Advanced Antennas for RF based Identification and Localization

RFID is one of the supporting technologies of the Internet of Things (IoT) concept. Objects from our everyday life carrying an RFID tag can form the nodes of an extraordinary network of information with potential to change our life routines. Antennas play a key role in this system, with new challenges constantly opening as unthinkable new services come to mind. This is the motto for new antenna developments in the project.

PROJECT WEBPAGE URL
http://www.it.pt/project_detail_p.asp?ID=1190

Main Project Team

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Funding Agencies

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Indicators

Journal Papers	7
Conference Papers	9
Patents	1
Concluded MSc	6

Two Main Publications

C. Cruz, J. Costa, and C. Fernandes, **"Hybrid UHF/UWB Antenna for Passive Indoor Identification and Localization Systems"** IEEE Trans. on Antennas and Propagation, Vol. 60, No. 1, January 2013

C. R. Medeiros, J. R. Costa, and C. A. Fernandes, **"RFID Reader Antennas for Tag Detection in Self-Confined Volumes at UHF"** IEEE Antennas and Propagation Magazine, Vol. 53, No. 2, April 2011

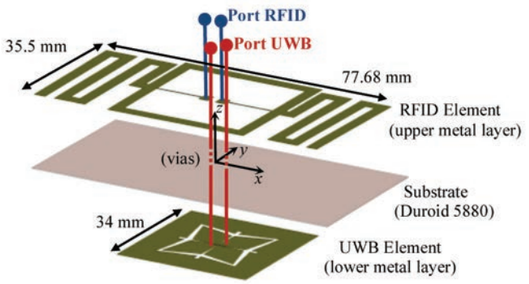

Fig. 1 Exploded view of the hybrid RFID-UWB antenna showing the two metalized faces from each side of a common planar substrate.

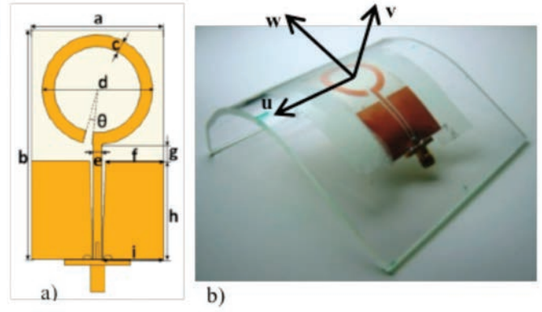

Fig. 2 Conformal UWB antenna for integration in travel suitcase wall.

GENERAL MOTIVATION

The Internet of Things (IoT) concept envisages linking people and objects as nodes of a huge communications network sharing information to improve work productivity and management efficiency, or to enhance aspects of our everyday life. Imagine that managers can remotely monitor the flow of every single document or file in the office or of every part of equipments being fabricated in a factory, or the automatic real time inventory of shop contents, all done wirelessly, remotely and without human intervention. Imagine the same concept extended to homes, helping to produce shopping list remotely while the user is at the supermarket, or to monitor vital signs of lone elderly or ill persons and automatically trigger help in case of emergency. These IoT services are starting to appear but its mass deployment at affordable cost depends in part on the availability of dedicated antennas. The main purpose of this project is to advance in the co-design of antennas with the attached artifacts for IoT, and propose new challenging applications.

CHALLENGE

One of the promising radio technologies to support IoT is UHF RFID. Objects carry an electronic tag with unique ID that can be retrieved wirelessly by a remote reader and processed by smart applications. Reading range is typically 7-15 m, which is good for most identification applications but it is not appropriate if fine localization is additionally required. Special reader antennas are needed to produce shaped self-confined reading volumes, for instance over shelves, tables, conveyor belts, etc. Also special antennas are needed to be attached to objects containing liquids or metals, which impair significantly antenna operation. The same happens when antennas are attached or implanted on the human body. Regarding localization, a more accurate radio technology is UWB that works with ultra-short impulses for range detection as in radars; so an additional challenge is to devise hybrid solutions that merge the best characteristics from UHF-RFID and UWB.

DESCRIPTION

Because antenna performance in IoT applications is especially affected by the objects where they are attached or integrated, this project deals specifically with the co-design of antennas and corresponding IoT items. This is especially important when passive UHF tags are used, that is, batteryless RFID or UWB tags (passive tags) powered by energy that its IC scavenges from the reader wake-up signal. RF power in the return link is weak, so antennas must be as efficient as possible. Passive UHF RFID is preferred, because tags are quite inexpensive compatible with printing technology. To deal with the above referred co-design complexity, powerful full-wave electromagnetic simulators are used to model the antenna together with the attached object. A typical parameter for antenna optimization is impedance bandwidth, which must be compatible with complex valued impedance from RFID ICs. Furthermore, antennas must be efficient, conformal and compatible with extremely low cost mass production. For UWB technology, further to these requirements, antennas must preserve as much as possible the pulse shape.

4) Multipath mitigation: Algorithms for multipath mitigation are usually based on the narrow correlator, and double-delta or other gating functions techniques. However, for close-in multipath these methods are inefficient and ML algorithms have to be employed, at the cost of a high computational effort. Alternative algorithms with smaller computational complexities have been investigated.

5) Assisted-GNSS and coordinated positioning: Aimed the development of navigation algorithms for coordinated positioning applications and the support of their implementation on portable units. Several algorithms were proposed for coordinated positioning, heading estimation, and road constrained positioning.

TECHNICAL ACHIEVEMENTS

1) Consolidation of a new concept of RFID-based smart IoT devices like store shelves, conveyors, mirrors, cabinets with co-designed reader antennas. All these antennas share a novel feature that allows self-confinement of the UHF RFID detection without the need for physical barriers.

2) Consolidation of the co-design approach to integrate RFID tag antennas with objects like travel suitcases and garments. New RFID tag antennas were developed also for body-area integration, including implantable antennas.

3) Development of new co-designed UWB antennas for improved localization accuracy as well new hybrid antennas combining RFID and UWB functionalities.

4) Development of full system demonstrators as a showcase of the IoT concept applying the new designed RFID, UWB and body implantable antennas.