Abstract

Macro-diversity reception is one of the most effective techniques which enables long term fading effects and short-term fading effects reductions, simultaneously. Thus, long term fading alleviation is provided by micro level (ML) diversity at single base station (BS) while long-term fading alleviation is provided by macro level (ML) diversity receiver processing signals from more BSs. Multipath propagation is caused by reflection, diffraction and scattering of radio waves causing signal envelope fluctuations, phenomena also known as short term fading. Shadowing is caused by obstacles between transmitter and receiver causing average signal power fluctuations, phenomena also known as long term fading. The proposed Macrolevel diversity system consists of three dual branches ML diversity SC structures routing the signals to the Mal diversity SC receiver as shown a 1 Mal diversity SC receiver process signal envelopes from BSs while Mal diversity SC receivers process signal envelopes from multiple antenna terminals at single BS.

System Model

Desired signal, $s_{ij}$ has Rayleigh distribution [1]:

$$p_{s_{ij}}(s_{ij}) = \frac{s_{ij}}{\Omega_i} e^{-\frac{s_{ij}^2}{2\Omega_i}}, i = 1,2,3; j = 1,2;$$

where $\Omega_i = E(s_{ij}^2)$, while the $E(\cdot)$ denotes expectation.

Similarly, CCI denoted with $y_{ij}$ has also Rayleigh distribution [1]:

$$p_{y_{ij}}(y_{ij}) = \frac{y_{ij}}{\eta_i} e^{-\frac{y_{ij}^2}{2\eta_i}}, i = 1,2,3; j = 1,2;$$

where $\eta_i = E(y_{ij}^2)$, while the $E(\cdot)$ denotes expectation.

In interference limited environment, such as cellular networks, level of interference is proposed to be significantly higher than level of Gaussian noise. Thus, the effect of Gaussian noise on system performances is negligible. The signal to interference ratio (SIR) is given as:

$$x_{ij} = \frac{s_{ij}}{y_{ij}}, i = 1,2,3; j = 1,2.$$  

(3)

The probability density function (PDF) of $x_{ij}$ using (16, (3478.1)) and some mathematical manipulations becomes:

$$p_{x_{ij}}(x_{ij}) = \int_0^\infty y_{ij} p_{y_{ij}}(y_{ij}) p_{s_{ij}}(s_{ij}) dy_{ij}$$

$$= 2\Omega_i \eta_i \int_0^\infty t e^{-\frac{t^2}{2\eta_i}} dt$$

$$i = 1,2,3; j = 1,2;$$

(4)

Cumulative density function (CDF) of SIR can be solved using (16, (3481.4)):

$$R_{x_{ij}}(x_{ij}) = \int_0^{x_{ij}} p_{x_{ij}}(t)dt$$

$$= \frac{x_{ij} e^{-\frac{x_{ij}^2}{2\eta_i}}}{\sqrt{2\pi \eta_i}}, i = 1,2,3; j = 1,2.$$  

(5)

CDF of SIR based Mal SC outputs signal envelopes are [1]:

$$R_{\Omega_i}(\Omega_i) = \int_0^{\Omega_i} R_{x_{ij}}(x_{ij})dx_{ij}$$

$$= \frac{e^{-\frac{\Omega_i^2}{4\eta_i}} - \frac{\Omega_i}{\sqrt{2\pi \eta_i}}}{\sqrt{2\pi \eta_i}}, i = 1,2,3.$$  

(6)

CDF of SIR based Mal SC outputs signal envelopes are [1]:

$$P_{\Omega_i, \Omega_i}(\Omega_i, \Omega_i) = \frac{1}{\Omega_i} e^{-\frac{\Omega_i^2}{4\eta_i}} e^{-\frac{\Omega_i}{\sqrt{2\pi \eta_i}}}$$

(7)

Numerical Results

In this paper, SIR based Mal diversity system with Mal SC reception and three dual Mal SCs in correlated Gamma shadowed Rayleigh multipath fading channel is considered. Novel, infinite series expressions for CDF of the output signal envelope is calculated and used for derivation of OP of SC Mal diversity system. The results are graphically presented regarding different system model parameters. In general the best possible outcome in theory is achievable for higher values of shadowing severity parameter and lower values of CCI fading severity parameter. It is shown, that obvious improvement is achievable with higher values of average desired signal power and lower values of CCI average power. Moreover, the impact of shadowing correlation on OP is even more for higher values of $\rho$. The obtained analytical and numerical results can be of significance in designing wireless communication systems using Mal diversity technique to reduce short-term, long-term fading and CCI impacts on system performances.

Conclusion

In this paper, SIR based Mal diversity system with Mal SC reception and three dual Mal SCs in correlated Gamma shadowed Rayleigh multipath fading channel is considered. Novel, infinite series expressions for CDF of the output signal envelope is calculated and used for derivation of OP of SC Mal diversity system. The results are graphically presented regarding different system model parameters. In general the best possible outcome in theory is achievable for higher values of shadowing severity parameter and lower values of CCI fading severity parameter. It is shown, that obvious improvement is achievable with higher values of average desired signal power and lower values of CCI average power. Moreover, the impact of shadowing correlation on OP is even more for higher values of $\rho$. The obtained analytical and numerical results can be of significance in designing wireless communication systems using Mal diversity technique to reduce short-term, long-term fading and CCI impacts on system performances.

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