Radiation Analysis of Antenna Located on Mobile Phone Cylindrical Tower by Using UTD Method

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***Abstract* - This paper presents the analysis of the effect of mobile phone cylindrical tower on the antenna radiation pattern by using the uniform geometrical theory of diffraction (UTD) method. Generally, the mobile phone base station antennas are installed on the tower such as single post cylindrical tower, cross-braced tower and others. The antenna is located far from the tower in a few wavelength. In that case, the original antenna radiation pattern in free-space will be distorted by the tower. The reflected and diffracted waves generate the interference in the total field radiation pattern. The ripple of radiation pattern as a function of direction is occurred. This paper focus on the single post cylindrical tower. The antenna radiation pattern of the single dipole and unidirctional corrugated horn antenna located on the single post cylindrical tower will be calculated by using the UTD method. The efficiency of the UTD method in the term of the computational time and accuracy is better than other numerical methods. The computational time comparison will be reported.**

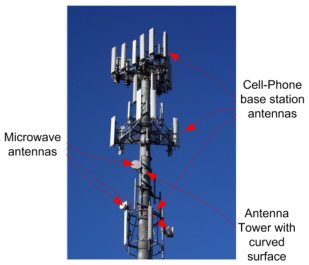
***Index Terms* — Mobile phone base station antenna, Uniform geometrical Theory of Diffraction (UTD) method.**

1. Introduction

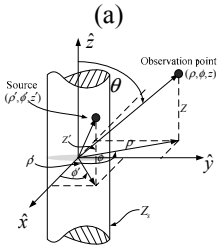
Generally, the mobile phone base station antenna such as the unidirectional pattern array, omnidirectional pattern array, omnidirectional pattern single element antennas are installed on the tower such as single post cylindrical tower, cross-braced tower and other. The original antenna radiation pattern must be distorted by the tower. The reflected wave from the tower affects the main beam radiation pattern. The diffracted wave affects the back lobe radiation pattern. In this case, the undesired side-lobe maybe occurred. The antenna is usually located far from the tower in a few wavelength [1] as can seen in Fig. 1 (a). This paper, the single post cylindrical tower is focused. The antenna radiation pattern of the single dipole and unidirectional horn antennas located on the single post cylindrical tower will be investigated. The UTD method [2] [3] is more efficient than other numerical methods for large problem simulation. The efficiency of the UTD method comparing with the EM software simulation in the term of the computational time and accuracy will be illustrated in this work.

2. Single Dipole Antenna Case Study

The single dipole antenna located on the tower can be represented by the electric current source as shown the equivalent scenario in Fig. 1(b). From the UTD calculation, the original omnidirectional pattern in free-space of the single dipole antenna is distorted by the single post cylindrical tower as shown in Fig. 1(c). The ripple is occurred at main beam by the reflection form the post tower. The back lobe is affected by diffraction. It is can found that back lobe is very weak. It is estimated that the main lobe of the other antenna types may be distorted by the tower. The computational time of UTD method in this case is 3.38 seconds. The CST-Microwave Studio with 2-GPU co-simulation and 11,288,340 mesh cells of 7 minute 44 seconds simulation time is employed.



(a)



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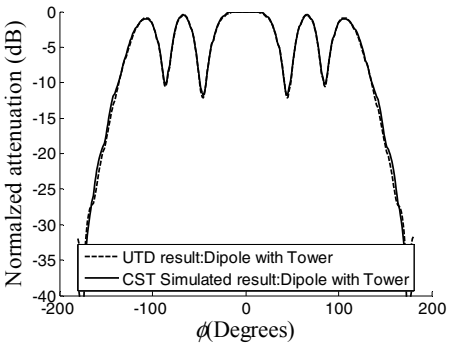


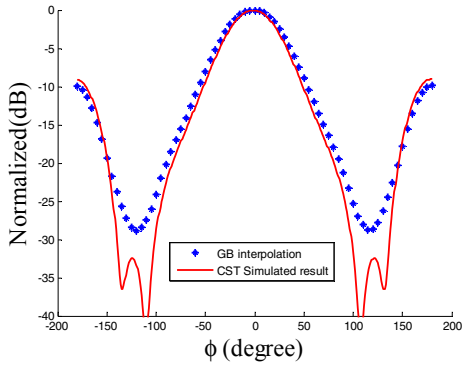
(c)

Figure 1. (a) The cell-Phone antenna located on tower (b) Equivalent scenario (c) single dipole with mobile phone tower pattern (antenna located at 3λ)

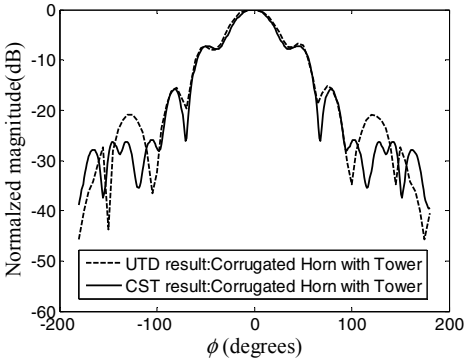
3. Corrugated Horn Antenna Case Study

As mentioned, It is estimated that the main lobe of the other antenna types may be distorted by the tower. In this section, the corrugated horn antenna located on the tower is focused. The corrugated horn antenna located on the tower as shown in Fig. 2(a). However, the corrugated horn antenna radiates unidirectional pattern. The unidirectional pattern source cannot be represented by the electric current point source. In this case, the Gaussian beam (GB) 3D radiation pattern construction is required [4] as shown the result in Fig. 2(b). From the UTD calculation together with the 3D GB radiation pattern construction called GB-UTD, it is found that the original unidirectional radiation pattern in free-space of the horn antenna is distorted by the single post cylindrical tower as shown in Fig. 2(c). The side-lobe is occurred at main beam by the reflection form the post tower. The back lobe is affected by diffraction. It is can found that the back lobe is very weak comparing with the original radiation pattern in free-space that of Fig. 2(b). The computational time of UTD method in this case is 16.6 seconds. The CST-Microwave Studio and 2-GPU co-simulation is employed. The 6,797,652 mesh cells of two symmetry plans technique is employed. The actual mesh cells around (6,797,652)x4. The simulation time is 16 minutes.

(a)



(b)



(c)

Figure 2. (a) The corrugated horn antenna located on tower (b) CST and GB corrugated horn antenna pattern in free-space (d) CST and GB-UTD corrugated horn antenna pattern on tower (antenna located at 3λ)

4. Conclusion

The original omnidirectional and unidirectional patterns of the single dipole and corrugated horn antennas are distorted by the single post cylindrical tower. The side-lobe is occurred at main beam by the reflection. The back lobe is affected by diffraction. It is estimated that the main lobe of the other antenna types may be distorted by the tower. The computational time of UTD method is lower than CST-Microwave Studio and also other numerical methods. Moreover, the spacing between antenna and tower will be investigated further.

Acknowledgement

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