On the Spatial Characterstics of Cellular Mobile Channel in Low Antenna-height Environments

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In order to exploit the spatial dimens ion efficiently, reliable channel models are required which can lead to the design of effective signal processing schemes. Physical channel models are the continu- ing efforts in this regard. Several approaches have been suggested for the distribution of scatterers. The two most common distributions are the uniform [1] and Gaussian [2, 3]. The latter has been identified as more practical in the literature. Gaussian Scatterer Density Model (GSDM) [2] proposes Gaussian Distributed Scatterers clustered around mobile station (MS). Since, in low antenna-height indoor environments, scatterers also exist in the vicinity of base station(BS). So a more generalized scattering model is needed for such environments.

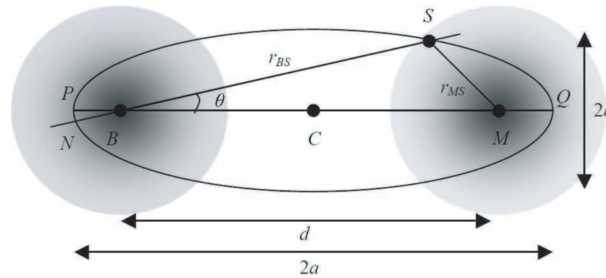

Figure 1: Physical channel model.

In this paper, we use the generalized Eccentro-Scattering physical channel model proposed in [3] to derive the probability density function (pdf) of the Angle of Arrival (AoA) of the multipath signals at BS from Gaussian distributed scattering regions around MS and BS for indoor environments.

We assume Gaussian distributed scatterers to be confined in an elliptical shaped scattering disc (see Fig. 1) whose eccentricity can be altered according to the maximum delay and the distance between MS and BS. A Gaussian model of the spatial pdf of scatterers around MS and BS can be written as,

$$p_{R_{BS},\Theta}(r_{BS},\, \theta) = \frac{\parallel r_{BS} \parallel}{2\pi\sigma_{MS}^2} \exp\left\{-\frac{\parallel r_{BS} - r_{BM} \parallel^2}{2\sigma_{MS}^2}\right\} \tag{1}$$

$$p_{R_{BS},\Theta}(r_{BS},\, \theta) = \frac{\parallel r_{BS} \parallel}{2\pi\sigma_{BS}^2} \exp\left\{-\frac{\parallel r_{BS} \parallel^2}{2\sigma_{BS}^2}\right\} \tag{2}$$

where σ_{MS} and σ_{BS} are the standard deviations of the distributions of scatterers around MS and BS, and θ is the AoA of the multipaths at BS from the scatterer S. All other parameters are explained in Fig. 1. From (1), (2) and Fig. 1, the final closed-form expression for the pdf of AoA can be written as

$$\begin{aligned} p_\Theta(\theta) = &\frac{\Omega}{2\pi}\left[1 + \exp\left(\frac{-d^2}{2\sigma_{MS}^2}\right) - \exp\left(\frac{-(4a^2 - 4ad\cos\theta + d^2)^2}{8\sigma_{MS}^2(2a - d\cos\theta)^2}\right) - \exp\left(\frac{-(4a^2 - d^2)^2}{8\sigma_{BS}^2(2a - d\cos\theta)^2}\right)\right] \\ &+ \frac{\Omega d\cos\theta}{2\sqrt{2\pi}\sigma_{MS}} \exp\left(\frac{-d^2\sin^2\theta}{2\sigma_{MS}^2}\right)\left\{\mathrm{erf}\left(\frac{d\cos\theta}{\sqrt{2}\sigma_{MS}}\right) + \mathrm{erf}\left(\frac{4a^2 - 4ad\cos\theta + d^2\cos 2\theta}{2\sqrt{2}\sigma_{MS}(2a - d\cos\theta)}\right)\right\} \end{aligned} \tag{3}$$

where Ω is the normalizing constant. Eq. (3) is helpful in finding correlation statistics of the channel.

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