TEXTILE YAGI ANTENNA AT 1.8GHz

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Abstract - In this work, a textile Yagi antenna on jeans fabric is designed, simulated and tested. The proposed textile antenna operates at the digital cellular service band (DCS 1800 MHz) and it has been designed by means of the commercial full 3D electromagnetic CST Microwave Studio simulator. The textile antenna under test presents a gain range from 6.32 dBi to 7.26 dBi, with radiation efficiency from 90.52% to 91.34%, respectively. The results demonstrate the feasibility to use textile Yagi antenna on RF energy harvesting applications.

1. INTRODUCTION

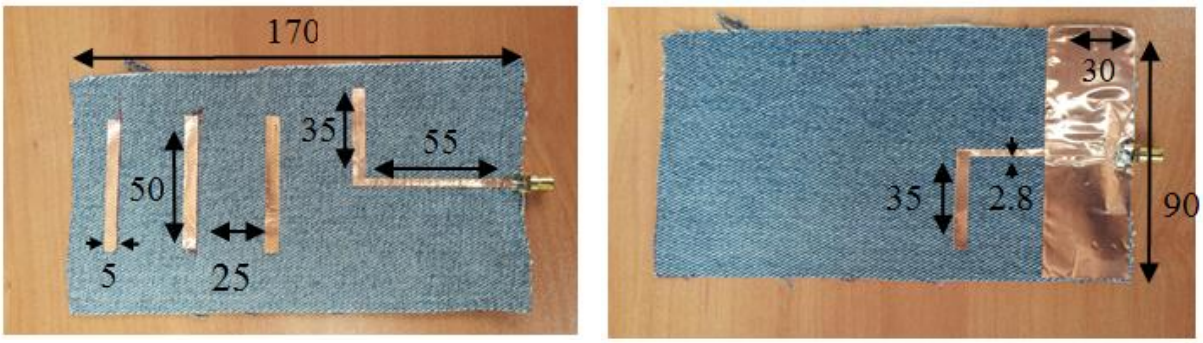
Recently, a massive increase of the use of wearable electronics on fields such as health monitoring, physical training, emergency rescue service and law-enforcement has been produced. On the one hand, to increase the usability and comfort of this technology, the integration of electronics components on textile should be addressed. On the other hand, wearable electronic should fulfill restrictions of low-cost and low-power consumption to guarantee its usefulness in commercial applications.

The integration of electronic on textile has been demonstrated in several papers addressed to develop specific sensors [1][2] and antennas [3], [4]. To satisfy the restrictions of low-cost and low-power consumption of wearable applications, some researchers have pointed out that the RF energy-harvesting technology can help to increase the battery lifetime [5]. In order to do that, high gain and high efficiency antenna are required. Only a few papers have been focused on the integration high gain /high efficiency antenna on textile substrates. In [6] Yagi textile antenna at 60 GHz was presented. In this case, the measured antenna gain about 9 dBi was achieved with a radiation efficiency of 74%. In [7] a UHF wearable patch antenna was developed with gain and efficiency of 4.6 dBi and 41.4%, respectively.

In this work, a high gain and high efficiency textile Yagi antenna is developed in order to demonstrate its feasibility on a RF Energy harvesting system. The antenna is designed at 1.8 GHz band, which is one of the main radiation bands due to digital cellular service (DCS) communications. The paper is organized as follows. In Section 2, the material properties and the proposed antenna are detailed. The experimental and simulation results are reported and discussed in Section 3. Finally, in Section 4, the main conclusions are summarized.

2. MATERIALS AND METHOD

The antenna has been implemented in a 1 mm thick jeans substrate with a dielectric constant (ε_r) of 1.7, and loss tangent (tan δ) of 0.025. The metal layer corresponds to a commercial WE-CF adhesive copper sheet with a thickness of 70 µm. The antenna has been designed and optimized by means of the commercial full 3D electromagnetic CST Microwave Studio simulator. Fig. 1 shows the implemented Yagi antenna. The antenna consists of a dipole radiating element. One arm of the dipole is located in the bottom jeans substrate layer; meanwhile the other one is located in the top layer. This layer also includes three pole directors in the front of the dipole. The reflector is located in the bottom layer. The optimized antenna dimensions are shown in Fig. 1.



a) top layer *b) bottom layer*

Figure.1 *Geometry (dimensions in mm) of the proposed Textil Yagi.Antenna.*

3. RESULTS AND DISCUSSION

The performance of the antenna has been measured by means of a Keysight FieldFox N9916A Microwave Analyzer by selecting the vector network analyzer mode. The simulated and measured return loss of the proposed Yagi antenna is depicted in Fig. 2. It can be observed a return loss coefficient lower than -10dB in the frequency range of DCS1800 (1710-1880 MHz). Moreover, the results confirm a good correlation between simulation and measurement.

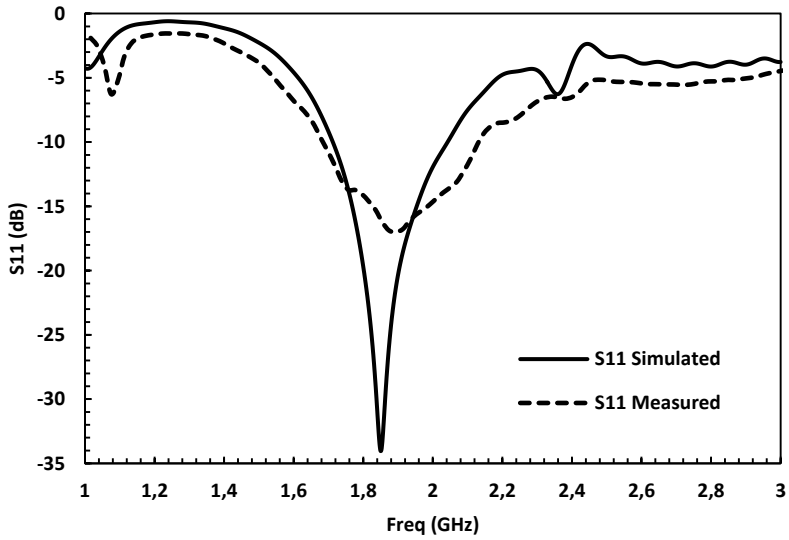
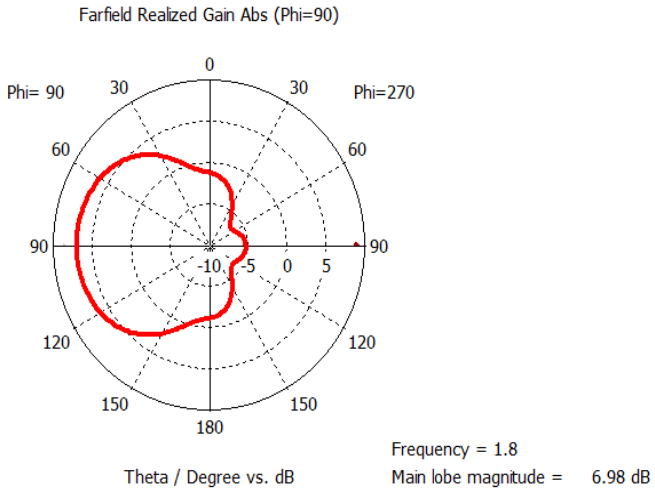


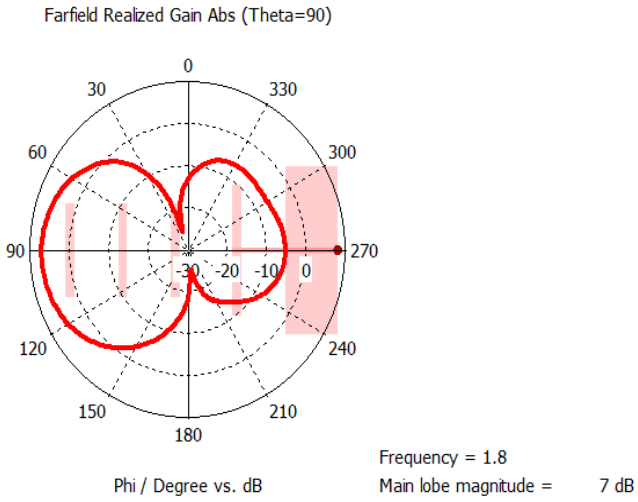
Figure. 2: *Simulated and measured return losses.*

The simulated radiation pattern of the antenna is plotted at 1800 MHz in Fig. 3. The figure indicates a half-power beam width (HPBW) of 101.2 degrees and 64.4 degrees for ZY and XY plane, respectively.

In Fig. 4 the simulated realized gain and efficiency is illustrated. In the frequency band of interest, the realized gain is 6.32 dB for the lower frequency band and 7.26 dB for the higher frequency band, with and radiation efficiency of 90.52% and 91.34%, respectively.



a) ZY radiation plane



b) XY radiation plane

Figure. 3: *Radiation pattern obtained by simulation at 1800 MHz*

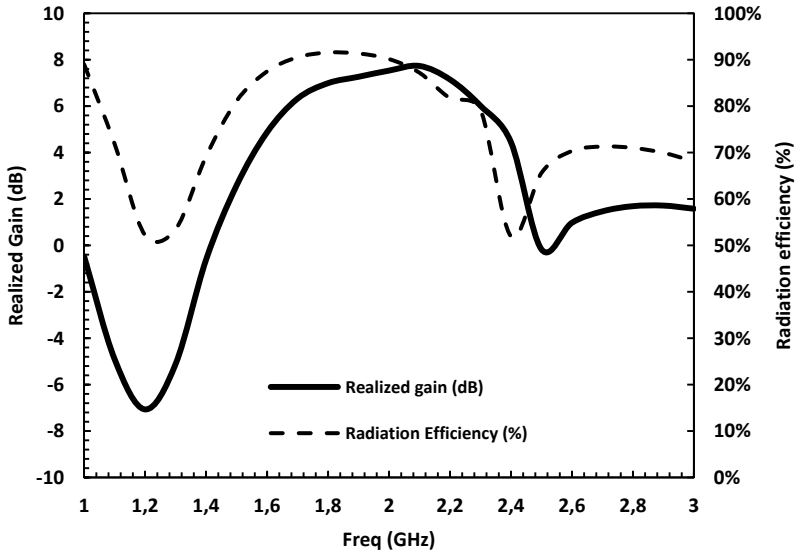


Figure.4 *Simulated realized gain and radiation efficiency.*

4. CONCLUSIONS

In this paper, a high gain /high efficiency textile Yagi antenna at 1.8 GHz has been presented in order to evaluate his feasibility on RF energy harvesting system. The antenna consists of a three element Yagi antenna located on jeans fabrics. The results show a good correlation between simulation and measurement. A gain higher than 6.32 dB with radiation efficiency higher than 90.52 % is obtained in the entire operation frequency band. These values demonstrate the feasibility to use textile Yagi antenna on RF energy harvesting applications.

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REFERENCES

1. L. M. Castano and A. B. Flatau, "Smart fabric sensors and e-textile technologies: a review," Smart Mater. Struct., vol. 23, no. 5, p. 53001, May 2014.
2. J.-S. Roh, "Textile touch sensors for wearable and ubiquitous interfaces," Text. Res. J., vol. 84, no. 7, pp. 739–750, Nov. 2013.
3. J.-Y. Kim, S.-J. Ha, D. Kim, B. Lee, and C. W. Jung, "Reconfigurable beam steering antenna using U-slot fabric patch for wrist-wearable applications," J. Electromagn. Waves Appl., vol. 26, no. 11–12, pp. 1545–1553, Aug. 2012.
4. T. Acti, A. Chauraya, S. Zhang, W. G. Whittow, R. Seager, J. C. Vardaxoglou, and T. Dias, "Embroidered wire dipole antennas using novel copper yarns," IEEE Antennas Wirel. Propag. Lett., vol. 14, pp. 638–641, 2015.
5. G. Monti, L. Tarricone, and M. Spartano, "X-Band Planar Rectenna," vol. 10, pp. 1116–1119, 2011.
6. N. Chahat, M. Zhadobov, and R. Sauleau, "Yagi-Uda Textile Antenna for On-Body Communications At 60 GHz," vol. 1, pp. 2012–2014, 2013.
7. G. Monti, L. Corchia, and L. Tarricone, "UHF Wearable Rectenna on Textile Materials," IEEE Trans. Antennas Propag., vol. 61, no. 7, pp. 3869–3873, Jul. 2013.