PROCEEDINGS OF ISAP '96, CHIBA, JAPAN

Analysis and Measurement of PHS Propagation Characteristics Around Shinjuku Railway Station

Yoshio INASAWA, Yoshiyuki CHATANI, Shigeru MAKINO and Shin-ichi SATOH
Mitsubishi Electric Corporation
5-1-1, Ofuna, Kamakura, Kanagawa, 247 Japan

1 Introduction

Personal Handyphone System(PHS) has been in service since the last year and has won popularity in Japan. It becomes more and more important to know the propagation characteristics for effective arrangement of base stations especially in the urban area which has high utilization rate. Ray tracing technique is an effective method especially in the case of microcelluar systems like PHS to predict received power, which is widely used to simulate the propagation characteristics in the city [1][2].

In this paper, we make a three dimensional propagation model around the east entrance of Shinjuku railway station in Tokyo which is one of the biggest railway stations in Japan and has complex propagation environment. We calculate mean field strength [1][2] using ray tracing technique and compare the calculated results with measured ones.

2 Calculation Model

It is important to make an appropriate model of the city, because calculation time and simulated result depend on it. In general, urban area has buildings, signboards, cars, trees and so on. If we consider all of these objects, huge calculation time is needed. And the detailed research of all environment requires a great deal of labor due to the complexity of urban area. So we consider only buildings and the ground.

The general map on the market is shown in Fig.1. We make a calculation model for propagation simulation around the east entrance of Shinjuku railway station from this map. One of the problems is how to make a model of buildings. Actual buildings have many windows and signboards. And they are made of some materials and their shapes are very complex. Some methods of simplification are needed for the reduction of calculation time. It is assumed that all buildings have uniform shape in height direction and its height is 3.5n[meter], where n is the number of building stories. On the other hand, we consider detailed shape around the base station, because simulated results are significantly influenced by the environment around it. Any nearby buildings having similar heights are united in one building and the narrow streets between the buildings are neglected. Relative dielectric constant of the buildings is assumed to be $\epsilon_r = 5.5$ and its conductivity, $\sigma = 0.023S/m$ [3]. For average ground, the relative dielectric constant is assumed to be $\epsilon_r = 15$ and its conductivity, $\sigma = 0.005S/m$ [4].

3 Analysis and Measurement

We calculate the mean field strength using ray tracing technique. The mean field strength is an impotant parameter for effective arrangement of base stations. Ray tracing technique is based on ray theory and used for propagation simulation in the city. The image figure of ray theory analysis in the city is shown in Fig.2. Electromagnetic waves radiated from the base station are reflected and diffracted by the buildings and ground. Many types of rays arrive

at received point. All types of rays considered in this analysis are shown in Table 1. Direct, reflected and diffracted waves are considered, but transmitted wave into the building and the higher order rays are neglected. Calculation of reflected wave is based on Geometrical Optics using Fresnel reflection coefficient. The Uniform Theory of Diffraction (UTD) method is applied for the diffraction calculation [5]. Here, all buildings are assumed to be made of the perfect conductor in the diffraction calculation.

The major parameters in analysis and measurement are shown in Table 2. Calculated and measured results are shown in Fig.3. Base station position is indicated by '•' mark. The positions of calculation and measurement are indicated by '×' mark. Calculated and measured results are denoted on the right of this mark. Upper value is calculated and lower one is measured result. It is shown that calculated and measured results are in good agreement. The errors are almost less than 10 dB.

4 Conclusion

We made a three dimensional propagation model around the east entrance of Shinjuku railway station from the information in the map on the market. We calculated mean field strengths using ray tracing technique and investigated the calculated results with measured ones. The calculated and measured results are in good agreement.

5 Acknowledgement

The authors wish to thank DDI Tokyo Pocket Telephone, Inc. for providing measured results around the Shinjuku railway station.

References

[1] F.Ikegami, S.Yoshida, T.Takeuchi and M.Umehira, "Propagation Factors Controlling Mean Field Strength on Urban Streets." IEEE Trans., Antennas Propagat., vol.AP-32, pp.822-829, Aug. 1984.

[2] F.Ikegami, T.Takeuchi and S.Yoshida, "Theoretical Prediction of Mean Field Strength for Urban Mobile Radio," IEEE Trans., Antennas Propagat., vol.AP-39, pp.299-302, Mar. 1991.

[3] S.Mitobe and S.Ito, "Measurement of VHF reflection from precast concrete walls." NHK Tech. Rep., Mar. 1974(in Japanese).

[4] H.H.Xia, et al., "Radio Propagation Characteristics for Line-of-Sight Microcellular and Personal Communications," IEEE Trans., Antennas Propagat., vol.AP-41, pp.1439-1447, Oct. 1993.

[5] R.G.Kouyoumjian, P.H.Pathak, "A uniform geometrical theory of diffraction for an edge in a perfectly conducting surface." Proc. of the IEEE, vol.62, no.11, pp.1448-1461, 1974.

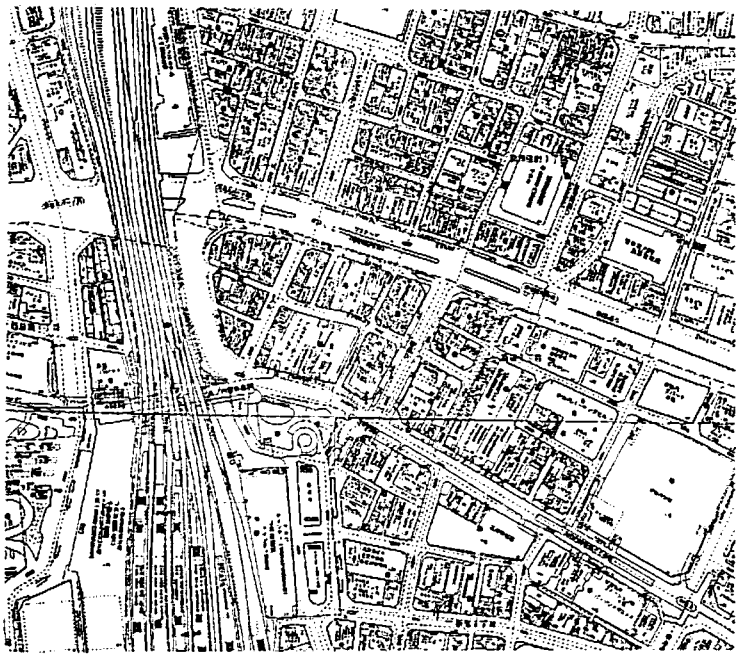

Figure 1: A Map Around the Shinjuku Railway Station

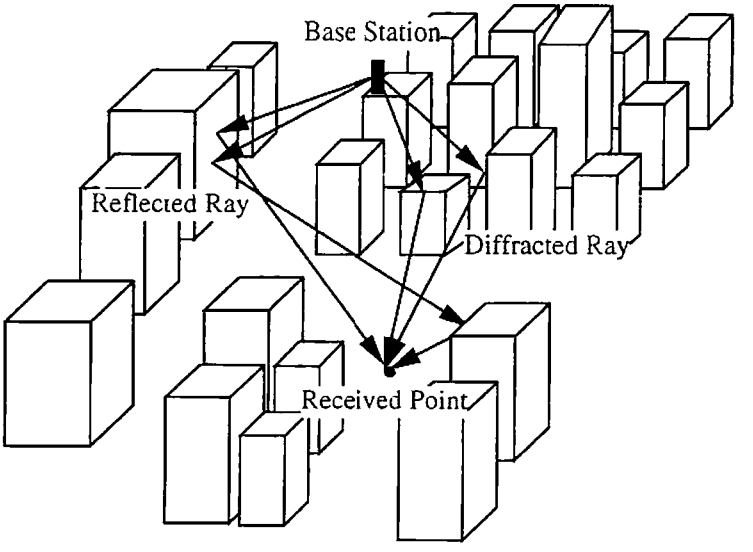

Figure 2: Ray Tracing Technique

Table 1: Considered Ray Types

Direct
Reflected
Reflected-Reflected
Reflected-Reflected-Reflected
Diffracted
Reflected-Diffracted
Diffracted-Reflected
Reflected-Reflected-Diffracted
Reflected-Diffracted-Reflected
Diffracted-Reflected-Reflected

Table 2: Major Parameters

Frequency	1.9GHz
EIRP	34dBm
Transmitted antenna	8 element collinear dipole array antenna
Tilted angle	5 degrees lower than horizontal direction
Received antenna	standard dipole
Received antenna height	1.5m above the ground

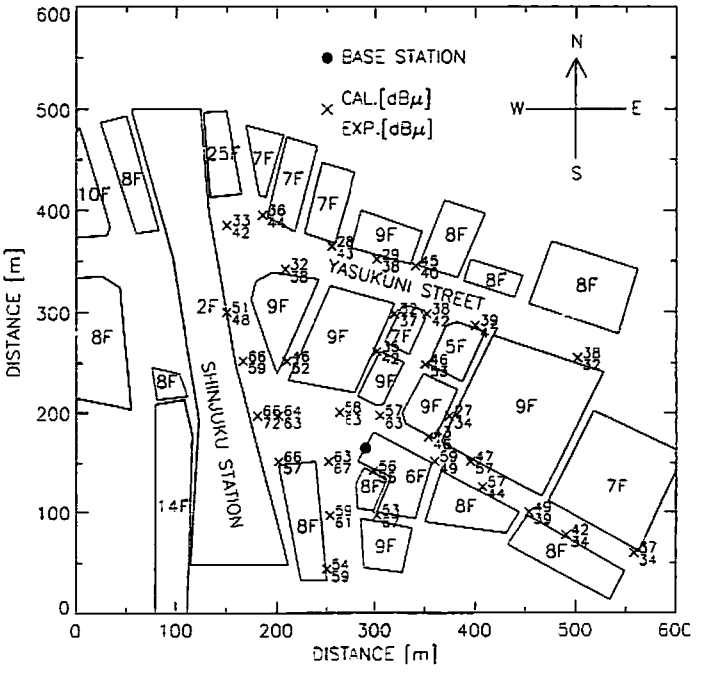

Figure 3: Calculated and Measured Results