Performance of Wireless System in the Presence of κ-μ Multipath Fading, Gamma Shadowing and κ-μ Cochannel Interference

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***Abstract*—In this paper, wireless communication system working over Gamma shadowed κ-μ small scale fading channel in the presence of cochannel interference exposed to κ-μ short term fading is analyzed. For considered model, signal to interference ratio (SIR) at the output can be presented as the ratio of κ-μ random variable and product of square root of Gamma random variable and κ-μ random variable. Here, probability density function (PDF) and moments of proposed ratio will be evaluated. By using derived expressions, the outage probability and the bit error probability can be calculated. The influences of Rician factors of desired signal envelope and interference envelope on moments will be discussed and analyzed.**

***Keywords*—cochannel interference; Gamma shadowing; κ-μ fading; moments; probability density function.**

I. INTRODUCTION

The long term fading, short term fading cochannel interference degrade the outage probability, symbol error probability, system capacity and average fade duration of wireless communication system. Small scale fading causes signal envelope average power variation resulting in system performance degradation [1], [2].

There are more distributions using to express signal envelope variation in multipath fading channels [3], [4]. In this paper, desired signal envelope is described with κ-μ distribution [5], [6]. Cochannel interference propagates in Gamma shadowed κ-μ multipath fading channel. The κ-μ distribution depicts small scale signal envelope variation in line-of-sight multipath fading channel with more clusters [7]. The parameter k is Rician factor which can be calculated as the ratio of line of sight components power and scattering components power. System performance is better for higher values of Rician factor. Rician factor increases as dominant components increase, or scattering components power decrease [8].

In [9], the authors performed a characterization of the fading experienced in body to body communications channels for fire and rescue personnel using κ-μ distribution. A general κ-μ model with parameters κ=2.31 and μ=1.19 was obtained using maximum likelihood estimation and shown to provide a good fit to measured data.

In [10], a generalized Laguerre polynomial expansion for the probability density function and the cumulative distribution function of the sum of independent nonidentically distributed squared κ-μ random variables is proposed. Based on these statistical results, the performance of maximal-ratio-combining diversity techniques operating over κ-μ fading channels with arbitrary fading parameters are investigated. Derived formulas are mathematically tractable and include as special cases several results available in the technical literature, namely, those of Rice and Nakagami-m fading channels. The κ-μ multipath fading channel converts to Nakagami-*m* multipath fading channel for κ=0 and to Rician multipath fading channel for μ=1. The κ-μ distribution reduces to Rayleigh distribution by setting κ=0 and μ=1.

Cochannel interference experiences Gamma shadowed κ-μ multipath fading. For *κ*=0, Gamma shadowed κ-μ multipath fading channel becomes Gamma shadowed Nakagami-*m* channel, and for μ=1, Gamma shadowed Rician multipath fading channel appears from Gamma shadowed κ-μ multipath fading channel. For μ=1 and k=0, Gamma shadowed κ-μ multipath fading channel get Gamma shadowed Rayleigh multipath fading channel. When μ or k goes to infinity, Gamma shadowed κ-μ multipath fading channel is pure Gamma long term fading channel and when Gamma shadowing severity parameter c goes to infinity, pure κ-μ multipath fading channel ensues from Gamma shadowed κ-μ multipath fading channel. When parameters μ, k and Gamma severity parameter c go to infinity, Gamma shadowed κ-μ multipath fading channel becomes no fading channel.

There are many papers in available technical literature, dealing with wireless communication system operating over Gamma shadowed multipath fading channel and wireless system in the presence of short term fading and cochannel interference.

In [11]-[18], wireless communication systems with selection combining diversity receiver in the presence of fading and cochannel interference are analyzed. Probability density function, cumulative distribution function, outage probability and average symbol error probability are calculated.

The wireless communication systems working over Weibull multipath channel with SC receiver in the presence of cochannel interference affected to Weibull multipath fading are evaluated in [11]-[14]. Probability density function, cumulative distribution function, moments, outage probability and bit error probability for several modulation schemes are calculated in these papers. The level crossing rate of dual SC receiver output signal envelope is computed in [13].

Macrodiversity system with macrodiversity SC receiver and two maximal ratio combining (MRC) receivers operating over Gamma shadowed Rician multipath fading channel is analyzed in [17]. The expressions for the PDF, cumulative distribution function (CDF) and moment generating function (MGF) of the output signal-to-noise ratio (SNR) are obtained. Also, the moments of the output SNR and outage probability are analytically derived. Moreover, the average bit error probability (ABEP) for noncoherent binary differential phase-shift keying (BDPSK) is calculated using the MGF based approach while the ABEP for coherent binary phase-shift keying (BPSK) is studied by averaging the conditional bit error probability over the PDF.

The paper [18] treats bit error probability (BEP), symbol error probability (SEP) and outage probability of MRC in the presence of fading. The authors presented fading model, PDF, CDF and PDF, CDF and outage probability of the L-branch MRC output. BEP/SEP is evaluated for broad class of modulation types and for coherent and noncoherent types of detection.

In this work, wireless communication system functioning over multipath fading channel in the presence of to cochannel interference is considered. Desired signal experiences κ-μ short term fading and cochannel interference experiences Gamma long term fading and κ-μ short term fading. In interference limited environment, the ratio of desired signal envelope to interference envelope is important performance measure of wireless communication system. For scrutinized case, signal to interference ratio can be calculated as the ratio of the κ-μ random variable and product of square root of Gamma random variable and the κ-μ random variable.

In this paper, probability density function and moments of proposed ratio are determined as expressions in closed form. To the best authors' knowledge, the proposed wireless communication system is not reported in open technical literature. The obtained results can be used in performance analysis and designing of wireless communication systems in the presence of long term fading, short term fading and cochannel interference.

II. Probability Density Function of Output Signal to Interference Ratio

Signal to interference ratio at the output of wireless communication system is:

$$w = \frac{x}{y \cdot z} \,. \tag{1}$$

Then, random variable x is:

$$x = wyz \,. \tag{2}$$

The random variable x follows κ-μ distribution [5]:

$$p_x(x) = \frac{2\mu_1 (k_1+1)^{\frac{\mu_1+1}{2}}}{k_1^{\frac{\mu_1-1}{2}} e^{k_1\mu_1} \Omega_1^{\frac{\mu_1+1}{2}}} x^{\mu_1} \cdot e^{-\frac{\mu_1(k_1+1)}{\Omega_1}x^2} \cdot I_{\mu_1-1}\left(2\mu_1 \frac{\sqrt{k_1(k_1+1)}}{\Omega_1} x^2\right) =$$

$$= \frac{2\mu_1 (k_1+1)^{\frac{\mu_1+1}{2}}}{k_1^{\frac{\mu_1-1}{2}} e^{k_1\mu_1} \Omega_1^{\frac{\mu_1+1}{2}}} \cdot \sum_{i_1=0}^{\infty} \left(\mu_1 \sqrt{\frac{k_1(k_1+1)}{\Omega_1}}\right)^{2i_1+\mu_1-1} \frac{1}{i_1! \Gamma(i_1+\mu_1)} \cdot$$

$$\cdot x^{2i_1+2\mu_1-1} \cdot e^{-\frac{\mu_1(k_1+1)}{\Omega_1}x^2} \,. \tag{3}$$

where k≥0 is the ratio between the total power of the dominant components and the total power of the scattered waves, μ ≥ 0 is given by:

$$\mu = \frac{E^2\{r^2\}}{\mathrm{var}\{r^2\}} \frac{1+2k}{(1+k)^2} \,,$$

with r is fading signal envelope; and $I_\nu(.)$ is the modified Bessel function of the first kind and arbitrary order ν (ν real).

Random variable y is defined as:

$$y = y_1^{1/2}, \; y_1 = y^2, \; \frac{dy_1}{dy} = 2y \tag{4}$$

where y_1 is Gamma random variable:

$$p_{y_1}(y_1) = \frac{1}{\Gamma(c_1)\beta_1^{c_1}} y_1^{c_1-1} e^{-\frac{1}{\beta_1}y_1} \,, \; y_1 \ge 0 \tag{5}$$

with Γ(.) being gamma function [19], [20].

Probability density function of y is:

$$p_y(y) = \left|\frac{dy_1}{dy}\right| p_{y_1}(y^2) = \frac{2}{\Gamma(c_1)\beta_1^{c_1}} y^{2c_1-1} e^{-\frac{1}{\beta_1}y^2} \tag{6}$$

Random variable z has κ-μ distribution [5]:

$$p_z(z) = \frac{2\mu_2 (k_2+1)^{\frac{\mu_2+1}{2}}}{k_2^{\frac{\mu_2-1}{2}} e^{k_2\mu_2} \Omega_2^{\frac{\mu_2+1}{2}}} \cdot \sum_{i_2=0}^{\infty} \left(\mu_2 \sqrt{\frac{k_2(k_2+1)}{\Omega_2}}\right)^{2i_2+\mu_2-1} \frac{1}{i_2! \Gamma(i_2+\mu_2)} \cdot$$

$$\cdot z^{2i_2+2\mu_2-1} \cdot e^{-\frac{\mu_2(k_2+1)}{\Omega_2}z^2} \,. \tag{7}$$

The probability density function of w is now:

$$p_w(w) = \int_0^\infty dy \int_0^\infty dz \cdot y \cdot z \cdot p_x(wyz) \, p_y(y) \, p_z(z) =$$

$$= \frac{2\mu_1 (k_1+1)^{\frac{\mu_1+1}{2}}}{k_1^{\frac{\mu_1-1}{2}} e^{k_1\mu_1} \Omega_1^{\frac{\mu_1+1}{2}}} \cdot \sum_{i_1=0}^{\infty} \left(\mu_1 \sqrt{\frac{k_1(k_1+1)}{\Omega_1}}\right)^{2i_1+\mu_1-1} \frac{1}{i_1! \Gamma(i_1+\mu_1)} \cdot$$

$$\cdot w^{2i_1+2\mu_1-1} \cdot \frac{2}{\Gamma(c_1)\beta_1^{c_1}} \cdot \frac{2\mu_2 (k_2+1)^{\frac{\mu_2+1}{2}}}{k_2^{\frac{\mu_2-1}{2}} e^{k_2\mu_2} \Omega_2^{\frac{\mu_2+1}{2}}} \cdot \sum_{i_2=0}^{\infty} \left(\mu_2 \sqrt{\frac{k_2(k_2+1)}{\Omega_2}}\right)^{2i_2+\mu_2-1} \frac{1}{i_2! \Gamma(i_2+\mu_2)} \cdot$$

$$\cdot\int_0^\infty dy\, y^{1+2i_1+2\mu_1-1+2c_1-1} e^{-\frac{1}{\beta_1}y^2}\int_0^\infty dz\cdot z^{1+2i_1+2\mu_1-1+2i_2+2\mu_2-1}\cdot$$

$$e^{-\frac{\mu_1(k_1+1)}{\Omega_1}w^2y^2z^2\frac{\mu_2(k_2+1)}{\Omega_2}z^2} \tag{8}$$

Let us introduce the integral J_1 as:

$$J_1=\int_0^\infty dy\, y^{2i_1+2\mu_1+2c_1-1}\cdot e^{-\frac{1}{\beta_1}y^2}\cdot\frac{1}{2}(\Omega_1\Omega_2)^{i_1+\mu_1+i_2+\mu_2}\,\Gamma(i_1+\mu_1+i_2+\mu_2)$$

$$\cdot\frac{1}{\left(\mu_1(k_1+1)\Omega_2w^2y^2+\mu_2(k_2+1)\Omega_1\right)^{i_1+\mu_1+i_2+\mu_2}} \tag{9}$$

Now, let us introduce replacement:

$$\frac{\mu_1(k_1+1)\Omega_2w^2y^2}{\mu_2(k_2+1)\Omega_1}=s \tag{10}$$

In this case, it is valid:

$$y^2=\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2w^2}s,\quad ydy=\frac{1}{2}\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2w^2}ds \tag{11}$$

After substituting, the expression (9) becomes:

$$J_1=\frac{1}{2}(\Omega_1\Omega_2)^{i_1+\mu_1+i_2+\mu_2}\,\Gamma(i_1+\mu_1+i_2+\mu_2)\cdot$$

$$\cdot\frac{1}{2}\left(\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)}\right)^{i_1+\mu_1+c_1}\cdot\frac{1}{\left(\mu_2(k_2+1)\Omega_1\right)^{i_1+\mu_1+i_2+\mu_2}}\cdot$$

$$\cdot\int_0^\infty ds\, s^{i_1+\mu_1+c_1-1}\cdot e^{-\frac{1}{\beta_1}\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2w^2}s}\cdot\frac{1}{(1+s)^{i_1+\mu_1+i_2+\mu_2}} \tag{12}$$

By using the formula [19]:

$$\int_0^\infty dt\, t^{a-1}\cdot e^{-ct}\cdot\frac{1}{(t+1)^{a+1-b}}=\Gamma(a)U(a,b,c), \tag{13}$$

in which $U(a,b,c)$ is Tricomi confluent hypergeometric function [21], in integral representation ([19], p. 505), the previous written integral obtains the form:

$$J_1=\frac{1}{2}(\Omega_1\Omega_2)^{i_1+\mu_1+i_2+\mu_2}\,\Gamma(i_1+\mu_1+i_2+\mu_2)\cdot$$

$$\cdot\frac{1}{2}\left(\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)}\right)^{i_1+\mu_1+c_1}\cdot\frac{1}{\left(\mu_2(k_2+1)\Omega_1\right)^{i_1+\mu_1+i_2+\mu_2}}\cdot$$

$$\Gamma(i_1+\mu_1+c_1)U\left(i_1+\mu_1+c_1,c_1+1-i_2-\mu_2,\frac{1}{\beta_1}\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2w^2}\right). \tag{14}$$

After substituting, the expression for PDF is:

$$p_w(w)=\frac{2\mu_1(k_1+1)^{\frac{\mu_1+1}{2}}}{k_1^{\frac{\mu_1-1}{2}}e^{k_1\mu_1}\Omega_1^{\frac{\mu_1+1}{2}}}\cdot\sum_{i_1=0}^{\infty}\left(\mu_1\sqrt{\frac{k_1(k_1+1)}{\Omega_1}}\right)^{2i_1+\mu_1-1}\frac{1}{i_1!\Gamma(i_1+\mu_1)}\cdot$$

$$\cdot\frac{2\mu_2(k_2+1)^{\frac{\mu_2+1}{2}}}{k_2^{\frac{\mu_2-1}{2}}e^{k_2\mu_2}\Omega_2^{\frac{\mu_2+1}{2}}}\cdot\sum_{i_2=0}^{\infty}\left(\mu_2\sqrt{\frac{k_2(k_2+1)}{\Omega_2}}\right)^{2i_2+\mu_2-1}\frac{1}{i_2!\Gamma(i_2+\mu_2)}\cdot$$

$$\cdot w^{2i_1+2\mu_1-1}\cdot\frac{2}{\Gamma(c_1)\beta_1^{c_1}}\cdot\frac{1}{2}(\Omega_1\Omega_2)^{i_1+\mu_1+i_2+\mu_2}\,\Gamma(i_1+\mu_1+i_2+\mu_2)\cdot$$

$$\cdot\frac{1}{2}\left(\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)}\right)^{i_1+\mu_1+c_1}\cdot\frac{1}{\left(\mu_2(k_2+1)\Omega_1\right)^{i_1+\mu_1+i_2+\mu_2}}\cdot$$

$$\Gamma(i_1+\mu_1+c_1)U\left(i_1+\mu_1+c_1,c_1+1-i_2-\mu_2,\frac{1}{\beta_1}\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2w^2}\right). \tag{15}$$

III. Moments of Signal to Interference Ratio at the Output

Moment of n-th order of signal to interference ratio at the output is:

$$m_n=\overline{w^n}=\int_0^\infty dw\, w^n\cdot p_w(w)=B\,J_2 \tag{16}$$

where

$$J_2=\int_0^\infty dw\, w^{2i_1+2\mu_1-1+n}\cdot U\left(i_1+\mu_1+c_1,c_1+1-i_2-\mu_2,\frac{1}{\beta_1}\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2w^2}\right) \tag{17}$$

with:

$$\frac{1}{\beta_1}\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2w^2}=u,\qquad w^2=\frac{1}{\beta_1}\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2}\frac{1}{u}$$

$$w\,dw=-\frac{1}{2}\frac{1}{\beta_1}\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2}\cdot\frac{1}{u^2}du\,. \tag{18}$$

After new substitution, the expression for J_2 is obtained as:

$$J_2=-\frac{1}{2}\left(\frac{1}{\beta_1}\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2}\right)^{i_1+\mu_1}\cdot\int_0^\infty du\, u^{-(i_1+\mu_1+1)+\frac{n}{2}}\cdot$$

$$\int_0^\infty du\, u^{-(i_1+\mu_1+1)+\frac{n}{2}}\cdot U(i_1+\mu_1+c_1,c_1+1-i_2-\mu_2,u) \tag{19}$$

By using the integral [19]:

$$\int_0^\infty dt\, t^{b-1}\cdot U(a,c,t)e^{-st}=\frac{\Gamma(b)\Gamma(b+1-c)}{\Gamma(a+b+1-c)}\,{}_2F_1(b,b+1-c,a+b+1-c,1-s) \tag{20}$$

the previous integral is:

$$J_2=-\frac{1}{2}\left(\frac{1}{\beta_1}\frac{\mu_2(k_2+1)\Omega_1}{\mu_1(k_1+1)\Omega_2}\right)^{i_1+\mu_1+n/2}\cdot$$

$$\cdot\frac{\Gamma(-i_1-\mu_1+n/2)\Gamma(-i_1-\mu_1+n/2+1-c_1-1+i_2+\mu_2)}{\Gamma(i_1+\mu_1+c_1-i_1-\mu_1+n/2-c_1+i_2+\mu_2)}$$

$${}_2F_1\left(-i_1-\mu_1+n/2,-i_1-\mu_1+n/2-c_1+i_2+\mu_2,n/2+i_2+\mu_2,1-s\right). \tag{21}$$

The function ${}_2F_1(a,b;c;x)$ is Gauss's hypergeometric function [22] and it converges if c is not a negative integer for all of $|z|<1$ and on the unit circle $|z|=1$, [23].

Moment of w is finaly:

$$m_n=\frac{2\mu_1(k_1+1)^{\frac{\mu_1+1}{2}}}{k_1^{\frac{\mu_1-1}{2}}e^{k_1\mu_1}\Omega_1^{\frac{\mu_1+1}{2}}}\cdot\sum_{i_1=0}^{\infty}\left(\mu_1\sqrt{\frac{k_1(k_1+1)}{\Omega_1}}\right)^{2i_1+\mu_1-1}\frac{1}{i_1!\Gamma(i_1+\mu_1)}\cdot$$

$$\cdot\frac{2\mu_2\left(k_2+1\right)^{\frac{\mu_2+1}{2}}}{k_2^{\frac{\mu_2-1}{2}}\,e^{k_2\mu_2}\,\Omega_2^{\frac{\mu_2+1}{2}}}\cdot\sum_{i_2=0}^{\infty}\left(\mu_2\sqrt{\frac{k_2\left(k_2+1\right)}{\Omega_2}}\right)^{2i_2+\mu_2-1}\frac{1}{i_2!\,\Gamma\left(i_2+\mu_2\right)}\cdot$$

$$\cdot w^{2i_1+2\mu_1-1}\cdot\frac{2}{\Gamma\left(c_1\right)\beta_1^{c_1}}\cdot\frac{1}{2}\left(\Omega_1\Omega_2\right)^{i_1+\mu_1+i_2+\mu_2}\Gamma\left(i_1+\mu_1+i_2+\mu_2\right)\cdot$$

$$\cdot\frac{1}{2}\left(\frac{\mu_2\left(k_2+1\right)\Omega_1}{\mu_1\left(k_1+1\right)}\right)^{i_1+\mu_1+c_1}\cdot\frac{1}{\left(\mu_2\left(k_2+1\right)\Omega_1\right)^{i_1+\mu_1+i_2+\mu_2}}\cdot$$

$$\cdot\Gamma\left(i_1+\mu_1+c_1\right)\left(-\frac{1}{2}\right)\left(\frac{1}{\beta_1}\frac{\mu_2\left(k_2+1\right)\Omega_1}{\mu_1\left(k_1+1\right)\Omega_2}\right)^{i_1+\mu_1+n/2}\cdot$$

$$\cdot\frac{\Gamma\left(-i_1-\mu_1+n/2\right)\Gamma\left(-i_1-\mu_1+n/2-c_1+i_2+\mu_2\right)}{\Gamma\left(n/2+i_2+\mu_2\right)}$$

$${}_2F_1\left(-i_1-\mu_1+n/2,\,-i_1-\mu_1+n/2-c_1+i_2+\mu_2,\,n/2+i_2+\mu_2,1-s\right).\quad(22)$$

IV. NUMERICAL RESULTS

The first moment of w (mean value $\overline{w}$) is given versus Rician factor of desired signal k_1, Rician factor of interference signal k_2 and parameter β in the next figures, with different parameters of curves, such as Gamma large scale severity parameter c and parameter μ.

In Fig. 1, the main value $\overline{w}$ versus Rician factor of desired signal k_1 is presented for β =0.2, μ=2, Gamma shadowing severity parameter c=2 and variable Rician factor of interference signal k_2. In Fig. 2, the first moment $\overline{w}$ is plotted versus Rician factor of desired signal k_1. The parameters of curves are: Rician factor of interference signal k_2=0.2, μ=2 and c=2. and changeable parameter β. One can see from Fig. 1 that the first moment of w increases when Rician factor of desired signal, k_1, increases. The first moment also is growing up with waning of Rician factor of interference signal k_2. An increment of mean value of w is visible from Fig. 2 for reduction of parameter β, whereby the increase is more pronounced for larger values of Rician factor of desired signal k_1. In order to achieve sufficient accuracy, we took into account a million of terms in (22) for calculation the moment of SIR at the output of wireless communication system.

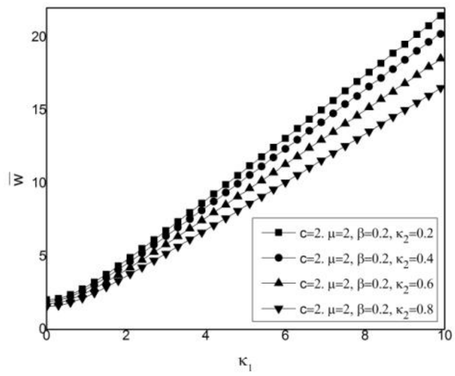

Fig. 1. Mean value $\overline{w}$ versus Rician factor of desired signal k_1 for β=0.2, μ=2, c=2 and variable Rician factor of interference signal k_2.

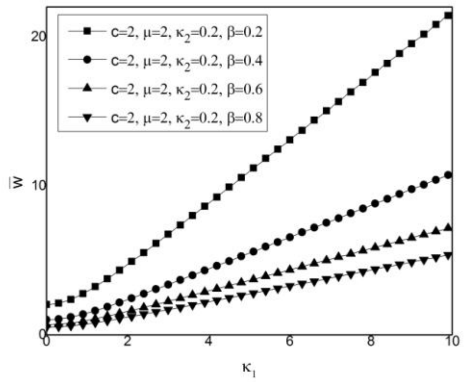

Fig. 2. The first moment of w versus Rician factor of desired signal k_1 for c=2, μ=2, k_2=0.2, and changeable parameter β

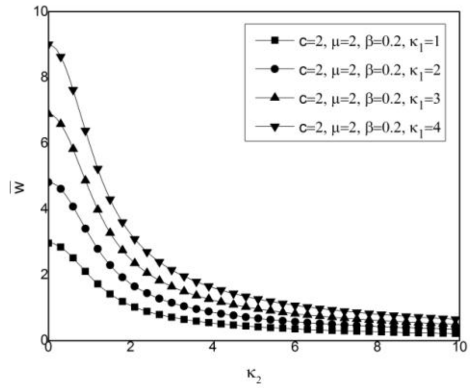

Fig. 3. Mean value $\overline{w}$ versus Rician factor of interference signal k_2 for c=2, μ=2, β=0.2 and changeable Rician factor of desired signal k_1.

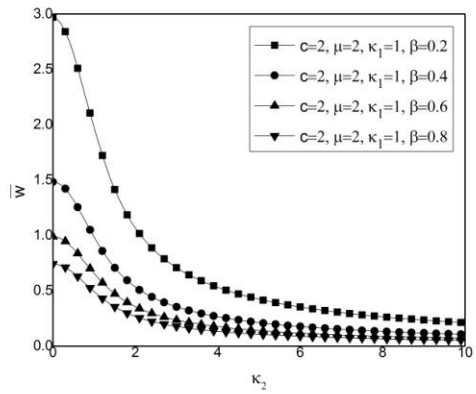

Fig. 4. Mean value $\overline{w}$ versus Rician factor of interference signal k_2 for c=2, μ=2, k_1=1 and variable parameter β.

Mean value $\overline{w}$ versus Rician factor of interference signal k_2 is shown in Figs. 3 and 4. In Fig. 3, the parameters of curves are: c=2, μ=2, β=0.2 and modifiable Rician factor of desired signal k_1. In Fig. 4, the curves are drawn for: c=2, μ=2, k_1=1and variable parameter β. It is evident from these figures that the mean value wanes with increasing of Rician factor of interference signal k_2. For small values of Rician factor k_2, the impact of Rician factor of desired signal k_1 and parameter β is larger. The first moment is getting bigger when Rician factor k_1 is rising and parameter β is decreasing.

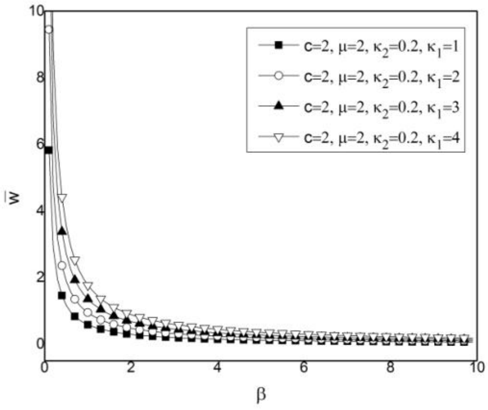

Fig. 5. Mean value $\overline{w}$ versus parameter β for c=2, μ=2, Rician factor of interference signal k_2=0.2, and variable Rician factor of desired signal k_1.

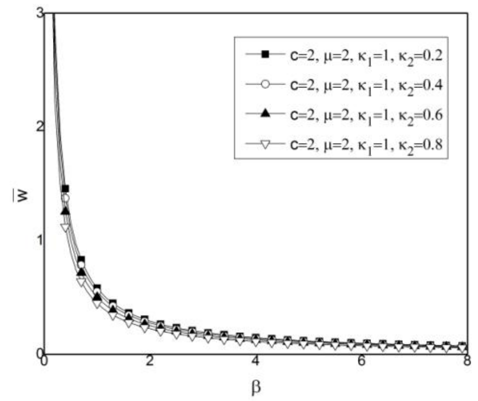

Fig. 6. The first moment of w versus parameter β for c=2, μ=2, Rician factor of desired signal k_1=1 and changeable Rician factor of interference signal k_2

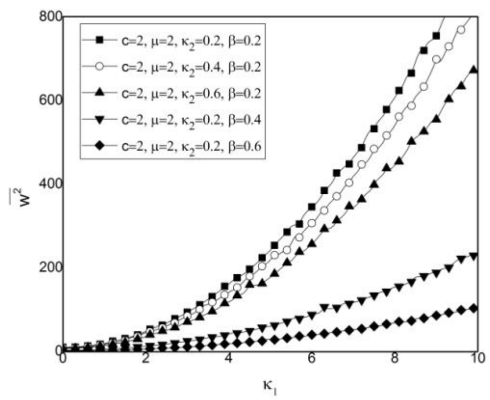

Fig. 7. The second moment of w versus Rician factor of desired signal k_1 with parameters c=2 and μ=2, and variable Rician factor of interference signal k_2 and parameter β.

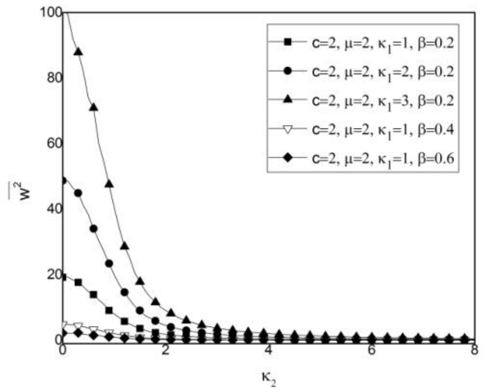

Fig. 8. The squared average value $\overline{w^2}$ versus Rician factor of interference signal k_2 for c=2, μ=2, and changeable Rician factor of desired signal k_1 and parameter β.

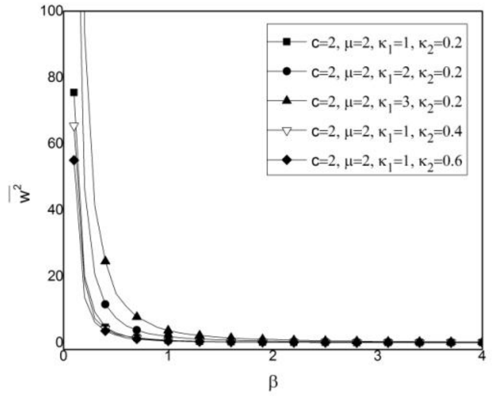

Fig. 9. The second moment $\overline{w^2}$ versus parameter β for c=2, μ=2 and mutable Rician factor of desired signal k_1 and Rician factor of interference k_2.

The first moment of w versus parameter β is displayed in Figs. 5. and 6. Gamma shadowing severity parameter c and κ-μ distribution parameter μ are equal for all presented cases: c=2, μ =2. The Rician factor of desired signal k_1 is changeable in Fig. 5. and Rician factor of interference signal k_2 is varying in Fig. 6. It is obvious from these two figures that mean value $\overline{w}$ is getting smaller with an enlargement of parameter β. One can also see that $\overline{w}$ declines very fast for small β and has approximately constant value for the remaining values of the parameter β.

The second moment of w (squared average value $\overline{w^2}$) is given versus Rician factor of desired signal k_1, Rician factor of interference signal k_2 and parameter β in Figs. 7 to 9, respectively. The parameters of curves are Gamma shadowing severity parameter c and parameter μ: c=2, μ=2, as well as Rician factor of desired signal k_1, Rician factor of interference signal k_2 and parameter β.

It is obvious from last three figures that: second moment $\overline{w^2}$ enhances with aggrandizement of Rician factor of desired signal k_1; decreases with increasing of Rician factor of interference signal k_2 and parameter β. The greatest impact on increasing of squared average value of w has waning of parameter β. The influence of parameter β is bigger for higher values of Rician factor of desired signal k_1.

V. CONCLUSION

In this paper, wireless communication system operating over multipath fading channel in the presence of cochannel interference subjected to shadowed short term fading is considered. Desired signal experiences κ-μ short term fading and cochannel interference signal experiences Gamma long term fading and κ-μ short term fading.

For this model, desired signal envelope to cochannel interference envelope ratio can be calculated as the ratio of the κ-μ random variable and product of square rooted Gamma random variable and the κ-μ random variable. The closed form expression for probability density function and moments of proposed signal to interference ratio at the output of considered wireless system are calculated. The obtained expressions rapidly converge since ten to fifteen terms need to be summed to achieve accuracy at fifth significant digit for any values of fading parameters. The influence of Rician factors of desired signal and cochannel interference and Gamma long term fading severity parameter on moments are analyzed and discussed.

By using the obtained expressions, moments of SIR for wireless system in the presence of Rician desired signal and Gamma shadowed Rician cochannel interference can be calculated as special case. The system performance is better for higher values of moments. When Rician factor of desired signal increases, the first moment and the second moment also increase. When Gamma long term fading severity parameter decreases, system performance also decreases.

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