Low VSWR High Efficiency Ultra-Wideband Antenna for Wireless Systems Applications

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Abstract- **In this paper, a novel and compact ultra-wideband (UWB) antenna with frequency range 800MHz to 6GHz for application in UWB systems and wireless indoor coverage systems is presented. It is composed of a V-cone and a three-quarter sphere geometry, two quarter-wavelength short stubs are also used in the antenna to match the impedance, which can significantly improve the voltage standing wave ratio (VSWR) of the antenna. Details of the antenna design and measurement results are presented in order to demonstrate the performance of the proposed antenna.**

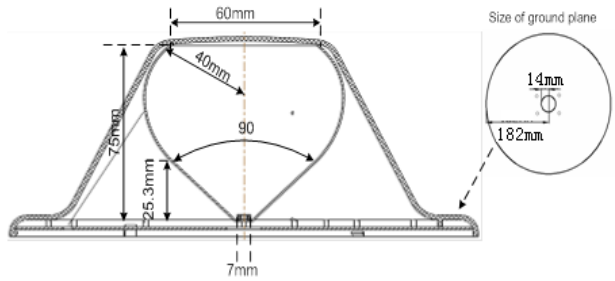
I. INTRODUCTION

The past decade has seen a phenomenal growth in wireless communications and antennas with wide bandwidth are in strong demand, so that various application are covered with fewer or preferably with a single antenna. It will be preferred that an antenna has bandwidth in exceed of frequency range from 800MHz to 11GHz or even more [1], to include all the existing wireless communication systems. To satisfy such a requirement, a variety of studies have been explored in the frequency range 3.1-10.6GHz [2-7]. However, the UWB antenna used in frequency band from 800MHz to 6000MHz is rarely reported.

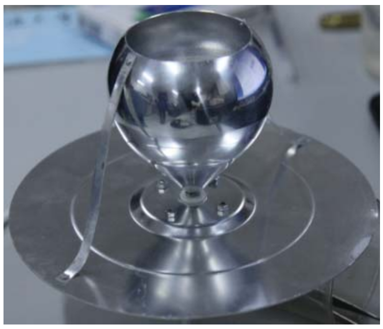
In this paper, a new type antenna with the V-cone and three-quarter sphere geometry is presented. The cone-sphere geometry is eventually developed for a UWB antenna which the ultra antenna can used in frequency band 800-6000MHz; Two quarter-wavelength short stubs are used in the novel UWB antenna to match the impedance, which can significantly achieve omni-directional pattern, and high gain, and improve the voltage standing wave ratio (VSWR) of the antenna. As expected at the beginning of this research, the VSWR is less than 2 in the frequency band 800-6000MHz.

II. ANTENNA DESIGN

Since cutting effect, finite V-cone antenna leads to large reflected current, and the impedance bandwidth is bad, so it's popular that the loading method is used to design UWB antennas. In order to get excellent impedance performance, a V-cone antenna of sphere loaded is designed in this paper. The geometry and dimensions of the UWB antenna is shown in Fig. 1, including ground plane, radial element of cone-sphere, short stubs and feed element. As the radial element, cone-sphere structure is composed of V-cone and one-second of the sphere. The height and angle of V-cone separately are 25.3mm and 90 degree, respectively, and the radius of loaded sphere is 40mm. Quarter of the sphere crown is cut to reduce the profile. Moreover, there are two quarter-wavelength short stubs inside the UWB antenna, which can be used to match the impedance. Consequently, the antenna bandwidth is future broadened. The one end of strip line is fixed in ground plane, the other end is fixed in the edge of spherical crown, and two short stubs are placed symmetrically, the length and width are 90mm and 10mm.



(a)

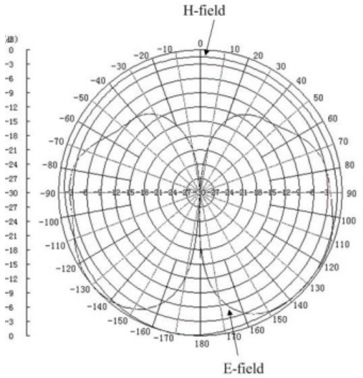


(b)

Fig. 1 The geometry configuration of the proposed antenna
(a) Schematic (b) Prototype front view

III. EXPERIMENTAL RESULTS AND DISCUSS

To verify the performance of the proposed approach, the UWB antenna was measured after fabrication. Fig. 2 shows the measured radiation patterns in E-plane (x-z) and H-plane (y-z) at 890MHz, 2010MHz, 3300MHz and 5900MHz, respectively.



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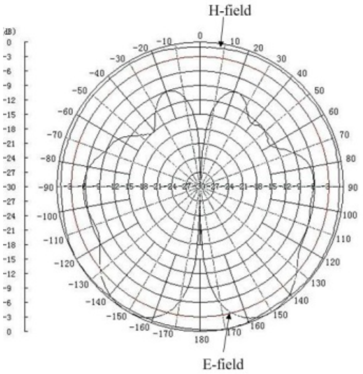

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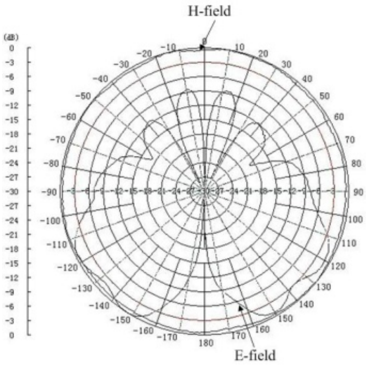

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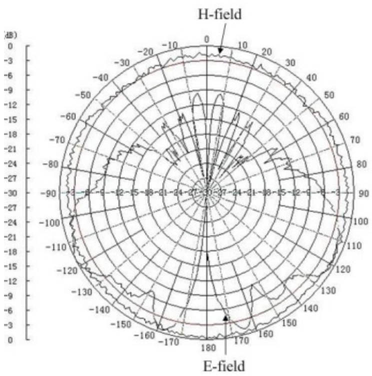

(d)

Fig. 2 Radiation patterns of the E-field and H-field at
(a) 890MHz (b) 2010MHz (c) 3300MHz (d) 5900MHz

As shown in Fig. 2(a) and 2(b), it can be perceived that the omni-directional patterns of E-filed are achieved when the frequency is at relative low value, but when the frequency is above 3GHz, the E-filed radiation patterns show the direction, especially in the near 6GHz. And the reason is contributed that the size of radius ground plane approximately equal or exceed the wavelength, and affect the radiation patterns. However it can be accepted in application of indoor coverage. The gain of the antenna is larger than 2.5dBi in the frequency band and it increases monotonously with the frequency band from 800MHz to 3550MHz. The maximal gain is 6.8dBi at 3550MHz. Therefore, the gain of the UWB antenna can be calculated by Eq.(1).

$$G_x(dBi)=G_s(dBi)+10lg(P_{xr})-10lg(P_{sr}) \qquad (1)$$

where, $G_x(dBi)$ is the gain of the UWB antenna, $G_s(dBi)$ is gain of the standard antenna, P_{xr} is the power of the UWB antenna, P_{sr} is the power of the standard antenna. Table 1 represents the gain of the UWB antenna.

Table 1
Gain of the antenna

Freq.(MHz)	G_s(dBi)	10lg(P_{xr})(dBm)	10lg(P_{sr})(dBm)	G_x(dBi)
824	12.94	-43.07	-32.70	2.57
860	13.30	-44.14	-33.20	2.36
890	13.60	-44.53	-33.21	2.28
960	14.30	-45.26	-33.45	2.49
1880	15.26	-47.16	-37.13	5.23
1990	15.62	-47.39	-37.26	5.49
2170	16.17	-48.47	-37.71	5.41
2700	17.57	-40.86	-28.98	5.69
3300	19.98	-41.79	-27.2	5.39
3550	20.37	-40.57	-27.08	6.88
5100	20.34	-47.41	-32.5	5.43
5900	21.13	-49.23	-32.95	4.85

Fig. 3 shows the comparison of the measured typical VSWR values of the UWB antenna with one short-stub, two short-stubs and no short stubs, respectively. It is apparent that the VSWR<1.5 in the frequency band 800-3800MHz and 4.5-6GHz when using two strips. Obviously, the UWB antenna can be used in indoor coverage system for GSM, CDMA, TD-SCDMA, WCDMA, WiMax, WLAN and CDMA2000 when using two stubs. It's sure that short-stubs main to match the impedance, and improve the poor VSWR performance in 800-1300MHz frequency band.

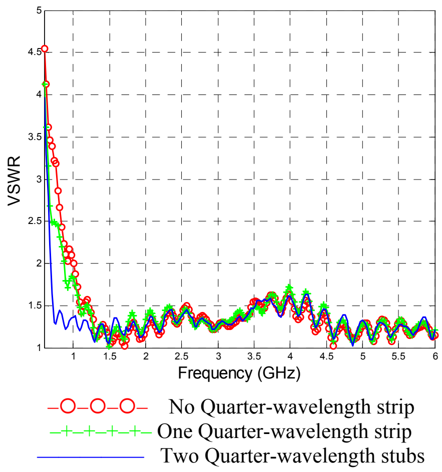

Fig. 3 The comparison of VSWR of the UWB antenna

IV. CONCLUSIONS

From the result of measurement of VSWR, radiation patterns and gain, the good performances are achieved, the VSWR of the UWB antenna is less than 1.7 in frequency band 800-6000MHz. The gain of the UWB antenna is more than 5dBi, when the frequency band is 1500-6000 MHz. Therefore, the UWB antenna can be used in GSM, CDMA, WCDMA, CDMA2000, TD-SCDMA, WiMax and WLAN.

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