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Wideband Wearable Patch Antenna for 5.6 GHz Wireless Applications

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Abstract: A wearablemicrostrippatch antenna for 5.6 GHz for wireless communication systems is presented. Cotton substrate with 3 mm of high and 1.5 of relative permittivity has been considered for the patch antenna. The available band reached by the patch antenna is 1.12 GHz, from 5.24 GHz to 6.36 GHz. The antenna has an omnidirectional radiation pattern.

Key words: Patch antenna · Wearable antenna · 5.6 GHz applications

INTRODUCTION

Many wireless standards operate on the 5.6 GHz frequency band. One is IEEE 802.11a Wireless Local Area Network (WLAN) with band frequencies 5.15-5.35 GHz and 5.725-5.825 GHz. Also, WiMAX (Worldwide Interoperability for Microwave Access) standards is the sixth new standard, so called IMT-2000 OFDMA TDD WMAN, to be admitted to the family of IMT-2000 radio interface specifications, is intended to obtain the same worldwidedistribution for Internet as that reached or current mobile-phone communications [1, 2]. Some WiMAX applications uses 5.6 GHz central frequency band, like Unlicensed National Information Structure (U-NII) with two band frequencies 5.15-5.35 GHz and 5.725-5.825 GHz, HiperLAN outdoor and indoor operations with band frequencies 5.15-5.35 and 5.470-5.725, respectively.

WLAN networks have a smaller service area than WiMAX networks. Currently, WiMAX technology is expected to provide high-capacity service in the Internet connection, even greater than currently achieved by mobile phone communication. Today, the scientific, technical and industrial community offers proposals in the research and manufacture of WiMAX devices for indoor and outdoor communication with wireless broadband service. For example, [2] proposes its antenna design for WiMAX terminals conformed by electronically coupled patches, achieving notable gain values and wide bandwidths.

Wearable Patch Antennas: Portable microstrip antennas in garments are widely used in wireless applications. Current mobile devices, such as laptops and smart cell phones, can use external patch antennas installed in garments and improve their connectivity to the Internet through technologies such as WLAN and WMAN networks. This type of patch antennas are intended for military, medical and sports applications. There are interesting proposals for microstrip antennas for garments, designed to meet stability in frequency of operation and bandwidth, compaction, light weight and good performance in gain and loss of return.

A rectangular patch antenna with an "L" aperture with good performance for the frequency bands of 2.4 GHz, from 2.25 GHz to 2.74 GHz and 5.6 GHz, from 4.3 GHz to 6.8 GHz, have been proposed by [6]. These designs were developed to operate in WLAN and WiMAX frequency bands.The substrates used in its design are polyester and cotton jeans in two different types of materials, conductive textiles (Electro-textiles) that are Pure Copper Polyester Taffeta and Zelt Fabrics. The directivity responses using cotton jeans with pure copper as substrate in the patch antenna reach 2.67 dBi and 3.68 dBi, for the frequencies 2.4 GHz and 5.8 GHz, respectively. A dual-band patch antenna is proposed by [7] for the 2.4 GHz and 5.2 GHz frequency bands, with maximum gains of 2.0 dBi and 1.74 dBi, respectively.

The proposed wearable patch antenna of this article operates at the frequency of 5.6 Ghz.

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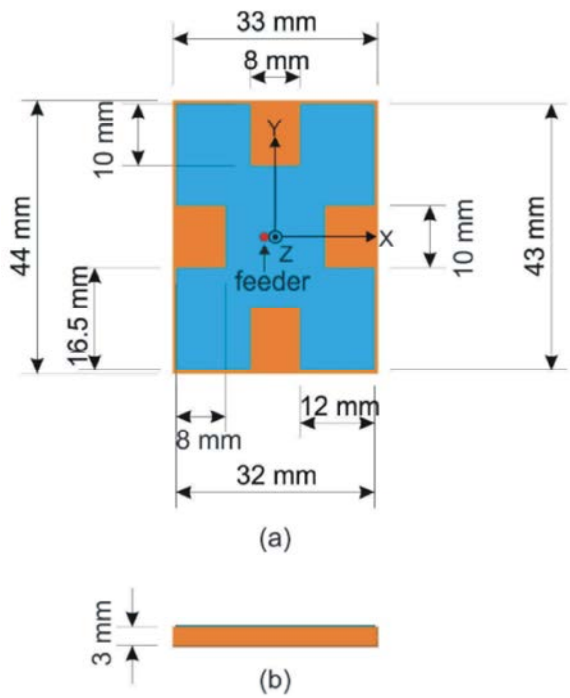

Fig. 1: Patch geometry (a) top and (b) side view

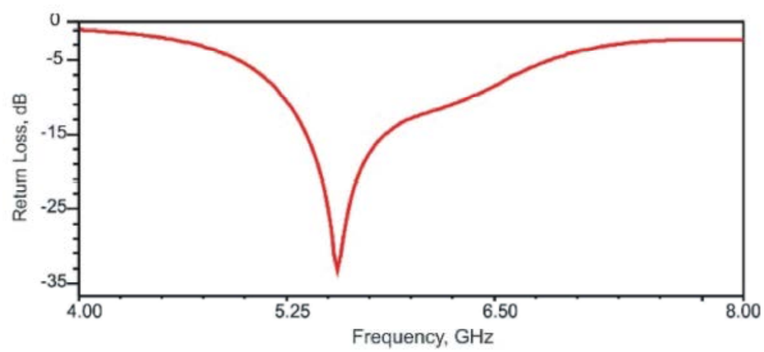

Fig. 2: Return loss S_{11} of the path antenna with cotton and jeans cotton substrate

Wearable Antenna Applications: Systems with portable antennas are considered part of the Wireless Body Area Networks (WBAN) and have several fields of applications, such as search, tracking, navigation, medical services, military, rescues, national defense, portable computing, sports, entertainment, etc. The frequencies assigned for the WBAN systems are 400 MHz for the Communication System in Medical Implants, 2.4 GHz and 5.8 GHz for Industrial, Scientific and Medical (ISM) applications and from 3 GHz to 10 GHz for the Ultra Wide Band services (UWB). The main requirements of WBAN systems are: compact transceivers, minimum power consumption, optimization for use in people, miniaturization, omnidirectional radiation pattern, tuning to counteract effects introduced by the human body [3-5].

Antenna Structure: Thepatch antenna designed for the 5.6 GHz frequency is shown in Figure 1. Four slots were made on the sides of the rectangular patch in order to reach the resonant frequency. The cotton substrate parametersare: 1.5 of relative permittivity, 3 mm of high and 0.025 of dielectric loss tangent.The feeding location is 1.8 mm in the direction of the semiaxis "-X", in the line "y"equal to zero. The connector type of the feeder port must be SMA coaxial, with internal conductor diameter equal to 1.4 mm and external conductor diameter equal to 3.4 mm.

Figure 2 shows the estimatedreturn loss for the patch. The resonant frequency is at 5.56 GHz.

The E and H-Plane electromagnetic radiation fields are presented in Figure 3.

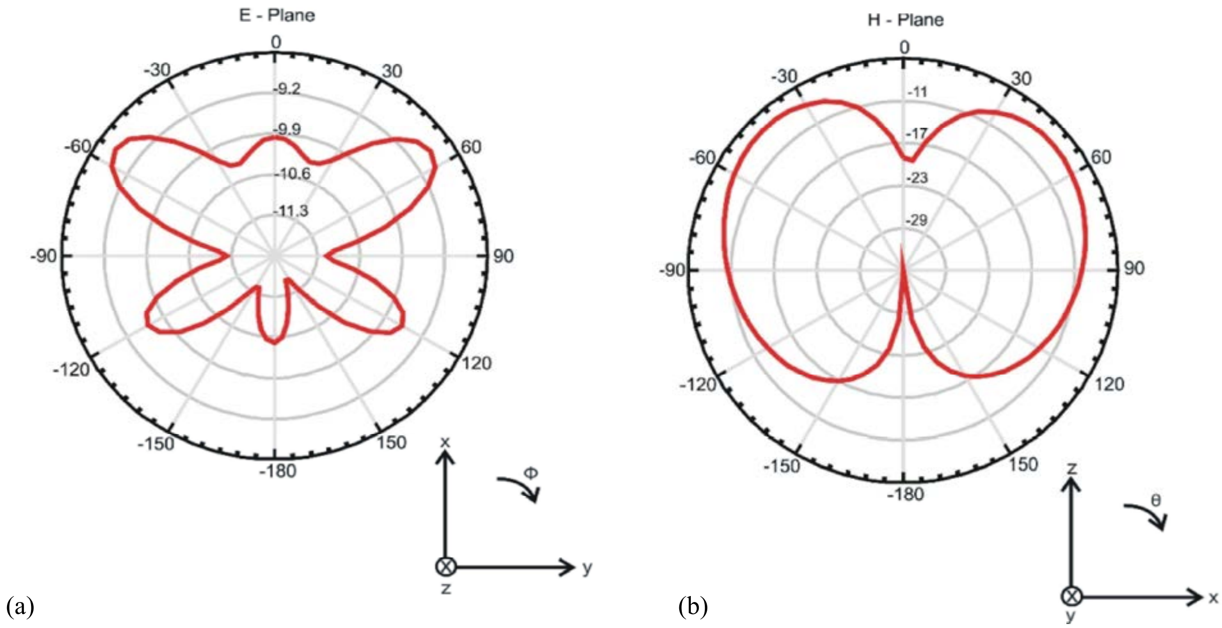

Fig. 2: (a) E and (b) H-Plane radiation

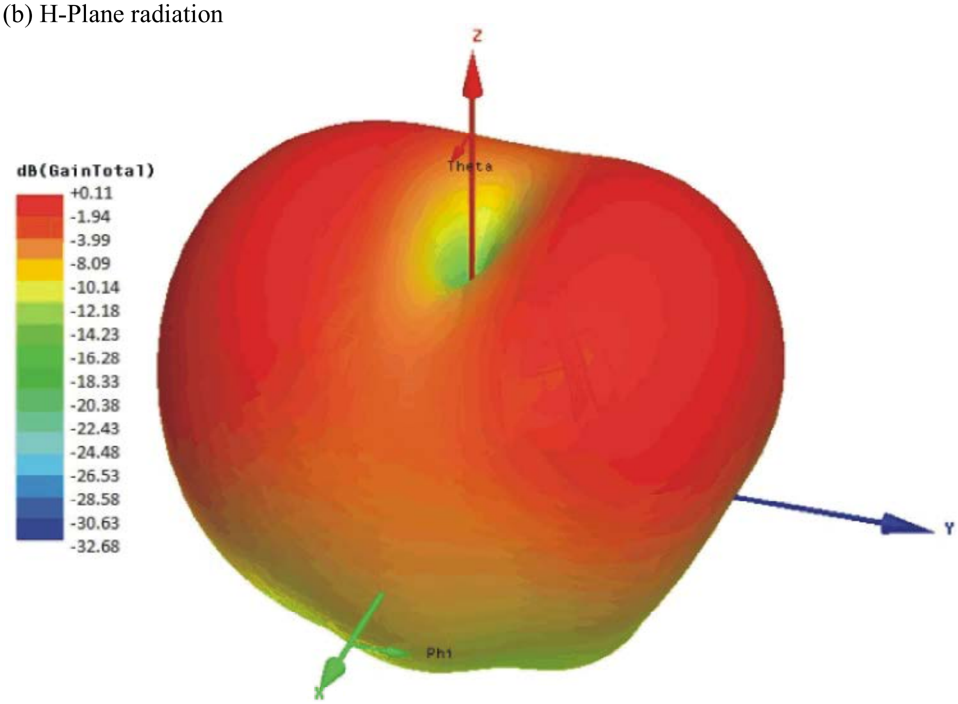

Fig. 3: 3D radiation pattern

Figure 3 shows the radiation pattern in 3D.

CONCLUSIONS

A Wideband wearable patch antenna for 5.6 GHz Wireless applications has been designed. The substrate material considered for the patch antenna is cotton. The bandwidth provided by the patch antenna for the modulated carrier signals of 5.6 GHz, like WiMax technology, is 1.12 GHz. The E and H –plane radiations are presented. The antenna has omnidirectional radiation pattern in H-plane having its radiation pattern very similar to an electric monopole. The simulated maximum gain reaches 0.1 dB.

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