Performance of Indoor Wireless BPSK System with One Interferer

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Abstract – This paper use a site-specific model to characterize the performance of millimeter wave BPSK system with single cochannel interference. Shooting and bouncing ray/image techniques are applied to compute the impulse responses for concrete-wall-partition rooms and plasterboard-wall-partition rooms. By using the impulse responses of these multipath channels, the BERs (Bit Error Rates) for high-speed BPSK (binary phase shift keying) systems with phase and timing recovery circuits are calculated. In addition, the carrier-to-interference ratio is also computed. Numerical results show that the interference for the plasterboard-wall-partition rooms is more severe than that for the concrete-wall-partition rooms.

I. Introduction

In a classical large cell cellular system, due to several interferers in different cochannel cells, the interference can be regarded as Gaussian distribution random variables. However, in a small personal communication system, interference is often due to a few signals. Moreover, the use of adaptive antennas and intelligent channel assignment techniques make the case of a large number of interferers less probable, i.e, the Gaussian approach cannot be applied. As a result, some researches focus on the analysis of small number interferers [1], [2]. In this paper, the performance of millimeter wave BPSK system with a single cochannel interferer is inverstigated by site-specific models. Channel modeling and system description is given in section II. Section III shows the numerical results. Finally, some conclusions are drawn in section IV.

II. Channel modeling and system description

(A) Channel modeling

Let us consider two adjacent rooms (room A and room B) in Fig.1. The impulse response for any transmitter-receiver location is computed by the shooting and bouncing ray/image (SBR/image) techniques. The SBR/Image method can deal with high frequency radio wave propagation in complex indoor environments. It conceptually assumes that many triangular ray tubes (not rays) are shot from the transmitter and each ray tube bouncing and penetrating in the environments is traced. If the receiver is within a ray tube, the ray tube will have contribution to the received field and the corresponding equivalent source (image) can be determined. By using these images and received fields, the impulse response of the channel can be obtained.

(B) System description

Let us consider the equivalent baseband BPSK system in Fig.2, in which, at the receiver, we have the contributions of the useful transmitted signal and one cochannel interferer. In the phase recovery circuit, the near optimum remodulation scheme suggested in [3] is used. In this method, the phase of the overall complex baseband channel impulse response is used as the phase reference. A squaring-enveloped scheme is used for timing recovery circuit [4]. The circuit consists of a square-law envelope detector and a narrowband filter extracting the spectral line at frequency $1/T$.

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III. Numerical results

Let us consider two adjacent rooms (room A and room B). 8cm-thick concrete ceilings and floors are assumed for these two rooms. Three different types of walls are considered as follows:

(1) 8cm-thick concrete walls
(2) 12cm-thick hollow plasterboard walls [12mm-thick plasterboard + 96mm-thick air gap + 12mm-thick plasterboard].
(3) 8cm-thick concrete walls with 3cm-thick wooden door and 0.68 cm-thick window.

Half-wave vertical dipole antennas are used for both transmission and reception. The receiving antennas are located at the center of these two rooms with a fixed height of 2.5m. The location of transmitting antennas are uniformly distributed inside the rooms with a fixed height of 1.5m. There are 200 transmitting points for room A and 100 interference points from room B. As a result, there are total 20000 different suiation. The impulse response for each channel was calculated at 57.5 GHz by SBR/Image method. The cumulative distribution of C/I (carrier to interference) ratio is depicted in Fig. 3 for the three different types of walls.

For the BER requirement of BER<10^{-5}, the outage probabilities for these three type of rooms are shown in Table 1. It is found that the outage probability for plasterboard wall without interference is the smallest. This can be explained by the fact that the reflection coefficient is small for the plasterboard wall. However, when the interference exists, the performance becomes worse. On the contrary, the interference has little effect on the performance of rooms with concrete wall partition due to the large wall transmission attenuation.

IV. Conclusions

A site-specific model to characterize the performance of millimeter-wave channel with single cochannel interference has been presented. Shooting and bouncing ray/image techniques are applied to compute the impulse response of rooms with three different wall partitions. By using the impulse responses of these multipath channels, the C/I ratios and the outage probability for BPSK systems with phase and timing recovery circuits are calculated. Numerical results show that the concrete wall has less interference but strong multipath effect. On the contrary, the plasterboard wall has less multipath effect but strong interference. As a result, the frequency can be reuse in the adjacent rooms with concrete wall partition but not for the plasterboard wall partition due to the strong interference.

References

[1] Marco Chiaui, "Performance of BPSK and GMSK with multiple cochannel interferers," *Proc. IEEE International Symposium on Personal, Indoor and Mobile Radio Communication*, vol. 1, pp. 833-837, Oct. 1996.

[2] Velio Tralli, Roberto Verdone, "Bit error and outage probability for digital cellular systems with a small number of interferers," *Proc. IEEE International Symposium on Personal, Indoor and Mobile Radio Communication*, vol. 1, pp. 73-77, Oct. 1996.

[3] L. J. Greenstein and B. A. Czekaj-Augun, " Performance comparisons among digital radio techniques subjected to multipath fading," *IEEE Trans. Commun.*, vol. 30, pp. 1184-1197, May 1982.

[4] J. C. Chuang, "The effects of multipath delay spread on timing recovery," *IEEE Tran. Veh. Technol.*, vol. 35, pp. 135-140, Aug. 1987.

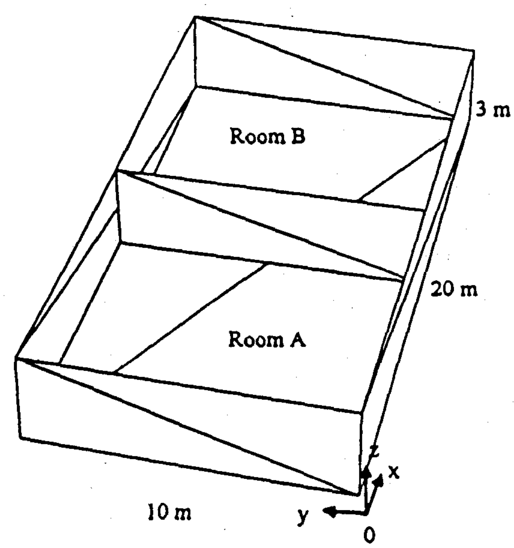

Fig. 1 Two rooms(room A and room B) modeled by triangular facets

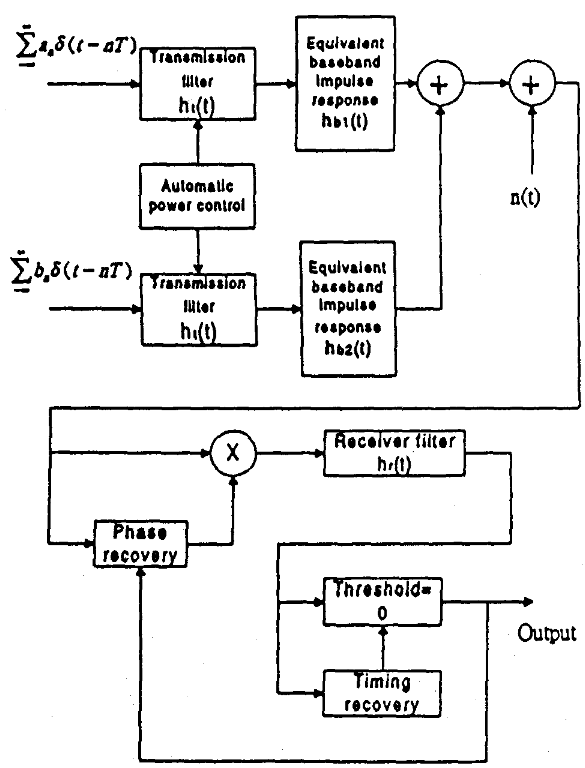

Fig. 2 Block diagrams of the equivalent baseband communication system

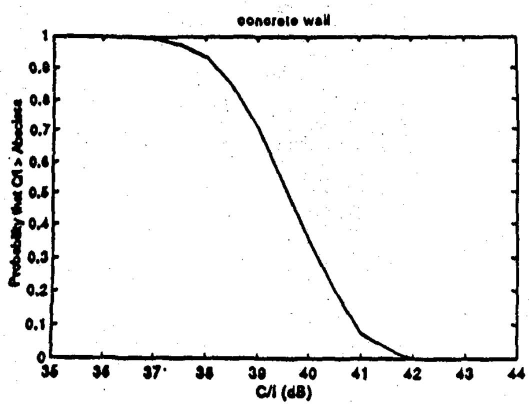

Fig. 3 (a)

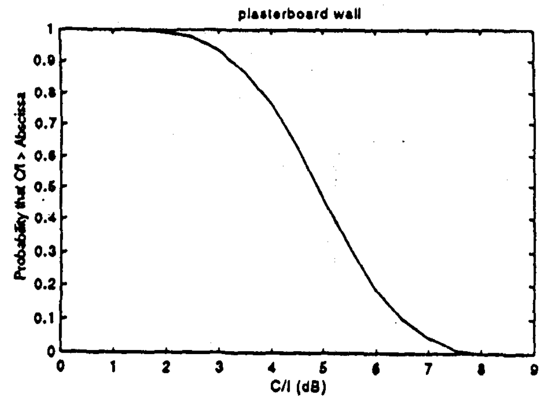

Fig. 3 (b)

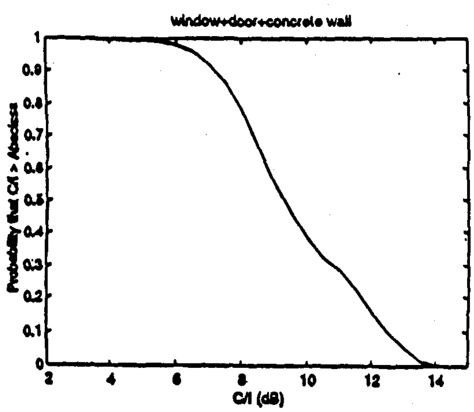

Fig. 3 (c)

Fig. 3

(a) Cumulative distribution of C/I ratios for concrete-wall-partition rooms.

(b) Cumulative distribution of C/I ratios for plasterboard-partition room.

(c) Cumulative distribution of C/I ratios for concrete-wall-partition rooms with windows and room.

Table 1 Outage probabilities for there types of wall partitions

Wall type / Condition	Concrete	Plasterboard	Concrete+door +windows
without interference	0.16	0.01	0.16
with interference	0.16	0.14	0.18