Design of RFID Textile Dipole Antenna

Yuanhua Sun, Ying Lei, Yihe Liu,Nianqing Tang, Yao Li, Dajun Xu,Yongyan Yu
School of Computer Science
Neijiang Normal Universtiy
Neijiang City, P.R. China
sunyuanhua17@hotmail.com

Zhibo Du
Chengdu Universtiy of Information Technology
Chengdu City, P.R. China

Abstract— A textile dipole antenna is presented. Based on the theory of dipole antenna, according to the selection of fabric weaving materials, the paper get an optimal material and structure textile antenna design according to the thickness of conductive fibers, fabric weaving density and the comparative analysis of the electromagnetic properties of the braided structure. The proposed antenna consists of two parts: one part is the polyester, the other two parts are metal wires. The copper fiber with a diameter of 0.1mm is applied to the design of the textile antenna. The density of copper fiber is 250×250 in100 square centimeters. The proposed textile antenna can cover 915MHz with 75MHz bandwidth.

Keywords—dipole; RFID antenna; textile antenna; polyester; copper fiber;

I. INTRODUCTION

Body-centric wireless communication is an important development direction of future wireless communications. It has wide range of applications in home intelligence, entertainment, identification systems, space exploration, military. The fast development of wearable low-power devices has increased the requirement of solutions for WBAN implementation. In addition to the need to reduce the device's dimensions and improve power consumption, it is also important to work on developing flexible antennas that may be integrated into clothes. The wearable antenna plays an important role in a WBAN, presenting a wide variety of applications. The antennas can be used in systems detecting body motion during exercise activity, monitoring heart rate and blood pressure, and used by emergency responders such as firefighters[1],[2].

Since most wearable devices are applied to clothes, it may be relevant to develop antennas that can be easily integrated into a garment, such as a textile antenna. These antennas consist of a textile conductive element integrated with another textile material acting as substrate and have the advantage of being lightweight, flexible, easy to produce, relatively inexpensive, and easily integrated into a garment.

Textile antennas have been extensively studied over the last years since they guarantee flexibility and can be directly integrated in to the clothing[2-5]. Several linearly Several linearly[6] and circularly[2], [7] polarized fabric-based patch antennas have been introduced. Single-band[3], dual-band[4],[8], and ultrawideband[9] textile antennas have been presented with satisfactory performance in free space. Some wearable textile antennas have been also characterized on the human body[5],[8-10]. When these antennas are placed close to a lossy medium.

II. ANTENNA DESIGN

Wearable antennas should be low-profile, lightweight, and compact. In some particular cases, it should be conformable to the body shape. The antenna operates in the Industrial, Scientific, and Medical (ISM) frequency band for short-range devices (SRDs) (2.4–2.4835 GHz). The patch antenna topology has been chosen because the antenna ground plane shields the body from antenna radiation and stabilizes the antenna characteristics in proximity of the human body, thereby mitigating the adverse effects that typically occur in body-centric communication applications. Computer-aided optimization by means of full-wave simulations has been performed to match the antenna impedance to the optimum source impedance of the transformer by varying the parameters of the antenna.

A 0.1-mm-thick fabric extracted from a polyester shirt. The permittivity is extracted using the open stub methodology, and the loss tangent is assessed using patch of different lengths. Simulations are carried out using CST Microwave Studio to find ε_r and $\tan\delta$. The dielectric properties found for the employed textile are $\varepsilon_r = 2$ and $\tan\delta = 0.016$.

The proposed textile antenna use copper fiber with diameter of 0.1mm, high-density, plain weave fabric to make a rectangular patch antenna. In the design of textile antenna, the conduction band and the ground plate are made of copper fiber, the density of the textile antenna is 250×250(root/10cm), 2/2 plain weave fabric. The design of the proposed textile dipole antenna is shown in Figure 1.

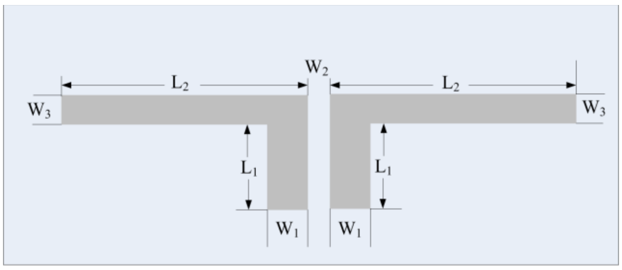

Figure 1. The geometry and parameters of the proposed RFID textile dipole antenna

The antenna consists of two dipole parts and textile fiber. The textile antenna is design to working in 915MHz. The antenna use polyester fiber as substrate. Metal fiber braid is used as the antenna arms. The length of the antenna arm is the half wavelength of the 915MHz. The final dimension of the antenna is : L_1= 2.6mm, L_1=76mm, W_1= 1.5mm, W_2=2mm, W_3= 1.2mm. The thickness of the metal fiber braid is 0.12mm. The thickness of the substrate is 2mm.

To verify the proposed textile antenna design, a prototype of the antenna is fabricated as shown in Figure 2. The return loss result is measured by a vector network analyzer (VNA). All the simulations are computed by CST studio.

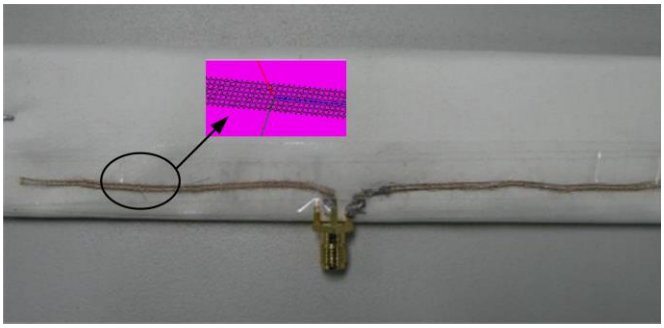

Figure 2. Fabricated proposed textile antenna

As shown in Figure 3, the S_{11} from the measurement is compared with the simulation results, which shows accordance between measured and simulated values. The metal fibers is easily broken and the longitudinal fibers are detached, so the measured center frequency moved to 900MHz. The proposed textile rectangular patch antenna can cove r 915MHz with the 75MHz bandwidth.

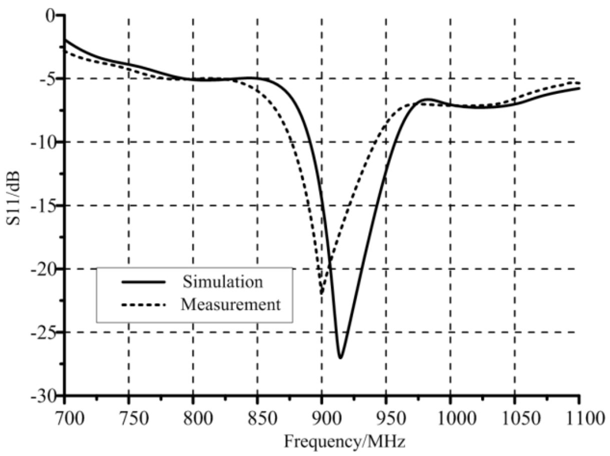

Figure 3. S11of simulation and measurement

III. CONCLUSION

A RFID textile dipole antenna has been designed for on-body communications. The proposed antenna can cover 915MHz with 75MHz bandwidth. The dielectric properties of the textile used as substrate have been characterized. The antenna has been fabricated using a commercial fabric and measured in reflection. The antenna is fexible and compact and is a very promising solution for on-body high-data-rate communications.

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