On the Design of a Mobile RFID System for Searching of Misplaced or Lost Tagged Items

Achilles Boursianis[2], Theodoros Samaras[2], Anastasis C. Polycarpou[1] and John N. Sahalos[1,2]
[1] University of Nicosia Research Foundation, UNRF, Nicosia, Cyprus (sahalos.j@unic.ac.cy, polycarpou.a@unic.ac.cy)
[2] Radio-Communications Laboratory, Department of Physics, Aristotle University of Thessaloniki, AUTH, Thessaloniki, Greece (theosama@auth.gr, bachi@physics.auth.gr)

***Abstract*—In this work, a UHF mobile RFID system for searching of misplaced or lost tagged items is presented. The system consists of a microstrip antenna array with alternate orthogonal dipoles which are fed in series by a microstrip line. The distance between the dipoles is adjusted in order to excite them in phase and radiate two orthogonal electric-field components. The number of dipoles and the large inter-element distance, create beams with direction diversity. From the analysis of the near zone field it is found that a semi-cylindrical area around the axis of the antenna is sufficiently covered.**

***Index Terms*—RFID, near-field antennas, propagation, library management system.**

I. INTRODUCTION

Radio Frequency Identification (RFID) is a growing technology with a plethora of useful applications in major sectors of the economy ranging from the healthcare [1] and pharmaceutical industry to retailing, transportation, libraries and logistics [2]. The use of passive RFID technology at UHF frequencies can develop intelligent, application specific, and low-cost management systems that reduce labor and running costs and improve productivity at workplace [3]. In general, the introduction of the emerging RFID technology in libraries will allow for: 1) replacement of traditional time-consuming processes for checking items in and out of the building; 2) automation of labor-intensive and time-consuming stock-taking processes; 3) improvement of productivity at workplace by eliminating tedious and paper-bound processes traditionally followed during inventory taking; 4) reduction of running cost due to a more productive and highly efficient working environment; 5) reduction of theft counts and the number of missing or misplaced items; etc.

This work presents a UHF (867 MHz) mobile RFID system for searching of misplaced or lost tagged items. The system consists of a microstrip antenna array of orthogonal dipoles which are fed in series by a microstrip line. The distance between the dipoles is adjusted to excite them in phase in order to have two orthogonal electric-field components. The number of dipoles (larger than 5) and the large inter-element distance, close to one wavelength, create beams with direction diversity. Thus, it is expected that there will be polarization matching with the tags irrespective of tag orientation. Fig. 1 presents a mobile RFID a system (trolley) in the corridor of a library. The system has two vertical antenna arrays mounted on the left and right sides of the trolley. The two arrays are connected to the corresponding output port of the mobile reader. Four wheels have been attached at the base of the trolley to facilitate its movement.

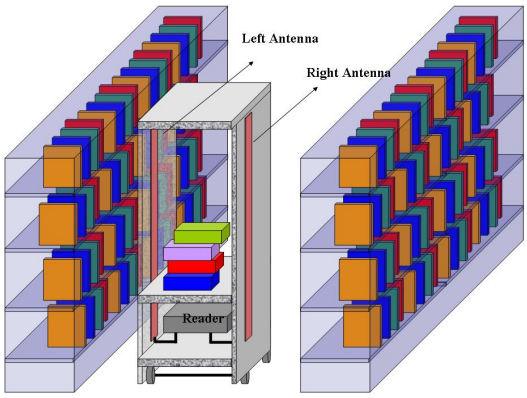

Fig. 1: A mobile RFID system for searching of misplaced or lost tagged items.

The schematic diagram of an N-dipole antenna array is shown in Fig. 2. The dipoles are excited by a microstrip line, which can be straight or meander-shaped for phase adjustment. A series of simulations were performed using commercial EM software (ANSYS Inc., Canonsburg, PA, USA) [6] and SEMCAD-X, Schmid & Partner Engineering AG, Zurich, Switzerland [7]) in order to optimize their performance.

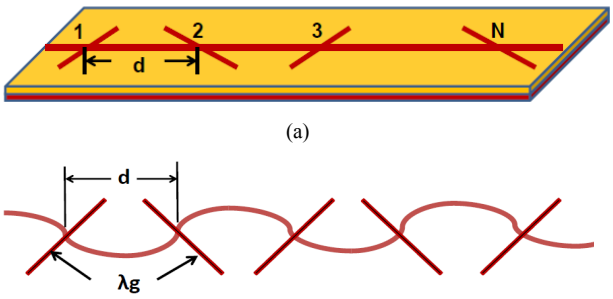

Fig. 2. (a) Dipole array antenna excited by a microstrip line. (b) A meander-shaped line configuration of the antenna.

II. ANALYSIS OF READER ANTENNA WITH MEANDER CONFIGURATION

The antenna is elongated along a longitudinal axis and includes a pair of coplanar strips, [5]. Our goal is to design the reader antenna at a center frequency around 867 MHz, which is different from the one used in [5]. After a series of simulations, it was found that the impedance, as well as the EM coverage, meets the desired constraints, when a 6-element array with pairs of dipoles (double dipole), instead of single ones, at each position is used (see Fig. 3). It is noticed that the meander was modified in order to have all the dipoles in phase for a given inter-element distance.

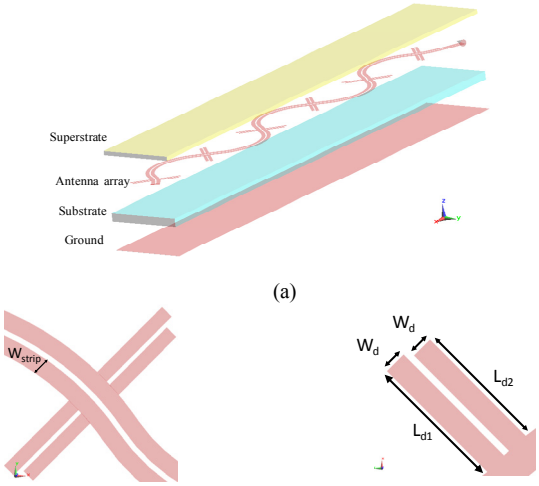

Fig. 3. (a) A 6-element meander array. (b) Detail of the double dipole. (c) Parameters of one arm of the double dipole. L_{d1} = 68.5mm, L_{d2} = 60.5mm, dipole width W_d = 10.0mm. Each of the stripline width is W_{strip} = 13.0mm, while the thickness of the designed antenna is 0.1mm. The superstrate and substrate layers have ε_r=2.5 and thickness 13.5mm & 28mm, correspondingly.

For a distance equal to 0.8λ between the elements, the 6-double dipole linear array has the desired bandwidth. Fig 4 shows the return loss (S11 parameter) versus frequency.

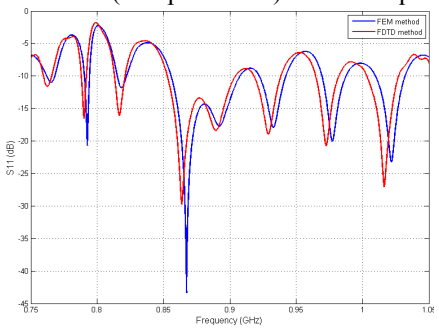

Fig. 4. S11 parameter as a function of frequency of the final antenna array model (blue color: FEM, red color: FDTD method).

Also, for the near zone field, it was found that a semi-cylindrical area around the axis of the antenna is sufficiently covered. Applications of the field coverage in the presence of library shelves loaded with certain tagged items are shown in Fig. 5.

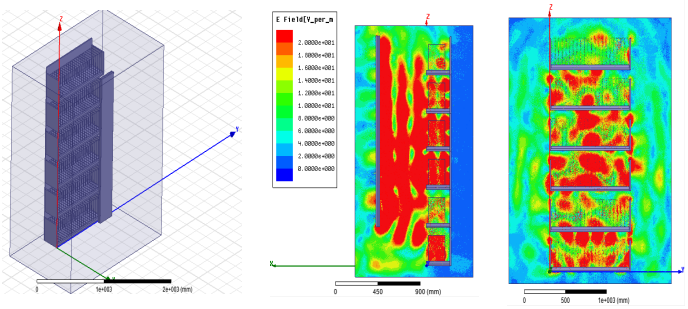

Fig. 5. (a) The array in front of a six shelves library cabinet and the field coverage in (b) xz-plane and (c) yz-plane.

III. CONCLUSION

A UHF mobile RFID system for searching of tagged items is presented. The system consists of a microstrip antenna array with alternate orthogonal pairs of dipoles, which are fed in series by a microstrip line. The line has a meander configuration that allows the dipoles to have the desired inter-element distance. The size of the antenna is approximately equal to the length of a six shelves library cabinet. The results of S11 parameter and the near zone field show that the design is within the desired specifications.

ACKNOWLEGMENT

This research is funded by the EU Structural Funds and the Cyprus Research Promotion Foundation (RPF) under the grant with protocol number ΤΠΕ/OPIZO/0311(BIE)/03.

REFERENCES

[1] A. C. Polycarpou, A. Dimitriou, A. Bletsas, P. C. Polycarpou, L. Papaloizou, G. Gregoriou, and J. N. Sahalos, "On the Design, Installation, and Evaluation of a Radio-Frequency Identification System for Healthcare Applications," *IEEE Ant. & Propag. Mag.*, Vol. 54, 4, pp. 255-271, 2012.

[2] T. Y. Peng, "Study on the Application of RFID Technology in Retail Logistics Industry," *IEEE 3rd Int. Conf. on Communication Software and Networks (ICCSN)*, pp. 396-400, 2011.

[3] M. G. Linquist, "RFID in Libraries – Introduction to the Issues," *World Library and Information Congress: 69th IFLA General Conference and Council*, Berlin, Aug. 2003.

[4] J. N. Sahalos, "Orthogonal Methods for Array Synthesis," John Wiley & Sons, UK, 2006.

[5] W. D. Burnside, R. J. Burkholder and F. E. Tsai, "Elongated Twin Feed Line Antenna with Distributed Radiation," Patent No.:8,058,998 B2, Nov. 2011.

[6] Ansoft Corporation HFSS. Available: http://www.ansoft.com.

[7] SEMCAD, Schmid & Partner Engineering AG (SPEAG). Available: http://www.semcad.com