

# Broadband Triangle Shape Printed Antenna for Mobile Wireless Communication

T. Alam, M.R.I. Faruque and M.T. Islam

**Abstract** In this paper, a broadband antenna for mobile wireless communication is presented and experimentally investigated. The proposed antenna is incorporated with triangle shape radiator and defected ground. The main radiator is connected with  $50\ \Omega$  microstrip feed line. The antenna has achieved measured VSWR  $\leq 2$  impedance bandwidth of 1.05 GHz (1.66–2.71 GHz) and 1.42 GHz (3.28–4.7 GHz), which cover GSM 1800, 1900, 2100, UMTS, Bluetooth (2.40–2.80 GHz), WLAN (2.40–2.485 GHz), WiMAX (2.50–2.69 GHz), and WiMAX (3.40–3.60 GHz). Moreover, the antenna has shown good antenna performances with stable radiation pattern and appreciable gain.

## 1 Introduction

Recently, along with rapid advancement of wireless technology wideband compact antenna for lower frequency bands become a challenging issues to the antenna researchers. Microstrip feed printed antennas has become most studied structure due to its some interesting features, like low cost, compact, lightweight, easy fabrication and installation.

Many low-cost small antennas have been investigated over the last decade [1, 2]. However, the appeal of wideband antenna is becoming robust as today mobile

---

T. Alam (✉) · M.R.I. Faruque  
Space Science Centre (ANGKASA), Universiti Kebangsaan Malaysia,  
43600 UKM Bangi, Selangor, Malaysia  
e-mail: touhid13@yahoo.com

M.R.I. Faruque  
e-mail: rashed@ukm.edu.my

M.T. Islam  
Department of Electrical, Electronic & System Engineering, Universiti Kebangsaan Malaysia,  
43600 UKM Bangi, Selangor, Malaysia  
e-mail: tariqul@ukm.edu.my

wireless devices are needed to have the function of multi-standard operations. Li et al. proposed a broadband planar antenna which achieved 40 % impedance bandwidth (VSWR < 2) with antenna size of  $18 \times 69 \text{ mm}^2$  [3]. Alam et al. proposed parasitic element loaded antenna for mobile wireless antenna which can cover GSM 1800, GSM 1900, GSM 2100, UMTS, Bluetooth (2.40–2.80 GHz), WLAN (2.40–2.485 GHz), WiMAX (2.50–2.69 GHz), and WiMAX (3.40–3.60 GHz). However, the antenna dimension was  $50 \times 62.9 \text{ mm}^2$  [4]. Montero et al. proposed a coplanar hybrid antenna having size of  $56 \times 24 \times 6 \text{ mm}^3$  for GSM 1800, PCS 1900, UMTS 2100, WLAN 2450/5200 applications [5]. Spline-shaped ultra wideband antenna for mobile application is presented in [6], which can operate at DCS 1800, the PCS 1900, the UMTS (1920–2170 MHz), and the ISM (2400–2485 MHz) bands. Though, the antenna was  $51.2 \times 60 \text{ mm}^2$ . Dual arm structure antenna is illustrated for DCS, PCS, UMTS and WLAN application in [7] with physical size of  $119 \times 50 \text{ mm}^2$ .

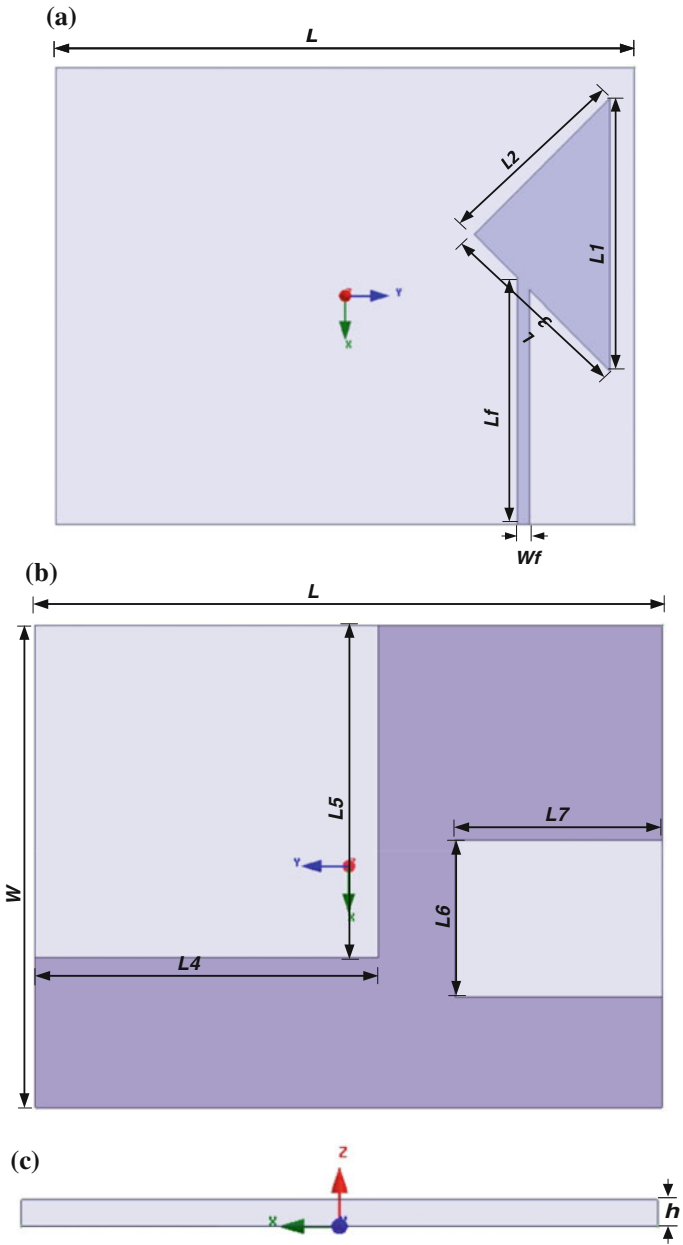
In this communication, a new broadband triangle shape antenna is illustrated for handheld devices, which can operate at GSM 1800, GSM 1900, GSM 2100, UMTS, Bluetooth (2.40–2.80 GHz), WLAN (2.40–2.485 GHz), WiMAX (2.50–2.69 GHz), and WiMAX (3.40–3.60 GHz). The physical dimension of the presented antenna is  $37 \times 47 \times 1.6 \text{ mm}^3$ , which is compact than reported antennas. The antenna performances has been analyzed and experimentally validated. Additionally, the electromagnetic absorption rate of the proposed antenna has been investigated.

## 2 Antenna Design

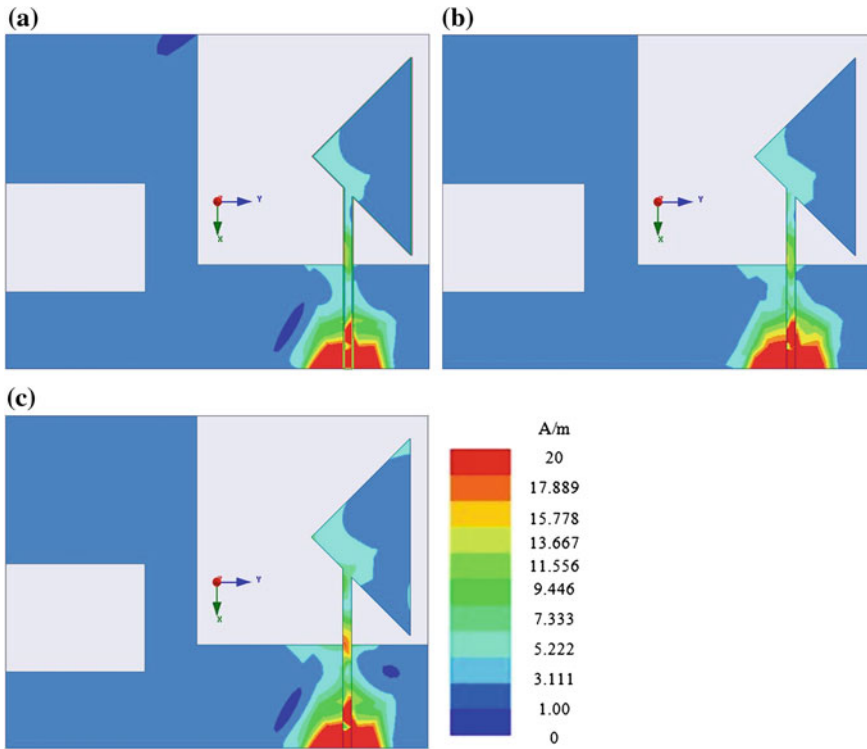
The geometric layout of the suggested antenna is depicted in Fig. 1, which is printed on low cost FR4 substrate material of  $37 \times 47 \times 1.6 \text{ mm}^3$ . The proposed antenna assimilated with inverted C-shaped ground plane and a triangular shape radiator. A  $50 \Omega$  microstrip feeding line is connected with prime radiator. The presented antenna parameters are:  $L = 47 \text{ mm}$ ,  $W = 37 \text{ mm}$ ,  $Wf = 1 \text{ mm}$ ,  $Lf = 20 \text{ mm}$ ,  $L1 = 22 \text{ mm}$ ,  $L2 = 15.55 \text{ mm}$ ,  $L3 = 15.55 \text{ mm}$ ,  $L4 = 25.75 \text{ mm}$ ,  $L5 = 24.5 \text{ mm}$ ,  $L6 = 12 \text{ mm}$ ,  $L7 = 15.5 \text{ mm}$  and  $h = 1.6 \text{ mm}$ .

## 3 Result and Discussions

The proposed antenna prototype has been fabricated and experimentally validate with measured one. The design and simulation of the proposed antenna have been performed by using the commercially available CST microwave studio and Ansoft high-frequency structure simulator (HFSS) software. The VSWR measurement has been performed using an Agilent TE8362C network analyzer. The surface current distribution of the presented antenna is presented in Fig. 2. It is shown from Fig. 2



**Fig. 1** Geometric layout of the presented antenna. **a** Top view, **b** bottom view, **c** side view



**Fig. 2** Surface Current distribution of the presented antenna **a** At 1.8 GHz **b** At 2.4 GHz **c** At 3.6 GHz

that the maximum current flows in feed line towards triangle shape radiator. There are some leakage current near feeding port.

Moreover, the smith chart of the presented antenna is also illustrated in Fig. 3. The simulated and measured VSWR is presented in Fig. 4. It is seen that the antenna has achieved measured VSWR  $\leq 2$  impedance bandwidth of 1.05 GHz (1.66–2.71 GHz) and 1.42 GHz (3.28–4.7 GHz), which cover GSM 1800, 1900, 2100, UMTS, Bluetooth (2.40–2.80 GHz), WLAN (2.40–2.485 GHz), WiMAX (2.50–2.69 GHz), and WiMAX (3.40–3.60 GHz). From Fig. 4, it is observed that the measured and simulated VSWR are identical. The radiation pattern of the presented antenna has been demonstrated in Fig. 5. It is shown from Fig. 5 that the antenna shows nearly omnidirectional radiation pattern at E-plane. Moreover, the researchers have been analyzed specific absorption rate [8–10]. To comply with the requirement of IEEE and ICNIRP guideline, the SAR value of the presented antenna has been analyzed and presented in Fig. 6. It is observed from Fig. 6 that, the electromagnetic absorption rate fulfill the requirements of IEEE and ICNIRP guideline for the electromagnetic absorption rate.

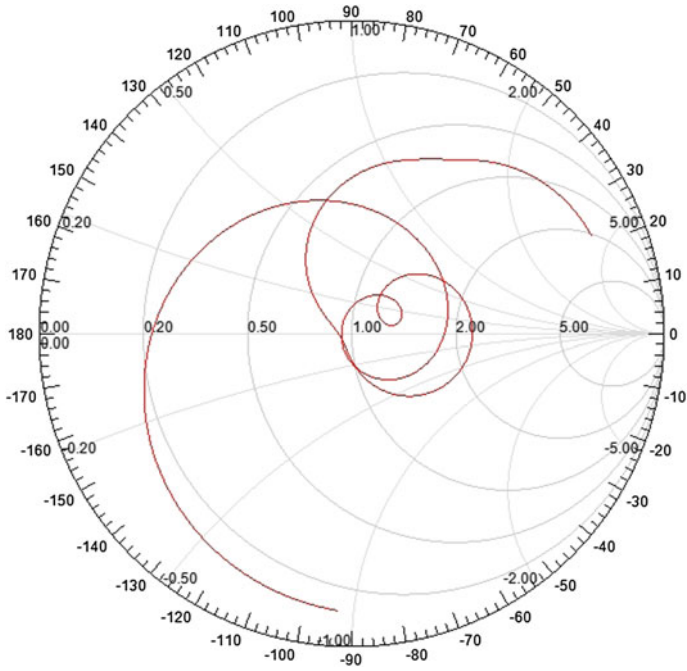
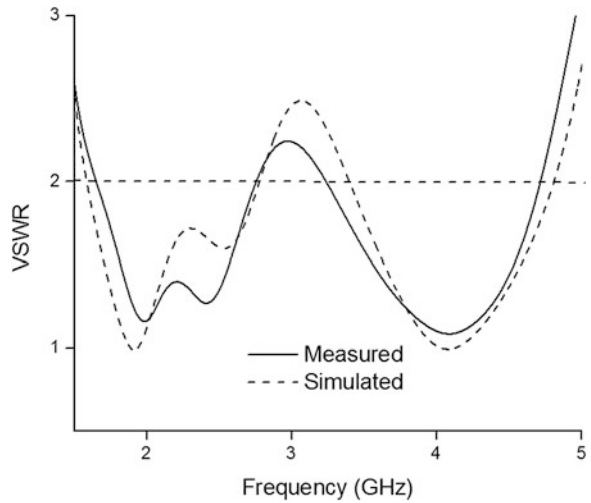


Fig. 3 Smith chart of the presented antenna

Fig. 4 Measured and simulated VSWR of the presented antenna



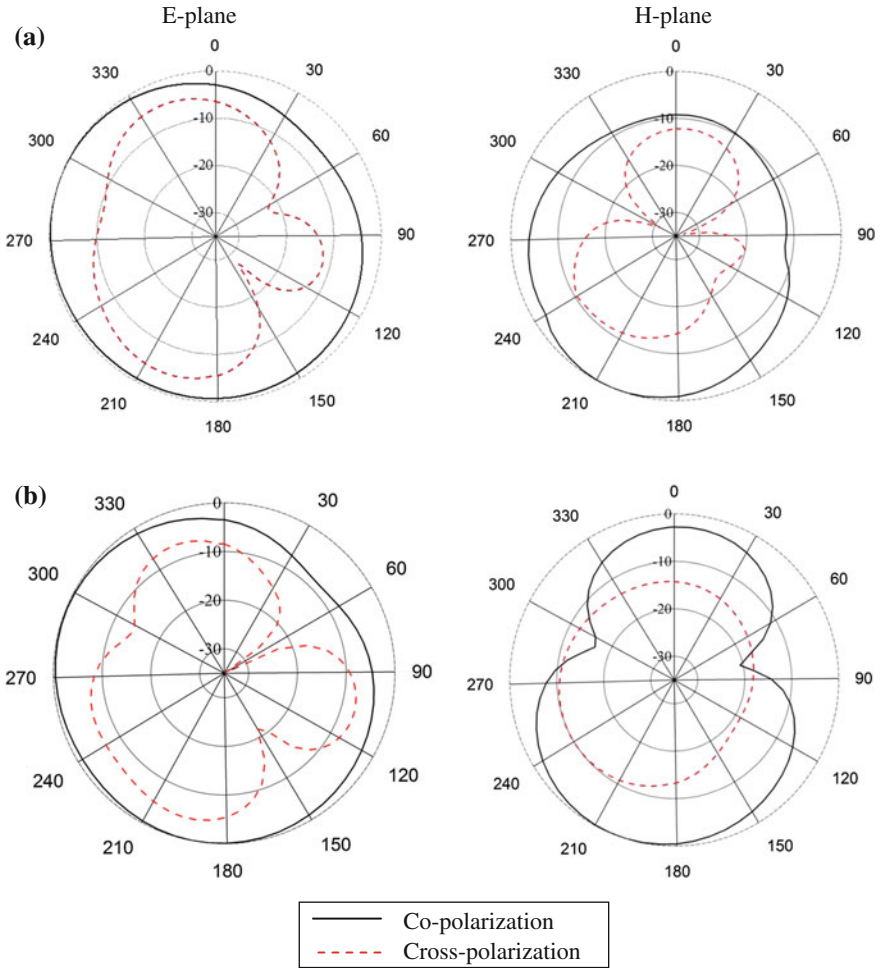
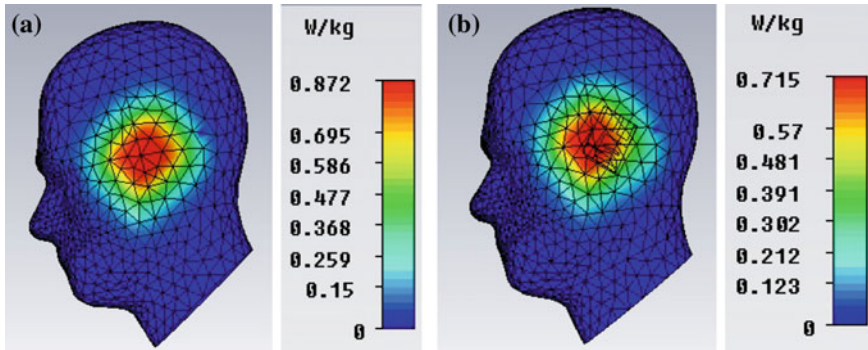


Fig. 5 Radiation pattern of the presented antenna at a 1.8 GHz and b 2.4 GHz



**Fig. 6** a 10 g SAR at 1.8 GHz, b 10 g SAR at 2.4 GHz

## 4 Conclusion

A new compact triangle shape radiator with inverted C-shape ground plane is presented for mobile wireless communication. Experimental result shows that the obtained  $VSWR \leq 2$  impedance bandwidth of 1.05 GHz (1.66–2.71 GHz) and 1.42 GHz (3.28–4.7 GHz) with compact size of  $37 \times 47 \times 1.6 \text{ mm}^3$ . So, the proposed antenna can play significant role in mobile wireless communication.

## References

1. Samsuzzaman, M., Islam, M.: Wideband hook-shaped circularly polarised antenna. *Electron. Lett.* **50**, 1043–1045 (2014)
2. Alam, T., Faruque, M.R.I., Islam, M.T.: Wideband linearly polarized printed monopole antenna for C-band. *Adv. Comput. Commun. Eng. Technol.* pp. 205
3. Li, R.L., Pan, B., Papapolymerou, J., Laskar, J., Tentzeris, M.M.: Broadband low-profile antennas for wireless applications. *IET Microwaves Antennas Propag.* **1**, 396–400 (2007)
4. Alam, T., Faruque, M.R.I., Islam, M.T.: Printed circular patch wideband antenna for wireless communication. *Informacije MIDEM* **44**, 212–217 (2014)
5. Sanchez-Montero, R., Langley, R.J., Salcedo-Sanz, S., Portilla-Figueras, J.A.: Coplanar hybrid antenna for mobile and wireless applications. *IET Microwaves Antennas Propag.* **5**, 192–199 (2011)
6. Lizzi, L., Azaro, R., Oliveri, G., Massa, A.: Printed UWB antenna operating over multiple mobile wireless standards. *IEEE Antennas Wirel. Propag. Lett.* **10**, 1429–1432 (2011)
7. Zhou, D., Abd-Alhameed, R.A., See, C.H., Alhaddad, A.G., Excell, P.S.: Compact wideband balanced antenna for mobile handsets. *Microwav. Antennas Propag. IET* **4**, 600–608 (2010)
8. Faruque, M.R., Islam, M.T.: Novel triangular metamaterial design for electromagnetic absorption reduction in human head. *Prog. Electromagnet. Res.* **141**, 463–478 2013

9. Faruque, M.R.I., Islam, M.T., Misran, N.: The study of specific absorption rate (SAR) reduction in mobile phones using materials and metamaterials. *Int. J. Phys. Sci.* **6**, 7212–7221 (2011)
10. Islam, M.T., Faruque, M.R.I., Misran, N.: Specific absorption rate analysis using metal attachment. *Informacije MIDEM* **40**, 238–240 (2010)