Effect of Distant Scatterers on MIMO Fading Channel Tracking

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This paper considers the problem of a wireless multi-input multi-output (MIMO) fading channel tracking, when a strong distant scattering cluster is present in the area in addition to the local scattering zone around the mobile. Time-varying fading channels are dynamic in nature and their tap values in signal processing depend significantly on the distribution of the angle of arrival (AOA) $p(\psi)$ at the mobile station. We assume N_T-input, N_R-ouput MIMO communication system where each receiver antenna observes a linear combination of all transmitted data sequences, each distorted by ISI, under white Gaussian noise [1]. Using state-space approach, a MIMO system operating over time-varying channel, can be modeled as, [1, 2].

$$h_l^{(m,j)}(i+1) = \alpha_l^{(m,j)} h_l^{(m,j)}(i) + v_l^{(m,j)}(i+1) \tag{1}$$

$$r^{(j)}(i) = \sum_{m=1}^{N_T} \sum_{l=1}^{L^{(m,j)}} h_l^{(m,j)}(i) x^{(m)}(i-l) + n^{(j)}(i) \tag{2}$$

where $h_l^{(m,j)}(i)$ is the lth tap of the impulse response of order $L^{(m,j)}$ between the mth input $x^{(m)}(i)$ (with $m = 1, \ldots, N_T$), and the jth ouput $r^{(j)}(i)$ (with $j = 1, \ldots, N_R$), of the time-varying MIMO channel, at time instant i. $x^{(m)}(i)$ is the transmitted signal from transmitter m, and $r^{(j)}(i)$ is the received signal at receiver j. $v_l^{(m,j)}(i)$ and $n^{(j)}(i)$ are i.i.d. process and measurement noises and $\alpha_l^{(m,j)}$ is the autoregressive (AR) coefficient of lth tap and accounts for the variations in the channel due to spatially dispersed multipath signals affected by the maximum Doppler shift $f_D^{(l)}$ [1–3].

$$\alpha_l = E\{h_l(i) h_l^*(i-1)\} = \int_{-\pi}^{\pi} p(\psi) e^{-j2\pi f_D^{(l)} T \cos(\psi)} d\psi \tag{3}$$

where T is the symbol duration. In rural or sub-urban areas, when mobile travels at fast speed under the influence of a dominant distant scatterer (e.g., hill), the distribution of the AOA, $p(\psi)$ deviates from the uniform shape (a common assumption usually made to find correlation statistics [1–3]), and can be written as,

$$p(\psi) = \Omega \frac{R^2 + 4D\cos(\psi - \psi_D)\sqrt{R^2 - D^2 \sin^2(\psi - \psi_D)}}{\pi R^2} \tag{4}$$

where R is the radius of the distant scattering cluster, D is the distance of its center from the mobile, ψ_D is the angle it makes with the virtual line of sight at mobile and Ω is the normalizing constant.

A variety of models may be used with different values of D, R and ψ_D depending on the terrain and geography of the area to obtain α_l, which can then be exploited in fading channel tracking algorithms using (1) and (2).

REFERENCES

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