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CITE THIS ARTICLE

Chuma, Euclides Lourenço, Iano, Yuzo, Pajuelo, Diego, de Oliveira, Gabriel Gomes; 2019. Design of Ultra wideband Textile Antenna for TV Broadcasting. SET INTERNATIONAL JOURNAL OF BROADCAST ENGINEERING. ISSN Print: 2446-9246 ISSN Online: 2446-9432. doi: 10.18580/setijbe.2019.9. Web Link: http://dx.doi.org/10.18580/setijbe.2019.9

Design of Ultra-wideband Textile Antenna for TV Broadcasting

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Abstract—**Digital television (DTV) has been adopted in many places throughout the world, and it is received in different device types, such as laptops, portable media players, and smartphones. However, the current antennas used in these devices to receive DTV channels have drawbacks, such as low performance and non-practical physical structure in many situations.**

This paper presents a flexible, lightweight, and thin textile antenna for DTV, operating at an ultra-wideband (UWB) of 200 MHz–800 MHz and capable of being embedded in a garment or bag, making it easily transportable when folded. The antenna operation was simulated and measured to verify its performance, and based on the measurement results, the proposed flexible textile antenna was confirmed to have good performance, even in real conditions.

Index Terms— **antenna, microstrip, TV, textile**

I. Introduction

ANTENNAS are essential parts of television broadcasting systems. Integrating them into portable receivers is very challenging, mainly because of their dimensions and rigid structure. Therefore, a new generation of flexible and lightweight antennas integrated into garments or bags should be developed [1, 2].

This article proposes a flexible, lightweight, and thin textile antenna applied to broadcasting receivers and operating at an ultra-wideband (UWB) of 200 MHz–800 MHz to be embedded into portable devices. The antennas can be easily transported when folded or integrated into the physical structure of a large-format television (i.e., back cover).

The proposed antenna could be used as part of smart clothing [2, 3, 4, 5, 6, 7, 8], which has received so much attention due to the high interest in wearable electronics connected in a large network with other devices through the Internet of Things (IoT) [9, 10, 11, 12].

This paragraph of the first footnote will contain the date on which you submitted your paper for review. It will also contain support information, including sponsor and financial support acknowledgment. For example, "This work was supported in part by the U.S. Department of Commerce under Grant BS123456".

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II. Antenna Design

The proposed antenna uses a log-periodic structure, which is a member of structures known as frequency-independent antennas; these antennas have been studied for more than five decades [13, 14, 15, 16, 17] and are still relevant because of their ability to maintain quasi-frequency-independent characteristics over a wide band of frequencies [18, 19, 20].

The log-periodic antennas have a very large bandwidth, with a reasonable gain, making them an excellent candidate for UWB systems. Therefore, because of these features, log-periodic antennas have been used for low-cost applications and a great broadband coverage.

The antenna structure shown in Fig. 1 is a planar log-periodic antenna proposed by DuHamel [13]. In the antenna, R_1 = 331.1 mm, R_2 = 215.2 mm, ⊠= 0.65, ⊠ = 0.81, ⊠ = 45º, ⊠ = 45º, and port gap width = 20 mm.

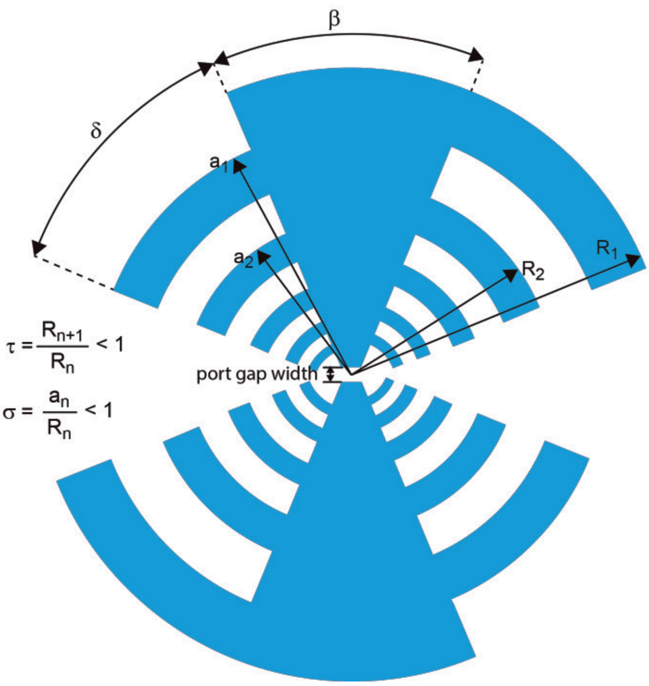

Fig. 1. Geometry structure of planar log-periodic antenna.

The substrate material is a polyester clothing with relative permittivity ⊠ = 3.2 and thickness of 0.15 mm. The conductor material used in the patch is a conductive fabric composed of 50% polyester and 50% silver-plated woven, as can be seen in Fig. 2.

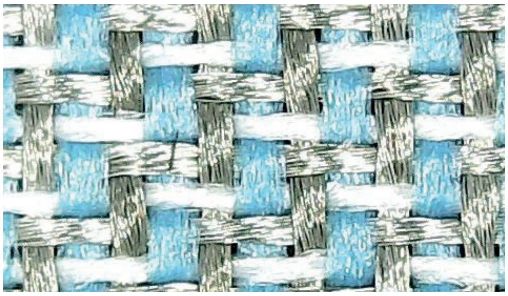

Fig. 2. Close-up image of the conductive textile used in the patch of the microstrip log-periodic antenna.

The structure of the conductive textile directly affects the surface resistivity. If the conductive paths in the woven are better aligned with the current direction, there will be less conductive loss [21, 22]. It is also important to mention that elongation and/or compression of the textile decreases the geometric precision of the antenna shape and changes the antenna features, such as the resonance frequency and directivity gain [23].

The initial dimensions of the microstrip log-periodic antenna were calculated. Then, simulations were performed using the full-wave simulator ANSYS HFSS to obtain the most optimized antenna dimensions for operations between 200 MHz and 800 MHz.

Figure 3 shows the model built in the simulator software and the simulated 3D radiation pattern. The simulation with a perfect electric conductor (PEC) presented an antenna gain of ~5.7 dB.

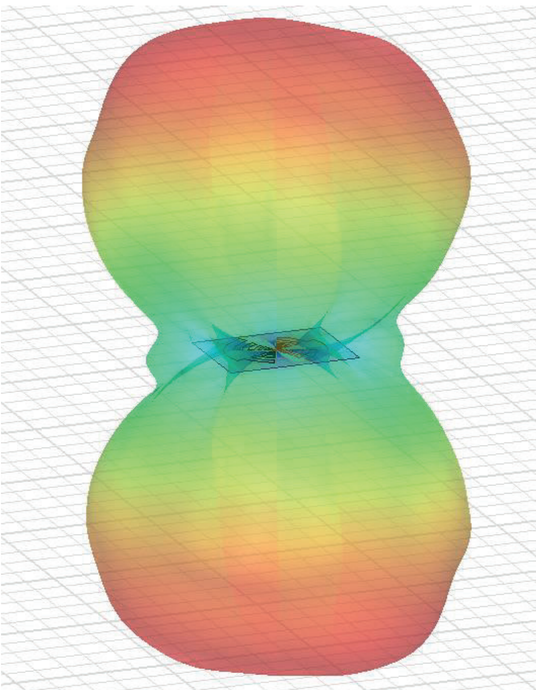

Fig. 3. Simulated 3D radiation pattern.

III. Measurements and Results

A prototype of the antenna was manufactured. The conductive textiles patches were cut and fixed into the polyester clothing substrate by sewing. Figure 4 shows the antenna prototype.

Fig. 4. Fabricated prototype of the antenna.

The performance of the antenna prototype was measured using a vector network analyzer (VNA) in order to obtain the S-parameters, as shown in Fig. 5.

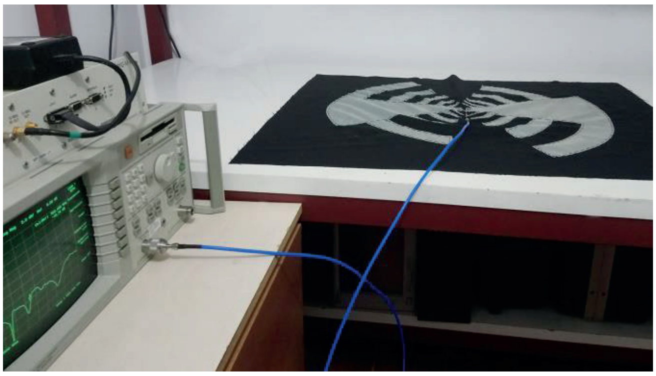

Fig. 5. Antenna measurement with VNA.

Figure 6 shows the antenna scattering parameters (S_{11}) according to the VNA measurement results and the electromagnetic simulation results.

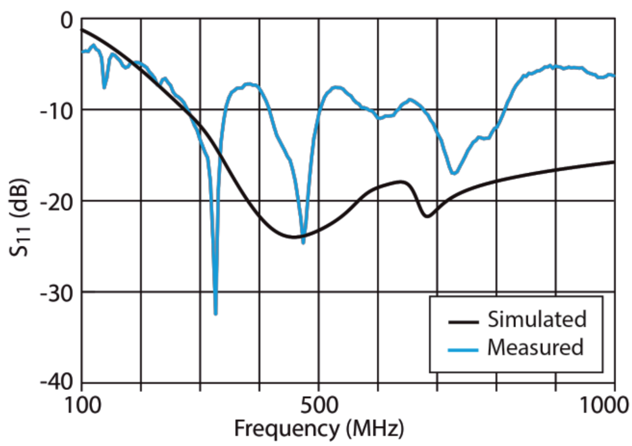

Fig. 6. Comparison of measured and simulated scattering parameters (S_{11}) of antenna.

http://www.set.org.br/ijbe/ doi: 10.18580/setijbe.2019.9 Web Link: http://dx.doi.org/10.18580/setijbe.2019.9

The measurements show an operating band for the antenna between 200 MHz and 800 MHz. Figure 7 shows the reception of channel television. A balun matching transformer is used for practical conditions.

Fig. 7. Proposed antenna working with television.

The proposed antenna can be carried by the user and folded so that it occupies very little space. Figure 8 shows the prototype of the folded antenna.

Fig. 7. Folded antenna.

IV. Conclusions

This work developed and tested a textile UWB microstrip log-periodic antenna to be able to operate over a frequency range of 200 MHZ–800 MHz. The proposed antenna is simple to manufacture and exhibits good flexibility. This paper presents a proven qualitative agreement between the experimental results and the numerical simulations. The differences are because PEC materials were used in the simulation models.

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Received in 2019-07-07 | Approved in 2019-11-25