Towards Green RFID Systems

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***Abstract*—This project aimed at realizing an UHF reader antenna on cheap and eco-friendly substrates. Numerical and experimental results are briefly discussed demonstrating that the antenna here presented is an optimum candidate to be used as reader antenna of ultra-high frequency RFID systems.**

***Index Terms*—Radiofrequency identification, patch antennas, eco-friendly substrate.**

I. Introduction

In the last years a great interest in green electronics has raised; many studies focused the attention on the use of biopolymer in electronics, which can be used for example as electrolyte in batteries or as a substrate for fabricating PCBs [1-3].

At the same time, there was a growing use of Radio Frequency Identification (RFID) systems, and in the next few years, an even more capillary distribution of such a technology is expected. As a consequence, the use of paper as substrate is very appealing, as paper is fully recyclable, cheap, and its properties (electric parameters, thickness and so on) can be ad-hoc customized.

Moreover, paper is easy to use in making prototypes, gives the possibility to fabricate electronic circuits on disposable products and packaging and can be made hydrophobic or fire retardant with the application of appropriate coating. Furthermore, the use of paper can enable the utilization of inkjet technology to print electronics [4].

In this project, a fully-3D Ultra-High Frequency (UHF) reader antenna on cheap and eco-friendly substrates has been realized. Compared to standard reader antennas, the solution here presented has several advantages: it is cheap and environmentally friendly, it has compact dimensions and it allows the integration of electronic equipment thanks to its cubic structure. Furthermore, it exhibits an almost omnidirectional radiation pattern.

This report is structured as follows. In sect. II the geometry of the proposed antenna is briefly described and some numerical and experimental results are given and discussed. Finally, conclusions are drawn in sect. III.

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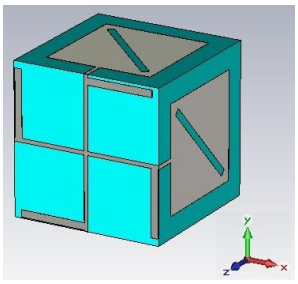

Fig. 1 Geometry of the proposed antenna using patches with a slot on the diagonal.

II. Numerical and Experimental Results

The geometry of the proposed antenna is illustrated in Fig. 1. It consists of four patch antennas placed on the lateral faces of a cube. As for the substrate used for the antenna, that is the material of the cube, it is a cardboard with a thickness of 3 mm. The antenna has only one RF input port and a network consisting of four microstrip lines has been used to feed each single patch. From Fig. 1, the presence of a loading open-ended stub for each microstrip line can be noticed; these stubs were used to achieve the matching with respect to a 50Ω coaxial cable.

Fig. 2 shows full-wave simulation results obtained for the radiation pattern; it can be seen that an almost omnidirectional pattern was obtained in the *xy* plane.

Each patch was designed with a diagonal slot. With respect to the use of traditional rectangular patches, this strategy allows obtaining a reduction of the volume occupied by the cube equal to 76%. Furthermore, the use of a diagonal slot on the patches results in a circular polarization of each patch while irradiation in the *xy* plane remains almost omnidirectional.

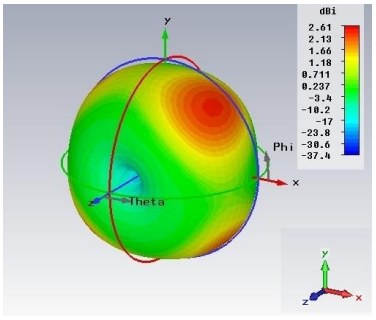

Fig. 2 Radiation pattern of the proposed antenna calculated by means of full-wave simulations.

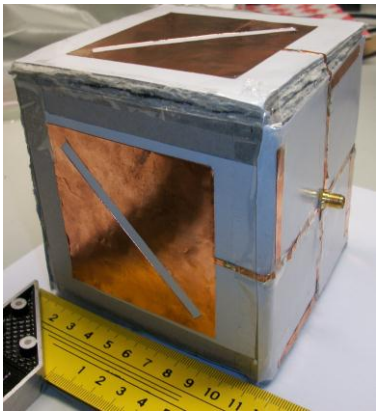

Fig. 3 Photograph of the realized prototype.

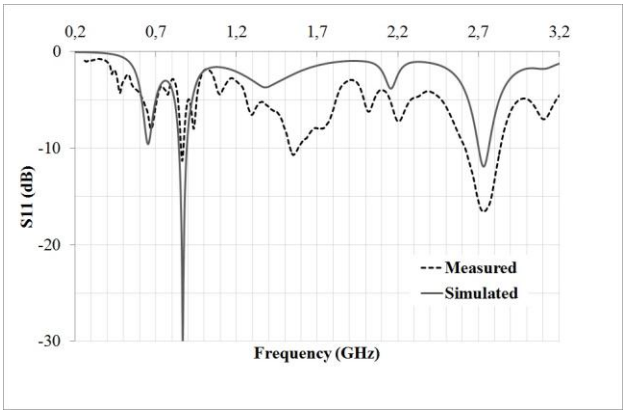

Fig. 4 Comparison between experimental data and full-wave simulations for the reflection coefficient of the prototype shown in Fig. 3.

It is worth underlining that the use of the microstrip technology guarantees the absence of any problem of electromagnetic compatibility between radiating elements placed on the external surface of the structure and the electronic devices potentially located in the cube's hollow. In fact, the ground-plane on the back of the antenna works as electromagnetic shield for the inner volume of the cube.

A prototype was realized for the antenna of Fig. 1, a photograph is given in Fig. 3. The patch antennas and the feeding network were realized by using adhesive copper. The measured reflection coefficient is in a good agreement with numerical data, as shown in Fig. 4.

III. Conclusion

A novel reader antenna for radio frequency identification applications has been presented. The main features of the proposed antenna are the use of a cardboard substrate, resulting in a low impact on the environment of the overall antenna, combined with compact dimensions, circular polarization and an almost omnidirectional radiation pattern.

The outcome of this project has been published in the Proceedings of the 42nd European Microwave Conference [4].

The MTT-S scholarship program was a great opportunity for me to improve my theoretical and technical knowledge by working on a small but real research problem. Moreover, thanks to the scholarship, I discovered IEEE and especially IEEE student activities: with some fellow students of my University, we decided to establish an IEEE Student Branch indeed.

Finally, thanks to the scholarship travel grant, I attended the 42nd European Microwave Conference in Amsterdam on November 2012, where I attended the Student Challenge too. It was an exciting experience, because I could listen to several interesting sessions about emerging topics and present to several students and researchers the results obtained during this research project.

I am currently a Master student at the University of Salento in Lecce, Italy, and then I would like to pursue a Ph.D. program.

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