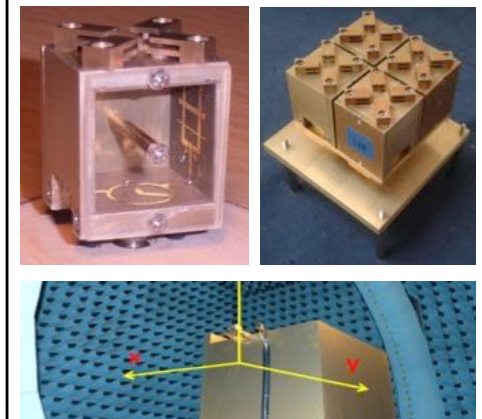
**Naval Structural Antenna system (2006)**  
Design of Multi-port broad-band HF antennas  
Loaded wires around a big mast may be used to improve efficiency or to shape the coverage



**FIAT-IVECO VM-90 (2007)**  
Antennas' Co-location  
Interference power at the VHF receiver's channels  $f \pm Df$



**ESA Nanosat (2010)**



**Plug&Play Satellite Avionics (2013)**

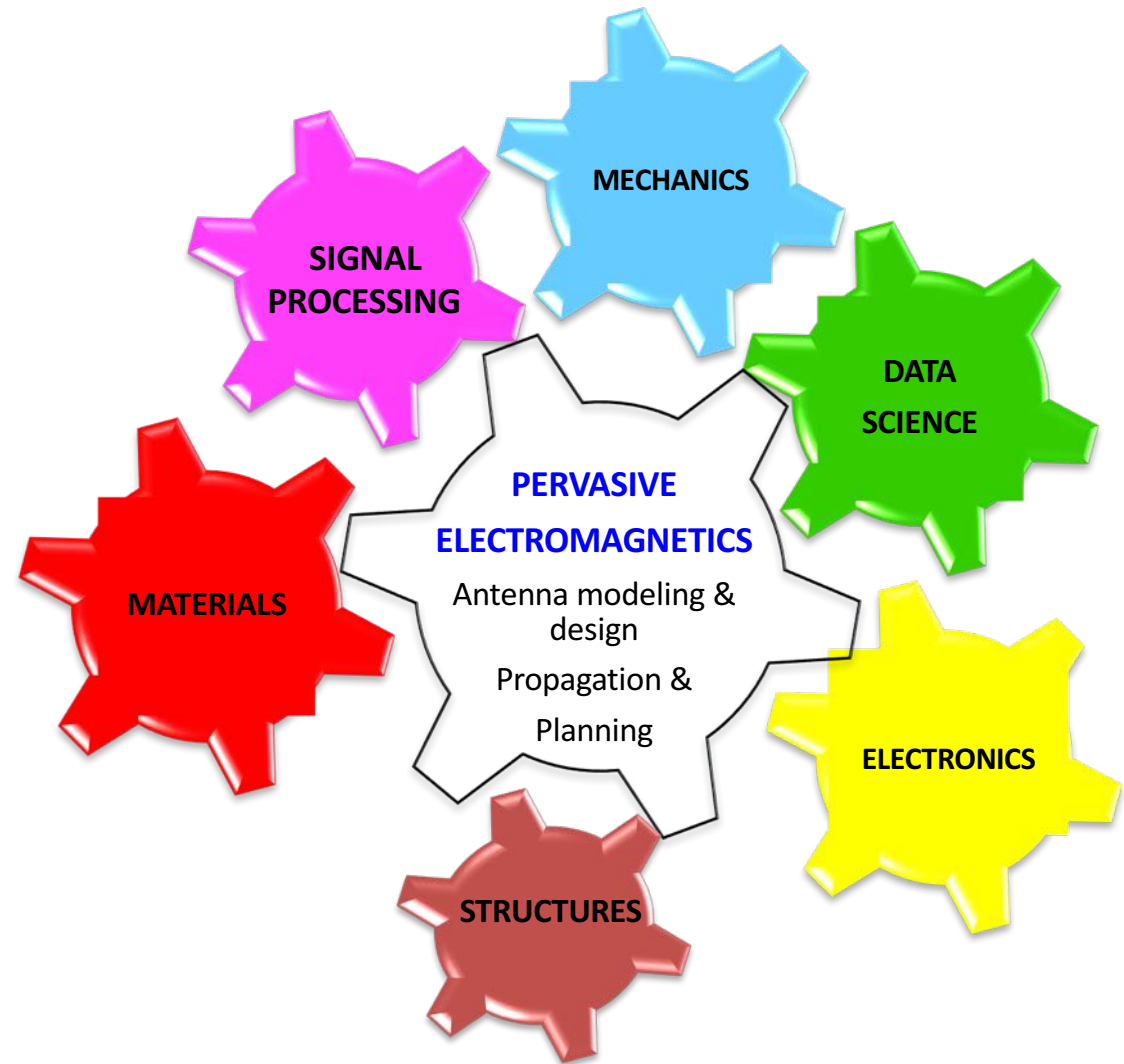
# Short Range Sensing for IoT

## A **Multi**-disciplinary Vision

Expanding the power and  
pervasivity of RFID Tech. beyond  
Identification

RFID-Sensors

Positive interaction of classic  
Electromagnetics with Materials  
Science, Data Science, Sensors,  
Medicine, Mechanics and  
Electronics

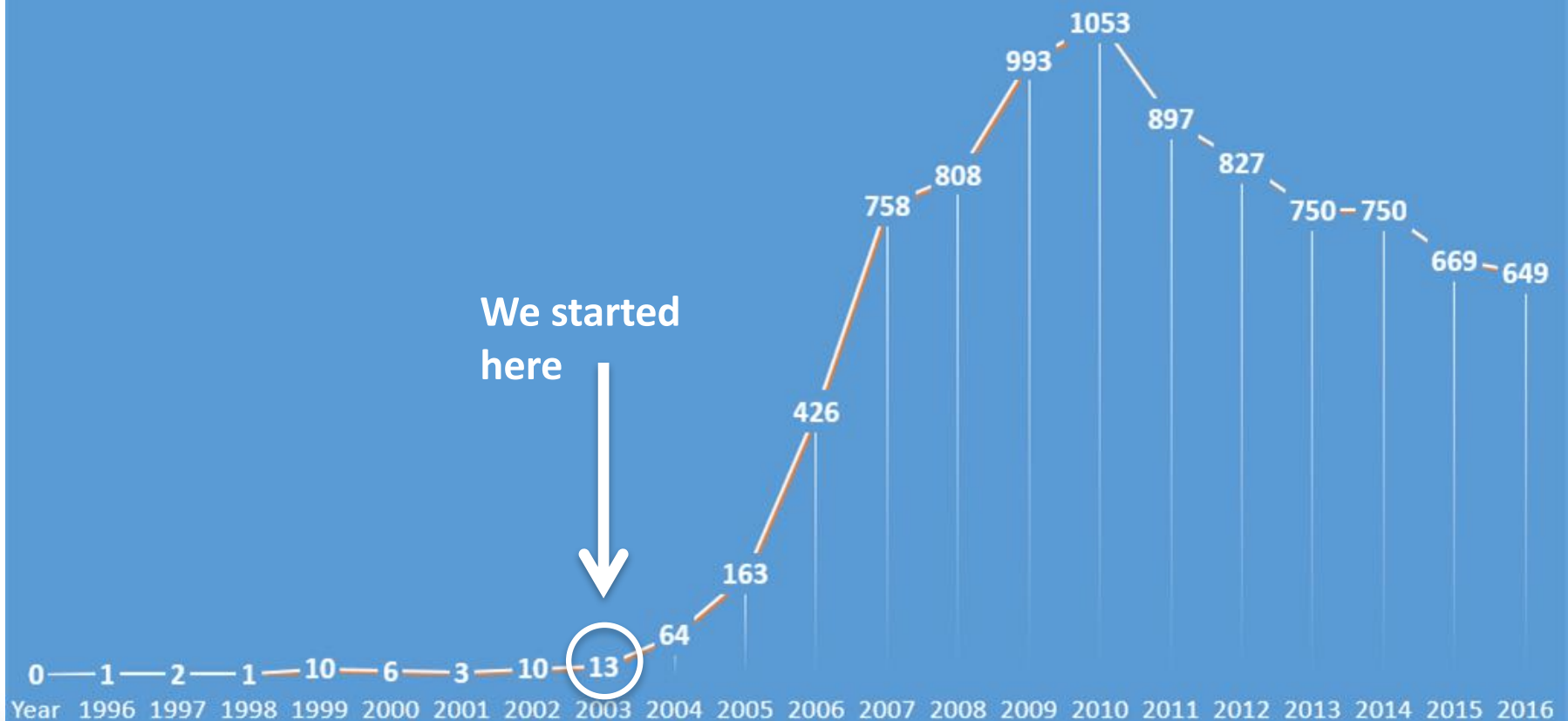






# Radiofrequency Identification Research where/when we started

Papers from IEEEXplore with “RFID” in title



Courtesy P. Nikitin



# Gain-Optimized Self-Resonant Meander Line Antennas for RFID Applications

Gaetano Marrocco

**Abstract**—New meander line antennas with improved gain are proposed as low-profile self-resonant tags for application in passive radio frequency identification. Antenna shape and size is optimized by genetic algorithm taking into account the conductor losses. Examples are presented for application at 869 MHz with antennas of different materials and sizes.

**Index Terms**—Genetic algorithms, miniaturized antenna, small antenna, transponders.

## I. INTRODUCTION

**R**ADIO frequency identification (RFID) of objects and people and remote control of devices has become very popular in logistics, inventory management and bio-engineering applications [1]. Data are contactless transferred to a local querying system (reader) from a remote transponder (tag) including the antenna and a microchip transmitter. A suitable antenna for the tag must have low cost, low profile, and especially small size, whereas the bandwidth requirement (a few kilohertz) is less critical. In passive tag systems, the querying signal coming from the reader must have enough power to activate the tag microchip, perform data processing and transmit back a modulated string up to the required reading range (typically 0.3–1 m). Since the maximum effective isotropic radiated power (EIRP) of the reader is constrained to local regulations, high-gain tags are required to increase the reading range. Additionally, to simplify the matching network

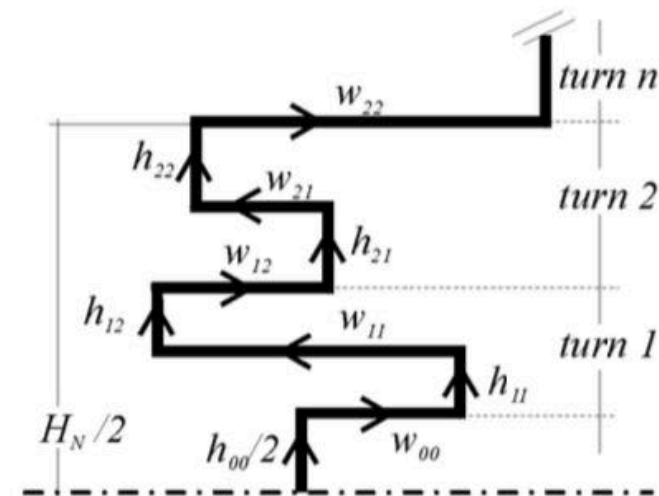


Fig. 1. Scheme for nonuniform  $MLA_N$  with indication of parameters to be optimized. Only half antenna is visible.

does not exhibit the optimum gain especially when the conductor losses can not be neglected and that the GA-optimized shapes with lossless wires are greatly different from the optimized antenna involving real conductors. It will be also proved that the optimized MLA shape converges to a top-loaded dipole as the available height increases.

## II. EVOLUTIONARY DESIGN OF MLAS





## Achievement 1: Systematization of RFID Antenna design

Web Immagini Altro...

Google

RFID antenna

Scholar Circa 255.000 risultati (0,10 sec)

Articoli

La mia biblioteca

In qualsiasi momento

Dal 2017

Dal 2016

Dal 2013

Intervallo specifico...

Ordina per pertinenza

Ordina per data

Qualsiasi lingua

Pagine in Italiano

☒ includi brevetti

☒ includi citazioni

Suggerimento: Cerca risultati solo in Italiano . Puoi specificare la lingua di ricerca su Impostazioni Scholar

**The art of UHF RFID antenna design: Impedance-matching and size-reduction techniques**  
G Marrocco - IEEE antennas and propagation magazine, 2008 - [ieeexplore.ieee.org](http://ieeexplore.ieee.org)  
Abstract: Radio-frequency identification technology, based on the reader/tag paradigm, is quickly permeating several aspects of everyday life. The electromagnetic research mainly concerns the design of tag antennas having high efficiency and small size, and suited to  
Citato da 551 Articoli correlati Tutte e 11 le versioni Web of Science: 248 Cita Salva Altro

**Antenna problems in RFID systems**  
PR Foster, RA Burberry - 1999 - IET  
As the frequency of choice for RFID devices rises into the microwave region, the problem of designing antennas to match the devices on the protected object becomes more acute. The objective of any such antenna must be to maximise the transfer of power into and out of the  
Citato da 305 Articoli correlati Tutte e 4 le versioni Cita Salva Altro

**Multi-directional RFID antenna**  
R Hatano, B Monahan, CR Kilgus - US Patent 6,069,564, 2000 - Google Patents  
A multi-directional RFID read/write antenna unit is described which provides multi-directional RF communication to a source, such as a RF tag. The antenna comprises a plurality of coils adapted to transmit multi-directional RF signals to a RF tag and receive RF  
Citato da 179 Articoli correlati Tutte e 2 le versioni Cita Salva







Google

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Qualsiasi lingua

Pagine in Italiano

☒ includi brevetti

☒ includi citazioni

☐ Crea avviso

**Modeling, design and experimentation of wearable RFID sensor tag**  
[C Occhiuzzi, S Cippitelli...](#) - IEEE Transactions on ..., 2010 - [ieeexplore.ieee.org](#)  
Abstract: Design of effective **wearable** tags for UHF **RFID** applications involving persons is still an open challenge due to the strong interaction of the antenna with the human body which is responsible of impedance detuning and efficiency degradation. A new tag geometry  
Citato da 121 [Articoli correlati](#) [Tutte e 10 le versioni](#) [Web of Science: 71](#) [Cita](#) [Salva](#) [Altro](#)

**Enabling implicit human computer interaction: a wearable RFID-tag reader**  
[A Schmidt, HW Gellersen, C Merz](#) - **Wearable Computers**, The ..., 2000 - [ieeexplore.ieee.org](#)  
Abstract: Implicit human computer interaction is based on the concept of using user activity in the real world as input to computers. Implicit HCI can help to reduce the problem of user input to **wearable** computers. In this paper we report on **wearable RFID** technology that  
Citato da 75 [Articoli correlati](#) [Tutte e 23 le versioni](#) [Cita](#) [Salva](#) [Altro](#)

**[HTML] Tagaboo: a collaborative children's game based upon wearable RFID technology**  
[M Konkel, V Leung, B Ullmer, C Hu](#) - **Personal and Ubiquitous Computing**, 2004 - Springer  
Tagaboo is an interactive game for two or more children that is based upon **wearable** radio frequency identification (**RFID**) technology. Tagaboo combines aspects from traditional athletic children's games with tagged physical objects that are bound to different sounds and  
Citato da 46 [Articoli correlati](#) [Tutte e 12 le versioni](#) [Web of Science: 17](#) [Cita](#) [Salva](#) [Altro](#)


**Wearable RFID-enabled sensor nodes for biomedical applications**  
[L Yang, R Vyas, A Rida, J Pan...](#) - ..., 2008. **ECTC 2008**. ..., 2008 - [ieeexplore.ieee.org](#)  
Abstract: A **wearable RFID**-enabled sensor node for continuous biomedical monitoring is investigated in this paper. Dielectric characterization of fabric substrates, inkjet-printing of conductive nano-particle silver ink, design of **RFID** antennas and integration of sensor active  
Citato da 47 [Articoli correlati](#) [Tutte e 11 le versioni](#) [Cita](#) [Salva](#) [Altro](#)






# RFID Research Visibility

## Achievement 3: RFID IOT


 RFID IOT

 Scholar Circa 27.600 risultati (0,05 sec)

**Suggerimento:** Cerca risultati solo in **Italiano** . Puoi specificare la lingua di ricerca su [Impostazioni](#)


### RFID technology and its applications in Internet of Things (IoT)

X Jia, Q Feng, T Fan, Q Lei - ... [Electronics, Communications and ...](#), 2012 - [ieeexplore.ieee.org](#)  
Abstract: Radio frequency identification system (**RFID**) is an automatic technology and aids machines or computers to identify objects, record metadata or control individual target through radio waves. Connecting **RFID** reader to the terminal of Internet, the readers can

☆  Citato da 140 Articoli correlati Tutte e 2 le versioni


### The application of IOT in medical system

D Lu, T Liu - [IT in Medicine and Education \(ITME\)](#), 2011 ..., 2011 - [ieeexplore.ieee.org](#)  
... Keywords-**RFID**;**IoT**;ECG monitoring; telemedicine;clinical care ; **IoT** (the Internet of things) is a network which integraes the sensor, sensor nets and other perceptive technologies, communication network, internet and other transmission technologies, intelligence operations ...

☆  Citato da 15 Articoli correlati

### RFID technology for IoT-based personal healthcare in smart spaces

S Amendola, R Lodato, S Manzari... - [IEEE Internet of ...](#), 2014 - [ieeexplore.ieee.org](#)  
Abstract: The current evolution of the traditional medical model toward the participatory medicine can be boosted by the Internet of Things (**IoT**) paradigm involving sensors (environmental, wearable, and implanted) spread inside domestic environments with the

☆  Citato da 155 Articoli correlati Tutte e 13 le versioni







# RFID Research Visibility

## Achievement 4: RFID Sensor

Google Scholar

RFID Sensor

Articoli Circa 358.000 risultati (0,06 sec)

In qualsiasi momento

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☒ includi citazioni

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Suggerimento: Cerca risultati solo in Italiano . Puoi specificare la lingua di ricerca su Impostazioni Scholar.

[HTML] Dynamics of person-to-person interactions from distributed RFID sensor networks

C Cattuto, W Van den Broeck, A Barrat, V Colizza... - PloS one, 2010 - journals.plos.org

Background Digital networks, mobile devices, and the possibility of mining the ever-increasing amount of digital traces that we leave behind in our daily activities are changing the way we can approach the study of human and social interactions. Large-scale datasets,

☆ Citato da 428 Articoli correlati Tutte e 26 le versioni

Enabling ubiquitous sensing with RFID

R Want - Computer, 2004 - ieeexplore.ieee.org

... A surgeon could place an RFID sensor in a patient's body during a single procedure; later the physician could use an external reader to periodically contact the device, perhaps during routine office visits, and obtain a report on this aspect of the patient's health. ...

☆ Citato da 454 Articoli correlati Tutte e 11 le versioni

[PDF] Revisiting smart dust with RFID sensor networks

M Buettner, B Greenstein, A Sample... - Proceedings of the ..., 2008 - conferences.sigcomm.org

ABSTRACT We argue that sensing and computation platforms that leverage RFID technology can realize "smart-dust" applications that have eluded the sensor network community. RFID sensor networks (RSNs), which consist of RFID readers and RFID sensor

☆ Citato da 127 Articoli correlati Tutte e 8 le versioni

Modeling, design and experimentation of wearable RFID sensor tag

C Occhiuzzi, S Cippitelli... - IEEE Transactions on ..., 2010 - ieeexplore.ieee.org

Abstract: Design of effective wearable tags for UHF RFID applications involving persons is still an open challenge due to the strong interaction of the antenna with the human body which is responsible of impedance detuning and efficiency degradation. A new tag geometry

☆ Citato da 132 Articoli correlati Tutte e 10 le versioni





# RFID Research Visibility

## Achievement 5: RFID Implanted

Google Scholar

RFID implanted

Articoli Circa 17.400 risultati (0,28 sec)

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Qualsiasi lingua  
Pagine in Italiano

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☒ includi citazioni

☐ Crea avviso

Suggerimento: Cerca risultati solo in Italiano . Puoi specificare la lingua di ricerca su Impostazioni Scholar.

**Wristband reader apparatus for human-implanted radio frequency identification device**  
PJ Dobosz - US Patent 7,385,498, 2008 - Google Patents  
A reader apparatus for an **RFID-implanted** human user is incorporated into a wristband such as a bracelet or a watchstrap worn by the user. ... FIG. 1 is a diagram of a **RFID-implanted** human wrist and a wristband reader apparatus according to the present invention; FIG. ...

**Design of implanted RFID tags for passive sensing of human body: The STENTag**  
C Occhiuzzi, G Contr... - IEEE Transactions on ..., 2012 - ieeexplore.ieee.org  
Abstract: Numerical processing of passive UHF-RFID tags' response may provide physical insight about the hosting object or about the nearby environment. This idea is here extended to **implanted** antennas with the purpose to sense the evolution of some human physiological

**RFID inside**  
KR Foster, J Jaeger - IEEE Spectrum, 2007 - ieeexplore.ieee.org  
... Who decides? Mandating guest workers to have **RFID** chips **implanted** in their bodies for identification purposes strikes us as coercive and opportunistic. ... Tattoos, an ID technology that is at least 4000 years old, share some key qualities with **implanted RFID** tags. ...

**Lend me your arms: The use and implications of humancentric RFID**  
A Masters, K Michael - Electronic Commerce Research and Applications, 2007 - Elsevier  
... Though the literature scientifically describes the theoretical tracking system for recovery of **RFID-implanted** humans, no further evidence is available to ascertain whether it has since been developed. ... These benefits would similarly exist with **implanted RFID**. ...

**Evaluation of HF RFID for implanted medical applications**  
E Freudenthal, D Herrera, F Kautz, C Natividad... - 2007 - digitalcommons.utep.edu  
Abstract Low cost HF **RFID** scanner subsystems that both deliver power and provide high bandwidth bidirectional communication channels have recently become available. These devices are anticipated to become ubiquitous in next-generation cell phones and enable a

**Human body sensing: A pervasive approach by implanted RFID tags**  
C Occhiuzzi, G Marrocco - Applied Sciences in Biomedical and ..., 2010 - ieeexplore.ieee.org  
Abstract: Starting from the physical evidence that passive **RFID** systems may be used as self-sensing devices, the feasibility of human monitoring by means of **implanted** tags is here investigated. The key parameters to master with the purpose to enhance the sensitivity of the

[PDF] uniroma2.it  
ACNP Full Text

[PDF] upenn.edu

[PDF] uow.edu.au

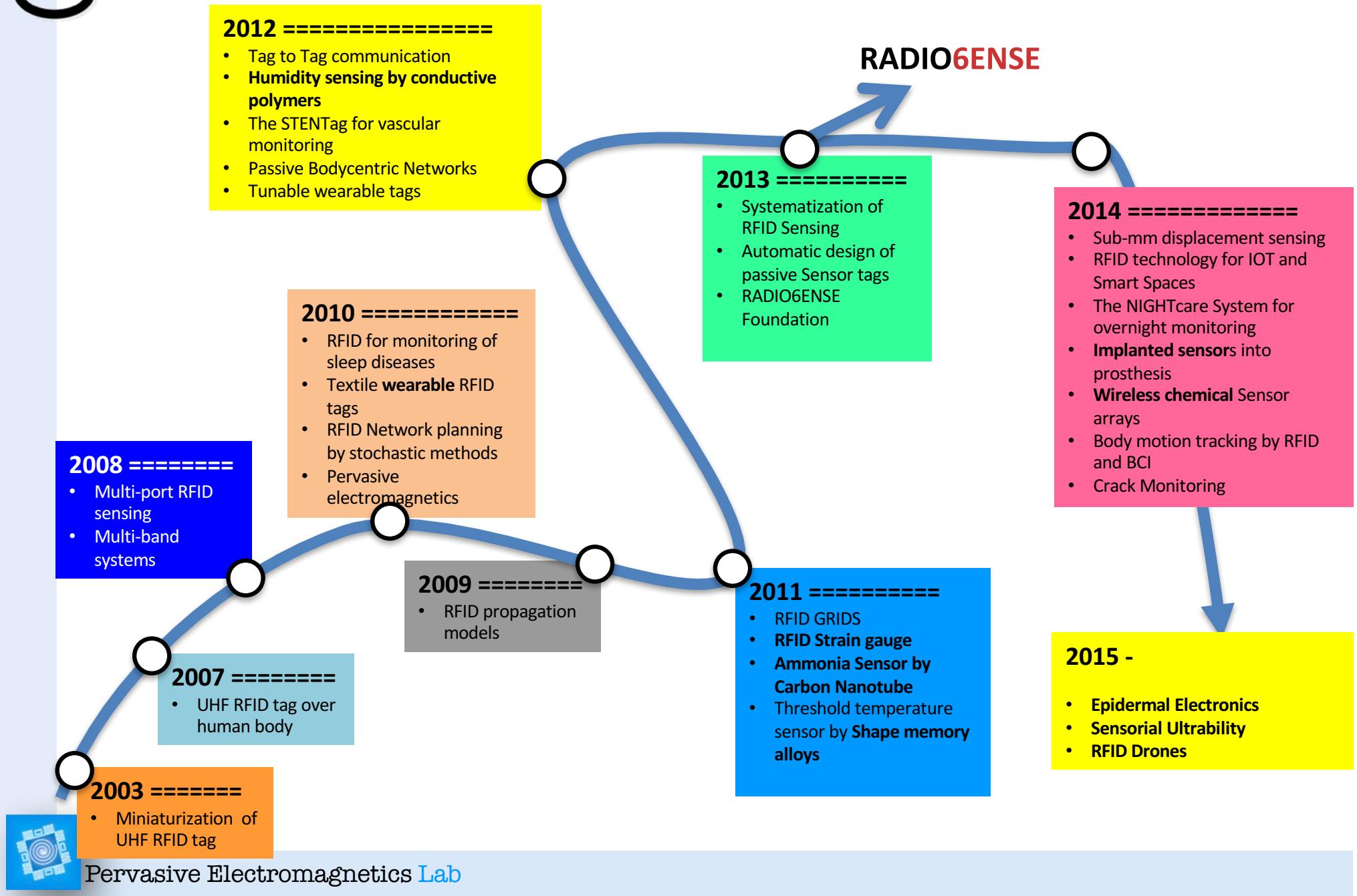
[PDF] utep.edu

[PDF] unipa.it





# RFID research Timeline

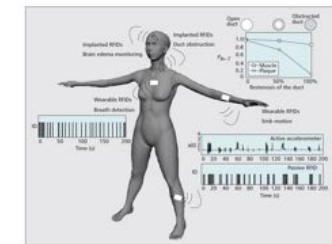
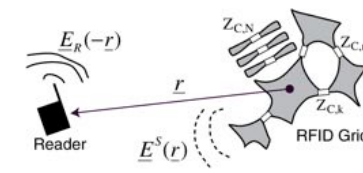
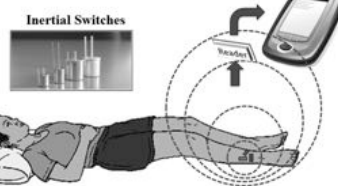
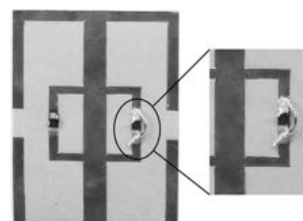
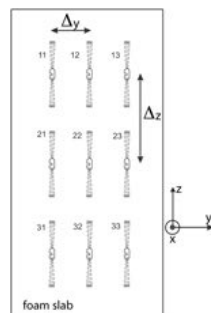
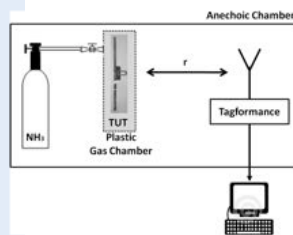
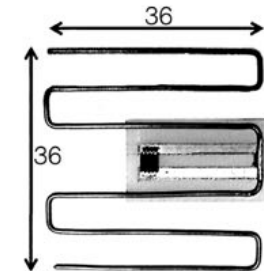
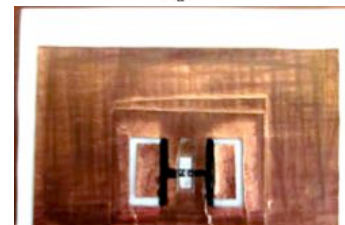
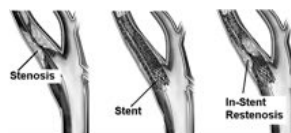
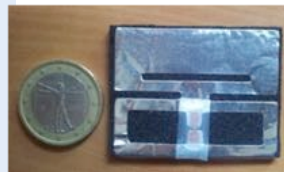
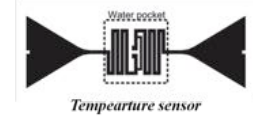
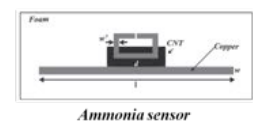
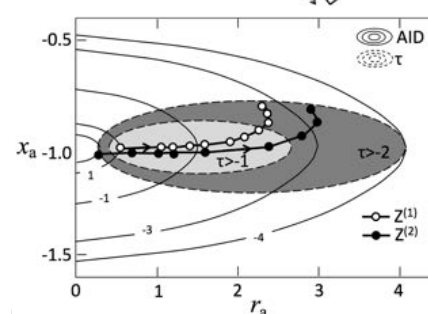
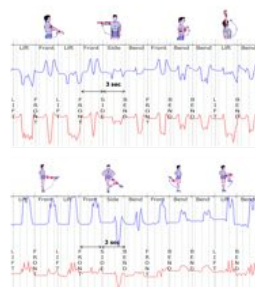
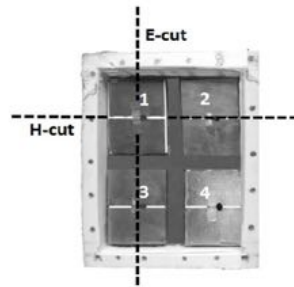
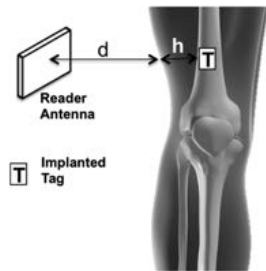
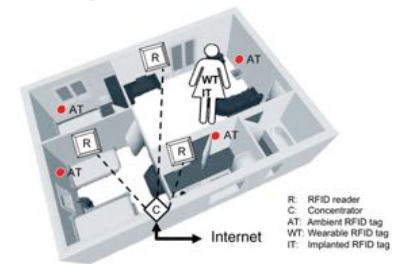
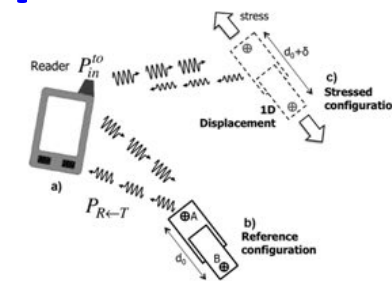
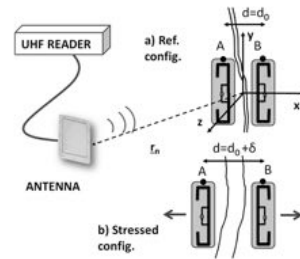
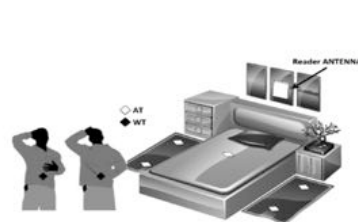
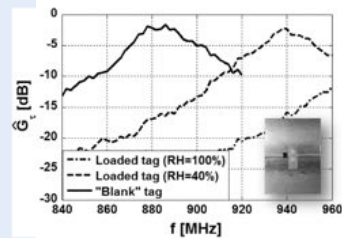




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# Pervasive Electromagnetics Lab

## passive sensing research

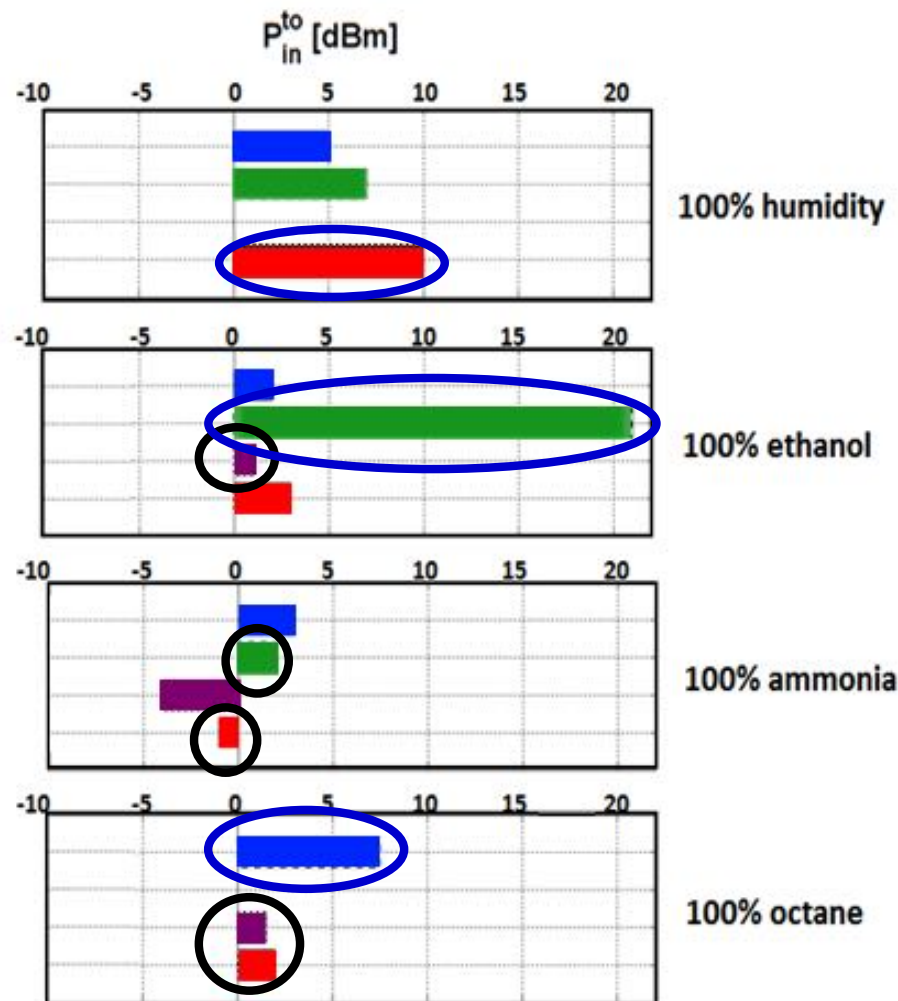
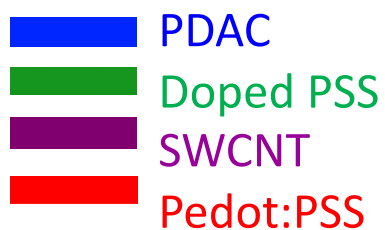
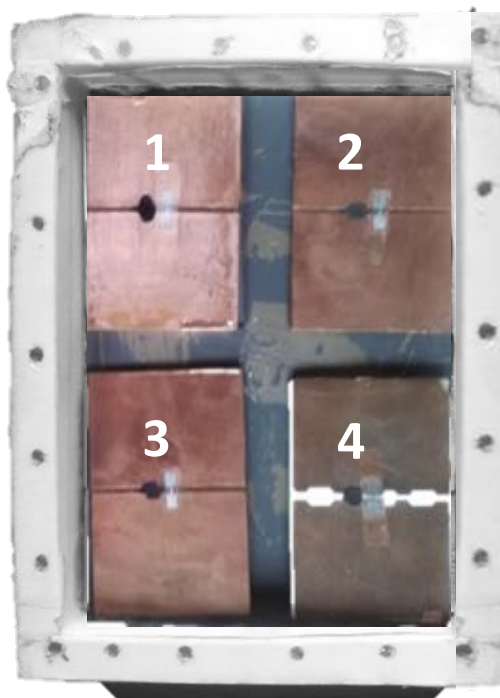


Electromagnetics Lab





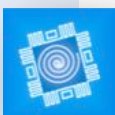
# RFID Sensing of Volatile Compounds



2012 IEEE MTT-S/AP-S Award - central-south Italy

S.Manzari, C. Occhiuzzi, S. Nawale, A. Catini, C. Di Natale, "G. Marrocco, Humidity Sensing by Polymer-loaded UHF RFID

Antennas

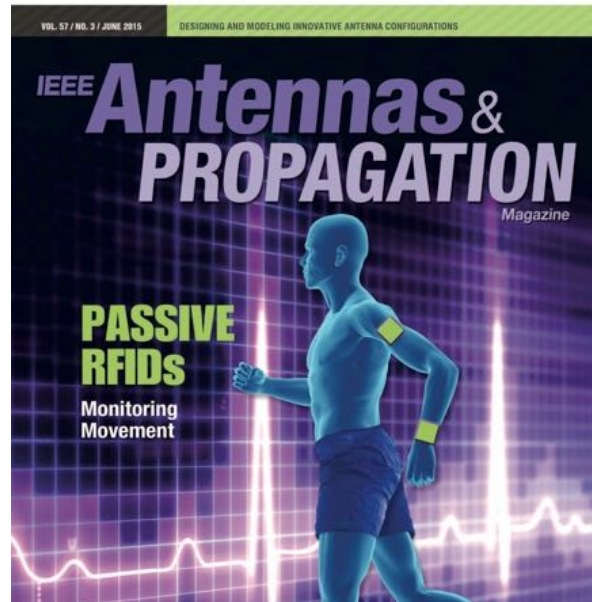




# Short Range Sensing for IoT

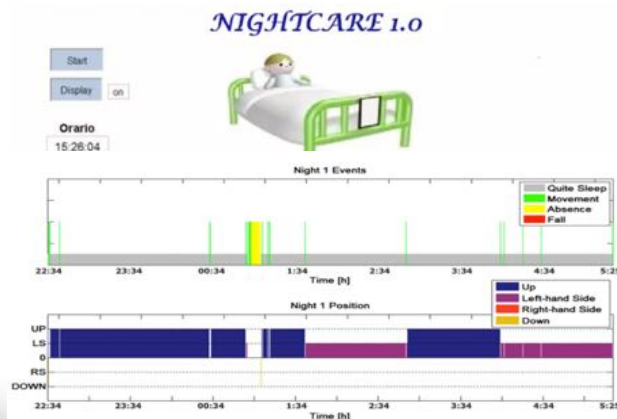
## Bodycentric Wireless Sensors (Wearable IoT)

### Wearable



<https://www.youtube.com/watch?v=0Yhy03tgRHl>

<https://www.youtube.com/watch?v=ITJsxL4xoxY>



### Epidermal



<https://www.youtube.com/watch?v=cEbpfayG38c>

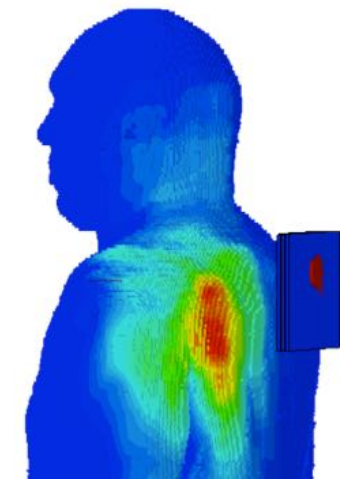


<https://www.youtube.com/watch?v=DGUKYgmt-5Q>

<https://www.youtube.com/watch?v=6quuuEiNEBs>

<https://www.youtube.com/watch?v=tJD9xzpsl7U>

### Implantable







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# RFID-assisted Human Motion Detection

Wearable RFID tag

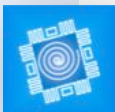
Data Science (Support Vector Machine)

Detection and Classification of Gestures

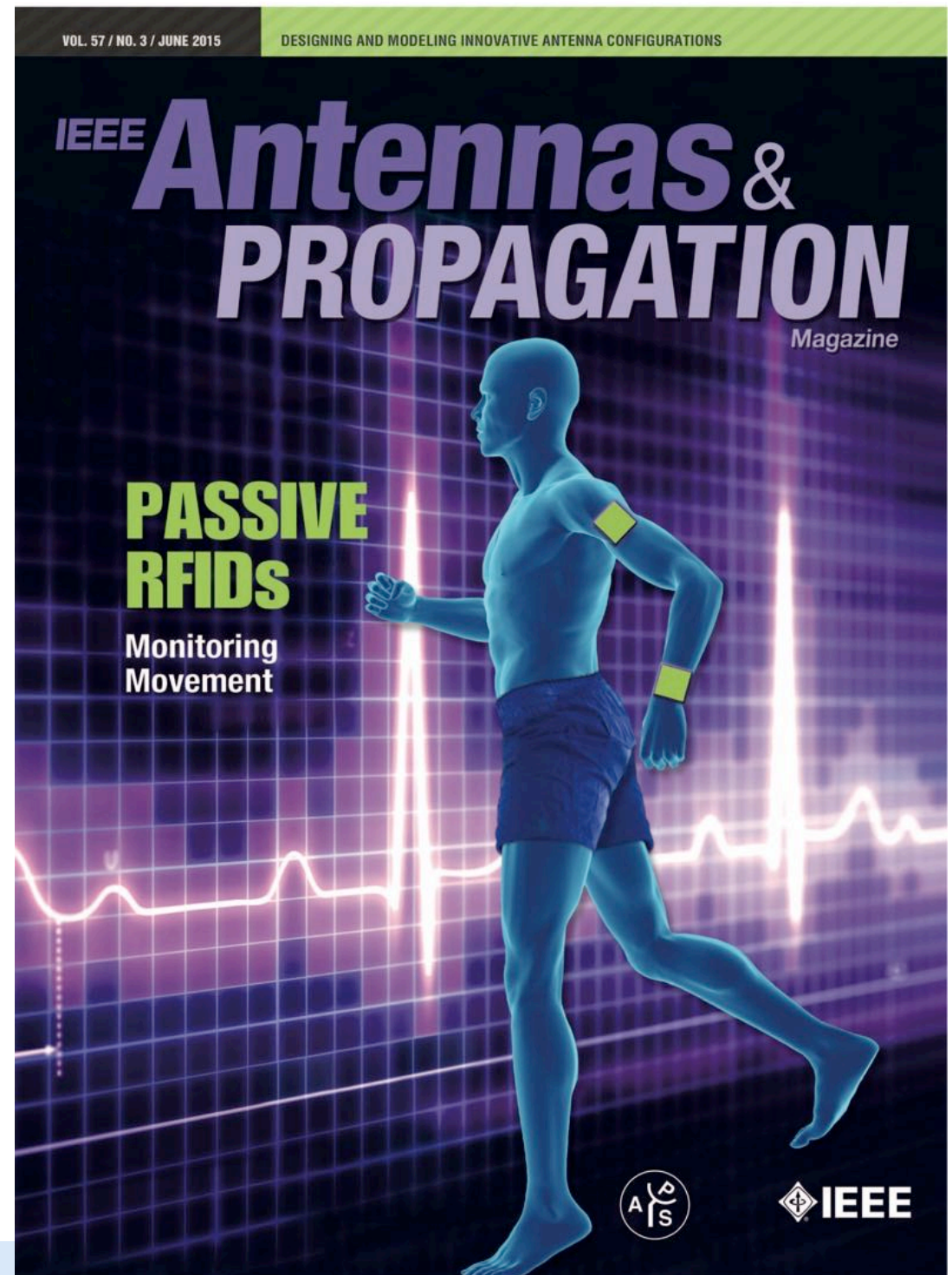


<https://www.youtube.com/watch?v=0Yhy03tqRHI>

<https://www.youtube.com/watch?v=ITJsxL4xoxY>

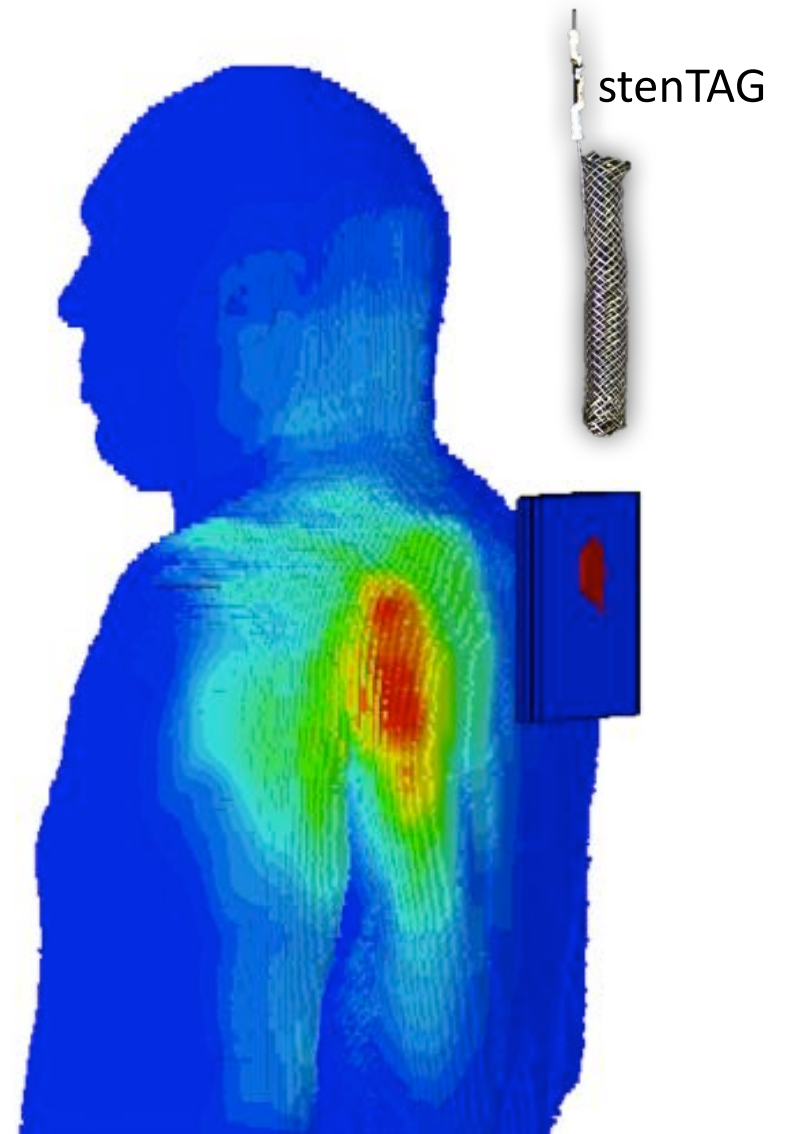


Pervasive Electromagnetics Lab





# Implantable tags: Smart Prosthesis



**Phd Thesis Awards** at RFID Journal Live 2012, Orlando

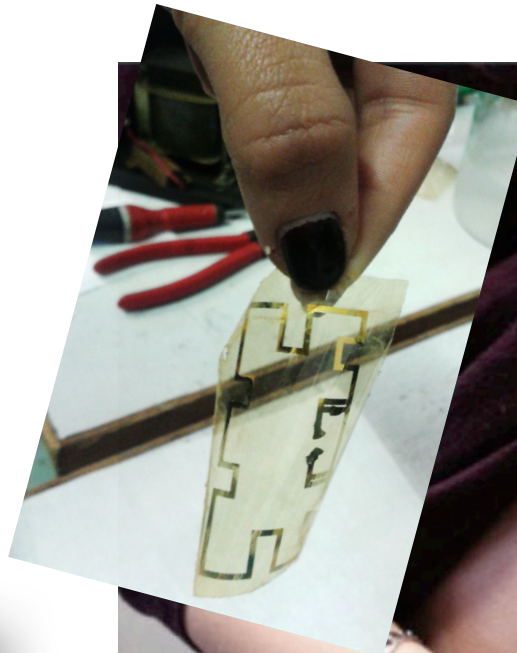
C. Occhiuzzi, "Wearable and Implantable RFID Technology for Pervasive Healthcare"

Pervasive Electromagnetics [Lab](#)



# Bio-integrated RFID Temperature Sensors

Lab on tag



**Best Paper Award**

2017 IEEE International Conference on Wearable and Implantable Body Sensor Networks (BSN2017),  
Eindhoven (The Netherlands)

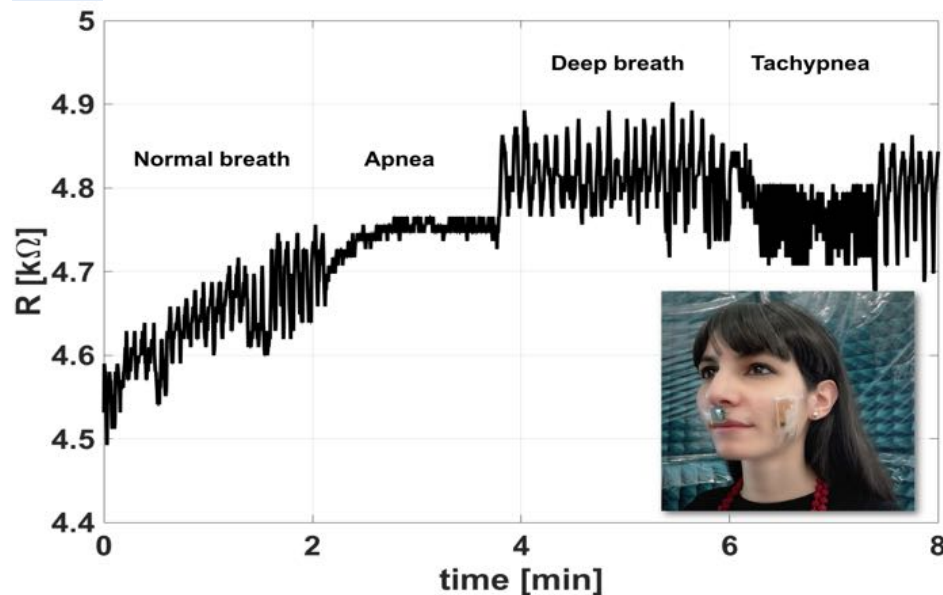






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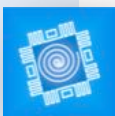
# Breath monitoring by graphene-powered epidermal RFID sensors



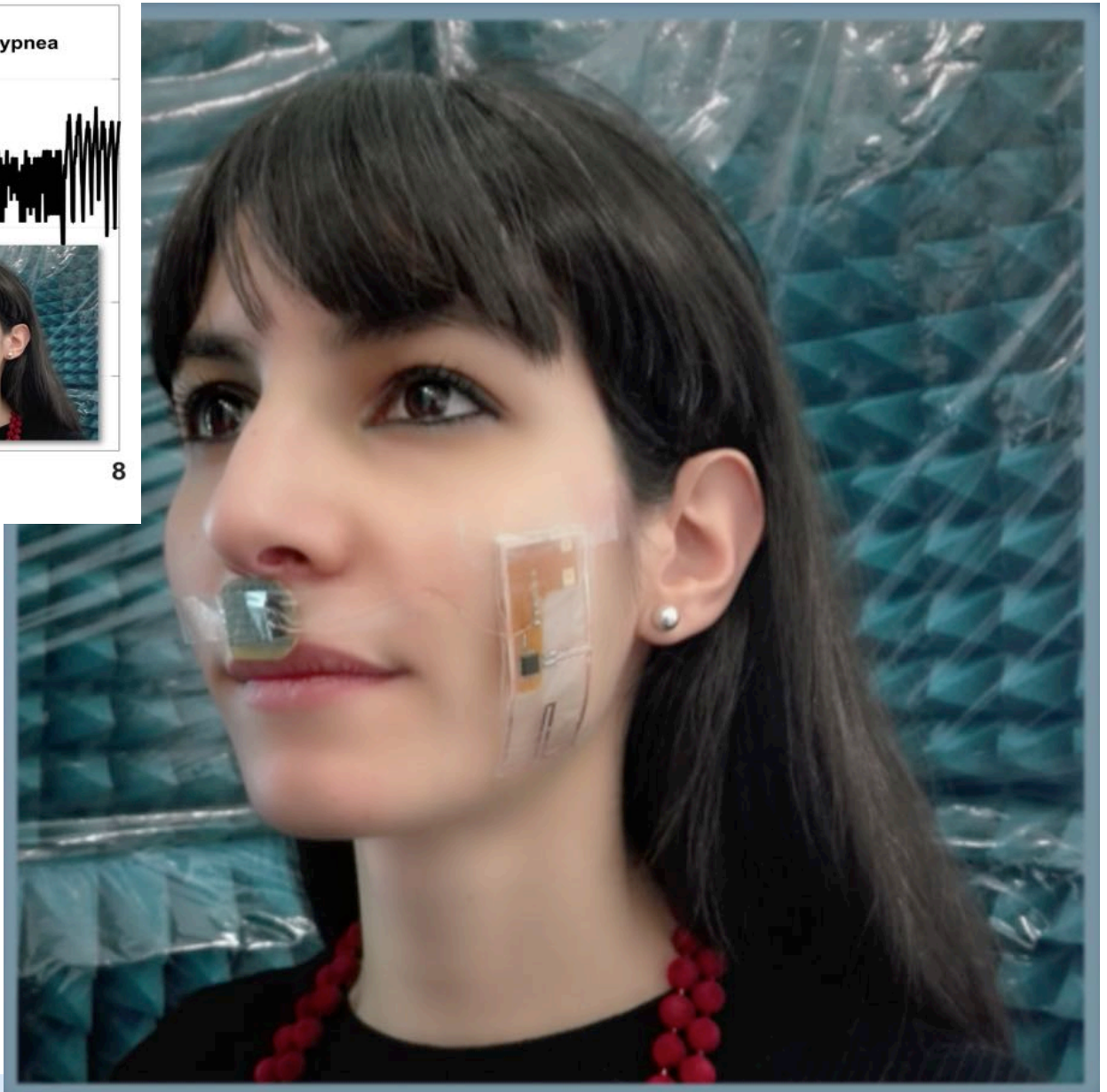
**Best Student Paper Award**  
2017 European Conference on  
Antennas and Propagation, Paris



**Best Paper Award**  
2017 IEEE RFID Technology &  
Applications  
Warsaw, 2017



Pervasive Electromagnetics Lab



<https://www.youtube.com/watch?v=cEbpfayG38c>

# Finger-augmented Device to restore lost senses in impaired people

Epidermal RFID temperature  
sensors onto finger tip

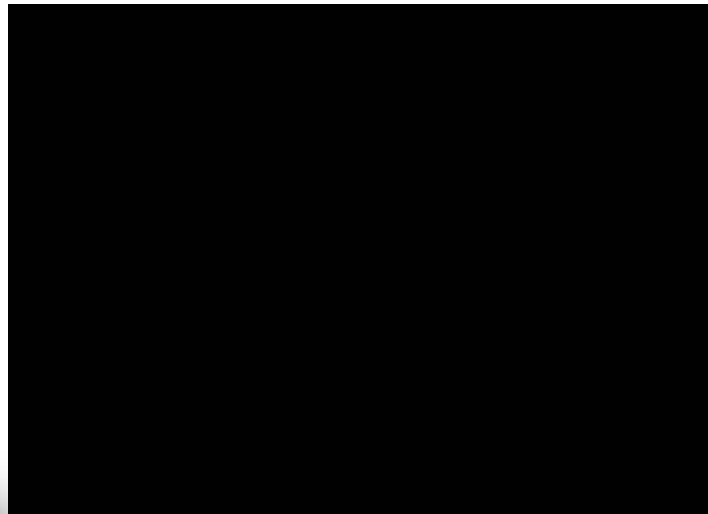
Wrist-mounted reader

Smart-watch(phone) haptic

<https://www.youtube.com/watch?v=DGUkYqmt-5Q>

<https://www.youtube.com/watch?v=6quuuEiNEBs>

<https://www.youtube.com/watch?v=tJD9xzpsl7U>

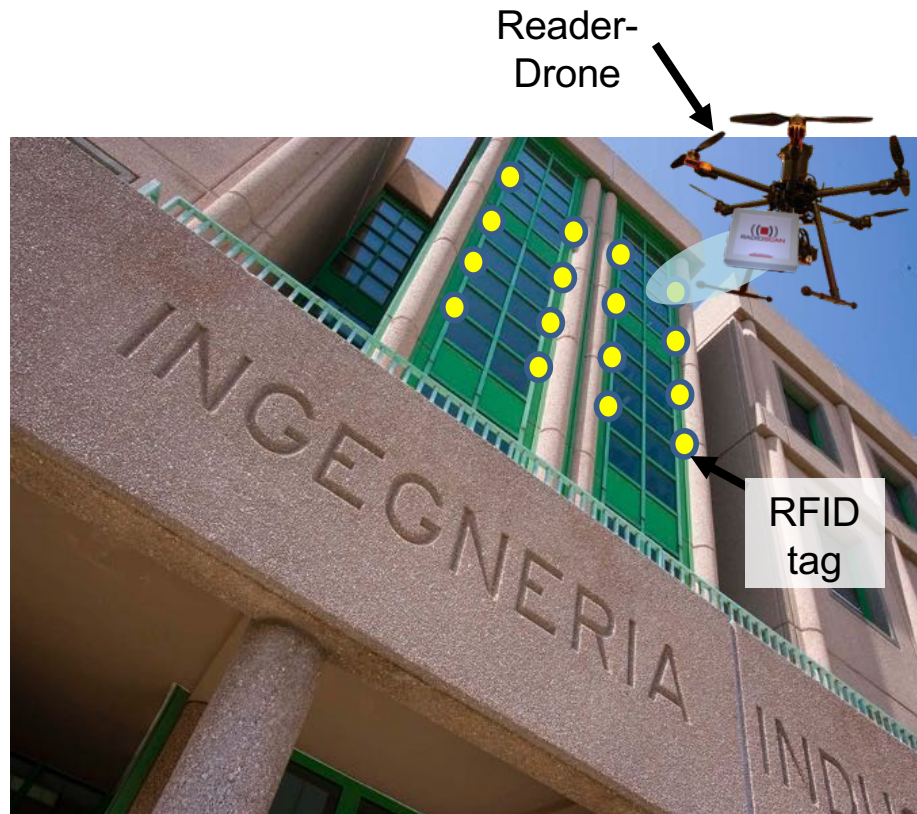


**Best Paper Award Finalist**

2017 RFID Virtual Journal / IEEE RFID

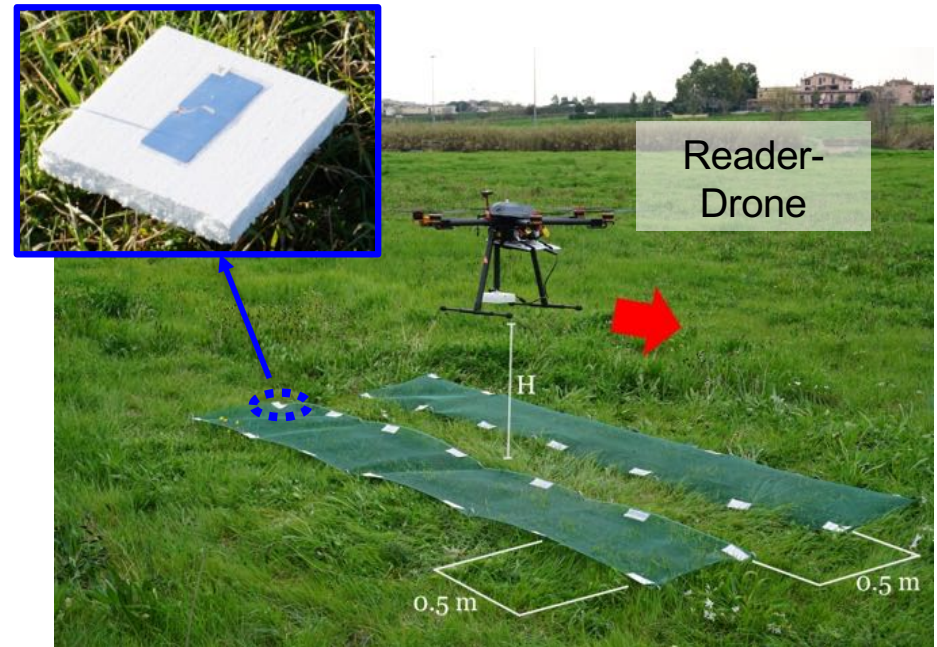


# RFID+DRONEs for Structural Health Monitoring



Structural Health Monitoring  
(Tags-on-surface)

Avery Dennison AD-843 dipole



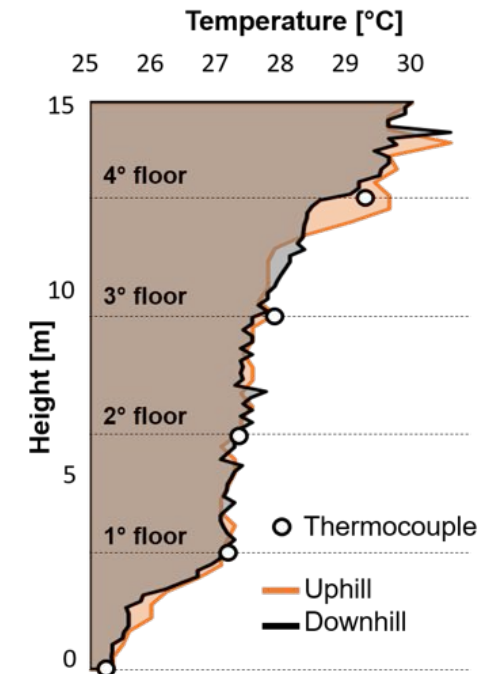
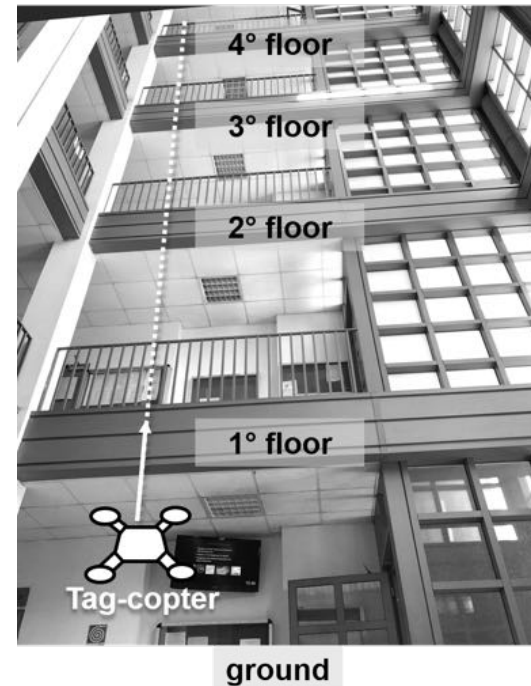
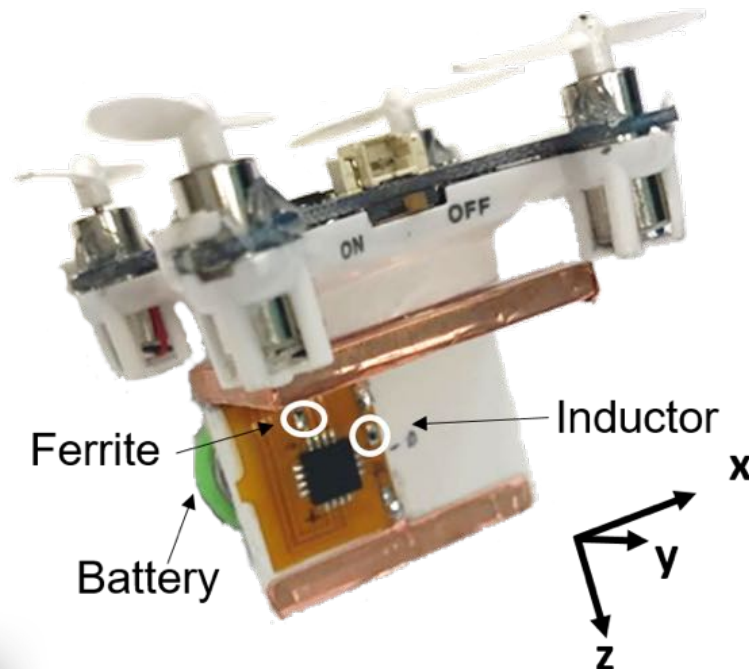
Precision Farming  
(Spaced-tags)

M. Longhi, G. Casati, D. Latini, F. Carbone, F. Del Frate, G. Marrocco, "RFIDrone: Preliminary Experiments and Electromagnetic Models," URSI International Symposium on Electromagnetic Theory (EMTS), Espoo, Finland, Aug. 2016. DOI: 10.1109/URSI-EMTS.2016.7571423



# Ubiquitous Flying Sensors

## Nanocopters + RFID datalogger



- Volumetric Scanners (swarm)
- Self-relocating and re-usable data-loggers
- Self-positioned disposable data logger

[https://www.youtube.com/watch?v=X\\_30lxlmjb4](https://www.youtube.com/watch?v=X_30lxlmjb4)





# Worldwide Positioning

2017

First Classified, Best Student Paper Award at EUCAP-2017

M. C. Caccami, M. Y. S. Mulla, C. Di Natale, and G. Marrocco

"Wireless Monitoring of Breath by means of a Graphene Oxide-based Radiofrequency Identification Wearable Sensor"

Maria Cristina Caccami

Best Paper Finalist IEEE-RFID 2017

V. Di Cecco, S. Amendola, P.P. Valentini, and G. Marrocco, "Finger-Augmented RFID System to Restore Peripheral Thermal Feeling"

Best Paper Award at IEEE 14th International Conference on Wearable and Implantable Body Sensor Networks (BSN2017), Eindhoven (The Netherlands),

C. Miozzi; S. Amendola; A. Bergamini; G. Marrocco, "Reliability of a Re-usable Wireless Epidermal Temperature Sensor in Real Conditions"

2016

COST IC1301 - Women in Wireless Power Transfer (WPT) Award.

Sara AMENDOLA

2015

AP-S/MTT-S CHAPTER CENTRAL AND SOUTHERN ITALY AWARDS 2015, AP-S Prize

Caccami, S. Manzari, G. Marrocco, "Phase-oriented Sensing by means of Loaded UHF RFID Tags", *IEEE Trans. Antennas Propagat.*, in press

2014

AP-S/MTT-S CHAPTER CENTRAL AND SOUTHERN ITALY AWARDS 2014, Honorable mention for the paper

S. Amendola, L. Bianchi, G. Marrocco "Body Movements Classification by Passive Radiofrequency Identification and Machine Learning Technologies", *IEEE Antennas Propagation Magazine*, in press

2014

First Classified ex-equo at INSIEM "Giovani Presso L'Impresa", XX Riunione Nazionale di Elettromagnetismo, Padova 16 Settembre 2012

C. Occhiuzzi, S. Amendola, S. Caizzone, S. Manzari, G. Marrocco, "NIGHTcare: sistema wireless per il monitoraggio e la diagnostica del sonno",

2014

Third Classified Student Competition at IEEE RFID-TA 2014, Tampere,

S. Manzari, T. Musa, M. Randazzo, Z. Rinaldi, A. Meda, G. Marrocco, "A Passive Temperature Radio-Sensor for Concrete Maturation Monitoring"

2013

Best Master's Thesis Award Italian Association for ICT (AICA) in cooperation with the National Inter-University Consortium for Telecommunications and Informatics (CNIT and CINI)

Sara Amendola, "Body Movements Classification by Passive Radiofrequency Identification and Machine Learning Technologies"

2012:

IEEE MTT-S/AP-S 2012 prize of central-south Italy

S. Manzari, C. Occhiuzzi, S. Nawale, A. Catini, C. Di Natale, "G. Marrocco, Humidity Sensing by Polymer-loaded UHF RFID Antennas

2012

AP-S doctoral award,

C. Occhiuzzi, "Wearable and Implantable RFID Technology for Pervasive Healthcare"

2012

First Classified Student Competition at IEEE RFID-TA 2012, Nice,

S. Manzari, S. Pettinari and G. Marrocco, "Miniaturized and Tunable Wearable RFID Tag for Body-Centric Applications"

2012

Phd Thesis Awards at RFID Journal Live 2012, Orlando

C. Occhiuzzi, "Wearable and Implantable RFID Technology for Pervasive Healthcare"

2012

First Classified, Best Student Paper Award at EUCAP-2012 Prague,

C. Occhiuzzi and G. Marrocco, "Experimental Characterization of the RFID STENTag for passive Vascular Monitoring"

2010

Second Classified, Best Student Paper Award at EUCAP-2010 Barcelona,

C. Occhiuzzi, G. Marrocco, "Sensing the Human Body by Implanted RFID Tags"

2004

Mario Sannino Award al XV Riunione Nazionale di Elettromagnetismo (RINEM), Cagliari, per il miglior lavoro con autori under 35.

M. Ciattaglia, G. Marrocco, "Calcolo della risposta impulsiva di antenne ad apertura per applicazioni ultra-wideband"





# Research Spin-off **RADIO6ENSE** (2013)

**Research,  
Prototypes,  
Papers,  
Patents**



**Pervasive  
Electromagnetics Lab**

Università di Roma Tor Vergata

[www.pervasive.ing.uniroma2.it](http://www.pervasive.ing.uniroma2.it)

Research outcomes



**Technology  
Development,  
Services**



**RADIO6ENSE**

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[www.radio6ense.com](http://www.radio6ense.com)

Challenges



MARKET

