Review on Compact Microstrip Antennas: Multiband, Wideband and UWB Applications

K. Djafri, F. Mouhouche, F. Guichi and F. Fertas

Abstract—The compact microstrip antennas that combine different applications is a vital topic of current research. From the work done in past few years, the call for multiband, wideband and ultra-wideband (UWB) antennas for wireless applications have increased exceptionally. In this review article, each design approach for modeling multiband, wideband and UWB antennas is discussed and compared. The photographs of the fabricated antenna prototypes and antenna parameters are as well presented.

Index Terms—Microstrip patch antenna (MPA), Multiband, WLAN, WiMAX, HiperLAN, C band, ITU, X band, Wideband, UWB.

1 Introduction

VARIOUS microstrip patch antennas (MPAs) for different function already exist, however the desire of excelling in this area has no end. MPAs have naturally a narrow bandwidth, and bandwidth improvement is generally required for practical applications [1]–[12]. Furthermore, most applications in present-day commonly require smaller antenna size so that to meet the miniaturization requirements. Therefore, bandwidth improvement and size reduction are becoming main design considerations of MPAs for practical applications. For this reason, miniaturized MPAs with narrow and wide bands operations for multiple services are in huge demand [1]–[12].

In the literature, several methods have been projected for the designing of miniaturized microstrip antennas for many applications such as wireless local area network (WLAN: 2.4–3.6–5.5GHz), worldwide interoperability for microwave access (WiMAX: 3.3–3.69GHz), high performance radio local area network (HiperLAN: 5.15–5.30GHz), C-band (4–8GHz), international telecommunication union (ITU: 8–8.5GHz), , X-band (8–12GHz) and ultra-wideband (UWB: 3.1–10.6GHz).

This article reviews and discusses some research design techniques to design of MPAs for better performance presented by many research articles. A simple procedure employed by researchers is etching slots on the radiating element or on microstrip feeding line or on ground plane. Several MPAs have been achieved by using this technique since the slots of various shapes influence the surface current paths and therefore causes diverse modes at the resonant frequencies [2]–[5], [8], [12].

2 Literature Survey

All the physical prototypes of the presented antennas were fabricated on an FR-4 dielectric substrate (relative permittivity of 4.3, height of 1.62 mm, and loss tangent of 0.017), and measured by a Rohde & Schwarz ZNB vector network analyzer (VNA) operating in the 100kHz–20GHz frequency band.

The procedure of using concentric fractal radiating rings fed with a Y-shaped microstrip line was reported in [4] as shown in Fig. 1. This technique permits to obtain a miniaturized antenna which operates at two resonant frequency bands to cover 2.45GHz and 4.2GHz, with overall size of $9.3 \times 17\text{mm}^2$, for wireless communication systems.

In [6], the authors have presented a small asymmetric coplanar strip (ACS) fed tri-band microstrip monopole antenna for WLAN and WiMAX applications as depicted

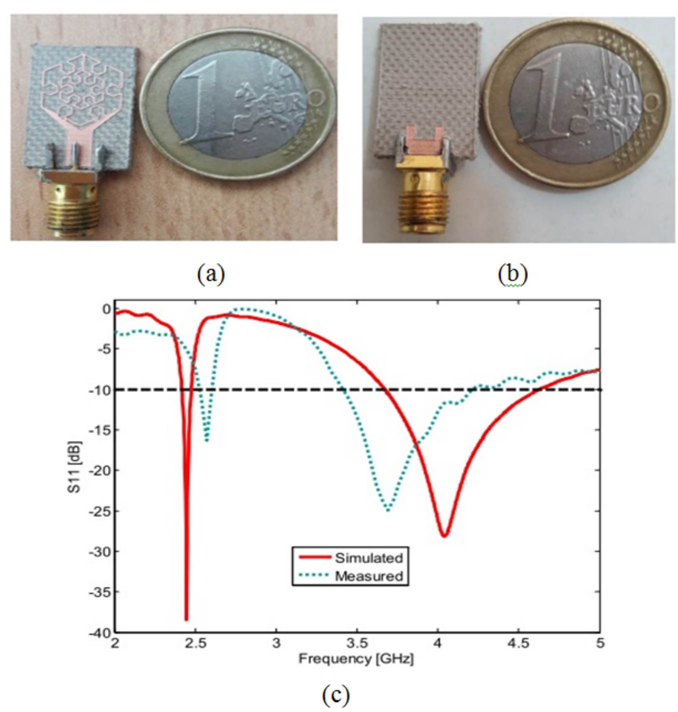

Fig. 1. Photograph of the fabricated compact dual-band antenna prototype and antenna parameters [4]. (a) Top view, (b) Bottom view and, (c) Comparison between simulation and measurement of the input reflection coefficients.

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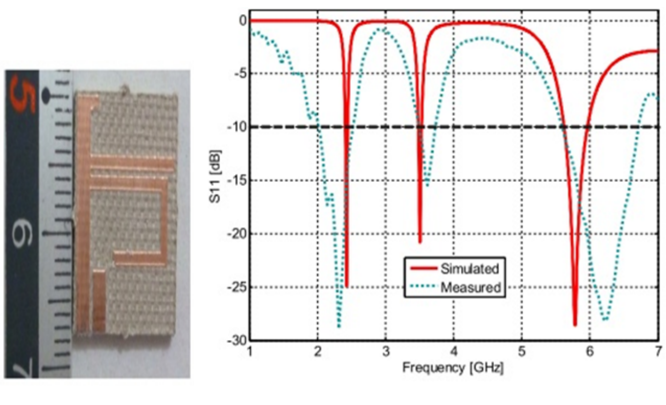
in Fig. 2. The proposed antenna is based on exiting strip connected to two different arms (J-shaped directed toward the asymmetric ground plane and an open stub). This method allows achieving an antenna, with a total size of $14.6 \times 17.5\text{mm}^2$, which operates at three distinct resonant frequencies at 2.45GHz, 3.5GHz and 5.8GHz.

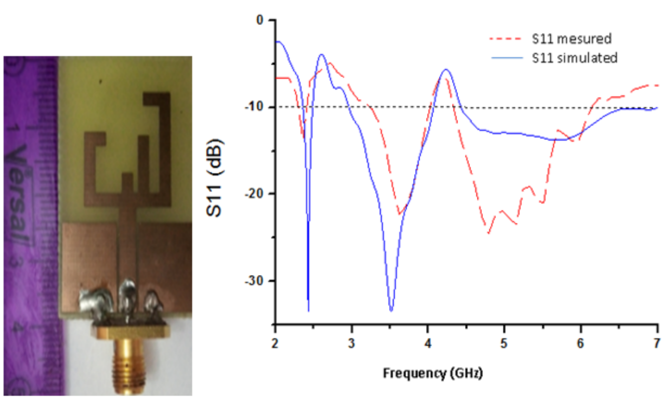
Another simple technique based on a modified rectangular patch element fed by a CPW technique for WiFi, WiMAX and HiperLAN was proposed in [7] as illustrated in Fig. 3. The proposed antenna has a small size and provides triple narrow and wide operating bands.

For quadruple-band applications, a novel microstrip antenna for WLAN, WiMAX, C and X bands applications was proposed in [8] as shown in Fig. 4. This antenna type is based on a modified rectangular patch antenna with U-shaped DGS unit and two parasitic elements. The presented antenna, with a total size of $31 \times 33\text{mm}^2$, covers the 4.4–4.58GHz, 5.4–5.6GHz, 7.2–8.3GHz and 9.6–10.3GHz bands which are mainly suitable for a variety of communication systems.



(a) (b)

Fig. 2. Photograph of the fabricated tri-band antenna prototype and antenna parameters [6]. (a) Top view and, (b) Comparison between simulation and measurement of the input reflection coefficients.



(a) (b)

Fig. 3. Photograph of the fabricated tri-band antenna prototype and antenna parameters [7] (a) Tope view and, (b) Comparison between simulation and measurement of the input reflection coefficients.

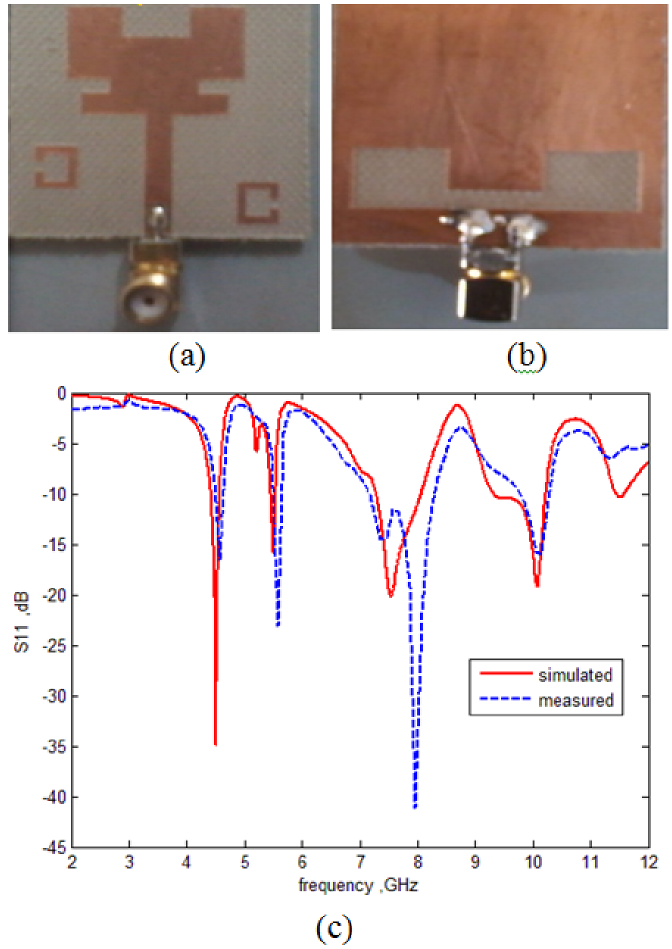


Fig. 4. Photograph of the fabricated quadruple-band antenna prototype and antenna parameters [8]. (a) Top view, (b) Bottom view and, (c) Comparison between simulation and measurement of the input reflection coefficients.

Concerning the UWB applications, an UWB microstrip patch antenna, based on a modified circular-shaped patch antenna and semicircular finite ground plane, was reported in [10] as depicted in Fig. 5. The antenna is operating over the frequency band between 3.0–14.6GHz with small size of $23 \times 28\text{mm}^2$. These results make the proposed antenna, with low cost manufacturing, very suitable for modern wireless communication systems.

An additional type of UWB antenna with dual band notch characteristics of $23 \times 32\text{mm}^2$ overall size was proposed in [12] as depicted in Fig. 6. The antenna is composed of a V-shaped patch with a stair case defect fed by a 50 Ohm microstrip line and a semicircular defected ground plane printed, respectively, on the top and bottom layer of the substrate. The dual band-notch function at WiMAX (3.17–3.85GHz) and ITU (7.9–9.1GHz) bands were achieved using two parasitic stubs and an inverted U-shaped slot etched on the transmission line, respectively.

The literature survey for multiband, wideband and UWB antennas is summarized in Table 1.

TABLE 1
Literature survey for multiband, wideband and UWB antennas.

Ref.	Technique	Result	Drawback
[4]	Dual concentric hexagonal rings connected to each other fed with a Y-shaped icrostrip line	A dual-band operation as well as antenna miniaturization for wireless applications is proposed	Complexity in designing the patch with not controllable bands
[6]	The feeding strip of the antenna connected to two different arms (J-shaped directed toward the asymmetric ground plane and an open stub)	An ACS-Fed tri-band microstrip monopole antenna for WLAN and WiMAX is introduced.	Not controllable bands
[7]	Modified rectangular patch element fed by a CPW technique	A CPW-Fed triple-band microstrip antenna for WLAN, WiMAX and HiperLAN standards is presented	
[8]	Modified rectangular patch antenna with a U-shaped DGS unit and two parasitic elements	A quadruple-band monopole antenna for WLAN, WiMAX, C and X bands applications is proposed	
[10]	Modified circular-shaped patch antenna with a stair case defect and a semicircular finite ground plane	An UWB microstrip antenna is presented	Complexity in designing the patch
[12]	V-shaped patch with a stair case defect, two parasitic stubs, an inverted U-shaped slot etched on the transmission line and a semicircular defected ground plane.	An UWB monopole antenna with dual band notch characteristics is introduced.	

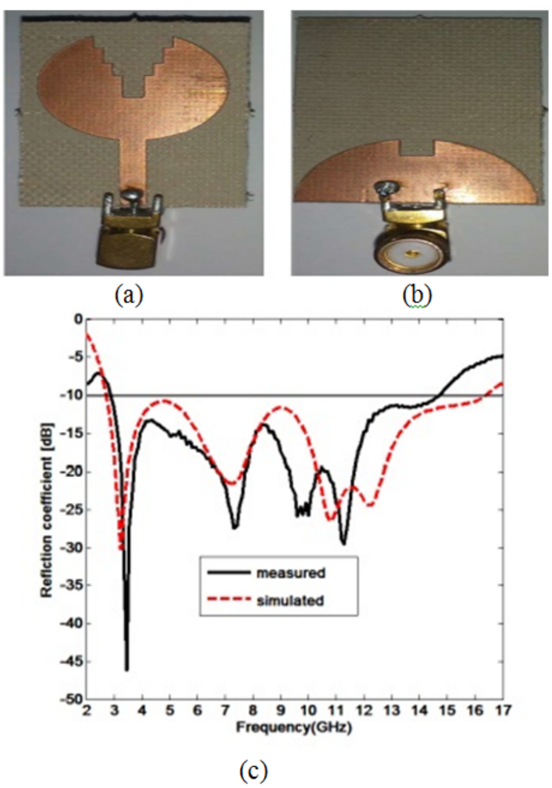


Fig. 5. Photograph of the fabricated UWB antenna prototype and antenna parameters [10]. (a) Top view, (b) Bottom view and, (c) Comparison between simulation and measurement of the input reflection coefficients.

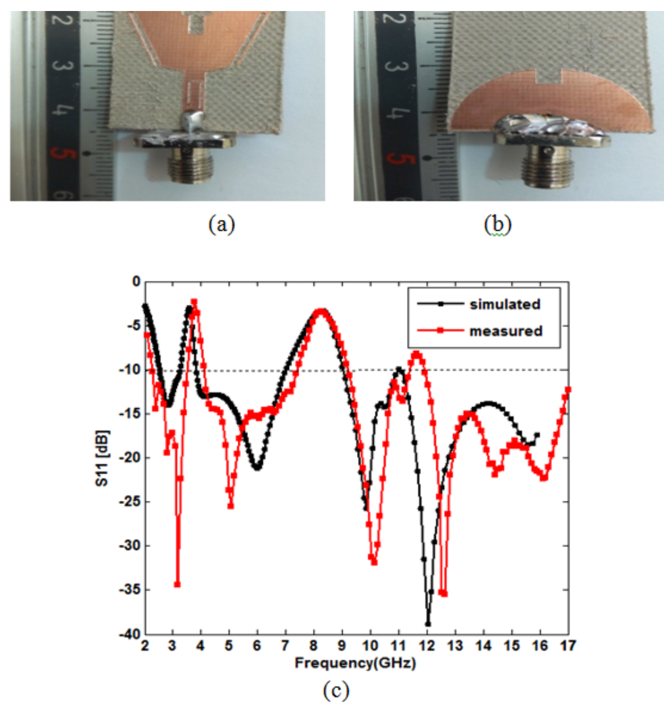


Fig. 6. Photograph of the fabricated UWB antenna dual band notch characteristics and antenna parameters [12]. (a) Top view, (b) Bottom view and, (c) Comparison between simulation and measurement of the input reflection coefficients t-name.

3 Conclusion

This review article has only briefly touched some significant techniques related to multiband, wideband and UWB MPAs designs. Designing an MPA with low profile, small size, better performance, ease of fabrication and low cost, for specific applications is a very fruitful research area and this article reviews on newest advances and developments in this area. It has been shown that each design technique has its own specificity and all proposed antennas confirmed their applications in modern communication systems.

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